Organisation de Coopération et de Développement Economiques
Organisation for Economic Co-operation and Development

07-Jul-2003

English - Or. English

ENVIRONMENT DIRECTORATE
ENVIRONMENT POLICY COMMITTEE

ENV/EPOC/WPNEP(2002)28/FINAL
Unclassified

Working Party on National Environmental Policy

THE USE OF TRADABLE PERMITS IN COMBINATION WITH OTHER ENVIRONMENTAL POLICY INSTRUMENTS

Contact: Nick Johnstone (Tel: 33 1 45 24 79 22) email: nick.johnstone@oecd.org

JT00147148

English - Or. English

FOREWORD

This report has been prepared by Nick Johnstone of the OECD Environment Directorate as an initial contribution to the work programme on the application of environmental policy mixes. Comments on drafts of this report from Tom Tietenberg, Jean-Philippe Barde, Nils Axel Braathen, Timothy Folkins and Peter Zapfel are gratefully acknowledged. Any remaining errors or omissions are my own. It is published under the responsibility of the Secretary General of the OECD.

TABLE OF CONTENTS

EXECUTIVE SUMMARY

1. The OECD Environment Directorate (and others) have frequently made reference to the environmental effectiveness and economic efficiency of using a mix of environmental policy instruments, rather than one single instrument, when seeking to address environmental concerns. However, very little work has been done on the conditions under which the use of multiple environmental policy instruments is likely to be preferable to the application of a single policy instrument. Moreover, little work has been done on examining the combinations of policy instruments which are likely to serve as effective and efficient complements. As such it is instructive to explore the conditions under which it is likely to be effective and efficient to use two instruments to hit one target.

2. A new work programme at the OECD Environment Directorate is exploring these issues. As an initial contribution toward this work, this report reviews the links between tradable permits and other instruments. The report concentrates on cases in which tradable permits are used as part of a policy mix to address negative environmental impacts associated with pollution emissions. It assesses the implications associated with the use of tradable permits in conjuction with environmentally-related taxes, subsidies, voluntary agreements, direct regulation, and other tradable permit systems.

3. There are, therefore, a number of relate issues which are not directly addressed in the report, including:

- The effects of the use of environmental policy instruments in conjunction with policy instruments with other public policy objectives (i.e. social or economic);
- The effects of the use of policy mixes in areas associated with natural resource exploitation such as fisheries, forestry and water; and,
- The effects of the use of two environmental policy instruments on completely different environmental impacts (i.e. different pollutants); [1] and,
- The effects of the use of two different environmental policy instruments for the same impacts from different sectors or sources.

4. While undoubtedly important, expanding the report in order to include their effects would broaden the scope considerably. Moreover, at least some of these issues are being addressed elsewhere in the Environment Directorate's work programme.

5. The report finds that in many cases the use of a mix of policies will be at best redundant and at worst counter-productive. If a particular instrument is an economically efficient and environmentally effective means of meeting a given environmental objective, there is little sense in introducing an additional instrument. However, if it is not possible to introduce a ‘first-best’ instrument then a strong case can be made for the use of multiple environmental policy instruments. In particular, the report highlights the benefits of using tradable permits as part of a policy mix in the following four areas:

- *Dealing with spatial differentiation of impacts.* Work on tradable permits has revealed that it is important for the smooth and efficient functioning of the market that the permit market be

1. Assuming that two instruments of the same type are not applied to hit one target.

very broad and deep. However, for pollutants whose impacts vary by place of emission, this implies that the permit price will only be incidentally associated with marginal damages for most emitters. There is, therefore, a trade-off between efficiency in the market for permits and the equalisation of marginal abatement costs with marginal environmental damages. In order to mediate this trade-off it may be preferable to use direct regulations as constraints on trading, rather than complicating the permit regime itself.

- *Addressing technology market barriers and failures.* Most tradable permit regimes target emissions (or a close proxy). Under perfect market conditions, such a regime should "call forth" the optimal rate and direction of technological change to reduce these impacts. However, if there are significant market failures which adversely affect the development of technologies for abatement, then it may be necessary to introduce complementary policies to overcome such failures if the environmental damages are to be reduced at least costs.

- *Expanding regulatory scope and reach.* The flexibility of tradable permit regimes allows them to play an important role in expanding the scope of the regulatory authority's reach, particularly when used in conjunction with other instruments. For instance, effective combinations can be devised to allow for voluntary adherence to tradable permit systems or to encourage regulated firms to improve environmental performance in unregulated firms. Using tradable permits can be a lower-cost option than extending regulatory reach by expanding the scope of direct regulations to areas which are difficult to reach.

- *Reducing compliance cost uncertainty*. Tradable permits have the singular advantage of environmental effectiveness. Unlike any other instrument - including direct regulations - the achievement of a particular environmental objective (if expressed in terms of emissions) can be achieved with certainty. However, they have uncertain cost implications. Using taxes as a cap on permit prices and subsidies as a floor, can reduce this uncertainty. By reducing risk, this can have benefits for both affected firms and for the regulatory authority.

6. However, in all cases the objective of each instrument must be clearly defined, and the relationship between the two instruments must be properly understood. As noted above, if the objectives are the same and one or the other instrument is ‘first-best’, the additional instrument will be at best redundant but more admininstratively costly, and at worst the combination will be economically inefficient and environmentally ineffective. Thus in order for the use of an additional policy instrument to increase efficiency and effectiveness in the presence of a tradable permit system, the “complementary” instrument must:

- meet a legitimate policy objective which can not be met directly through the tradable permit system;

- be the best instrument available to the regulatory authority if it is to meet that policy objective;

- be administratively feasible and be introduced at reasonable cost by the public authorities; and,

- be an effective complement to the tradable permit system.

7. The difficulties involved in satisfying all of these conditions is a reflection of the difficulties involved in putting in place an effective and efficient policy mix.

THE USE OF TRADABLE PERMITS IN COMBINATION WITH OTHER ENVIRONMENTAL POLICY INSTRUMENTS

Introduction

8. The OECD Environment Directorate (and others) have frequently made reference to the effectiveness and efficiency of using a mix of environmental policy instruments, rather than one single instrument, when seeking to address environmental concerns. (See for instance, the OECD *Environmental Outlook and Strategy*.) However, very little work has been done on the conditions under which the use of multiple environmental policy instruments is likely to be preferable to the application of a single policy instrument. Moreover, little work has been done on examining the combinations of policy instruments which are likely to serve as effective and efficient complements.

9. As such it is instructive to explore the conditions under which it is likely to be effective and efficient to use two instruments to hit one target, and the means by which to co-ordinate such policy mixes.[2] A new work programme has been initiated at the OECD to explore these issues, and an initial contribution toward this work this report reviews the links between tradable permits and other instruments. The choice of tradable permits is particularly instructive since they are increasingly important elements in the policy mix, and only very rarely do they entirely displace pre-existing policy instruments. (A companion report is being prepared on the links between voluntary approaches and other instruments. See Part II in OECD 2003.)

10. In order to narrow the focus somewhat, the report concentrates on cases which are related to pollution emissions. This is not to say that resource-based tradable quota systems do not also co-exist with other policy instruments. For instance, in the area of fisheries it is quite common for individual transferable quota regimes to co-exist with technology-based regulations such as gear restrictions as well as spatial and temporal restrictions on fishing activity. While many of the effects are analogous to those discussed with reference to pollution below, resource-based policies are not addressed explicitly.

11. In addition, the report focuses on cases in which more than one instrument is used to hit the same environmental target - i.e. a given environmental damage from a given source. This includes cases in which one instrument targets a particular type of environmental damage which is a sub-set of the damages targeted by another instrument. It also includes cases in which two instruments seek to elicit different types of behavioural responses which reduce the same type of environmental damage. In addition, it includes cases in which two different types of pollutants are closely related in ecological terms – such as synergistic pollutants – since the target remains effectively the same. And finally, it includes cases in which one instrument seeks to reduce overall emissions, while another instrument is used to address specific local concerns.

12. There are, however, a number of issues which are not addressed, namely:

- The effects of the use of environmental policy instruments in conjunction with policy instruments with other objectives (i.e. social or economic);
- The effects of the use of two environmental policy instruments on completely different environmental impacts (i.e. different pollutants and/or resource use);[3] and,

2. However, cases where two instruments are used to hit two different targets which are closely related, whether as joint products in technological terms (SO_2 and CO_2 from electricity generation) or as synergistic pollutants in environmental terms (VOC's and NO_X producing atmospheric ozone), will be discussed.

3. Assuming that two instruments of the same type are not applied to hit one target.

- The effects of the use of two environmental policy instruments for different sectors or sources.

13. All of these issues are important. However, expanding the report in order to include their effects would broaden the scope considerably. Moreover, at least some of these issues are being addressed elsewhere in the Environment Directorate's work programme.

Tradable Permits and Direct Regulation

14. Unquestionably it is in combination with direct forms of environmental regulation (technology standards, performance standards, input bans, etc….) that tradable permits have been used most frequently. Indeed, to a great extent it can be argued that in most instances emissions trading extends but does not replace direct regulation. As such, it is with direct regulations that the report will begin.

Using Direct Regulations as the Basis for the Allocation of Tradable Permits

15. The simplest means by which direct regulations can interact with tradable permits is through the initial allocation of permits. In theory, tradable permits can either be issued to firms *gratis* (grandfathering) or through an auction. However, there are few existing tradable permit regimes which rely exclusively on auctions,[4] while some form of gratis allocation of permits one sort or another is the standard. However, the precise means by which permits are initially allocated through some form of gratis allocation is very important.

16. While other allocations methods can be applied (i.e. based upon historical output or input use), it is very common for tradable permit regimes to use pre-existing regulatory requirements as the basis for this allocation. The regulations become the means of defining the property rights under the TP regime. In theory this is more easily done under performance-based schemes in which the regulations are defined directly in terms of emissions rather than technology-based regulations in which specific technologies are designated. In the latter case, additional efforts are required in order to convert the regulations into a "currency" which can be used in the denomination of permits. (See Godard 2001.)

17. In some cases this relationship is direct. For instance, under the South Coast Air Quality Management District's RECLAIM program in Southern California, firms received initial allocations for SO_x and NO_x equal to the emission factors achieved by command and control regulations ("Best Available Control Technology") in place the day before RECLAIM took effect (times a meaure of production activity). (See Fromm and Hansjürgens 1996.) In addition, under the EPA's SO_2 Allowance Program, permits were allocated on the basis of fuel use and pre-existing statutory limitations on emissions (see Hahn and May, 1994).

18. Interestingly *future* allocations under RECLAIM are based upon a similar methodolody using the command and control rules that would have been implemented had the 1991 Air Quality Management Program (AQMP) been introduced (rather than RECLAIM). Thus, a *proposed* command and control regime continues to affect permit allocations even though it was never actually implemented. The allocation of credits declines each year at a facility-specific rate which is equivalent to the average

4. The Singapore auction for permits for ozone-depleting substances was one notable exception. (See Markandya and Shibli 1995.) In addition in many other schemes a small percentage of permits are retained by the government and auctioned, with the majority being grandfathered. This is the case, for instance, with the American SO_2 Allowance Program.

reductions that would have been achieved under the AQMP's plan to implement technology-based regulations. (See Polesetsky 1995, Johnson and Pekelney 1996.)

19. Even if gratis allocation is "pure" grandfathering - i.e. actual historical emissions are used to determine allocations, the direct regulations play a determinant role in the allocation. Unless the firms were not previously regulated at all, their emissions (and thus their initial permit allocations) will be determined in large part by those performance and technology-based standards to which they were previously subject.

20. It must be noted, however, that if direct regulations are used to allocate permits in a pre-determined manner this removes one of the principal benefits of tradable permits - i.e. the ability to separate distributional effects from efficiency effects. Unlike other policy instruments, distributional concerns can be addressed directly within the instrument itself without undermining the efficiency of the policy. If governments' "hands are tied" by the need to allocate permits in a pre-determined manner this advantage is more apparent than real (see Tietenberg 2002).

21. However, the distinction between the case in which permits are allocated on the basis of assumed emissions under existing regulations and those in which they are issued on the basis of actual emissions is significant. Under pure grandfathered allocation "early movers" who have already abated above and beyond regulatory requirements are penalised relative to the case where gratis allocations are modified by regulatory standards. For this reason, pre-existing command-and-control regulations are often used as the basis for permit allocation.

Using Direct Regulations to Generate Tradable Credits

22. "Cap-and-trade" systems are generally preferred to "baseline-and-credit" systems by economists since they provide greater environmental certainty and usually incur fewer administrative costs. However, in practice many countries have used credit-based schemes in which permits are generated when firms reduce emissions below a certain baseline. This is usually due to their greater political acceptability. These schemes are intimately linked to pre-existing direct regulations since the baseline is usually that which is defined by the regulatory system (Dewees 2001). Unlike under the case where regulatory standards are used for permit allocation, this raises more than just distributional concerns, having implications for the stringency of the environmental target itself.

