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Marketable Permits: The Case of Chlorofluorocarbons

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INTRODUCTION

Chlorofluorocarbons (CFCs) are a group of chemicals which have been suspected of causing destruction of stratospheric ozone. In 1978, the Environmental Protection Agency (EPA) prohibited the use of CFCs as aerosol propellants. In 1980, EPA announced that it was considering the use of a marketable permit system as a possible option, in the event that regulation of non-aerosol use of these chemicals was deemed appropriate. Although the Agency has used somewhat similar regulatory approaches in its bubble and offset programs under the Clean Air Act, those initiatives have been overlaid on an existing, extensive regulatory structure consisting of mandatory standards for emissions levels, and are implemented on a relatively local scale. In the case of chlorofluorocarbons, the marketable permit system was evaluated for application as a basic regulatory approach on a nationwide scale. As such, the chlorofluorocarbon case represents a relatively unique instance in EPA's efforts to consider the use of economic incentives in place of traditional regulations.

This paper will focus on the economic aspects of the Agency's considerations as they relate to a marketable permit system. The scientific aspects of the chlorofluorocarbons issue, while obviously critical from the standpoint of the Agency's overall policy toward chemicals, will only be touched upon here. Our basic purposes are to illustrate how considerations of marketable permits evolved from broad concepts to highly detailed analyses and to describe some of the results of these analyses.

We will begin by providing a brief historical overview of the chlorofluorocarbon ozone issue and of the reasons why marketable permits were considered as a possible regulatory approach. We will then summarize some of the detailed economic studies which were conducted for EPA to determine the costs and impacts of this and other regulatory approaches.

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Next we will describe some of the issues which were considered once the basic results of the economic modeling were available, and will summarize industry's reactions to the marketable permit approach. We will conclude with some observations about what we have learned in the course of this work.

BACKGROUND

Chloroflurocarbons (CFCs) are a group of stable halogen compounds used in a variety of applications including refrigeration, solvents, blowing agents, and food freezing. Since 1974, scientists have theorized that when CFCs are emitted into the atmosphere the compounds migrate to the stratosphere where they photodisassociate into chlorine and other compounds.

The chlorine is thought to react with ozone, upsetting normal ozone creation and destruction processes.[1] Since ozone acts as a shield for ultraviolet (UV) radiation, a depletion of the ozone layer would increase harmful UV levels at the earth's surface. Increased UV may have a number of adverse health and environmental consequences, including increased incidence of skin cancer, damage to crops and aquatic life, and climatic changes. Substantial scientific disagreement exists with respect to the ozone theory and its consequences. Following the theory's articulation in 1974, additional research and analysis expanded knowledge in the area, but neither validated nor disapproved the original theory.[2]

In response to concern over the ozone depletion problem, the Environmental Protection Agency (EPA) and the Food and Drug Administration (FDA) prohibited the use of CFCs as aerosol propellants in nonessential uses in 1978.[3] Several other countries subsequently acted to limit the use of CFCs as aerosol propellants.

In 1979, the National Academy of Sciences published additional reports on the ozone depletion question.[4] These reports tended to support the

1. Stolarski and Cicerone, *Stratospheric Chlorine: A Possible Sink for Ozone*, 52 CAN. J. CHEMISTRY 1610 (1974); Molina and Rowland, *Stratospheric Sink for Chlorofluoro methanes: Chlorine Atom Catalyzed Destruction of Ozone*, 249 NATURE 810 (1974); Crutzen, *Estimates of Possible Future Ozone Reduction from Continued Use of Fluorochloromethanes*, 1 GEOPHYSICAL RESEARCH LETTERS 205 (1974).

2. NAT'L ACADEMY OF SCIENCES, INTERIM REPORT OF THE PANEL ON ATMOSPHERIC CHEMISTRY (1975); and HALOCARBONS: EFFECTS ON THE STRATOSPHERIC OZONE (1976).

3. 43 Fed. Reg. 11,301–325 (1978) (codified at 40 C.F.R. § 762).

4. NAT'L ACADEMY OF SCIENCES, STRATOSPHERIC OZONE DEPLETION BY HALOCARBONS: CHEMISTRY AND TRANSPORT (1979); and NAT'L ACADEMY OF SCIENCES, PROTECTION AGAINST DEPLETION OF STRATOSPHERIC OZONE BY CHLOROFLUOROCARBONS (1979).

earlier concerns, suggesting that the best estimate of ozone depletion was greater than had earlier been predicted. But again it was not possible to empirically confirm the ozone depletion hypothesis.

In October 1980, EPA issued an Advance Notice of Proposed Rulemaking (ANPR), stating that it was considering possible regulation of non-aerosol CFC uses.[5] The Agency solicited comments from interested parties on the ozone depletion theory and related scientific issues, as well as economic aspects of possible CFC control measures. The Agency described a number of regulatory options, including mandatory controls and variations of two economic incentives approaches—taxes and marketable permits.

What factors led EPA to consider economic incentive approaches for these chemicals? CFCs have certain characteristics which seem to lend themselves to the use of economic incentives. In particular, only total CFC use determines the ultimate damage to the stratosphere. This characteristic is in contrast to most other types of pollutants, where ultimate environmental impact depends on the specific location and circumstances of use. For such pollutants, efficient incentive strategies require that taxes or permits be adjusted to take into account the circumstances of location, environmental fate and transport. Since the ozone depletion potential of CFCs does not depend on where or how they are used, either tax setting or permit trading are greatly simplified. A single tax or permit market could be employed on a national scale to efficiently regulate CFC activities. While various CFCs differ in their ability to deplete atmospheric ozone, scientific assessments of this potential can be used to define a relatively straightforward weighting scheme. Again, however, there is no need to tailor either a tax scheme or a permit system to take local variation into account.

