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Analysis of Options for *Gratis* Distribution of Allowances

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INTRODUCTION

This is one of a series of National Round Table on the Environment and the Economy (NRTEE) papers dealing with issues common to several possible designs for a domestic greenhouse gas emissions trading system.

This paper deals with *gratis* distribution of allowances in a "cap and trade" system and the allocation of emission rights implicit in a credit trading system.

In a "cap and trade" system designated sources are required to hold allowances equal to their actual emissions. The number of allowances available is limited. In this paper it is assumed that the regulatory authority distributes the allowances *gratis* (free of charge), usually to the participants.[1] Free distribution of allowances is often referred to as "grandfathering". Grandfathering implies distribution to participants based on historic emissions. Since this is only one possible allocation rule, *gratis* distribution is used here to cover any rule for free distribution of allowances.

The main arguments for *gratis* distribution of allowances are that:

- Before the cap and trade system is introduced, sources are usually allowed to discharge unlimited quantities of the emissions free of charge. *Gratis* distribution of allowances comes as close as possible to maintaining that arrangement, allowing sources to discharge the now restricted quantity of emissions free.

- Introduction of a limit on emissions reduces the value of existing capital stocks that give rise to such emissions. *Gratis* distribution of allowances is compensation for the loss of value of existing capital.

For these reasons, allowances are usually distributed *gratis* to emissions sources. But they are not the only group affected by a limit on emissions. Consumers face higher prices for products whose production discharges emissions that are now restricted. And consumers continue to face higher prices after sources have recovered the loss of value of their existing capital.

The main issue that arises, then, with *gratis* distribution of allowances is the appropriate distribution of allowances; the allocation rule. The allocation rule should be "fair" for all existing sources and other affected groups, such as consumers. Moreover, the allocation rule should continue to treat all of these groups "fairly" over time as the relative impacts

[1] The alternative of distributing the allowances by auction is discussed in a separate NRTEE paper, *Analysis of Options for Distributing Allowances by Auction*, Issue 7.

change and the composition of the affected groups changes. The main issue, then, is the equity of the allocation rule across affected groups and over time.

An advantage sometimes claimed for credit trading over "cap and trade" (allowance trading) systems is that there is no need to agree on an allocation rule. Since getting agreement on an allocation rule for *gratis* distribution can be very difficult, this can be a significant advantage. But the fact that there is no explicit allocation rule should not obscure the fact that emission rights are allocated by a credit trading system. Emission rights are allocated implicitly based on historic emissions, emission regulations, and current levels of activity.

Topics addressed by this paper are:

- Allocation rules
- Experience with *gratis* distribution
- Implications of the allocation rule
  - Efficiency considerations
  - Equity considerations
- The allowance market
- Implicit allocations with credit trading

The whole paper, except the section on credit trading, deals with *gratis* distribution of allowances for a cap and trade (allowance trading) system.

ALLOCATION RULES

Gratis allocation means free distribution of allowances, usually to participants, for a cap and trade program. The formula, or formulae, for calculating the number of allowances to be given to each recipient is called the allocation rule.

The allocation rule has efficiency and equity implications. It is generally believed that economic theory indicates that the initial distribution of allowances has no impact on the outcome, so the allocation rule has no impact on efficiency. This is largely, but not exactly, true as will be seen in the section on efficiency.

The allocation rule clearly has equity implications. Different rules assign different quantities of allowances to different recipients. Since allowances are valuable and the total supply is limited, each rule favours different recipients. There is no universally accepted standard for a "fair" or "equitable" allocation. So recipients tend to support allocation rules that give them larger allocations.

Because the allocation rule divides a valuable asset (the total number of allowances) among a set of recipients, it can be very difficult to get voluntary agreement on an allocation rule. Thus, the decision on the allocation rule is almost always a political

decision. And the allocation rule often incorporates a variety of adjustments to accommodate special circumstances or special interests.

EXPERIENCE WITH *GRATIS* DISTRIBUTION

Every cap and trade program implemented to date in the United States has distributed allowances *gratis*. This section discusses the rules used to allocate allowances in the ozone-depleting substances, electric utility SO_2 emissions, and RECLAIM NOx and SOx emissions trading programs. The trading program for consumption allowances for ozone-depleting substances in Canada is also discussed.

Ozone-Depleting Substances - U.S.

Trading in production and consumption allowances for ozone-depleting substances was established in the United States in July 1989 to implement commitments under the Montreal Protocol.[2] The Montreal Protocol, which came into force on January 1, 1989, attempts to reduce the use of substances that destroy the stratospheric ozone layer.

The trading program covered five separate groups of ozone-depleting substances. These groups of substances were regulated at different times between 1989 and 1992 and were subject to different phase out schedules.

Production allowances were allocated to five CFC producers and three halon producers.[3] Consumption allowances were allocated to five CFC producers, three halon producers, 14 CFC importers, and 6 halon importers. A producer needed both production allowances and consumption allowances to produce a regulated substance. Importers only needed consumption allowances to import ozone-depleting substances.

Each participant was allocated allowances for production (consumption) of each substance based on the participant's baseline year market share of the production (consumption) of that substance.[4] The allocations did not change over the life of the program. There were no new producers or consumers of ozone-depleting substances for

[2] The Montreal Protocol has been amended and supplemented by several other agreements. These agreements and revisions are collectively referred to here as the Montreal Protocol. Consumption is defined as production + imports - exports.

[3] There were only 17 producers of ozone depleting substances in the world when the Montreal Protocol went into effect.

[4] The baseline year is 1986 for Groups I and II and 1989 for Groups III, IV and V.

the program's duration. Allowances were substance specific, but could be traded for other substances within the same group.[5]

The trading program was complemented by a tax on ozone depleting substances and regulations governing allowable uses for the different substances. As a result of this combination of measures U.S. consumption of CFCs dropped from about 300,000 tonnes in 1989 to about 40,000 tonnes in 1995. Consumption was well below allowable levels in 1990, 1991, 1992, 1993, and 1995.[6] Nevertheless, about 30% of allowable production was exchanged in inter-company trades.[7]

In summary, the trading programs for ozone depleting substances used a very simple grandfathering allocation rule -- each participant received its share of the baseline (1986 or 1989 depending upon the substance) production (consumption) of each substance. The shares of the allowable production (consumption) did not change over the life of the program.

Ozone-Depleting Substances - Canada

Canada has used a system of "consumption allowances" to meet its Montreal Protocol commitments. Under this system, Canada's maximum consumption of each group of ozone-depleting substances as established by the Protocol is divided among Canadian companies. Each company receives allowances equal to its share of Canada's consumption of that group of substances during the specified base year. Transfer of consumption allowances between companies has been permitted since 1993.

CFCs and methyl chloroform were the first substances covered by the transferable consumption allowance system. Although there were no restrictions on the transfer of allowances, companies involved in a transfer had to request approval from Environment Canada. The purpose of this approval was to verify that the quantity transferred by a company was indeed still unused and therefore available for the transfer. It also kept Environment Canada informed of the maximum consumption each company was allowed.