23. For instance, under the US Clean Air Act's Emissions Reduction Credit Program credits are created when firms reduce emissions below the level allowed by their operating permit (see Hahn and Hester 1989). In effect, the regulatory regime plays a role in determining the generation of credits. This is true of all credit-based tradable permit systems. In the Connecticut NO_X programme, firms generate credits if they control NO_X greater than that which would be achieved with "Reasonably Available Control Technologies" (RACT) (Solomon 1999, p. 379).

24. This is also true of performance-based schemes. For instance, in the Swiss VOC trading programme in the Canton of Basel which was initiated in 1993, credits are created for reductions in emissions below the Canton's emission performance standard (75 mg/m^3)[5] (Jeanrennaud 1999). Similarly, under the American lead trading programme credits were earned if fuel was manufactured by refineries with a lower lead content than that necessitated by regulatory limits (see Stavins 2001). The same is true of the EPA's Heavy Duty Motor Vehicle Emissions Trading Program for NO_X which was initiated in 1997 (see Stavins 2001).

5. Although in practice very few credits have ever been generated due to the stringency of the standard.

25. In all of these cases there are very close links between the pre-existing direct regulations and the baseline-and-credit tradable permit scheme. Whether performance-based or technology-based the regulations provide the very basis upon which permits are created. This has the advantage of increasing the political acceptability of the tradable permit system. It also provides incentives for firms to abate above and beyond the levels implied by the regulatory standards. At a practical level, the use of direct regulations as the means to determine credit creation can save on start-up costs since any baseline-and-credit scheme necessitates the calculation and implementation of a baseline of some kind.

Using Direct Regulations to Protect Local Environmental Conditions under a Tradable Permit System

26. While the use of direct regulations in permit allocation and creation are significant, the use of direct regulations as constraints within the permit regime itself is potentially much more important. Indeed, the US EPA has explicitly applied "regulatory tiering" in cases where it is felt that a single instrument will not meet the environmental objective (see Tietenberg 1995). While trade in permits remains unfettered, regulatory constraints restrict the use of such permits.

27. Such constraints are often used to protect local environmental conditions. For instance, in the UK, the architects of the proposed trading programme for NO_X and SO_X have made it clear that the regime would have to protect local environmental conditions. However, it is not yet clear whether this would require the application of “Best Available Technologies” as directed under the IPPC Directive, which would severely restrict trading opportunities (see Palmer and Davies 2002). This is an issue to be resolved between the UK Government and the European Commission.

28. However, other countries have also expressed concern. Indeed, Poland - as an accession country to the European Union - appears to have significant reservations about the implications that a strict application of the IPPC would have on reducing the potential efficiency gains from trading (Zylicz 1999). Interestingly, in the Explanatory Memorandum of the Commission's proposal for a GHG trading programme, it is stated that its use of permits may be limited by the need to meet minimum technological standards in order to preserve local environmental conditions (see CEC 2001, p.9). This may appear to be superfluous since the contribution of GHG’s to radiative forcing (and thus climate change) does not depend upon the place of emission. However, some GHG’s (i.e. ozone) may also contribute to other local and regional environmental impacts.

29. In the Swiss VOC trading programme in the Canton of Basel the basis for the trade is linked to the difference between Canton emission standards (75 mg/m^3) and federal standards (150 mg/m3). The tighter Canton standard was applied out of a dissatisfaction with the consequences of Federal standards on local environmental conditions. Firms can earn credits for reductions below the Canton limit, which they can sell to other firms (at a 20% discount). No firm in the Canton can buy permits which would result in emissions in excess of the Federal standard (see Jeanrennaud 1999). Thus the gap between the two standards delimits the basis for trade.

30. Even under the American SO_2 Allowance programme, some states have imposed regulatory constraints on the scope for trading in order to protect local environmental conditions. For instance, in Wisconsin, local air pollution regulations prevented generators from buying permits even though their marginal costs exceeded the prevailing permit price. In Illinois, the use of scrubbers was mandated (see Conrad and Kohn 1996 and Fullerton et al. 1997). In New York, the Department of Environmental Conservation filed a suit to force the EPA to use "deposition standards" to restrict the use of permits in environmentally-sensitive areas (see Tietenberg 1995). In the lead trading program, California refineries could not exceed state standards through permit acquisitions (see Hahn and Hester 1989, p. 389).

31. What are the costs of such restrictions? Fullerton et al. (1997) undertake a simulation which shows that the cost of "forcing" utilities to invest in scrubbers (rather than purchase permits) within an individual state can increase compliance costs five times if the state had been a net buyer in the unconstrained market. Applying minimum performance standards can increase costs more than two-fold. Farrell et al (1999) provide similar results for the Northeast's NO_x programme. (For a hypothetical numerical illustration see Box 1.)

32. Of course neither of these studies look at whether the benefits of constraining trade through regulatory requirements in order to protect local environmental conditions outweigh the increase in compliance costs. Unrestricted trade would also be inefficient, resulting in emissions from different sources with very different marginal damages. A full cost-benefit analysis would have to take both sets of issues into account.[6] In addition, it would have to examine the implications of any uncertainty introduced into the permit market by the potential for changes in the regulations (see Godard 2001).

33. The key point is that because of the administrative cost of using one instrument to target the impacts directly in a differentiated manner which allows for marginal costs to equal marginal benefits for all emitters, a combination of policies is applied.[7] If applied efficiently this can be a 'second-best' policy option. Abatement cost minimisation for a given level of emissions is achieved through the use of the tradable permit system, while still insuring against breaches of local environmental thresholds and other non-linearities in damage functions through regulatory constraints.[8]

6. In a study of air pollution regulations in Baltimore, Oates et al. (1989) compare the net costs of an incentive-based regime which treats all emitters equally and an 'intelligent' command-and-control regime which seeks to differentiate regulations by impact. While still supporting the use of incentive-based regulations, the case is much weaker when the spatially differentiated nature of impacts are included in the analysis.

7. The usual economic case for the efficiency of marginal cost equalisation is really just a special case in which marginal benefits of abatement are equal across emission sources.

8. In mathematical terms this can be seen as a maximin strategy.

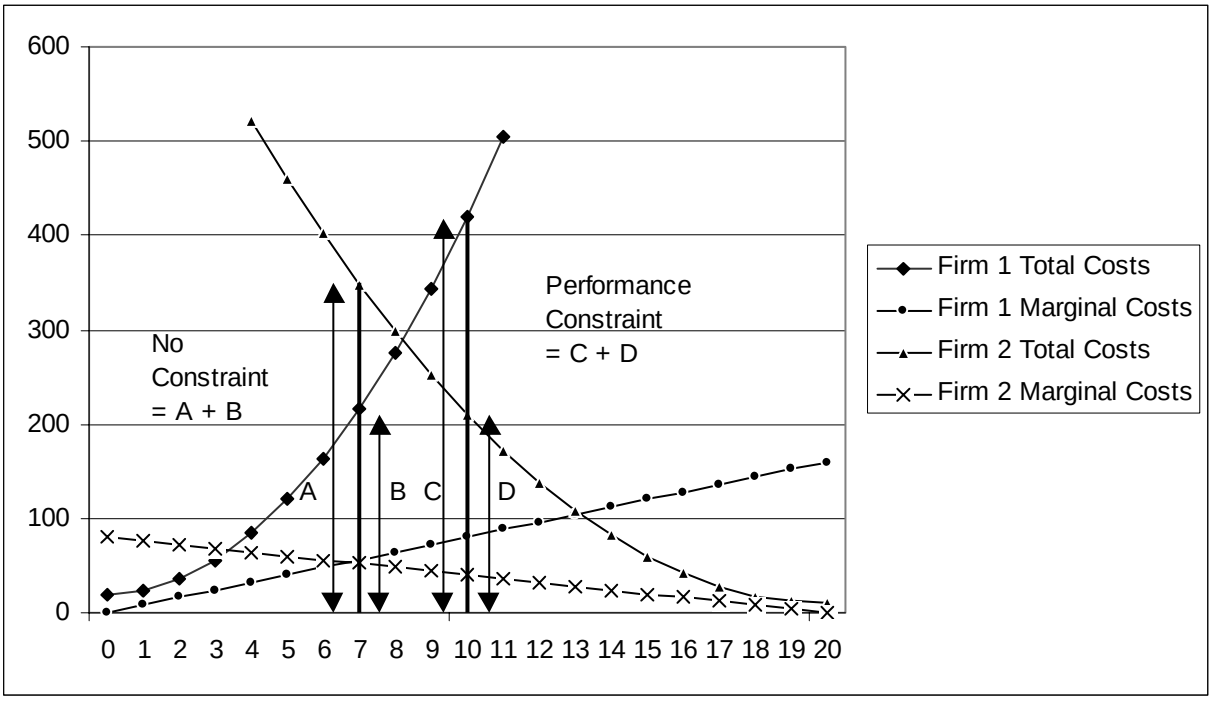
Box 1. The Costs of Regulatory Constraints on Permit Trading

The costs of introducing a regulatory constraint (a minimum performance standard) on a firm within a permit trading system can be illustrated with a hypothetical permit trading market. Assume that prior to the introduction of any type of environmental regulation, two firms emit 40 units of a particular pollutant. The two firms have the following hypothetical total abatement cost (TAC) curves:

Firm 1: $TAC = 20 + 4\ EA^2$

Firm 2: $TAC = 10 + 2\ EA^2$

Where TAC is total abatement costs and EA is emissions abated. The figure below shows total and marginal abatement costs for Firm 1 (Firm 2) increasing from left to right (right to left) as levels of abatement rise along the horizontal axis. Upon the introduction of a tradable permit system which caps emissions at 20 units, firms are allocated 10 permits each. Total costs will be minimised at the point at which marginal costs for the two firms are equal. This point is reached at the heavily shaded line to the left, when firm 1 buys approximately 3 units from firm 2, at a permit price of $52, and total abatement costs of $563 (the sum of the two arrows A and B).



Assume now that the regulatory authority decides to protect local environmental conditions in the jurisdictions where each of the plants are located by placing a regulatory constraint (such as a performance standard) of 10 units on firm 2. This might be a result of a concern that damages rise sharply above this level. In this case, the equilibrium is the heavily-shaded line to the right and total costs would rise to $630 (the sum of the two arrows C and D). Costs of compliance are, therefore, approximately 20% higher than in the case where permit trading is not restricted.

Whether or not this results in improved economic efficiency depends upon the relationship between marginal damages of emissions from the two plants. Assuming that the constraint is placed on the firm with higher marginal damages - which is a reasonable assumption - the 20% figure is an upper bound on efficiency losses. Conceivably, the constraint could result in an optimal allocation of abatement. However, this assumes that the regulator has full information about both marginal abatement costs and marginal emission damages for both firms. In such a case, the static benefits of introducing a tradable permit system would be nil.

Direct Regulations and Negative New Source Bias under a Tradable Permit System

34. In some cases, efforts to protect local environmental conditions through regulatory restrictions on trading can affect new firms specifically. For instance under the US's Emissions Reduction Credit Program, new and expanding sources in "non-attainment zones" must be in compliance with New Source Performance Standards even *after trading*. Thus, the performance standards set a ceiling on permit use for new and expanding sources (see Hahn and Noll, 1983).

35. This is true elsewhere as well. For instance, under their offset program a similar rule is in place in Germany (see Klaassen and Nentjes 1995, pp. 2-3). Under Denmark's SO_2 and NO_X trading regime a comparable constraint is applied. New plants must meet NO_X regulatory standards, even after trading (see Klaassen and Nentjes, 1995, pp. 2-3). Similarly, under Los Angeles' Air Quality Management Program new firms in non-attainment zones must invest in the more stringent "Best Available Control Technology" and in "extreme" non-attainment zones in technologies which generate the "Lowest Achievable Emission Rate". These remain in place under RECLAIM (Polesetsky 1995).

36. This has important implications for the overall efficiency of the programme since a large proportion of efficiency-improving trades can not be realised if the negative "new source bias" of pre-existing regulations are retained. "New" firms with high marginal abatement costs will not be allowed to buy a sufficient number of permits from "existing" firms with much lower abatement costs in order to equalise abatement costs. In effect the existence of regulatory requirements places a ceiling on permit use for "new" firms, which is likely to be less than the optimal level. Moreover, since the definition of "new" is often retrospective, in some cases this can affect a large number of firms and plants which are already operational. For instance, in the case of the lead trading programme, "new" sources were all those established after the mid-1970s (Hahn and Hester 1989).

37. More significantly, such rules reduce incentives for capital turnover. As such the dynamic implications can be significant with older dirtier plants staying in operation and newer cleaner plants being discouraged from entering the market. Innovation and productive efficiency may be reduced, further increasing the cost of meeting given environmental objectives in the long run.[9] This can not be attributed to the use of a policy mix *per se*, but rather to the retention of inefficient elements of the direct regulatory system within the tradable permit system.

38. In effect, the dynamic benefits of the use of tradable permit systems is partially undermined. Indeed, a number of empirical studies have shown that technology-based rules have tended to have particularly adverse consequences for firm entry, capital turnover and productivity growth. (See Maloney and Brady (1988) and Nelson et al. (1993) for some evidence.) The evidence with respect to pollution emission levels is more ambiguous.

Using Tradable Permits to Increase Regulatory Flexibility and Regulatory Reach

39. In some senses, the examples cited above place the "burden" of regulatory impact on the tradable permit system with the regulatory regime serving as a constraint on the realisation of some of the potential efficiency gains. However, in some cases the policy burden falls mainly on the direct regulations with tradable permits merely serving to help introduce a degree of flexibility.

9. See Johnstone (1999) for a discussion of the implications that this may have on long-run productivity (and thus sectoral competitiveness).

40. Perhaps the foremost example of the use of "trading" to increase regulatory flexibility was the United States Emissions Trading Progam. While the program did not involve the development of a full market in permits, by allowing for the creation of - and trade in - Emission Reduction Credits through "offsets" (trades between new and existing sources), "bubbles" (trades within the firm), and other measures. While such measures did not result in a market, they did increase flexibility within the regulatory structure (see Tietenberg 2001).

41. The American lead trading program was perhaps best understood as a means to reduce the cost of adjustment to a new regulatory standard. (Smith 1999, p. 205). Through trading, the adjustment costs of shifting from one standard to another were significantly reduced, perhaps allowing some refineries to stay in business which would have not been able to do so under an undifferentiated application of the standard. The Heavy Duty Motor Vehicle Engine Emission Trading program is similar. The difference between actual emissions of NO_x and particulate matter and the rate defined in regulatory standards can be sold to offset emissions from other firms' engines. However, credits cannot be used to offset emissions above a maximum rate (see Stavins 2001, p. 22.).

42. The American ODS programme was similar, with trading reducing the costs of adjustment to an outright ban on the production of CFC's. Since different firms would choose to comply with the ban at different rates - depending upon sunk investment costs and other factors - trading allowed the total costs of adjustment to the ban across all producers to be minimised (see Solomon 1999).

43. Perhaps the most interesting example is the UK's Package Recovery Notes. In this case, a market for permits emerged "spontaneously" as a means to reduce the cost of compliance with the EU's Packaging Directive which had set binding requirements to recover set percentages of packaging (see Salmons 2002). As firms sought to reduce their costs through shared responsibility, a market emerged which was eventually accredited by the Government *ex post*.

44. In some cases tradable permit systems may be used to extend regulatory reach, providing regulated firms with the incentive to bring about abatement in unregulated sectors. For instance, under the American Clean Water Act, point sources must have “Best Available Technology” in place. However, in the face of more stringent regulations (including some which mandate zero discharges), they may "buy" the necessary rights from non-point sources on the same watercourse. For instance, if a pulp and paper mill is unable to reach zero discharges it may pay for reductions at a nearby farm (i.e. buying up land to create a buffer). The regulatory requirement is still in place, but the firm's own permit to operate becomes dependent on buying up reductions elsewhere amongst unregulated sources (see Shabman et al. 2002, p. 10).

45. Conversely, if ‘unregulated’ firms are able to generate credits for emission reductions that they would have undertaken anyway (i.e. because of the installation of capital equipment in the normal course of their investment plans, but which incidentally reduces emissions), this may undermine environmental effectiveness of the policy mix. The question of ‘additionality’ is key to the environmental effectiveness of any baseline-and-credit scheme.

Conclusions

46. As noted above, pre-existing direct regulations can serve a useful role in initial permit allocations. Even if actual historical emissions are not known with any degree of certainty, "assumed" emissions based upon existing regulatory requirements can be a reasonable proxy. Moreover, such a means of permit allocation would avoid penalising firms that had gone above and beyond regulatory requirements prior to the introduction of the tradable permit system. The use of direct regulations as the

baseline in creation of credits is more problematic. However, this is not due to the role of direct regulations *per se* in the scheme, but rather to the problems inherent in any baseline-and-credit system.

47. The use of tradable permits in an incremental fashion to increase regulatory flexibility is likely to bring important benefits relative to retention of the *status quo*. Given the relatively limited number of applications of tradable permit systems outside the United States, capturing such benefits elsewhere would surely result in reduced costs. Moreover, the use of offsets to extend regulatory reach could also provide significant welfare gains. While far from being fully-fledged tradable permit regimes, such measures are likely to increase the efficiency and effectiveness of direct regulation.

48. Nonetheless, the benefits are likely to be less than with the introduction of more ambitious regimes which seek to introduce fully-fledged tradable permit systems. In practice, however, even in such cases existing direct regulations are often used as a constraint on trading. In most cases, these constraints are applied in order to protect local environmental conditions. A single undifferentiated market for permits for a pollutant whose impacts vary by point of emission can never be economically optimal. However, the use of regulatory constraints should be applied with considerable care.

49. Indeed, as a practical matter, the best way to deal with local impacts remains unclear. On the one hand, they can be addressed through "regulatory tiering" of the sort described above in which use is restricted but trade is unfettered. On the other hand, they can also be addressed directly within the tradable permit scheme. Tietenberg (1995) discusses a number of possible solutions including the use of zonal permit trading, the use of spatial restrictions on trade, or the use of price ratios within the trading area (see also Shabman et al. 2002, Nash and Revesz 2001 and Butters 2000). However, all such regimes will increase transaction costs and/or thin markets. Moreover, they may have unpredictable effects on the spatial distribution of emissions since the behaviour of market participants can not be known with any degree of certainty.

50. Thus, under certain conditions it may well be preferable to keep the trading regime simple and apply regulatory constraints of the sort discussed above. However, such constraints should be as "neutral" as possible, treating existing and new sources equally. By penalising new firms, biased regulatory constraints can have the perverse effects of discouraging the "exit" of more polluting older facilities and the “entry” of newer cleaner facilities. Moreover, whenever possible, such regulatory constraints should be based on performance standards and not technology-based standards. Unfortunately, none of the examples cited above are consistent with such an approach.

Tradable Permits and Environmentally Related Taxes

51. There has also been considerable experience with the joint application of tradable permits and pollution taxes. There are three potential motivations for the introduction of taxes in the presence of tradable permits:

- As a means to reduce compliance cost uncertainty;
- As a means to penalise non-compliance; and,
- As a means to capture windfall rents from permit creation.

52. While the second motivation (penalties for non-compliance) is not strictly a tax, the close link between it and the other two cases means that it must also be included in the discussion. These three different motivations - which are not mutually exclusive - will be discussed in turn.

Using Taxes to Reduce Cost Uncertainty

53. The potential desirability of the joint application of taxes and permits (rather than using one or the other on its own) has been recognised for a considerable length of time. In particular, Roberts and Spence (1976) proved that the joint application of the two instruments was preferable in the presence of: A) non-linear environmental damages; and, B) uncertainty concerning abatement costs. Since both of these conditions are likely to hold in a large number of cases, the practical importance of this result can hardly be overstated.

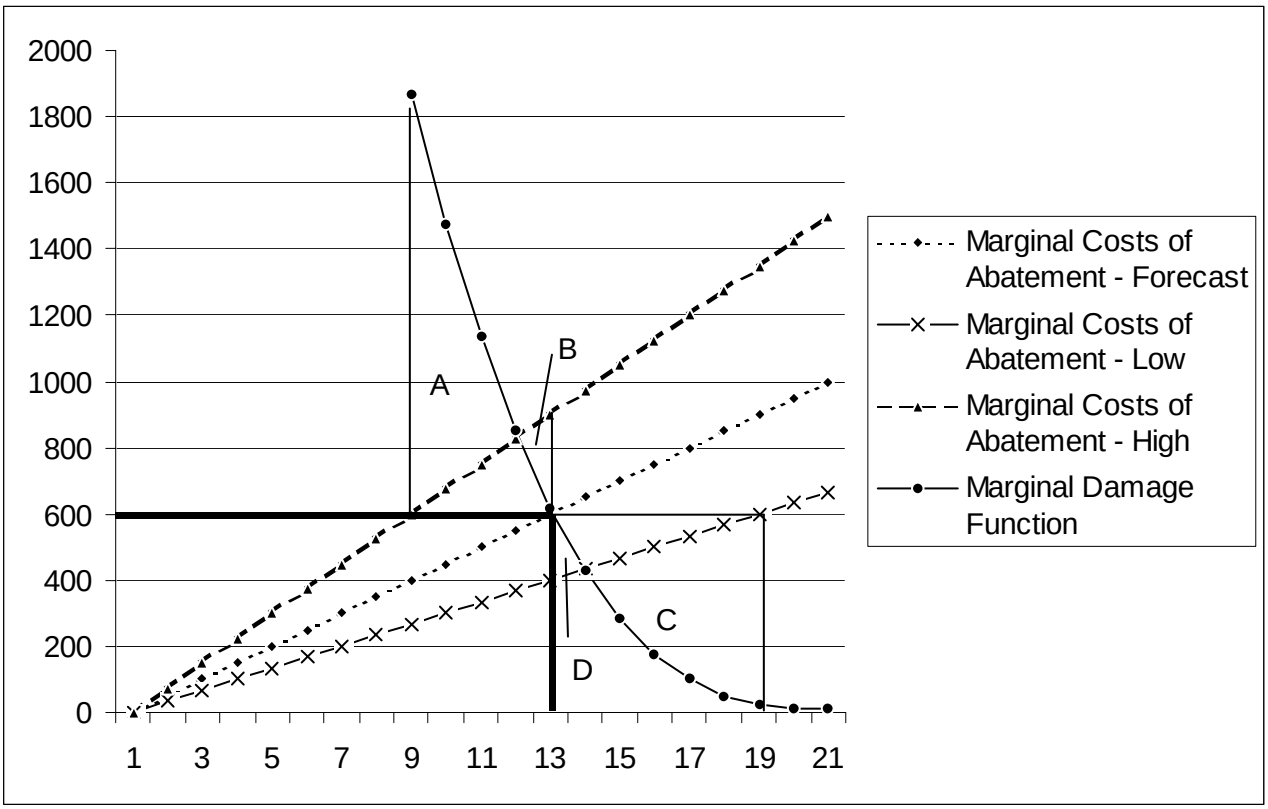
54. The point can be illustrated with reference to Figure 1. Assume initially that the firm emits 20 units of pollution. With environmental damages rising steeply, the welfare implications of under- over-estimating abatement costs can be considerable. Assume that a tax is introduced at a level at which assumed marginal abatement costs equal marginal damages. The tax would be approximately $600 with emissions equal to 7 units (20 minus 13). Alternatively 7 permits could be issued, resulting in a permit price equal to the tax.

55. If, on the one hand, the marginal abatement cost proves to be higher than estimated, abatement levels will be too high under the permit regime and too low under the tax. On the other hand, the MAC curve proves to be lower than expected, then abatement levels will too high under the tax regime and too low under the permit regime. Which results in greater welfare losses? Roberts and Spence (1976) showed that if marginal damages from emissions rise sharply and non-linearly, then the permit regime will be preferable.

56. In the Figure - if the marginal cost of abatement is higher than expected, welfare losses are greater under the tax (area A) than under the permit (area B). If costs are lower than expected this is also true (area C is greater than area D). With steeply rising marginal damages from emissions, the benefits from having certainty with respect to the level of damages exceed any costs associated with uncertainty concerning abatement costs. Of course, if marginal abatement costs are steep (but uncertain), but marginal damages from emissions are low, the opposite is true, and the tax is preferable.[10]

10. The effects of uncertainty with respect to the marginal benefits of abatement do not have analogous effects since firms will respond equivalently in the two cases.

Figure 1: The Welfare Costs of Abatement Cost Uncertainty under Permits and Taxes



57. However, Roberts and Spence (1976) make the additional point that a mixed regime is better still. In effect, by delimiting the bounds of permit price uncertainty through taxes and subsidies, the potential welfare losses from the regulatory authority either over-estimating or under-estimating marginal abatement costs can be reduced. Implicitly, many policymakers have recognised this by using emission taxes as a means to "cap" potential permit prices. The analogue - using subsidies to put a floor on permit prices has not been used explicitly.

58. This has been dubbed the "safety valve" argument. By putting a cap on permit prices, regulatory authorities are able to convince risk-averse affected firms and households of the desirability of introducing a tradable permit regime. In Denmark, the government explicitly used a "safety-valve" argument in setting the the penaly at 40 DKK ($US 4.78)/ ton of CO_2. In addition, some commentators have argued that the CFC tax in the United States was the binding instrument, and not the ODS permit trading programme (see Stavins 2001, p. 26).