Only a few transfers of CFC and methyl chloroform allowances took place between 1993 and 1996 when production and imports of these substances ceased. This was due to the small number of companies involved, about 12 for each category of substances, and the

[5] From 1989 through 1991 allowances were for denominated in ODP kilograms for Group I and Group II substances (the only substances regulated at the time) so an allowance could be used for production or consumption of any substance in the Group.

[6] Cook, 1996, Figure 3, p. 5.

[7] Cook, 1996, Figure 1, p. 35.

intense competition among the companies. The possibility that the buyer could gain market share from the seller was more important than the revenue from the sale of unused allowances to a competitor.

Methyl bromide allowances were introduced in 1995.[8] In contrast to the other ODS allowances, methyl bromide allowances were distributed to *users* rather than importers. This was done to address the concern that, given the small number of importers (5), they could control the market. Some importers apply the substance themselves and sell it to other applicators, so a distribution to importers might place firms that are only applicators at a disadvantage relative to firms that are both applicators and importers.[9] From a logistical point of view, distribution to users was a viable alternative as the total number of users was relatively small (133).

In 1997, the allowance holdings for individual users ranged from 0.45 kg to over 50,000 kg.[10] Fewer than 20 companies collectively control more than 95% of the methyl bromide. Of the 133 allowance holders, 90 did nothing with their allowance in 1997, i.e., they did not transfer the allowance or use it to import methyl bromide. Presumably, they simply stopped using methyl bromide in their business. However, the large allowance holders were active. In 1997, 24 of the 26 largest allowance holders used at least part of their allowance. This included 5 companies that had no initial allowance but received transfers enabling them to import methyl bromide.

In total there were 45 transfers in 1997. It appears that 32 were from users to their suppliers, so the distributor could import methyl bromide on behalf of the user. The supplier needs allowances to import the methyl bromide, so some importing distributors require customers to transfer allowances to them before they will sell the methyl bromide. The other 13 transfers appear to be to recipients who import methyl bromide for their own use.

The HCFC consumption allowance system came into effect on January 1, 1996. In this case, the importers get the allowances. Since Canada's allowable HCFC consumption under the Protocol is based on an estimate of HCFC needs to replace CFCs and the demand for HCFCs was less than the allowable comsumption, Environment Canada distributed consumption allowances equal to about 80% of the allowable consumption. The other 20 % will be distributed based on market demand.

HCFC consumption allowances are divided into categories; refrigeration uses and other uses. Transfers can only take place within a category. No transfers have occurred yet. The

[8] Although the base year for methyl bromide consumption under the Protocol is 1991, the allowances were distributed on the basis of average use over 1991-1993 period because use fluctuates a lot from year to year.

[9] Users could become importers, but becoming a licensed importer of a toxic gas like methyl bromide may involve considerable effort.

[10] Canada's maximum allowable methyl bromide consumption was approximately 200,000 kg.

reasons are similar to those noted above for CFCs, competition among the small number of firms (about 12) in each category. Concern about possible loss of market share due to a transfer overwhelms the potential revenue.

In summary, consumption allowances for ozone-depleting substances are grandfathered; allocated on the basis of each participant's base year share of consumption. With the exception of methyl bromide, allowances are issued to importers and producers. Methyl bromide is interesting because the allowances are issued to the users rather then the importers. This addresses the impacts of the trading system on the consumers of the product and allays concerns about market power.

Electric Utility SO_2 Allowance Trading[11]

Title IV of 1990 Clean Air Act Amendments created an allowance trading system for SO_2 emissions by electric utilities. The objectives are to reduce SO_2 emissions by 10 million tons from 1980 levels and to cap utility emissions at 8.95 million tons per year after 2010.[12] The system is introduced in two phases, each designed to achieve a 5 million ton reduction, beginning in 1995.

Phase I, from 1995 through 1999, is mandatory for 263 units listed in Table A of the Act. These units include, with few exceptions, all units of 100 MW capacity or greater with average emission rates above 2.5 pounds of SO_2 per million BTU of energy input. Phase I is optional for *compensating* and *substitution* units and other sources that choose to opt-in.[13]

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[11] A small (2.8%) fraction of the allowances is withheld and sold at auction. Revenue from the auction is allocated to the units whose allowances were withheld for sale. This is discussed further in the paper on allocation by auction, NRTEE Issue Paper 7.

[12] Approximately 1.5 million tons of the reduction is expected to come from industrial sources through existing programs and 8.5 million tons is expected to come from electric utility sources, which account for about 70% of total SO_2 emissions.

[13] If there is reduced utilization, in aggregate, of Table A units in the same dispatch system, the operator of the unit may designate Phase II units -- *compensating units* -- to which generation was shifted. The reduction obligation is then shared between the Table A unit and the compensating unit. To provide more flexibility, the owner or operator of a Table A unit may reassign a unit's emission reduction obligations to a designated non-Table A unit under the owner's or operator's control -- the *substitution unit*. Non-electric utility sources of SO_2 emissions may choose to *opt-in* to the trading program. The emission reduction is accomplished by giving allowances to the new units and increasing the emissions cap by an amount equal to the allowances issued to the new units. The compensating, substitution and opt-in units receive allowances approximately equal to their historic emissions. The total number of units participating during 1995 and 1996 was 445 and 431 respectively.

Phase II (from 2000 on) applies to all electric utility generating units with an output capacity of 25 MW or greater that use fossil fuels with a sulfur content greater than 0.05%. There are now approximately 2,050 units that will be regulated under Phase II. These units accounted for over 99% of electric utility SO_2 emissions in 1995.

In Phase I the Table A units are allocated SO_2 allowances on the basis of a standard emission rate (2.5 lbs of SO_2 per million BTU) multiplied by the average energy input for the years 1985 through 1987.[14] The allowance allocation for compensating, substitution and opt-in units is generally the lower of the actual or allowable emission rate multiplied by the baseline energy input.[15]

In Phase II the emission rate drops to 1.2 pounds per million BTU but it is still multiplied by the average energy input for the years 1985 through 1987.[16] The basic allocation rules are supplemented by a number of provisions for special cases.[17] Efforts by many utilities, states and Congressional delegations to obtain a "fair share" of allowances led to a system with six special allowance reserves and 29 different methods to allocate allowances in Phase II. Some of these reserves and special provisions are designed primarily to achieve environmental objectives while others provide differential treatment for various categories of units.[18]

Sources built after 1995 receive no allowances and must purchase allowances to cover their total emissions from existing sources.[19] Existing sources continue to receive allowances even if they cease to operate. Allowances can be banked for future use.[20]

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[14] The rate of 2.5 lbs per million BTU was determined as the rate needed to achieve a 3.5 million ton reduction from electric utility sources during Phase I. (Brian McLean, EPA, personal communication).