59. The potential benefits of capping prices in the presence of abatement cost uncertainty has been explicitly recognised by some governments. For instance, in the UK's landfill permit scheme for biodegradable municipal waste, the government considered the possibility of introducing a cap through a penalty/tax, but felt that this was unnecessary since there was little uncertainty concerning the costs of waste diversion. Thus, Salmons (2002) points out that in the UK's Package Recovery Notes scheme, penalties were approximately equal to permit prices.

60. In the original proposals for the EU Directive on greenhouse gas emissions trading, the permit price cap was set at 50 EUR/ton in the first phase and 100 EUR/ton in the second phase (CEC 2001).

However, the original proposal also included the provision that the penalty shall be twice the average market price if higher than these levels. In a subsequent amendment to the Directive this provision was removed (CEC 2002). In effect, by removing this clause the penalty becomes a price cap, which would have not been the case under the previous system proposed. Indeed, the Commission explicitly stated that price certainty was the objective of the amendment.[11]

61. Arguably this increased cost certainty can also be achieved with the permit trading programme by keeping permit reserves available for use. For instance, under the US SO_2 Allowance Trading program the government initially held reserves of permits which it could have released onto the market if the price had reached $US 1,500 (see Tietenberg 1998). In practice, permit prices never approached this threshold, but some initial estimates were sufficiently high to elicit some concern about compliance costs. However, such a scheme has the disadvantage that the price can only be capped for as long as the reserve holds - excessive demand will eventually drive the price higher. Thus, the price effects are less certain, undermining the benefits in terms of reduced uncertainty. On the other hand, of course, the environmental effects are more certain with a permit reserve since under a tax-based price cap the government has no direct control over emissions.

Using Taxes to Penalise Non-Compliance

62. Financial payments can also be used to penalise non-compliance. In this case, the logic is quite different. Rather than serving as a "safety valve" the tax is designed to serve as a deterrent. In one case (the cap on permit prices) the tax is designed to allow for legitimate and strategic behaviour on the part of the firm. In the other case (the penalty) it is designed to serve as a deterrent on behaviour which is considered to be malign and illegitimate. As such, the penalty is set much higher relative to the prevailing or expected permit price than would be the case with a tax which is designed to serve as a price cap. The penalty under the ODS tradable permit program was $25,000/kg.

63. The optimal level of the penalty will differ depending upon the cost of monitoring. For instance, under the American SO_2 programme there is real-time monitoring of emissions. This means that the probability of being caught for non-compliance is close to 100%[12]. However, if monitoring is imperfect then the penalty will have to be correspondingly higher to serve as an effective deterrent. (See Fromm and Hansjürgens 1996 for a discussion.) There is a negative correlation between the probability of being caught for non-compliance and the optimal level of the penalty.

64. In addition, issues of fairness need to be addressed. For instance, under most systems penalties need to be "reasonable" and "proportionate" to the magnitude of the offence. While it may be possible to improve compliance rates by increasing penalties to "unreasonable" levels, this would be inconsistent with principles of fairness in most legal systems. The penalty level must be commensurate with the nature of the violation. (See DETR 2001 for a discussion of the principles used to determine the level of the penalty under the UK's Landfill Permit Scheme.)

65. Since they serve different functions single charges can not serve as both effective deterrents and caps on permit prices. (See Table 1 for a comparison of penalties and permit prices under various systems.) The two functions are not complementary. In practice, however, the distinction between them can be

11. Conversely, in the UK's landfill permit scheme for biodegradable municipal waste, the government considered the possibility of introducing a cap through a penalty/tax, but felt that this was unnecessary since there was little uncertainty concerning the costs of waste diversion (UK DETR 2001).

12. See http://www.epa.gov/airmarkets for data on the efficacy of monitoring in the program. Separate sanctions can be introduced for tampering with the monitoring equipment.

ambiguous. Due to abatement cost uncertainty resulting in lower permit prices than anticipated a penalty can end up serving as more of a deterrent than a cap, as might have been the original intention. This may well have been the case with the American SO_2 Allowance Program where permit prices ended up being much lower than anticipated. For instance, the EPA had made "ex ante" estimates of over $1,000/ton, but actual prices had converged to less than $US 200/ton by the mid-1990s. Analogously, if permit prices end up being higher than anticipated then the tax might be less meaningful as a deterrent, but serve as more of a price cap.

Table 1: Permit Prices and Penalties for Selected Tradable Permit Systems

	Permit Prices	Penalty
United States - Acid Rain	$US 150/ton-US$ 220/ton in 2000-2001 (www.epa.gov.airmrkts)	$US 2,525/ton (www.epa.gov.fedrgstr)*
United States - ODS		Penalty - $US 25,000/kg (Harrison)
Los Angeles – RECLAIM	Approximately $100/1000 lbs in 1995 (Fromm & Hansjürgens 1996.)	Maximum of $500/1000 lbs*[13]
Northeastern US - OTC NO_x	$US 100-$US2000 in 1999-2001 (www.epa.gov.airmrkts)	Allowance allocation lost in subsequent years (i.e. 3 x in New York)
Denmark – CO_2	NA	DKK 40/ton (Kitamori)
Proposed EU CO_2 Programme	NA	EUR 100/ton (CEC 2002)
Tar-Pamlico Nitrogen and Phosphorous	NA	$US 56/ton (Kraemer and Banholzer, 1999)

* plus one allowance reducion in following year's allocation.

66. However, it is not just the relative size of the payment which distinguishes the tax and penalty functions. In some cases, the penalty is left purposefully uncertain. For instance, under the UK's Packaging Recovery Notes scheme penalties for non-complinace can be as high as £20,000, however in practice they have only averaged approximately £3,250 (see Salmons 2001). Questions such as intentionality are used in determining the level of the penalty. Similarly, under the RECLAIM programme penalties are "discretionary" (subject to a maximum), dependent upon the reason for the violation and subject to appeal. This *ex ante* uncertainty means that even if the penalties are not far in excess of potential permit prices, they are unlikely to serve as an effective cap - or rather will do so in an unpredictable manner.

67. And finally, since many penalties include additional sanctions - such as the need to purchase additional permits in subsequent years in a proportion greater than one - the penalty will not be an effective indicator of permit price maxima. Firms will need to account for all sanctions (and not just the direct financial penalty) when deciding how many internal resources should go towards ensuring that the firm is continuously in compliance. This may include a number of elements which are difficult for the firm to quantify such as the 'stigma' associated with being in non-compliance.

Using Taxes to Capture Windfall Rents

68. The third use of taxes in tradable permit regimes arises from the common use of gratis allocations to allocate tradable permits, rather than auctions. Whether this is done on the basis of historical emissions

13. Penalties are based upon number of days of excess emissions, with each day constituting a separate violation.

or regulatory requirements or some other mechanism, firms will receive a windfall rent equal to the value of the permits allocated. In order to recover some of these windfall rents, taxes can be applied in conjunction with the tradable permit regime.

69. This appears to have been the motivation behind the use of the CFC tax in conjunction with the ODS permit trading programme. Initially set at $1.37/lb in 1990, it rose to $5.35 in 1995 (see Harrison 1999, p. 32). This tax is paid on all ODS sold (and on any stocks of ODS). As such, it is complementary with the ODS permit trading program and not a substitute (as is the case with taxes which serve as permit price caps). Thus, irrespective of the permit price, the tax has to be paid. Moreover, it is also complementary to the penalty ($25,000/kg) since this is charged for non-compliance, while the CFC tax is charged on all sales.

70. Why was this tax introduced in the ODS programme and not elsewhere? Part of the reason is clearly political, with the likelihood of there being considerable resistance to its application.[14] Moreover, the issue of rent capture was particularly important since under the ODS program firms were effectively receiving a right to produce or import a commodity (see Stavins 2001, p. 26). The commodity was a permit to produce or import valuable commercial commodities, granted *gratis* to 28 firms. The rent (or windfall profit) arose from the distribution of a production right. This is quite different from being granted permits for a pollutant which can be substituted to a greater or lesser extent in the production of other commodities.

71. There are, however, other cases where taxation of windfall rents might have been equally justified as in the CFC case. For instance, in the Dutch Nutrient Quota farmers were granted tradable rights to produce manure. These were allocated based upon number of hectares and livestock. On the basis of an empirical study, Vukina and Wossink (2000) has shown that the rents from this allocation derived were capitalised into land values. However, no effort was made to capture these rents. The same could be said of Singapore's ODS programme.

Conclusions

72. While the intention and motivation for the use of taxes as permit price caps and penalties as legal deterrents are often quite different, in practice they can often have similar effects. This is because if the penalty is set too low, firms will see it as a feasible "compliance" strategy. Similarly if the tax is too high, it will serve as a deterrent, perhaps encouraging greater vigilance but not being seen as an economic option.

73. In any event, in order for the cap to be efficient it is important that the use of permit price cap is explicit, and its size is known ex ante. A penalty which serves as a default price cap is unlikely to be efficient since penalties are often of uncertain size - for the reasons discussed above. This will have the effect of introducing uncertainty into the market, precisely the opposite effect as the usual motivation for the introduction of a tax.

74. In some cases it may also be advisable to introduce taxes on the windfall rents associated with the gratis allocation of permits. This is likely to be most important when the permits relate to commercial

14. In this vein, it is important to note that this rent was already being received under pre-existing regulatory systems through issuance of permits (see Fullerton and Metcalf 1997 for a discussion). However, it was not convertible as an asset. This is not to say that it was less valuable. Indeed in some cases, it may have been more valuable than grandfathered permits. For instance, the New-Source Bias in EPA pollution regulations meant that existing permited firms received the rents associated with high barriers to entry for new firms.

products (such as CFC's) and not pollutants *per se*. However, this may also be important under certain emission-based permit regimes, depending upon how important the rents are in relation to total compliance costs. This will depend upon the slope of the cost curve and the degree of stringency of the environmental target (i.e. the tightness of the cap) (Johnstone 1999).

Tradable Permits and Subsidies

75. Given the widespread use of subsidies in sectors involved in resource extraction and processing, it can be argued that all tradable permit systems co-exist with subsidies. However, most such subsidies are not environmentally-motivated and, indeed, are likely to have negative environmental consequences. Given the nature of this report we will focus on the use of environmentally-motivated subsidies in conjunction with tradable permit regimes which have closely related environmental objectives. The use of subsidies in conjunction with (or as an element) of tradable permit schemes is, perhaps, less widespread than the use of taxes or direct regulations with tradable permits, but there are still numerous important examples.

Tradable Permits and the Incidence of Subsidies

76. Tradable permit regimes are usually targeted directly on environmental externalities (i.e. CO_2 emissions) or close proxies for these externalities (i.e. sulphur content of fuels). However, this is rarely the case for subsidies, which are usually designed to support the means of amelioration of an externality, and as such are usually targeted at very different points. Depending upon their point of incidence, the effects of a subsidy on a tradable permit system will vary significantly.

77. In some cases, subsidies are targeted at the level of investment (i.e. capital depreciation allowances for abatement technologies); in other cases they are targeted at specific inputs or outputs (i.e. tax exemptions on sales of renewable energy); and, in still other cases they are targeted much further upstream at technology development (i.e. public support for research and development in environmentally-benign technologies).

78. As such, the relationship between the two instruments must be examined in terms of the different effects they may have depending upon differences in their point of incidence. In the event that subsidies target inputs which are related to abatement, the subsidy will result in a shift down in the marginal abatement cost and in the average abatement cost curve, and a drop in permit prices. Conversely, an investment subsidy will shift the average cost curve down, but will leave short-run marginal costs unchanged. As such, it will leave permit prices unchanged (at least in the short run). However, it will certainly affect the timing and scale of new investments. It may also affect firm entry and exit. The effect of other measures such as public support for research and development are more ambiguous, since it will depend upon the nature of any technological developments which may arise.

79. As long as the subsidies co-exist with a cap-and-trade system they will not undermine (or strengthen) the environmental effectiveness of the tradable permits. They will, however, have effects on the distribution of impacts across firms and the economic efficiency of the system. For instance, under the SO_2 Allowance Progam, the Public Utility Commissions of some states have provided favourable tax treatment for capital expenditures on scrubbers relative to expenditures on permits, low-sulphur coal and other compliance strategies. Since the electricity generators are regulated natural monopolies this can arise through cost recovery rules in price regulation (see Bohi and Burtraw 1997 and Bailey 1996.)

80. The effect of the subsidy will be to distort decision-making. SO_2 emitters will be encouraged to purchase scrubbers in excess of the level which would be optimal. This will not improve the

environmental effectiveness of the program in a global sense, but will merely to drive down permit prices by releasing permits onto the market and encouraging others to increase permit use as a compliance strategy. It will also increase overall costs, above and beyond the costs associated with the direct financial implications of the subsidy.[15]

81. Moreover, if the subsidies co-exist with a 'baseline-and-credit' scheme they may also undermine the environmental effectiveness of the tradable permit scheme by encouraging firm entry.[16] For instance, in the case of an investment subsidy which does not affect the firm's operating costs, marginal costs of production will remain the same but average costs will decrease. This will result in excess profits, encouraging firm entry (and discouraging firm exit). This is likely to result in greater overall levels of emissions.