[15] For example the emission rate for a substitution unit is the lowest of the following three rates: (1) 1985 actual (or allowable, if it is lower) SO_2 emission rate, (2) the greater of 1989 or 1990 actual emission rate, and (3) the most stringent federal or state allowable SO_2 emission rate known as of November 15, 1990 applicable in 1995-1999.

[16] The rate of 1.2 lbs per million BTU is the 1971 New Source Performance Standard for coal-fired boilers.

[17] If the allocations based on the formulae do not exactly meet the overall emission limit, the allocations are scaled down proportionally to ensure that the allowances issued equal the emissions cap.

[18] Solomon, 1994, p.9.

[19] Sources that began to operate after October 1990 and before December 1995 receive allowances at a rate of 0.3 lbs per million BTU.

[20] Banking encourages early reduction of emissions. Assuming that a ton of SO_2 does less damage when total emissions are lower, early reductions benefit the environment.

State and regional regulations limiting SO_2 emissions by electric utilities to protect human health and the environment take precedence.[21]

In summary, the equity principle reflected in the basic allocation rule is that all sources get the same emission rate applied to an historic (1985-87) level of activity. However, this basic principle is modified by numerous reserves and special provisions. Units that already have lower emission rates generally receive allowances that reflect their actual emissions rate. In principle, this means that they do not need to incur additional control costs and they do not reap windfall profits from the allocation of surplus allowances.

The phased implementation of the trading program can be interpreted as a crude form of intertemporal equity across existing units. It forces older, more-polluting units to first reduce their emissions to levels already achieved by newer units. The allocation rules clearly discriminate against new sources. They receive no allowances and must purchase allowances to cover their emissions from existing sources. In contrast, sources operating at the time the program was implemented continue to receive allowances even if they cease to operate.

RECLAIM

The Regional Clean Air Incentives Market (RECLAIM) was established by the South Coast Air Quality Management District (SCAQMD) for NOx and SOx emissions by point sources beginning January 1, 1994. All stationary sources that held permits for equipment or processes that generally emit more than 4 tons per year of NOx or SOx or which emit more than 4 tons of NOx or SOx per year during any year after 1990 must participate.[22]

The NOx program has roughly 340 participants which account for approximately 65% of the NOx emissions from permitted stationary sources in the SCAQMD and the SOx program has approximately 40 participants which account for roughly 85% of the SOx emissions from permitted stationary sources. But the RECLAIM program covers only 17% of total NOx and 31% of total SOx emissions in the SCAQMD.

Each facility receives an allocation of RECLAIM Trading Credits (RTCs) annually. The allocation is calculated from a starting allocation for 1994, a mid-point allocation for

[21] In another words, if state regulations limit actual emissions (annually or for particular periods) the unit can not use allowances to exceed that limit.

[22] Sources such as equipment rental facilities, essential public services (police, fire, landfills, wastewater treatment, hospitals, prisons and schools), restaurants, and dry cleaners are exempted.

2000, and an ending allocation for 2003.[23] Each allocation was calculated by multiplying the historic use or throughput of each piece of NOx and SOx equipment at the facility by appropriate emission factors based on the adopted and proposed rules. The historic use was based on the peak year for each facility between 1989 and 1992. Allocations are in annual tons of NOx or SOx. Allocations for intermediate years are straight line interpolations between the 1994, 2000 and 2003 allocations.[24]

In addition, existing Emission Reduction Credits were converted to RECLAIM Trading Credits (RTCs) and added to the starting allocation. The external offsets provided by facilities subject to New Source Review during 1993 were added to their starting allocation.[25] A facility may also have non-tradable credits (NTCs) for the first three years (1994,1995 and 1996) if its reported 1987, 1988 or 1993 emissions are greater than its starting allocation.[26]

All new and expanded sources are required to provide RTCs equal to their emissions for the first year of operation and every year thereafter at the beginning of the compliance period.[27] Existing participants continue to receive allowances if they cease to operate.[28]

In summary, the RECLAIM program replaced over 40 existing and proposed rules governing NOx and SOx emissions by stationary sources. The RTC allocations reflect the emissions that would have been allowed under the existing and proposed rules. Hence, the equity principle reflected in the allocation is to maintain the situation that would have

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[23] The starting allocation was based on rules adopted as of December 31, 1993. The 2000 allocation reflects 100% implementation of 1991 Air Quality Management Plan proposed Tier I control measures. And the 2003 allocation reflects 100% implementation of proposed Tier I and Tier II control measures.

[24] Each facility has its own emission reduction rate determined by its allocations for 1994, 2000 and 2003 with linear interpolation for the intervening years. The weighted average emission reduction rates are 8.3% per year for NOx and 6.8% per year for SOx from 1994 through 2003.

[25] The ERCs and external reductions are not reduced during the 1994-2000 period, but are reduced at the same rate as the RECLAIM inventory from 2000 to 2003.

[26] The NTCs are available for 1994 and reduced by 1/3 for 1995 and a further 1/3 for 1996 and are eliminated for 1997 and later years.

[27] This is similar to the requirement that existed prior to RECLAIM; new sources were required to purchase emission reduction credits (ERCs) representing emission reductions from allowable levels from existing sources. The ERCs have been converted to RTCs to improve liquidity in the market.

[28] Under the previous rules a source that ceased operating could create Emission Reduction Credits which could be sold to a new or expanding source, so continued allocation of allowances is similar to the provisions of the previous rules.

prevailed under the rules replaced by RECLAIM. The definition of historic use and the creation of NTCs can be seen as mechanisms to accommodate special situations.

Even though the treatment of new sources and sources that cease to operate reflects existing rules, existing sources are favoured over new sources. New sources must purchase RTCs equal to their total emissions from existing sources. Sources that cease to operate continue to receive RTCs.

Summary

The four programs use different equity principles to allocate allowances among participants: market shares prior to implementation of the program, a fixed rate per unit of input during an historic period, and treatment equivalent to existing and proposed rules. The allocation rule for ozone-depleting substances treats all participants equally, while the RECLAIM program includes some provisions for special circumstances and the SO_2 program includes numerous special allocations.

Intertemporal equity was not a major concern for any of the programs. Since there were no new producers or consumers over the life of the ozone-depleting substances programs, they avoided the issue of intertemporal equity. But in both the SO_2 and RECLAIM programs existing sources are favoured over new sources. The decision to allocate consumption allowances to methyl bromide users, rather than the importers, to allay concerns over market power is interesting.

IMPLICATIONS OF THE ALLOCATION RULE

The allocation rule has efficiency and equity implications. Both are discussed, in turn, below. Economic theory is generally believed to indicate that the initial distribution of allowances has no impact on the outcome, so the allocation rule has no impact on efficiency. This is true in a static setting, but not strictly true in a dynamic context, as will be discussed below.

Different rules assign different quantities of allowances to different recipients, so the allocation rule clearly has equity implications. Since allowances are valuable and the total supply is limited, each rule favours different recipients. Equity issues raised by the allocation rule are discussed below.