Auctioned Tradable Permits and Earmarking of Rents

82. It has been noted above that gratis allocation of tradable permits sometimes raise "political economy" concerns about the distribution of the "property rights" created by a tradable permit system. An auctioned permit raises rather different questions. In effect, prior to the introduction of a tradable permit system the "rights" to pollute were granted to firms. As long as they complied with existing technology- and performance-based regulations, they possessed the right to discharge residual pollutants into receiving waters and atmosphere.

83. However, with the introduction of a auctioned tradable permit system these rights are no longer held. Instead the firm must bid for permits. Thus, for a given level of abatement the firm will pay for both abatement costs and permit use, while under direct regulation the firm will have only paid abatement costs. Although average abatement costs may well have been higher due to inefficiencies, they are unlikely to be in excess of total compliance costs under a permit regime. (See Johnstone 1999 for a discussion of the conditions under which abatement costs are likely to represent a relatively high proportion of total compliance costs.)

84. It is for this reason that gratis allocation of permits are often preferred to auctions. However, they are less efficient than auctioned permits because rather than using the rents to reduce distorting taxes, they remain with the producers (Cramton and Kerr 1998). Alternatively, in those cases where permits have been auctioned, the revenues have sometimes been "earmarked" as subsidies to recipients within the sector in order to overcome resisitance. For instances, in Singapore's ODS trading program the revenue from the auctions were funelled back to many of the same firms that bid for the permits (Markandya and Shibli 1995).

85. If the subsidies are targeted efficiently and do not undermine the incentive effects of the permit scheme by affecting the marginal costs of abatement, the use of an auction/subsidy in this way may be preferable to gratis allocation of permits. However, since subsidy schemes are intensive in terms of information requirements and may result in problems such as adverse selection and moral hazard, depends upon the implementation of the scheme.

---

15. Whether this is efficient depends upon the marginal damages of emissions from the firms which are buying the permits. Since the buyers can not be known ex ante, such a scheme is unlikely to serve the wider interest of environmental protection, although it may be efficient from the individual state's perspective.

16. Indeed, it is for reasons such as this that the OECD has promoted the use of the "Polluter Pays Principle", of which subsidies for pollution abatement are a clear violation.

Tradable Permits, Technology Market Failures and Subsidies

86. The preceding analysis was based upon the assumption that the motivation for the provision of the subsidy is largely the same as the motivation for the introduction of the tradable permit scheme. However, in practice, while the intended environmental objective of the two instruments is often the same, the assumed behavioural response for environment-related subsidies is often quite different from that assumed for other environmental policies. Indeed, they are often designed not so much to address the environmental market failure directly, but rather some other failure associated with the innovation and diffusion of technologies which might reduce externalities indirectly. The distinction is important and requires some explanation.

87. In particular, it is generally argued that due to the pervasiveness of positive externalities in technology development and diffusion, market forces will not generally provide the optimal rate of innovation in the absence of government intervention. These externalities arise due to the "spillovers" which exist in technological development. Due to the difficulty of excluding others from the benefits of applied research and product development, firms will not have sufficient incentive to undertake the necessary investments (see Jaffe et al. 2002). These effects can be exacerbated by other factors. For instance, it is commonly argued that financial markets do not tend to assess low-probability high-return investments - such as those in research and development of new products – appropriately.

88. Many subsidy programmes of the sort described above aim to help overcome these barriers and failures for environment-related technologies. For instance, proponents of wind-energy subsidies usually justify them on the basis of the existence of some market failure or barrier associated with technological development and diffusion (Ibenholt 2002). If this is not the case, then another environmental policy instrument would be more effective and efficient. Indeed, even if there are market failures or barriers, the case for the use of subsidies rather than other tools of industrial policy still needs to be made. In particular, issues such as firm entry and the marginal cost of public funds need to be considered.

89. Nonetheless, it is at least potentially possible for subsidies and tradable permits to be used in a complementary manner to address environmental problems. The tradable permit would be used to create a property right for the environmental externality such as pollution emissions, and the subsidy would be used to address some technology-related market failure or barrier which is preventing firms from introducing the optimal means of its amelioration. This was clearly the logic behind the use of the auction rents in Singapore's ODS programme to support the development and diffusion of CFC-free technologies (Markandya and Shibli 1995).

90. In other cases, it may be necessary to use subsidies as a complement to tradable permits due to the inability to target externalities directly. For instance, Fullerton and Wolverton (1997) make such a case for issues related to solid waste. If it is impossible to target the waste-related environmental externalities directly - which is usually the case for mixed municipal waste - then it is not possible to design a first-best tradable permit system. However, it may be possible to approximate the first-best outcome, by having a tradable permit system which targets waste generally in an undifferentiated manner (i.e. on the basis of mass or volume), and provide a subsidy based upon qualitative aspects of the waste, such as recyclability. To the author's knowledge such a mix has not been implemented in practice.

Tradable Permits as a Means of Distributing Subsidies

91. Perhaps the best-known combination between a tradable permit system and the provision of subsidies is the United Kingdom's "sellers' auction" for CO_2 emission reductions under the UK Emissions Trading Scheme (ETS). (See Kitamori 2002 for a discussion.) In a decreasing-price auction firms bid for

government-provided subsidies against emissions reductions relative to their baseline emissions in 1998-2000. In total £215 million in subsidies will be provided in the period 2002-2006. In the first year, 34 firms bid for £43 million in the first year's auction held on March 11th-12th, 2002. (See DETR, 22/03/2002) The ultimate price for allowances was £53.37/tonne.[17] From April 2002, these permits for these reductions can then be sold in the ETS, alongside permits generated through other means. The firm can sell any allowances for any reductions that it undertakes in excess of the amount for which it has bid.

92. New Zealand has been considering introducing a similar scheme as part of their "Projects" programme to reduce CO_2 emissions. The government will provide financial support to firms through a contestable bidding process. Even though New Zealand does not envisage introducing a tradable permit scheme in the first instance, the government may also issue emission rights which can be traded on the international carbon trading market when it comes into existence.[18]

93. While the ability to sell excess allowances is characteristic of baseline-and-credit tradable permit systems, the importance of the financial incentive for participation in a voluntary cap-and-trade scheme is more significant. In effect the bidding scheme is perhaps best understood merely as a potentially efficient means of the allocation of subsidies. Instead of granting investment funds through detailed project applications on the one hand, or in a non-discretionary manner through undifferentiated subsidies on the other hand, firms are encouraged to reveal the true costs of abatement through the auction. However, the economic efficiency of the programme is dependent upon effective auction design, such that firms are not able to behave collusively in order to minimise reductions relative to the subsidies available.

94. In effect, the subsidy scheme could serves as a "floor" on permit prices, analogous to the role that taxes played as a price cap in the discussion in Section III above. If abatement costs prove to be lower than anticipated, too many permits would have been issued than is optimal - i.e. than could be justified by a cost-benefit analysis. The provision of the subsidy will serve to drive up the level of abatement in the face of such uncertainty.

95. However, this objective could also be achieved by allowing the government to buy up permits ex post. This strategy is being considered by the EPA for the SO_2 Allowance Program where permit costs have been much lower than anticipated (Ellerman 2002). This solution may well be preferable, but it may have the effect of making the introduction of future TP schemes more difficult since if firms believe that the cap may be revised downward they are likely to be more resistant to its introduction. This is avoided by the use of subsidies as a floor on prices.

Tax Exemptions and Adherence to Tradable Permit Regimes

96. A final role that subsidies can play in conjunction with tradable permits is through the use of tax exemptions. In some cases firms which agree to participate in tradable permit schemes are exempted from pre-existing emission taxes. On its own, such an exemption is equivalent to a subsidy. However, when used in conjunction with a tradable permit system, the effect is to split affected sectors into those who are affected by a quantity-based measure and those who are affected by price-based measure.

---

17. This is not equivalent to the market price for the cost of abatement of a tonne of carbon due to the annual nature of the commitment and other factors.

18. Intervention by Murray Ward (Department of the Prime Minister and Cabinet, New Zealand) "Greenhouse Gas Emissions Trading: Domestic and International Issues" IEA/EPRI/IETA Worshop, 17th-18th September, 2002.

97. There are some discussions about the use of such a regime. Under a scheme proposed in France for CO_2 permits, firms which participate would have been exempted from the "general tax on polluting activities", which was a CO_2-weighted energy tax. However, neither have been adopted (see Kitamori 2002). In the UK firms which have agreed to Climate Change Agreements are given an 80% reduction on the Climate Change Levy. In 2001 the levy was equal to 0.43 pence/kWh for electricity and 0.15 pence/kWh for coal and gas (Kitamori 2002). This reduction is maintained if they enter the Emissions Trading Scheme.

98. There are also examples where the two regimes co-exist for the same firm. For instance, in Denmark the tax and permit regime will co-exist for a period of time, before the former is discontinued. Conversely, in Norway firms that are presently exempted from the carbon tax will be required to participate in a carbon trading scheme scheduled to be introduced in 2005. It is anticipated that they will be allocated gratis 80% of historic emissions.

Conclusions

99. The case for the use of subsidies in conjunction with tradable permits is perhaps strongest if they are used as a means to overcome technology-related market failures which may undermine the responsiveness of firms and households to the incentives provided by tradable permit regimes. In such cases, the environmental target is the same, but the two instruments play complementary roles in ensuring responses by firms and households. However, in order to be efficient and effective the subsidy scheme should be designed in such a way as to discourage adverse selection and moral hazard. In addition, they should incorporate "sunset" clauses in which the provision of the subsidies is time-delimited.

100. Using subsidies as a means to increase the political acceptability of tradable permit regimes, whether by earmarking rents for particular firms or more fundamentally by using the tradable permit regime to allocate subsidies is potentially more problematic. In the former case it may be more efficient to encourage political acceptability by allocating permits gratis. In the latter case, it is difficult to identify any benefits that would arise relative to the introduction of a pure cap-and-trade system on its own.

101. And finally, the use of tax exemptions to encourage adherence to a tradable permit regime is potentially useful. Using two instruments (one quantity-based and one price-based) to hit precisely the same target can not usually be justified. However, there may be a case for providing firms with the option of choosing the regime to which they are subject. This may be important if firms have very different levels of risk aversion to price uncertainty for permits. Providing tax exemptions for adherents to the tradable permit regime is one means of providing firms with the opportunity to exercise this choice.

Tradable Permits and Voluntary Approaches

102. Voluntary approaches can be integrated with tradable permits in three ways:

- Participation in tradable permit systems can be voluntary for individual firms, an issue which was touched upon above;
- Tradable permits can be used as a means of allocating responsibilities within an industry-wide negotiated agreement; and,
- Emission reductions agreed to under voluntary agreements can be used as a means to allocate permits when there is gratis allocation.

103. These three links between voluntary approaches and tradable permit regimes will be discussed in turn.

Voluntary Participation in Tradable Permit Systems

104. To a certain extent all baseline-and-credit schemes can be described as "voluntary approaches" to environmental regulation. Credits are issued to all firms which achieve emission reductions below a set amount, such as the level of emissions that would prevail under a regulatory system. They can then sell these credits to firms which have emissions in excess of regulated emission levels. In both cases, involvement is voluntary. Low-cost abaters are not "required" to create credits, and high-cost abaters are not “required” to purchase them. In effect, the efficiency gains provided by the tradable permit system are the carrots which provide the incentive for firms to volunteer to be involved in the system.

105. However, in a cap-and-trade scheme the situation is quite different. If the permits are auctioned, no firms would be likely to participate in the scheme in the absence of a regulatory threat or a financial inducement. In the case where permits are allocated gratis the question is significantly more complicated. It is also more policy-relevant since a number of countries are considering to introduce or are introducing voluntary cap-and-trade schemes with ‘opt in’ provisions and gratis allocation mechanisms.

106. In a sense voluntary cap-and-trade schemes based upon gratis allocation of permits are a means to increase abatement efficiency in a manner which is analogous to the case where the regulatory reach is extended through the use of tradable credits for unregulated sites discussed above. However, in this case the reach of the tradable permit system is extended by allowing the affected firms themselves to "volunteer" to participate. In the aforementioned case those already in the scheme encourage others to become involved. In both cases, productive efficiency is increased, since a greater number of firms should mean greater abatement cost heterogeneity, and thus greater potential efficiency gains.