Efficiency Considerations

Relatively little attention has been devoted to the allocation of allowances in the economics literature. In a static context, Montgomery observed that because of the independence of the equilibrium from the initial allocation, "the management agency can distribute licenses as it pleases. Considerations of equity, of administrative convenience, or of political expediency can determine the allocation. The same efficient result will be achieved."[29]

Hahn demonstrated that in an oligopolistic (a few large sellers) or oligopsonistic (a few large buyers) market for either the permits or the products produced by the participants, the large participants can exercise market power to their advantage and so reduce the efficiency of market.[30] This situation can be corrected in an oligopolistic permit market by withholding some of the allowances for sale at auction as is done in the SO_2 allowance program.

Another way to minimize market power in either an oligopolistic or oligopsonistic permit market is to have an allocation that is close to the actual emissions.[31] An oligopolist would not have any surplus allowances to sell. Selling allowances to affect the price would simply create a requirement to buy an equal quantity for compliance purposes. An oligopsonist would not need to buy any allowances for compliance purposes. Buying allowances to drive down the price would leave the oligopsonist with surplus permits purchased at higher prices. To get an allocation close to actual emissions, the allocation rule would obviously need to change the number of allowances given to each participant over time in response to changes in their actual emissions.

Experiments demonstrate that a double auction -- the open outcry institution used by many exchanges with continuous trading and transactions at different prices -- yields efficient outcomes even when the market is dominated by a few buyers or sellers. This enables the issue of market power to be addressed through institutional design rather than the allowance allocation. Indeed, there is some experimental evidence to suggest that addressing market power through allowance allocation as suggested by Wetskog may be inefficient. An allocation of allowances close to actual emissions produces thin markets that may not generate sufficient price information to achieve the optimal outcome.[32]

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[29] Montgomery, 1972.

[30] Hahn, 1984.

[31] Wetskog, 1996.

[32] Godby, 1996.

Stavins concludes that if marginal transactions costs are constant, the usual result in the absence of transactions costs still holds -- the initial allowance allocation has no effect on the control measures implemented.[33] However, the larger the difference between the initial allocation and the equilibrium emissions, the higher the total transaction costs. If marginal transaction costs are increasing, the initial allocation can affect the post-trading outcome. The closer the initial allocation is to the efficient outcome the lower the transactions costs and the potential distortionary effects of rising marginal transaction costs.

Laffont and Tirole consider intertemporal behaviour in a situation where the market price for allowances exceeds the marginal cost of emissions control.[34] They assume this situation arises because the government sells the allowances and that it must meet a revenue requirement. However, the prospect of capital gains on allowances issued *gratis* could also create such a situation. They find that this situation induces excessive investment.[35] A futures market lowers, but does not eliminate, the incentive for excessive investment.

Devlin and Grafton show that if allowances become valuable it can distort behavior -- sources consider options to increase the value of future allowances as well as options for reducing emissions.[36] An example illustrates the argument. In cities where the number of taxi licenses is limited, owners have an incentive to reduce investment in vehicles, to minimize maintenance, and to keep drivers' incomes low while arguing for higher fares to increase the value of the license. Devlin and Grafton suggest a tax to capture most of the economic "rents" and so keep the allowance price low.

In summary, concerns about market power by participants, and hence market inefficiency, can be addressed through institutional design or the allocation rule. A double auction with continuous trading and transactions at different prices yields efficient outcomes even when the market is dominated by a few buyers or sellers. A rule that allocates allowances roughly equal to actual emissions reduces market power and transactions costs, but may not generate robust price information. The potential for capital gains due to an increase in the price of allowances may lead to inefficient emissions control decisions. Devlin and Grafton suggest a tax to capture most of the economic "rents" (windfall profits) to increase efficiency in this situation.

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[33] Stavins, 1995.

[34] Laffont and Tirole, 1996.

[35] Laffont and Tirole use partial equilibrium analysis and are careful to note that the results could be reversed in a general equilibrium analysis.

[36] Devlin and Grafton, 1996.

Equity Considerations

Any policy to limit greenhouse gas emissions will have price effects and wealth effects. The price effects are similar regardless of the policy adopted, but the wealth effects differ.[37] A cap and trade system with *gratis* distribution gives ownership to the recipients of the allowances. Different allocation rules therefore have different wealth effects.

Four equity considerations are addressed below:

- Wealth effects and allocation to participants
- Intertemporal equity in the allocation rule
- The distribution of costs across income groups
- The costs borne by specific interest groups

In addition to these considerations, competitiveness impacts are discussed briefly here.

Wealth Effects and Allocation to Participants

In principle, the participants in an emissions trading program should be the entities best able to reduce emissions given the options available. In the case of energy-related CO_2 emissions, this would be fossil fuel users. They can switch to less carbon-intensive fuels or implement energy efficiency measures. Some emissions trading designs focus on fossil fuel users, but they tend to exclude smaller users to keep the number of participants to a manageable number.

Other designs for energy-related CO_2 emissions propose that the trading program apply to the carbon content of the fuels and be implemented "upstream" of the fuel users. Such designs tend to cover a larger fraction of energy-related CO_2 emissions with a smaller number of participants. Producers, refiners and transporters can do little to change the carbon content of fossil fuels and hence the CO_2 emissions when the fuel is used. To reduce energy-related CO_2 emissions, fossil fuel users must still switch to less carbon-intensive fuels or implement energy efficiency measures.

Since allowances in an "upstream" trading system limit the amount of carbon available for fossil fuels, fuel prices can be increased. The price increases provide the incentives for fossil fuel users to implement measures to reduce emissions. The price increases also translate into windfall profits for the participants in the trading program because their costs of producing the fossil fuels have not changed. Fossil fuel users, on the other hand,

[37] Price effects may vary somewhat due to differences in the efficiency of different policies.

incur the costs of implementing measures to reduce emissions and pay higher prices for their remaining consumption.

One of the main arguments supporting *gratis* distribution of allowances is that introducing a limit on greenhouse gas emissions reduces the value of existing capital stocks that give rise to such emissions.[38] In the case of an upstream system for energy-related CO_2 emissions, the impact is likely to be greatest on the value of the reserves. The extent to which these are privately owned, and hence merit some compensation, or leased from the government, and hence warrant no compensation, would need to be analysed.

The energy-using capital stock, except in public facilities, is almost entirely privately owned. Thus, the argument for *gratis* distribution is stronger for programs where the participants are fossil fuel users. Under an upstream program for the carbon content of fossil fuels, the value of the energy-using capital is also reduced, but the owners of this capital typically do not receive compensation in the form of free allowances.

The potential windfall for profits in an upstream system might induce inefficient behaviour by participants as suggested by Devlin and Grafton. Some analyses suggest that the profits could be large relative to the loss in value of privately-owned reserves. If the profits are large and are used by firms to support additional exports of fossil fuels or to switch to an unrelated business, the *gratis* distribution could be challenged as an unfair subsidy.[39] Under those circumstances a tax to capture most of the windfall profits might be appropriate. The tax revenue could be used to address equity and competitiveness issues created by the price increases for fossil fuels.