107. However, such schemes are characterised by strategic behaviour and financial uncertainty. Unlike under a mandatory cap-and-trade scheme the firm does not know what the ultimate "cap" will be, since this depends upon how many (and which) firms ‘opt in’. More significantly it must try to predict the ultimate permit price - which is the key factor in its evaluation of whether it makes sense to volunteer or not - without knowing how many and which firms are likely to volunteer. Thus, in order to make an informed choice, each firm must estimate:

A) other firms’ probabilities of volunteering;

B) other firms’ emission levels; and,

C) other firms’ marginal abatement costs.

108. Depending upon the system used for the allocation of permits between the firms, it is quite possible that no firm will choose to volunteer. In effect, each firm faces a different benefit and cost schedule depending upon which other firms are involved. In some cases the net benefits will be positive and in some cases they will be negative relative to the case where they continued to adhere to some existing regulatory regime. It is possible that the distribution of costs and benefits is such that no firm will volunteer, even if it is in their collective interest to do so.

109. This can be seen in Table 2, which provides hypothetical net benefits (or costs) for firms who decide whether or not to volunteer for the scheme, taking into account the choice of other firms. For instance in the cell which is shaded Firm 1 will be a net beneficiary (+20) if Firm 2 also volunteers, perhaps because it will receive a relatively large allocation of permits and/or has relatively low abatement

costs in comparison with Firm 2. However, Firm 2 will not volunteer if it knows that Firm 1 will volunteer since it will lose under these conditions (-10). Similarly if Firm 1 thinks that Firm 3 will volunteer it will not choose to do so, and vice versa. As such, all three firms may well choose to remain under the regulatory scheme, rather than volunteer for the tradable permit system.

Table 2. Incentives for Adherence to Voluntary Tradable Permit Schemes

	Firm 1	Firm 2	Firm 3
Firm 1	X	20 -10	-10 20
Firm 2	-10 20	X	20 -10
Firm 3	20 -10	-10 20	X

110. It is important to note that this can be true even if the overall net benefits for both firms are positive in all cases, as in the hypothetical examples shown in Table 2. There is a “prisoners’ dilemma” in which firms are unlikely to adopt a strategy which is in all their interests since they there is no means by which the commitment of all firms to participate can be enforced.

111. In many instances, however, voluntary adherence is only an option for a sub-set of firms, with most firms being mandatory participants. This is the case with the EPA's SO_2 Allowance Program. In addition, under another section of the EPA's Clean Air Act Amendments, firms or households are able to earn credits by volunteering to retire older high-emitting motor vehicles (see Solomon 1999, p. 379). It is also the case with Pennsylvania's NO_x Allowance Retirement Program which is mandatory for fossil-fuel powered electric generating plants, but voluntary for others (Stavins 2001, p. 30). Similarly, under RECLAIM it is possible for mobile sources and small point sources to volunteer to become involved (see Nash and Revesz 2000).

112. To a great extent allowing for voluntary adherence for some firms while preserving a core of firms for which the cap-and-trade programme is mandatory simplifies the decision for the firm since if the number of potential "voluntary" firms is small relative to the number of "mandatory" firms, the permit price can be taken as given. In such cases, the firm need not be concerned with the three factors mentioned above, but only its own calculus of costs and benefits. This also means that the regulator faces less uncertainty about the likely number of firms that are to be involved.

113. However, even in such cases voluntary adherence can raise concerns. Most importantly, depending upon how the permits are allocated such a scheme might encourage "adverse selection". If the permit allocation is based upon historical emissions (or some variant) those firms that would be most likely to volunteer would be precisely those firms which have since undertaken abatement even in the absence of the programme.

114. The case of the SO_2 Allowance Program is instructive. Between 1996 and 1999 the percentage of emissions that were attributable to "opt-ins" was between 12% and 13% (www.epa.gov/airmarkets). However, Montero (2000) found that this "substitution" provision of the program tended to be taken up by those firms which were allocated permits gratis far in excess of actual emissions. An increase of one

standard deviation in the firm's allocation of permits relative to actual emissions increased the probability of "volunteering" from 32% to 84%. Indeed, the "adverse selection" effect dominated the effects of productive efficiency. Moreover, McLean (1997) has estimated that this single provision was responsible for over half of total administrative costs of the programme.

Tradable Permits as Elements of Voluntary Approaches

115. Rather than voluntary adherence being elements of tradable permit programmes, in some cases tradable permit regimes may be the vehicle through which firms meet their commitments in voluntary agreements. These would, of course, only be relevant for voluntary agreements which are negotiated at the industry or sector level. Moreover, in most cases the trading (if it can even be labeled as such) is implicit.

116. For instance, in the Australian Greenhouse Challenge, aggregate agreements can be struck between the Australian Government and an industry association, on behalf of its members. The agreement describes the actions to be taken and the emission forecasts for the member companies (AGO 1999). These actions and forecasts are the outcome of negotiations between these companies. To a great extent, therefore, the agreement can be considered as a springboard toward voluntary tradable permit system, with industry serving as a "bubble" and the firms negotiating "offsets" internally.

117. In the Australian case, it does not appear that any of the agreements resulted in formal trading schemes. However, under New Zealand's "negotiated greenhouse agreements" (NGA's) the government has explicitly allowed for the use of "trading" mechanisms within collective agreements. Firms are encouraged to consider "intra-signatory trading, bubbles, and offsets" between those signatories which are under-complying and those which are over-complying with the terms of the agreement.[19]

118. In other cases industry itself has initiated discussions concerning the introduction of formal trading as a means to reduce negotiating/bargaining costs which can plague industry-level voluntary agreements. For instance, in the Dutch covenant with the chemical industry the trade association responsible (VNCI) is considering the possibility of creating a tradable permit system to reach the NO_x emission targets (see OECD 1999, p. 116). The aforementioned proposed French scheme for CO_2 permits was to be based upon a permit regime amongst the affected firms (Kitamori 2002).

119. A third example relates to the addition of the ‘pooling’ provision in the proposed EU Emissions Trading Scheme (CEC 2002, Article 25b). In this case installations are allowed to form ‘pools’which take on all the responsibility of issuing, trading, and surrendering allowances for the member firms. This was introduced as a means to protect pre-existing German negotiated agreements. Although, the benefits of this provision are unclear and the costs (additional administration costs and possible free-riding) potentially significant (Sorell 2003)/

Accounting for Voluntary Approaches in Permit Allocations and Baseline Estimation

120. An important additional point relates to the treatment of "voluntary" commitments in the determination of permit allocations. There have been discussions in the literature about the extent to which reductions achieved through formal "voluntary" approaches (negotiated agreements, etc….) should be

19. Intervention by Murray Ward (Department of the Prime Minister and Cabinet, New Zealand) "Greenhouse Gas Emissions Trading: Domestic and International Issues" IEA/EPRI/IETA Workshop, 17th-18th September, 2003.

included in the allocation of permits and in the evaluation of the baseline. To a certain extent, this relates to the ambiguous legal status of different types of voluntary approaches. There is a significant difference between the case of firms which volunteer to reduce emissions through a negotiated agreement under threat of a regulatory backstop, and firms which cooperate amongst themselves without the government playing an active role, and this could affect the volume of reductions achieved.

121. In the proposed Swiss programme for the reduction of CO_2 emissions a large number of firms have negotiated commitments with the government to reduce their emissions. It is envisioned that permits will be issued to firms on the basis of these commitments by 2010, with a pilot trading programme envisioned for 2005-2007. These permits will be freely tradable between firms.[20]

122. In the latter case the inclusion of voluntary reductions in the calculation of the permit allocation or the baseline may be controversial. As noted, with respect to permit allocation, one criticism of "pure" grandfathering has been that it is biased against firms that have been "early movers", investing in abatement above and beyond regulatory requirements prior to the year (or years) which are used as the basis for the allocation of permits. This is obviated by the use of modified grandfathering, such as the allocation on the basis of the maximum level emissions which would have been emitted by firms, while still being in compliance.

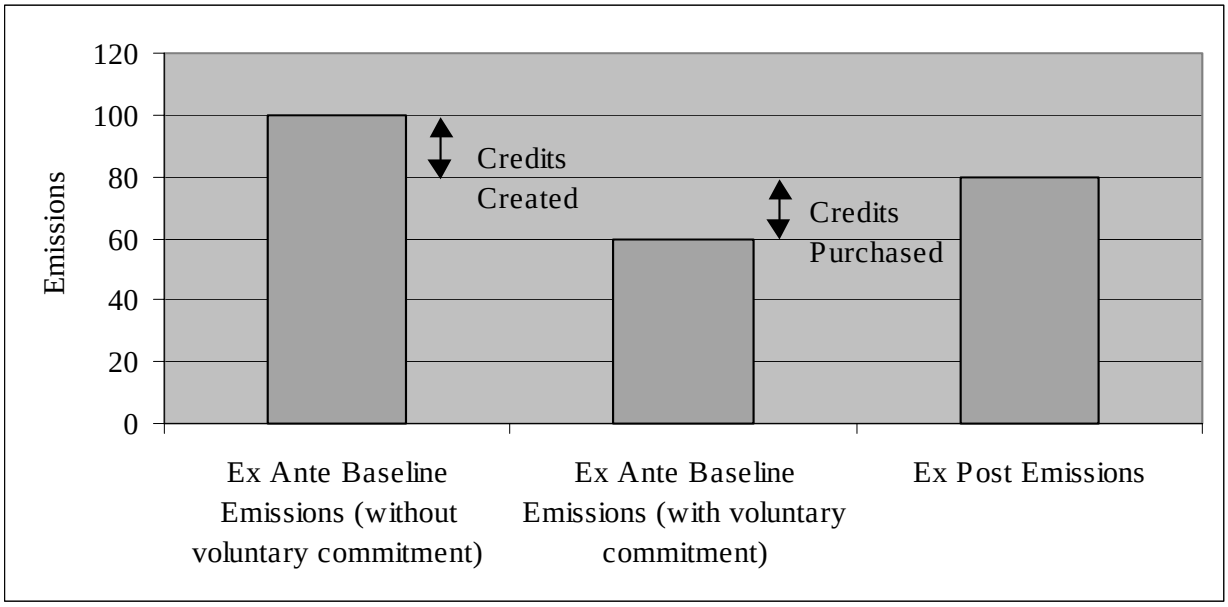
123. For instance, in the Explanatory Memorandum for the CEC's (2001) original proposed directive for an emissions trading scheme for GHG's it is stated that "the target set under the [negotiated] environmental agreements can serve as a useful basis for the allocation of allowances by Member States". This would, however, be politically difficult to achieve if the scope of the permit trading scheme is broader than the scope of the pre-existing agreement since firms which were not party to the agreement would benefit. More generally, this may raise the issue of "moral hazard", perhaps making it more difficult for governments to negotiate agreements with firms in future due to the possibility of this affecting future permit allocations.

124. These ambiguities are even more important in credit-and-baseline schemes where credit creation is affected by the choice of the baseline. In the case where voluntary commitments are not considered part of the baseline, the firm will create more credits than in the case where voluntary commitments are considered part of the baseline. In some cases, the distinction may result in a switch from the firm being a net buyer rather than net seller of permits. This can be seen in Figure 3, where for a given price of permits a firm shifts from being a net seller if voluntary commitments are not included to a net buyer if they are. In some cases it may be preferable to register baselines prior to the introduction of the voluntary agreement.

125. In the Canadian Pilot Emission Reduction Trading Program, Trading Rule 2.4.3 states "an emission reduction is surplus if it is not otherwise required of a source by current regulations or other obligations (e.g. a voluntary commitment). The precise meaning of a "voluntary commitment" was to be elaborated by a special Task Team. In their deliberations it was proposed that one required element for a "voluntary commitment" was that it include a "negotiated agreement between an organization and the government and/or ENGO's such as a Memorandum of Understanding". (See Humphries 2000.)

20. Intervention by Andrea Burkhardt (Swiss Agency for the Environment, Forests and Landscape) "Greenhouse Gas Emissions Trading: Domestic and International Issues" IEA/EPRI/IETA Workshop, 17th-18th September, 2002.

Figure 3: Credit Creation With/Without Voluntary Commitments



Conclusions

126. The benefits of combining tradable permit systems with voluntary approaches depend crucially upon what element of the regime is voluntary. Including "voluntary" emission reductions in the gratis allocation of permits under a cap-and-trade system may make it much more difficult for the government to negotiate future voluntary agreements. By penalising the "early movers" such a scheme has few merits. Including voluntary reductions in the baseline of a baseline-and-credit scheme would also have consequences in terms of incentives for discouraging future abatement efforts by firms.

127. Effectively, in both cases the regulatory authority would have decided "ex post" to convert the voluntary scheme into a mandatory scheme. In one case this is reflected in initial permit allocations and in the other cases it is reflected in the possibilities for credit creation. This may increase the efficiency of the programme, but is better understood as a reflection of the inadequacies of the voluntary approach in some circumstances, than a case for their use in combination with tradable permit regimes.