In short, a trading program focused on fossil fuel users would allocate allowances to entities whose capital stock is devalued by the imposition greenhouse gas emissions limits and that would incur costs to implement measures to reduce such measures.[40] But an upstream program for the carbon content of fossil fuels may be desirable because the

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[38] The windfall profits could be large relative to the value of the capital stock. Standard and Poor's DRI estimated the price increases for coal under various greenhouse gas emission reduction scenarios. The smallest price increase is for a scenario for stabilization of emissions at 1990 levels in 2010 with international emissions trading within Annex I countries. The increase in 2010 is 1995C$1.9/GJ or about $42 per tonne of coal. Luscar Ltd. reports average revenues of C$23 to $27 per tonne over the period 1993 through 1997. In 1997 Luscar shipped 14.1 million tonnes of coal, 10 million tonnes to domestic customers and 4.1 million tonnes to foreign customers. Unitholders' equity for the Luscar Coal Income Fund as of March 31, 1998 is $35.60 per tonne of coal produced and the total liabilities and shareholders equity for Luscar Ltd. are equivalent to $46.20 per tonne of coal produced. Assume that the equity is approximately equal for domestic and export markets. Thus, if allowances were allocated on the basis of historic shipments to domestic customers, the value of the allowances (about $42 per tonne) would cover the loss in value of the capital stock related to domestic sales in a year or less. In less than 18 months the equity for both domestic and export sales would be recovered. Foreign competitors might claim that the allowances are an unfair subsidy for export sales.

[39] See Crane, Holmes and Friedman, Appendix 6.

[40] Such a program would not compensate upstream entities for any loss in value of their capital, as distinct from publicly-owned resources.

share of total emissions covered is larger and the number of participants is smaller. The participants in such a program would likely to earn windfall profits while energy users incur costs to reduce emissions and suffer a loss in value of their capital stock. In the U.S. a tax was imposed on ozone-depleting substances to capture the windfall.

Intertemporal Equity in the Allocation Rule

Since greenhouse gas emissions are likely to be regulated for 50 to 100 years or more, intertemporal equity becomes a more important consideration than for any existing trading program.[41] This requires an allocation rule that changes the distribution of allowances over time to accommodate the changing population of sources. Such a rule could also help to minimize market power and reduce incentives for distortionary behaviour.

Intertemporal equity requires that the allocation of allowances change over time to accommodate changes to the participant population. The only way this can be achieved in a substance trading program, such as the carbon content of fossil fuels or HFCs, with *gratis* allocation is to change the distribution of allowances in response to changes in sales. Intertemporal equity in an emissions rights trading program, such as CO_2 emissions by fossil fuel users or methane emissions from landfills, with *gratis* allocation can be achieved by changing the distribution of allowances based on output, input or actual emissions. In general, a rule based on output is likely to be more efficient than one based on input or actual emissions.

An allocation rule based on output would take the form of allowances equal to X kg of CO_2 per kWh, per tonne of cement, per tonne of raw steel, etc. The difficulty with this approach is that there is no single measure of output that encompasses all of the participants in a market for greenhouse gas emissions.

To implement an output-based allocation in practice, the available allowances could first be divided among categories of participants -- such as electric utilities, cement manufacturers, and fertilizer manufacturers -- based on their share of total emissions. Then the allowances for a particular category could be allocated to individual participants based on a measure of output common to those sources. The division among the categories would need to be adjusted periodically (say every five years) or continuously (say as a three or five year moving average).[42]

[41] The importance of intertemporal equity for a trading program depends on the magnitude and speed of the emissions reduction. If emissions are to be reduced to zero over a period of a decade, intertemporal equity is less of a concern than if emissions are to be reduced by 20% over 50 years. It is expected to take a century or more to stabilize atmospheric concentrations of greenhouse gases, so intertemporal equity is a more important issue than for any existing program. Recall that in both the SO_2 and RECLAIM programs existing sources are favored over new sources. Since there were no new producers or consumers over the life of the ozone-depleting substances program, it avoided the issue of intertemporal equity.

[42] Another possibility is to use data for the current year to determine the allocation for the fifth year in the future.

An allocation rule based on input would take the form of allowances equal to Y kg of CO_2 per unit of a common input, such as energy. To provide an incentive to switch to less carbon-intensive energy forms, the allocation should be based on total energy input.

Energy input may not be a suitable basis for allocating allowances to all of the participating sources of greenhouse gases. Again, the available allowances could first be divided among categories of users based on their share of total emissions and then be allocated to individual participants based on a common measure of input with the shares for the different categories being adjusted periodically or continuously.

An allocation rule based on actual emissions would calculate the share of total emissions due to each source during the most recent period and award each participant allowances equal to this share of the emissions cap for the upcoming period.

An allocation rule based on actual emissions must be designed carefully to ensure that sources have an incentive to reduce their emissions. Since many actions to reduce greenhouse gas emissions, such as energy efficiency and fuel switching measures, involve capital investments, the allocation rule must provide participants who make such investments with surplus allowances for a reasonable period of time so that they can recover their investment. Calculating the shares based on a moving average of actual emissions over the most recent 5 to 7 years should provide a sufficient return.

In addition to improving intertemporal equity by treating new entrants and existing sources equally, a rule that changes the distribution of allowances over time can improve efficiency. Such a rule also helps keep the initial allocation during a period close to the post-trading outcome and so reduces the market power of large participants. In addition, such a rule reduces total transaction costs.

Whether other countries could challenge a *gratis* distribution of allowances as an "actionable subsidy" under the World Trade Organization Agreement on Subsidies and Countervailing Measures is not clear. Some experts argue that as long as the allowances are needed for operating purposes, they are not a subsidy.[43] Then it is only allocations that are surplus to actual emissions that would represent a financial contribution (from the sale of the surplus allowances) and could be challenged as an actionable subsidy. An allocation rule that adjusts the distribution of allowances over time reduces the risk of having the *gratis* distribution challenged.

Finally, a rule that changes the distribution of allowances over time may be easier to negotiate than a fixed distribution among existing sources. The future circumstances of each source is uncertain, so the best outcome for a given source is an allocation rule that it considers fair under a range of possible circumstances. Such a rule is likely to treat

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[43] See Crane, Holmes and Friedman, Appendix 6.

other sources fairly as well. In contrast, if the allocation is fixed every source has a strong incentive to argue for a larger share of the allowances.

Distribution of Costs across Income Groups

Although entities participating in the trading program receive allowances free, they must factor the value of the allowances into their decisions.[44] Firms that participate in the trading program shift this cost to their customers, employees, suppliers, shareholders and lenders. Suppliers and customers of intermediate goods shift the cost to their customers, employees, suppliers, shareholders and lenders. Ultimately the costs are borne by individuals in their capacities as consumers of different products, employees of particular firms, and owners of capital.[45]

The distribution of costs across income groups with *gratis* allocation should be the same as with an auction of allowances or a carbon tax. This is discussed by Cramton and Kerr in a paper attached to the NRTEE paper on auction of allowances, Issue 7. They note that the available studies do not reflect the effects of changes in capital value and that they assume perfectly competitive pricing, which may not be appropriate for some key industries. Studies for the U.S. suggest the effects will be slightly regressive -- higher costs as a percentage of income for low-income groups.

The slightly regressive impact of limiting greenhouse gas emissions could be addressed in either of two ways given *gratis* distribution of allowances. One option, especially if allowances are allocated to participants in an upstream system for the carbon content of fossil fuels, is to tax the windfall profits of the participants and to use the revenue to offset the adverse impact on low-income groups through changes to the personal income tax or goods and services tax.

A second option is to distribute some or all of the allowances *gratis* to individuals. Then the firms participating in the trading program would need to buy allowances from individuals to achieve compliance. This would compensate individuals for the costs they incur for the greenhouse gas limitations. Administration of this option might be relatively costly. The same result could be achieved by using an auction to distribute the allowances and then using the auction revenue to offset the adverse impact on low-income groups through changes to the personal income tax or goods and services tax.

[44] The value of the allowances represents an opportunity cost to the trading program participants. They can either sell the allowances at the market price or use them for compliance. In the latter case the opportunity cost of using the allowances is the foregone sales revenue.

[45] Some suppliers and owners of capital may reside in other countries, so Canada's policies to limit greenhouse gas emissions can affect individuals in other countries. Conversely, the policies adopted by other countries can affect Canadians.

Costs Borne by Specific Interest Groups

Limiting greenhouse gas emissions will have adverse impacts on activities that generate such emissions. Due to its relatively high emissions per unit of energy and the availability of substitute energy sources for many applications, coal producers and users appear to be particularly vulnerable. This is true regardless of the policies adopted to limit greenhouse gas emissions.

Gratis distribution to fossil fuel producers as part of an upstream system for the carbon content of fossil fuels would give allowances to coal mining companies. As noted above, *gratis* distribution can be argued to be a form of compensation for the loss of value of capital associated with the generation of greenhouse gas emissions.[46] The mining companies would determine how those allocations are used. If the value of the surplus allowances is large relative to the loss of value and is used by the coal companies to support additional exports or to enter another business, the *gratis* distribution of allowances could be challenged as an actionable subsidy under WTO rules.

Allowances could also be distributed *gratis* to funds charged with facilitating adjustment by specific interest groups, such as firms, individuals, and communities affected by the closure of coal mines. They would sell the allowances to participants in the trading program and use the revenue to fund adjustment programs for the groups adversely affected by the limits on greenhouse gas emissions.

Competitiveness Impacts

Participants in a trading program, even if they are given their allowances free, may be less competitive as a result. If the participants in the trading program are fossil fuel users, they can implement energy efficiency measures and switch to less carbon-intensive energy sources to reduce their emissions, and use allowances to cover their remaining emissions. Presumably they would implement a strategy to minimize the cost of compliance. That would help to minimize adverse competitiveness impacts. But competitiveness impacts also depend on the policies adopted by other countries.

If the participants in the trading program are fossil fuel producers, importers and exporters, the competitiveness impacts for those firms are likely to be limited to the effects of the international commitments to limit greenhouse gas emissions on international fossil fuel prices. In Canada, imported fossil fuels would need allowances equal to their carbon content as would domestically produced fuels. Fossil fuels produced in Canada for export would not need allowances and so could continue to compete with fossil fuels produced in countries without emissions limitation commitments. However, processing and transportation costs could be higher for exported fuels due to regulations limiting emissions from those activities.

[46] Some calculations suggest that the value of the allowances could cover the loss in value of coal mining assets in a year or less. Any additional allocations would be a windfall profit.

If the participants in the trading program are fossil fuel producers, importers and exporters, domestic energy prices will rise. This will increase costs for all energy users and could adversely affect the competitiveness of some firms. The impact on competitiveness is very complex. It depends on the ability of participants to shift costs to their suppliers, employees, customers and sources of capital. The impact on the competitiveness of Canadian sources also depends on the policies adopted by other countries.

The competitiveness impacts of different domestic greenhouse gas emissions trading program designs is the subject of another NRTEE paper, Issue 14. It is sufficient to note here that with *gratis* distribution of allowances competitiveness impacts could be addressed either by distributing some allowances to adversely affected firms, or by imposing a tax on windfall profits and using the revenue to offset adverse competitiveness impacts.[47] However, the allowances or revenue would need to be distributed in a manner consistent with international trade rules.[48]

THE ALLOWANCE MARKET

Recipients could sell allowances they were allocated and did not need for compliance purposes. Participants in the trading program could purchase additional allowances for compliance purposes if needed. The allowance market would also include credits from specified domestic sources and credits or allowances available from international emissions trading, joint implementation and the clean development mechanism. Thus, the allowance market will reflect global supply and demand for greenhouse gas allowances and credits.

Given that Canada's emissions are small relative to global emissions, the global market will largely determine prices in the allowance market unless international or Canadian rules restrict the ability to use, or raise the cost of using, allowances or credits from other countries. This is the desired outcome from an economic efficiency perspective.

Relatively close links between the Canadian allowance market and the global market should also alleviate concerns about strategic behaviour by large buyers or sellers in the Canadian market. These entities simply will not be large enough relative to the global market to influence prices. However, if the links between the Canadian and global markets are not close due to restrictions or transactions costs, the potential to exercise market power in the Canadian market would still need to be addressed.

[47] Devising rules to determine which firms were eligible for allowances and how many allowances they should be awarded would be very difficult.

[48] Foreign competitors, for example, might be able to argue successfully that some forms of revenue redistribution constituted an unfair subsidy.

IMPLICIT ALLOCATIONS WITH CREDIT TRADING

A credit trading program does not have an explicit allocation rule. But that does not mean there is no allocation of emission rights under a credit trading program.

Credits are created by reducing emissions below a baseline. Sources can use credits to meet a voluntary commitment or specified regulatory obligations. The baselines for creating and using credits determine the allocations to individual sources.

The baseline for creating credits is usually the lower of actual historic or allowable emissions. The baseline is often defined as an (historic or allowable) emission rate multiplied by the actual activity level, although it could be a cap on annual emissions based on historic or allowable emissions. In addition, the baseline often applies only to specific activities by an entity rather than its total emissions.

In the absence of a national commitment to limit greenhouse gas emissions, most emissions of these gases are likely to be unregulated. Thus, the baselines for credit creation will tend to be actual historic emissions. And the baselines for use of credits will tend to be voluntary commitments.

With a commitment to limit national greenhouse gases in effect and responsibility for limiting emissions allocated fairly to all sources, most sources would be subject to some form of regulation governing their emissions. Then the baselines for credit creation would tend to reflect the allowable emissions under the applicable regulations. And credit use would tend to be driven by compliance with applicable regulations as well.