128. The use of tradable permit schemes by firms within negotiated agreements is surprisingly rare. Considering that many such agreements involve significant bargaining costs which would be avoided by a tradable permit system, the potential benefits could be important. However, such schemes would be dependent upon tight monitoring and enforcement, attributes which are rare in most voluntary agreements. A firm would not want to buy a permit from a competitor unless they were certain that it represented a real property right. However, when satisfactory monitoring and enforcement are present, a strong case could be made for the government serving as an "honest broker" in order to help firms set up credible trading schemes.

129. Voluntary adherence to tradable permit systems potentially has a more important role to play. While an entirely voluntary scheme is unlikely to result in many adherents for the reasons discussed above, using voluntary provisions to expand the scheme beyond the scope of the scheme may increase efficiency by bringing in firms with very different abatement costs. However, the danger of adverse selection must

be confronted. This can only be done by ensuring that the permit allocation mechanism does not grant "excess permits" ("hot air" for climate change negotiators) to firms which can then volunteer for the programme.

Tradable Permits and Tradable Permits

130. Tradable permit regimes are unlikely be used in conjunction with another tradable permit regime which targets the same firms and precisely the same environmental externalities. This would be at best redundant and at worst inefficient. However, if either the target group or the environmental objective differs to some extent two permit regimes may co-exist. In keeping with the scope of this report in this section we will focus on cases in which one tradable permit regime targets a specific environmental impact which is also targeted by a tradable permit regime with much wider objectives, or in which the environmental objectives are distinct but very closely related in technological or ecological terms.

Tradable Emission Permits and Tradable Emission Permits

131. As tradable permit systems become increasingly popular environmental policy instruments there is a greater likelihood that firms will find themselves subject to multiple regimes, just as they are often subject to different direct forms of regulation. This has already started to occur in the United States. For instance, many of the electricity generating plants that are included in the SO_2 Allowance Program are also included in the Northeast's Ozone Transport Commission's (OTC) NO_x programme.[21]

132. However, the issue is perhaps even more important when permits are related in ecological terms, such as the synergistic effects between NO_x and VOC's in the generation of tropospheric ozone. In this case the two regimes would be seeking to reduce the impacts from a single environmental phenomenon (ozone concentrations) which is generated by two emissions. In this case the effectiveness and efficiency of the regime will depend upon whether the more strictly regulated pollutant is the “excess” pollutant or the “scarce” pollutant since this will determine the extent to which the introduction of the permit system achieves environmental benefits. However, the joint use of tradable permit systems can simplify the task for the policymaker. By relaxing and tightening the supply of permits for the two pollutants, it may be easier to minimise abatement costs than under alternative pairs of instruments.

133. Thus, in some senses, complementary sets of tradable permit systems may be necessary for the full realisation of efficiency gains when pollutants are related in technological or ecological terms. In a sense, multiple tradable permit regimes are analogous to integrated permitting for multiple pollutants. However, by allowing firms to trade-off the cost of abatement and permit use for different emissions, the flexibility associated with tradable permits is particularly valuable.

21. In a related vein. Devlin and Grafton (1994) discuss the case in which two pollutants are substitutable in generation and abatement, and a permit regime is introduced for one pollutant but not the other pollutant. Not surprisingly, there is a tendency for firms to substitute towards emissions of the unregulated pollutant. In the worst case scenario, the benefits of the introduction of the permit regime for one pollutant may result in net welfare losses relative to the case where no permit regime is introduced. This will depend upon degree of substitutability and the slope of the marginal damage functions for the two pollutants.

Tradable Emission Permits and Renewable Energy Credits

134. One area in which there has been much discussion of interdependence between tradable permit regimes is the case of tradable renewable energy credits and tradable CO_2 emission permits. (Nielsen and Jeppersen 2001). For example, in Denmark they are considering the joint existence of a tradable credit scheme for "green" energy and a tradable permit system for CO_2 emissions (Morthorst 2001, p. 347). In addition, in the United States, at least eight states have tradable renewable energy credits, which would co-exist with a CO_2 trading programme if it is to be introduced (Dernbach 2000). The Dutch have also had a renewable energy credit scheme in place since 1998 (Nielsen and Jeppersen 2001), and the Australians since 2000.[22] And finally, under the United Kingdom's Renewables Obligation, Tradable Green Certificates can be created for use of renewables beyond a pre-defined baseline (Sorrell 2003).

135. Under tradable renewable energy credits energy suppliers are issued certificates for each kWh of electricity they produce using renewable energy sources. The firms in aggregate must own a minimum of permits. For example, in the White Paper on developing renewable energy, the European Commission proposed an objective of 12%. (CEC 1997) This target could be used as the basis for a tradable renewable energy credit regime. If individual firms exceed this figure they can sell their excess permits to others for whom the costs of using renewable energy is relatively higher. In the Dutch scheme wind energy is the biggest beneficiary, and there has been an average price of approximately 4 Dutch cents (2 € cents) per kWh in the first years (see Nielsen and Jeppersen 2001).

136. The combination is interesting insofar as one of the schemes (CO_2) targets a subset of the targets of the other scheme (renewable energy). Indeed, the defining characteristics of renewable energy schemes is the multiplicity of environmental objectives they are supposed to meet - including climate change and resource conservation. In many senses they are perhaps best described as tools of industrial policy used to support market and technological development, rather than environmental policy tools to internalise externalities (see Baron and Serret 2002).

137. Investments in renewable energy will simultaneously allow for the sale of TRECs and reduce the need to own CO_2 permits. In a sense, this means that there has to be explicit co-ordination between the application of the two instruments. While this need not necessitate integration of the two regimes, it should involve co-ordination with respect to setting objectives. This point has been explicitly recognised by the CEC, which states that "Member States should take account of renewable energy targets when deciding on the quantities of allowances to be allocated under this proposal." (CEC 2001, p. 16.) Firms' incentives to buy and sell CO_2 permits under a cap-and-trade scheme will be affected by the existence of TREC's. In turn, the marginal abatement costs for CO_2 and the opportunity cost of permit use will be affected by the TREC regime.

Relative and Absolute Tradable Permit Systems

138. The links between tradable renewable energy credits and CO_2 permits raises a broader issue related to the links between "absolute" and "relative" tradable permit systems. Tradable renewable energy credits are usually introduced as "relative" TP systems in which firms are subject to an obligation, such as the need to produce x% of total output from renewable energy sources, irrespective of the level of output. If they use less than x% renewable energy they have to buy renewable energy credits up to the level at which they meet their obligation (see Baron and Serret 2002).

22. Intervention by Mr. Steve Moran (Climate Change Section, Foreign Affairs and Trade, Australia) "Greenhouse Gas Emissions Trading: Domestic and International Issues" IEA/EPRI/IETA Worshop, 17th-18th September, 2003.

139. However, relative tradable permit schemes arise in other areas as well. Under the UK Emissions Trading Scheme some firms are subject to a relative target (expressed in terms of CO_2 per unit of output) under the Climate Change Agreements while others will be subject to a cap expressed in absolute terms under the Emissions Trading Scheme (see Kitamori 2002). A similar scheme is being proposed for the Dutch NO_x and CO_2 programmes, in order to protect firms in those sectors which are highly traded (see Koutstaal et al. 2002).

140. The problem with such schemes is that the relative scheme does not provide environmental certainty insofar as emissions depend upon the level of output. More importantly, they can jeopardise the effectiveness of the absolute scheme (Baron and Serret 2002). The reason is simple - the relative scheme is equivalent to a scheme in which absolute permits are issued for emissions, but a subsidy is provided to output (see Koutstaal et al. 2002). Under such a scheme, the relative target has to decline continuously in step with changes in output. It must be recognised that this conclusion relates only to emission levels from firms within the scheme. If, however, there are concerns that an absolute scheme will result in competitiveness impacts, the greater environmental certainty for firms within the scheme may be counterbalanced by increased emissions due to 'leakage' to firms (domestically or internationally) who are not affected by the scheme.

141. In order to try and overcome this problem in the UK scheme, a "gateway" has been devised between the absolute and relative schemes in an effort to ensure that the relative scheme does not "contaminate" the absolute scheme such that environmental effectiveness is jeopardised. This is done by restricting sales from the firms subject to relative obligations under the CCA to the firms subject to absolute obligations under the ETS to the level which has been sold from the ETS to the CCA. (See Kitamori 2002.) Depending upon market developments the two markets could become entirely segmented.

Conclusions

142. The joint use of tradable permit regimes for pollutants which are substitutable in technological or ecological terms is necessary for the maximisation of efficiency gains. Indeed, it is even possible that if a regime is introduced for only one pollutant, there may be net welfare costs associated with its introduction. In any event, jointness of production and environmental synergies highlight the need for integrated policy regimes.

143. The joint use of emission permits and TREC's may also result in increased welfare gains compared to the application of just one instrument. However, this is very much dependent upon the ability of the TREC scheme to meet clearly-defined objectives. If their primary objective is to reduce CO_2 emissions, then their use as a complement to CO_2 permits can only be made if they are used to overcome barriers or failures which are slowing market development. While it is not always easy to make such a case, TREC regimes are likely to be preferable to less neutral policy instruments such as subsidies.

144. And finally, the case for the joint use of relative and absolute permit regimes can only be made on political grounds. There is no analytical case for the use of a relative permit regime if an absolute regime is feasible. Moreover, insofar as they may "corrupt" the absolute permit regime, overall environmental effectiveness may be reduced. Even as a means of addressing competitiveness concerns, there are likely to be much better options, such as using revenues to reduce particularly distortionary taxes.

Summary Conclusions and Further Work

145. In practice tradable permit systems almost always co-exist with other environmental policy instruments. Examples of this dependence include: the use of direct regulation in permit allocation or

credit creation; the use of taxes or penalties to ensure compliance; and, the "voluntary" nature of adherence to credit-and-baseline schemes. Whether or not these are desirable combinations of instruments is a subject for more in-depth analysis. However, this report has shown that there are specific conditions under which the joint use of tradable permits in conjunction with other policy instruments may be preferable to the application of one or the other instrument on its own. Perhaps the most important cases are the following:

- *Dealing with spatial differentiation of impacts*. Work on tradable permits has revealed that it is important for the smooth and efficient functioning of the market that the permit market be very broad. However, for pollutants whose impacts vary by place of emission, this implies that the permit price will only be incidentally associated with marginal damages for most emitters. There is, therefore, a trade-off between efficiency in the market for permits and the equalisation of marginal abatement costs with marginal environmental damages. In order to mediate this trade-off it may be preferable to use direct regulations as constraints on trading, rather than complicating the permit regime itself.

- *Technology market barriers and failures*. Most tradable permit regimes target emissions (or a close proxy). Under perfect market conditions, such a regime should "call forth" the optimal rate and direction of technological change to reduce these impacts. However, if there are significant market failures which adversely affect the development of technologies for abatement, then it may be necessary to introduce complementary policies to overcome such failures if the environmental damages are to be reduced at least costs. Instruments such as subsidies and renewable energy credits may serve such a role.

- *Expanding regulatory scope*. The flexibility of tradable permit regimes allows them to play an important role in expanding the scope of the regulatory authority's reach, particularly when used in conjunction with other instruments. For instance, effective combinations can be devised to allow for voluntary adherence to tradable permit systems or to encourage regulated firms to improve environmental performance in unregulated firms. Using tradable permits can be a lower-cost option than extending regulatory reach by expanding the scope of direct regulations to areas which are difficult to reach.

- *Reducing cost uncertainty* Tradable permits have the singular advantage of environmental effectiveness. Unlike any other instrument - including direct regulations - the achievement of a particular environmental objective (if expressed in terms of emissions) can be achieved with certainty. However, they have uncertain cost implications. Using taxes as a cap on permit prices and subsidies as a floor, can reduce this uncertainty. By reducing risk, this can have benefits for both affected firms and for the regulatory authority.

146. However, in all cases the objective of each instrument must be clearly defined, and the relationship between the two instruments must be properly understood. If the objectives are the same, in almost all cases one or the other instrument will be at best redundant, and at worst the combination will be inefficient and administratively costly. Thus in order for the use of an additional policy instrument to be increase efficiency in the presence of a tradable permit system, the “complementary” instrument must:

- meet a legitimate policy objective which can not be met through the tradable permit system;

- be the best instrument available to the regulatory authority if it is to meet that policy objective;

- be administratively feasible at reasonable cost; and,

- be an effective complement to the tradable permit system.

147. More generally, exploring the conditions under which multiple instruments are likely to be more effective and efficient than the application of a single policy instrument requires considerable further analysis and, is thus the subject of a new work programme being developed [see ENV/EPOC/WPNEP(2002)29].

REFERENCES

ALBRECHT, J., D. FRANCOIS and K. SCHOORS (2002). "Energy Efficiency Benchmarking and Emissions Trading" Paper Presented at the *CATEP Workshop on the Design and Integration of National Tradable Permit Schemes for Environmental Protection*, University College London, March 2002.