When an emission rate is established, each unit to which the rate applies is treated equally. The implicit allocation to each participant is then determined by the number of units it produces or uses. If the rate is the same for new and existing sources, they are treated equally. Since baselines are typically, the lesser of actual or allowable emissions, the implicit allocation changes over time, providing a measure of intertemporal equity.

The American programs for trading lead for use in gasoline and meeting emissions standards for heavy-duty engines are examples of credit trading programs in the context of a commitment to limit total emissions.

Lead in Gasoline Trading

Lead credit trading was instituted from November 1982 through December 1987 to enable refiners and importers to reduce the lead content of leaded gasoline quickly at lower cost. There was no overall cap on lead used in gasoline. Total lead use was limited by the quantity of leaded gasoline produced and imported multiplied by the maximum lead content. The allocation of lead credits changed each quarter depending on each participant's production and imports of leaded gasoline.

Effective November 1982, each refiner and importer was required to keep its actual lead use during each quarter below the regulatory limit of 1.1 grams per gallon of leaded gasoline. Refiners or importers could create credits by keeping actual lead use below this level. They could sell the credits to refiners or importers whose lead content exceeded the standard. Lead credits could only be used during the quarter in which they were created. Trades were reported to EPA at the end of the quarter.

Faced with new evidence of health damage from lead, the EPA reduced the maximum lead content for leaded gasoline to 0.5 grams per gallon effective July 1, 1985 to 0.1 grams per gallon after January 1, 1986. To facilitate this sharp reduction in the lead content of leaded gasoline, the EPA introduced banking into the trading system effective January 1, 1985. Refiners and importers were allowed to bank lead use rights during calendar 1985 and to withdraw them until the end of 1987.

"The program is notable for its lack of discrimination among different sources, such as new and old sources. It is also notable for its rules regarding the creation of credits. Lead credits are created on the basis of existing standards. A firm does not gain any extra credits for being a large producer of leaded gasoline in the past. Nor is it penalized for being a small producer. ... To the extent that current production levels are correlated with past production levels, the system acknowledges the existing distribution of property rights. However, this linkage is less explicit than those made in other trading programs."[49]

Hahn notes that one of the reasons EPA set up the allocation rule this way was to transfer some of the windfall profits from producers to consumers.[50] Anderson *et al.* conclude that "[t]here is clear evidence that the program provided a gain in efficiency, although the precise amount of gain is difficult to estimate with available data. ... There is also good reason to believe that prices to gasoline consumers were lowered by the trading program ... and that under plausible assumptions, the price decrease exceeded efficiency gains, lowering overall gasoline producer profits."[51]

Perhaps the most surprising feature of the trading program for lead in gasoline is the large number of new "refiners" that entered the market.[52] A "refiner", for the purposes of the

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[49] Hahn, 1989, p. 102.

[50] Hahn, 1989, fn. 4, p. 102.

[51] Anderson *et al.*, 1990, p. 31.

[52] The number of "refiners" reporting grew from 265 in 1983(3) to 849 in 1985(3) and then fell to 547 in 1987(4). About 200 of the participants were refineries that produced leaded gasoline from crude oil. The number of importers was more stable, rising from 48 to 80 and then falling to 60. Entry on this scale was possible only because of the nature of the allocation; every refiner that manufactured and importer that imported leaded gasoline during a given quarter received lead use rights.

program, was anyone who manufactured gasoline, thus someone who added ethanol to leaded gasoline was deemed to make an amount of leaded gasoline equal to the amount of ethanol added.[53]

In summary, the lead trading program established a standard for lead use in leaded gasoline. Sources that used less lead could create credits equal to the difference and sell them to refiners or importers whose lead content exceeded the standard. The implicit allocation of lead credits changed quarterly in response to current activity. This allowed large numbers of new entrants (and exits) over a five-year period. All refiners and importers active during a given quarter were treated equally.

Heavy-Duty Vehicle Engine Emissions Standards Trading

Another example of a credit trading program where the allocation changes over time is the averaging, banking and trading (ABT) provisions of the emissions standards for heavy-duty truck and bus engines. The U.S. Environmental Protection Agency regulates emissions from heavy-duty truck and bus engines. The regulations cover different emissions for different engines. Some standards must be met by every engine, others must be met by engine categories as a group and allow the use of averaging, banking and trading provisions.

The regulations apply to new motor manufacturers. The averaging, banking and trading provisions were introduced to facilitate compliance with the lower standards that came into effect for the 1990 model year. The ABT provisions are limited to NOx and PM because the emissions standards for these pollutants have been tightened to the point where they are driving engine technology. Thus the need for flexibility in achieving compliance is greatest for these pollutants.

Where ABT is allowed, the regulations specify both the standard and a maximum emission rate for the pollutant. Every engine must have an emission rate lower than the maximum rate for each ABT pollutant and below the standard for each of the other regulated pollutants. The standards and maximum emission rates for the pollutants for which ABT is allowed are shown in Table 1.

Engines whose emissions are lower than the specified standard generate emission credits. Credits can be used to help engines in the same category whose emissions exceed the standard (but are below the maximum rate) achieve compliance with the standard. Averaging, banking and trading are different possible uses of credits:

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[53] If the leaded gasoline was already at the maximum concentration, adding the ethanol would reduce the concentration below the allowed level and so generate credits equal to the volume of ethanol times the maximum concentration.

Table 1

Standard and Maximum Emission Rates for Heavy-Duty Engines
(rates are in grams per brakehorsepower-hour)

	Standard				Maximum			
	NOx	NOx + NMHC	PM Trucks	PM Urban Buses	NOx	NOx + NMHC	PM Trucks	PM Urban Buses
1988 - 1989[a]								
Diesel	10.7		0.6	0.6				
Otto	10.7							
1990 - 1992								
Diesel	6.0		0.6	0.6	10.7			
Otto	6.0				10.7			
1993								
Diesel	5.0		0.25	0.1	6.0		0.6	0.25
Otto	5.0				6.0			
1994 - 1995								
Diesel	5.0		0.1	0.07	6.0		0.6	0.25
Otto	5.0				6.0			
1996 - 1997								
Diesel	5.0		0.1	0.05[c]	6.0		0.6	0.25
Otto	5.0				6.0			
1998 - 2003								
Diesel	4.0		0.1	0.05[c]	5.0		0.6	0.25
Otto	4.0				5.0			
2004 -								
Diesel		2.4[b]	0.1	0.05[c]		4.5	0.6	0.25
Otto	4.0				5.0			

Notes: a) The ABT provisions did not come into effect until the 1990 model year.
b) The standard for 2004 and subsequent years is 2.4 g/bhp-hr for NOx+NMHC or 2.0 g/bhp-hr for NOx with a cap of 0.5 g/bhp-hr for NMHC
c) This is combined with a 0.07 g/bhp-hr in-use standard

- *Averaging*: Credits offset emissions for engines manufactured during the same year whose emissions are above the specified average to help the company achieve compliance during that year.

- *Banking*: Credits offset emissions for engines manufactured during a future year whose emissions are above the average specified to help the company achieve compliance during that year.

- *Trading*: Credits are sold to another company and are used to offset emissions for engines manufactured during the current or a future year whose emissions are above the average specified for the year the credits are used.

Credits can only be created and used within the same engine category. There are three categories of diesel truck and bus engines: light, medium and heavy-duty engines. Otto cycle engines is a separate category.

Credits previously had a life of three years, but beginning in 1998 they have an unlimited life. Previously banked or traded credits were discounted by 20%, but beginning in 1998 a differential discount is applied depending on the emission rate of the engines used to generate the credit.

Eleven manufacturers are covered by the program. Reports on ABT activity for on-highway diesel engines have been submitted on paper and are confidential. Data on use of the ABT provisions is expected to be made public late in 1998, but is currently not available. Program staff indicate that manufacturers have used averaging a little more than banking.[54] Banking tends to be used just before standard changes. The first inter-company trade occurred in 1997 and involved a small quantity of PM credits.

In summary, credits are created by manufacturing engines whose emissions are lower than the standard. Credits can be used to enable engines in the same category whose emissions of the pollutant exceed the standard to comply with the standard. Credits can also be banked for use in achieving compliance with a more stringent future standard, although banked credits are discounted. While credits can also be traded this has only happened once so far, probably for strategic reasons and because the credits are discounted. There is no cap on total emissions; the total depends on engine production multiplied by the applicable emission standards. The allocation to each manufacturer depends on its engine production which changes each year.

Equity Considerations

It is useful to summarize the equity principles reflected in the implicit allocations for a credit trading program assuming a national commitment to limit greenhouse gas emissions is in effect. To meet the national commitment, all sources are assumed to be subject to regulations that limit their greenhouse gas emissions. It is assumed that the regulations do not impose an unfair burden on any category of sources or region.

It is assumed that the regulations are primarily of the form of limits on emission rates -- grams per litre of gasoline, per tonne of steel, per kWh, etc. The standards may be different for new and existing sources where it is difficult to change the emissions from existing equipment. In other cases the emission rates would be the same for new and existing sources.

The allocation of emission rights implied by such a regulatory structure changes in response to changes in the participant population. Emission rights vary with activity

[54] Averaging is more attractive because banked credits have been discounted by 20% while credits used for averaging are not discounted.

levels. Existing sources that cease to operate lose their emission rights. New sources generally receive emission rights free, although perhaps at a lower rate than existing sources. This implies a considerable degree of intertemporal equity. Such a structure also rewards good past performance.

SUMMARY

The main arguments for *gratis* distribution of allowances are that:

- *Gratis* distribution of allowances comes as close as possible to maintaining the prior arrangement of allowing unrestricted discharge of emissions free; and

- *Gratis* distribution of allowances is compensation for the loss of value of existing capital stocks that give rise to such emissions.

The allocation rule used for *gratis* distribution has efficiency and equity implications. While the distribution can have impacts on market power and dynamic efficiency, these considerations are probably secondary to the equity effects. Different rules assign different quantities of allowances to different recipients. Since allowances are valuable and the total supply is limited, each rule favours different recipients. There is no universally accepted standard for a "fair" or "equitable" allocation.

Every past or current program has used *gratis* allocation, but each program used different equity principles to allocate allowances among participants. The typical allocation rule involves a basic equity principle with adjustments for special circumstances.

Intertemporal equity was not a major concern for any of the programs. However, since greenhouse gas emissions are likely to be regulated for 50 to 100 years or more, intertemporal equity becomes a more important consideration than for any existing trading program. This requires an allocation rule that changes the distribution of allowances over time to accommodate the changing population of sources. Such a rule could be based on sales in the case of a substance trading program, such as the carbon content of fossil fuels, or on output, input or actual emissions in the case of an emission rights trading program, such as energy-related CO_2 emissions by fossil fuel users. An output-based rule is likely to be more efficient than an input- or emissions-based rule.

A trading program focused on fossil fuel users would allocate allowances to entities whose capital stock is devalued by the imposition of greenhouse gas emissions limits and that would incur costs to implement measures to reduce such emissions. But an upstream program for the carbon content of fossil fuels may be desirable because the share of total emissions covered is larger and the number of participants is smaller. The participants in such a program would likely earn windfall profits while energy users incur costs to reduce emissions and suffer a loss in value of their capital stock. In the case of ozone-depleting substances a tax was imposed on the substances to capture the windfall.

The costs of limiting greenhouse gas emissions, regardless of the policy used, are ultimately borne by individuals in their capacities as consumers, employees, and owners of capital. In aggregate the distribution of costs is likely to be slightly regressive, but some groups will be significantly affected. Allowances could be given *gratis* to institutions that sell them and use the revenue to offset some of these impacts; adjustment assistance to coal mining firms, employees and communities for example. In principle, allowances could also be allocated to individuals to offset the costs they bear. But the same end can probably be achieved at lower administrative cost by selling the allowances at auction and using the revenue to finance changes to the personal income or goods and services tax.

Participants could sell surplus allowances or buy additional allowances in the allowance market. Credits from specified domestic sources and credits or allowances available from international emissions trading, joint implementation and the clean development mechanism would also trade in this market. Unless international or Canadian rules restrict the ability to use, or raise the cost of using, allowances or credits from other countries the allowance market will closely reflect global prices. This is the desired outcome from an economic efficiency perspective.

While a credit trading program does not have an explicit allocation rule, it does imply an allocation of emission rights. When a national commitment to limit emissions is in place, the implicit allocation of emission rights reflects the regulations that limit emissions by each source. Assuming these regulations focus on emission rates and actual activity levels, they embody a considerable degree of intertemporal equity.

Clearly, any rule for *gratis* allocation of allowances has equity implications. Thus, the decision on the allocation rule is almost always a political decision. And the allocation rule often incorporates a variety of adjustments to accommodate special circumstances or special interests. A rule that changes the distribution of allowances over time may be easier to negotiate than a fixed distribution among existing sources. The future circumstances of each source is uncertain, so the best outcome for a given source is an allocation rule that it considers fair under a range of possible circumstances. Such a rule is likely to treat other sources fairly as well. In contrast, if the allocation rule is fixed every source has a strong incentive to argue for a larger share of the allowances.

WTO rules on subsidies may also affect the rule chosen for *gratis* distribution of allowances. It is possible that any *gratis* distribution could be considered an actionable subsidy. But it is also possible to argue that only allowances surplus to operating needs are a subsidy. That would require an allocation rule that distributed allowances roughly in proportion to actual emissions. Allocations of allowances to groups adversely affected by the emissions limits also could not exceed the losses suffered without being subject to challenge as actionable subsidies.

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