AUSTRALIAN GREENHOUSE OFFICE (1999). *Greenhouse Challenge: Evaluation Report* (Canberra: AGO).

BAILEY, E. M. (1996). "Allowance Trading Activity and State Regulatory Rulings: Evidence from the U.S. Acid Rain Program." Cambridge, MA: Massachusetts Institute of Technology, CEEPR Working Paper.

BARON, RICHARD AND YSE SERRET (2002). "Renewable Energy Certificates: Trading Instruments for the Promotion of Renewable Energy" in OECD *Implementing Domestic Tradable Permits: Recent Developments and Future Challenges* (Paris: OECD).

BOHI, D. R. and D. BURTAW (1997). "SO_2 Allowance Trading: How Experience and Expectations Measure Up." Washington, D.C.: Resources for the Future Discussion Paper 97-24.

BUTTERS, MIKE (2000). "Pilot Emission Reduction Trading: Clean Air Mechanisms and the PERT Project" (Toronto: PERT, 2000).

COMMISSION OF THE EUROPEAN COMMUNITIES (1997). "Energy for the Future: Renewable Sources of Energy" (COM(97)599).

COMMISSION OF THE EUROPEAN COMMUNITIES (2001). "Directive of the European Parliament and the Council Establishing a Framework for the GHG Emissions Trading within the European Community and Amending Council Directive 96/61/EC" (COM(2001) 581 Final - 2001/0245 (COD)).

COMMISSION OF THE EUROPEAN COMMUNITIES (2002). "Amended Proposal for a Directive of the European Parliament and the Council Establishing a Framework for the GHG Emissions Trading within the European Community and Amending Council Directive 96/61/EC" (Com(2002) 680 Final - 2001/0245 (COD)).

CONRAD, K. and R.E. KOHN (1996). "The U.S. Market for SO_2 Permits: Policy Implications of the Low Price and Trading Volume" in *Energy Policy*, Vol. 24, No. 12, pp. 1051-1059.

CRAMTON, PETER and SUZI KERR (1998). "Tradable Carbon Permit Auctions: How and Why To Auction, Not Grandfather" Washington, D.C.: Resources for the Future Discussion Paper 98-34.

DERNBACH, J. et al. (2000). "Moving the Climate Change Debate from Models to Proposed Legislation: Lessons from State Experience" in *Environmental Law Review*, Vol. 30, No. 11, pp. 10935-10979.

DEWEES, D. N. (2001). "Emissions Trading: ERCs or Allowances?" in *Land Economics*, Vol. 77, No. 4, pp. 513-520.

ELLERMAN, A. D. (2002). "Analysis of the Bush Proposal to Reduce the SO_2 Cap" Cambridge, MA: Massachusetts Institute of Technology, CEEPR Working Paper.

FARRELL, A., R. CARTER and R. RAUFER (1999). "The NO_x Budget: Market-Based Control of Tropospheric Ozone in the Northeastern United States" in *Resource and Energy Economics*, Vol. 21, pp. 102-124.

FROMM, O. and B. HANSJÜRGENS (1996). "Emission Trading in Theory and Practice: An Analysis of RECLAIM in Southern California" in *Environment and Planning C: Government and Policy*, Vol. 14, pp. 367-384.

FULLERTON, D. and A. WOLVERTON (1997). "The Case for a Two-Part Instrument: Presumptive Tax and Environmental Subsidy" Cambridge, Mass.: NBER Working Paper 5993.

FULLERTON, D., S. P. MCDERMOTT and J. P. CAULKINS (1997). "Sulfur Dioxide Compliance of a Regulated Utility" in *Journal of Environmental Economics and Management*, Vol. 34, pp. 32-53.

FULLERTON, DON and GILBERT METCALF (1997). "Environmental Controls, Scarcity Rents and Pre-existing Distortions" Cambridge, Mass.: National Bureau of Economic Research, Working Paper 6091.

GODARD, OLIVIER (2001). *Domestic Transferable Permits for Environmental Management: Design and Implementation* (Paris: OECD).

GRAFTON, R. Q. and R. A. DEVLIN (1994). "Les Permis d'émission et les charges: efficacité et substitutabilité" in *L'Actualité Economique: Revue d' Analyse Economique*, Vol. 70, No. 2, pp. 159-176.

HAHN, R. W. and C. A. MAY (1994). "The Behaviour of the Allowance Market: Theory and Evidence" in *Electricity Journal*, March, pp. 28-37.

HAHN, R. W. and G. L. HESTER (1989). "Marketable Permits: Lessons for Theory and Practice" in *Ecology Law Quarterly*, Vol. 16, 361-406.

HAHN, R. W. and R. G. NOLL (1983). "Barriers to Implementing Tradable Air Pollution Permits: Problems of Regulatory Interactions" *Yale Journal on Regulation*, Vol. 1, No. 63, pp. 63-91.

HARRISON (1999). "Tradable Permits for Air Pollution Control: The United States Experience" in OECD *Domestic Tradable Permit Systems for Environmental Management: Issues and Challenges* (Paris: OECD).

HUMPHRIES, D. (2000). *What is a Voluntary Commitment within the PERT Trading Rule?* (Toronto: CleanAir Canada).

IBENHOLT, K. (2002). "Explaining Learning Curves for Wind Power" in *Energy Policy* (forthcoming).

JAFFE, A., R. NEWELL and R. STAVINS (2002). "Technological Change and the Environment" in Karl-Göran Mäler and Jeffrey Vincent, eds, *Handbook of Environmental Economics* (Amsterdam: North-Holland).

JEANRENNAUD, C. (1999). "Obstacles to the Implementation of Tradable Permits: The Case of Switzerland" in OECD *Implementing Domestic Tradable Permits for Environmental Protection* (Paris: OECD).

JOHNSON, S. L. and D. M. PEKELNEY (1996). "Economic Assessment of the Regional Clean Air Incentives Market: A New Emissions Trading Program for Los Angeles" in *Land Economics*, Vol. 72, No. 3, pp. 277-97.

JOHNSTONE, N. (1999). "Tradable Permit Systems and Industrial Competitiveness" in OECD *Implementing Domestic Tradable Permits for Environmental Protection* (Paris: OECD).

KITAMORI, KUMI (2002). "Domestic GHG Emissions Trading Schemes: Recent Developments and Current Status in Selected OECD Countries" in OECD *Implementing Domestic Tradable Permits: Recent Developments and Future Challenges* (Paris: OECD).

KLAASSEN, G. and A. NENTJES (1995). "Emission Trading for Air Pollution Control in Practice" Laxenberg, Austria: International Institute for Applied Systems Analysis Working Paper 95-21.

KOUTSTAAL, P., A. M. GIELEN and H. VOLLERBERGH (2002). "A Comparison Between Emission Trading with Absolute and Relative Targets" Paper Presented at the *CATEP Workshop on the Design and Integration of National Tradable Permit Schemes for Environmental Protection*, University College London, March 2002.

KRAEMER, A. and K. M. BANHOLZER (1999). "Tradable Permits in Water Resource Management and Water Pollution Control" in OECD *Implementing Domestic Tradable Permits for Environmental Protection* (Paris: OECD).

LARSEN, BJORN AND ANWAR SHAH (1994). "Global Tradable Carbon Permits, Participation Incentives and Transfers" in *Oxford Economic Papers*, Vol. 46, pp. 841-856.

MARKANDYA A., AND A. SHIBLI (1995). *Industrial Pollution Control Policies in Asia* (Cambridge, MA: Harvard Institute for International Development, Environmental Discussion Paper No. 3).

MCLEAN, B. J. (1997). "Evolution of Marketable Permits: The U.S. Experience with Sulfur Dioxide Allowance Trading" in *International Journal of Environment and Pollution*, Vol. 8, Nos. 1/2, pp. 19-36.

MONTERO, J.-P. (2000). "Voluntary Compliance with Market-Based Environmental Policy: Evidence from the U.S. Acid Rain Program" Cambridge, Mass.: MIT Center for Energy and Environmental Policy Research, Working Paper.

MORTHORST, P.E. (2001). "Interactions of a Tradable Green Certificate Market with a Tradable Permits Market" in *Energy Policy*, Vol. 29, pp. 345-353.

NASH, J. R. and R. L. REVESZ (2001). "Markets and Geography: Designing Marketable Permit Schemes to Control Local and Regional Pollutants" in *Ecology Law Quarterly*, Vol. 28, pp. 559-661.

NIELSEN, LENE and TIM JEPPESEN (2001). "Green Electricity Certificates: A Supplement to the Flexible Mechanisms of the Kyoto Protocol" Odense, Denmark: Department of Economics, University of Southern Denmark, Working Paper.

OATES, W. E. et al. (1989). "The Net Benefits of Incentive-Based Regulation" in *American Economic Review*, Vol. 79, No. 5, ppp. 1233-1242.

OECD (2000). *Voluntary Approaches for Environmental Policy: An Assessment* (Paris: OECD).

OECD (2003). *Voluntary Approaches for Environmental Policy: Effectiveness, Efficiency and Usage in Policy Mixes* (Paris: OECD).

PALMER, R. and N. DAVIES (2002). "Proposals for a Nox and SO2 Trading Scheme in the United Kingdom" Paper Presented at the *CATEP Workshop on the Design and Integration of National Tradable Permit Schemes for Environmental Protection*, University College London, March 2002.

POLESETSKY, M. (1995). "Will a Market in Air Pollution Clean the Nation's Dirtiest Air? A Study of the South Coast Air Quality Management District's Regional Clean Air Incentives Market" in *Ecology Law Quarterly*, Vol. 22: 359-411.

ROBERTS, MARC J. and MICHAEL SPENCE (1976). "Effluent Charges and Licenses under Uncertainty" in *Journal of Public Economics*, Vol. 5, pp. 193-208.

SALMONS, R. (2002). "New Areas for the Application of Tradable Permits: Solid Waste Management" in OECD *Implementing Domestic Tradable Permits: Recent Developments and Future Challenges* (Paris: OECD).

SHABMAN, L, K. STEPHENSON and W. SHOBE "Trading Programs for Environmental Management: Reflections on the Air and Water Experiences" Blacksburg, Virginia: Department of Agricultural and Applied Economics, Virginia Tech.

SMITH, S. (1999). "The Compatibility of Tradable Permits with other Environmental Policy Instruments" in in OECD *Implementing Domestic Tradable Permits for Environmental Protection* (Paris: OECD).

SOLOMON, BARRY D. (1999). "New Directions in Emissions Trading: The Potential Contribution of New Institutional Economics" in *Ecological Economics*, Vol. 30, pp. 371-387.

SORRELL, STEVE (2003). “Back to the Drawing Board?”: Implications of the EU Trading Emissions Directive for UK Climate Policy” University of Sussex at Brighton, SPRU Science and Technology, Environment and Energy Programme Working Paper.

STAVINS, R. N. (2001). "Experience with Market-Based Environmental Policy Instruments" in Karl-Göran Mäler and Jeffrey Vincent (eds.). *Handbook of Environmental Economics* (Amsterdam: North-Holland/Elsevier Science).

TIETENBERG, T. (1998). "Tradable Permits and the Control of Air Pollution in the United States" Colby College, Department of Economics, Working Paper.

TIETENBERG, T.H. (1995). "Tradable Permits for Pollution Control when Emission Location Matters: What Have We Learned?" in *Environmental and Resource Economics*, Vol. 5, No. 1, pp. 95-113.

TIETENBERG, T.H. (1998). "Ethical Influences on the Evolution of the U.S. Tradable Permit Approach to Pollution Control" in *Ecological Economics*, Vol. 24, Nos. 2-3, pp. 241-257.

TIETENBERG, T.H. (2001). *Emissions Trading Programs Vol. 1: Implementation and Evaluation* (Aldershot UK: Ashgate).

TIETENBERG, T.H. (2002). "The Tradable Permit Approach to Protecting the Commons: What Have We Learned?" in T.H. Tietenberg (ed.). *The Drama of the Commons* (Washington: National Academy Press).

UNITED KINDGOM DEPARTMENT OF THE ENVIRONMENT, TRANSPORT AND THE REGIONS (2001). "Tradable Landfill Permits Consultation Paper" (London: DETR).

VUKINA, T. and A. WOSSINK (2000). "Environmental Policies and Agricultural Land Values: Evidence from the Dutch Nutrient Quota System" in *Land Economics*, Vol. 76, No. 3, ppp. 413-429.

WEITZMAN, M. L. (1974). "Prices vs. Quantities" in *Review of Economic Studies*, Vol. 41, No. 4, pp. 477-491.

ZYLICZ, T. (1999). in "Obstacles to the Implementation of Tradable Permits: The Case of Poland" in OECD *Implementing Domestic Tradable Permits for Environmental Protection* (Paris: OECD).