A second major advantage seems to arise from the nature of CFC markets. CFCs are used in many applications by large numbers of small firms. Limited use regulations could be extremely difficult and costly for EPA to enforce effectively. Moreover, it is virtually impossible for EPA to take into account the large variation in individual users' production and control cost functions in attempting to develop an efficient set of mandatory regulations. However, given a general limit on CFC production and use or a tax, there are a variety of options available to users who, faced with rising CFC costs, would voluntarily implement these options.

These factors convinced a number of Agency analysts that economic incentives approaches should be seriously considered. As a result, a series of detailed analyses of these options were undertaken.

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5. 45 Fed. Reg. 66,726–734 (1980).

ECONOMIC MODELING

The Rand Corporation provided economic analysis support to EPA through a series of contracts beginning in 1976.[6] Rand gathered basic background data on the markets and technologies involved in the various uses of CFCs and their feedstocks, and developed a simulation model which related CFC use to price. This model was then used to evaluate the costs and effectiveness of various regulatory options for a 10 year period, from 1980 to 1990.

The market segments and the CFC categories considered by Rand are listed in Figure 1, along with 1976 use data. Three CFC types were included in the model: CFC 11, 12 and 113. While other CFC types are used commercially, they were not included in the Rand analysis because their potential for depleting stratospheric ozone was much lower than that of CFCs 11, 12 and 113. The use estimates are presented in weighted pounds, where CFCs are weighted by their relative potential to deplete

FIGURE 1

CFC USES—1976

CATEGORY	CFCs	WEIGHTED USE 10^6 POUNDS
FLEXIBLE URETHANE FOAMS	11	34
SOLVENTS	113	53
RIGID FOAMS	11, 12	55
MOBILE AIR CONDITIONERS	12	71
CHILLERS	11, 12	12
HOME REFRIGERATORS AND FREEZERS	12	5
RETAIL FOOD REFRIGERATION SYSTEMS	12	9
MISCELLANEOUS	11, 12	18
TOTAL		257

6. A. PALMER, W. MOOZ, T. QUINN, & K. WOLF, ECONOMIC IMPLICATIONS OF REGULATING CHLOROFLUOROCARBON EMISSIONS FROM NONAEROSOL APPLICATIONS (The Rand Corp.—Contract No. R-2524, 1980); W. MOOZ & T. QUINN, FLEXIBLE URETHANE FOAMS AND CHLOROFLUOROCARBON EMISSIONS (The Rand Corp.—Contract No. N-1472, 1980); K. WOLF, REGULATING CHLOROFLUOROCARBON EMISSIONS: EFFECTS ON CHEMICAL PRODUCTION (The Rand Corp.—Contract No. N-1483, 1980); A. PALMER & T. QUINN, ECONOMIC ASSESSMENT OF A CHLOROFLUOROCARBON PRODUCTION CAP (The Rand Corp.—Contract No. N-1656, 1981); A. PALMER & T. QUINN, ALLOCATING CHLOROFLUOROCARBON PERMITS: WHO GAINS, WHO LOSES, AND WHAT IS THE COST? (The Rand Corp—Contract No. R-2806, 1981).

ozone. CFC 11, which has the greatest potential, is assigned a weight of one.

Eight market sectors were included in the model:

1. *Flexible Urethane Foams*. CFCs are employed as blowing agents to produce flexible urethane foams used in furniture, automotive seats, bedding, carpet underlay and in other products as cushioning materials.
2. *Solvents*. CFC 113 is used as a solvent in industrial cleaning and degreasing operations.
3. *Rigid Foams*. Like flexible foams, rigid foams utilize CFCs as blowing agents. Rigid foams are used to provide insulation in construction, refrigeration and transportation applications, and in a wide variety of consumer products, including cups, food chests, fast food packaging, flotation devices, etc.
4. *Mobile Air Conditioners*. CFC 12 is used as the refrigerant in these conditioners.
5. *Chillers*. Air conditioning systems used in large commercial and industrial buildings are known as chillers. CFCs 11 and 12 are utilized in many of these units as the primary refrigerants.
6. *Home Refrigerators and Freezers*. Such appliances use a relatively small quantity of CFC 12.
7. *Retail Food Refrigeration*. CFC 12 is used in medium temperature food refrigeration systems which store meat and dairy products for display.
8. *Miscellaneous*. The remaining uses for CFCs include sterilants, liquid fast freezing systems for foods, and a variety of miscellaneous uses, some of which may become significant in the future.

For each of the major use areas, substitutes or emissions reduction technologies were identified. These control measures are listed in Figure 2.

In three areas—flexible foams, rigid foams, and solvents—non-CFC substitutes can be used for at least a portion of the CFC applications. A CFC substitute, CFC 502, is feasible in retail food refrigeration applications and would have much less ozone depletion potential than CFC 12. Similarly, less depleting CFCs can be used in place of the standard CFCs in testing chillers and refrigeration equipment. Finally, recovery and reuse of CFCs is possible in flexible and rigid foams, solvents, and during servicing or salvage of mobile air conditioning equipment.

These control measures do not reflect the full range of technically possible control options. The basic approach was to select those technologies that could be implemented without much further development. In addition, Rand excluded certain costly control measures that would

FIGURE 2

CFC CONTROL TECHNOLOGIES

USE	CONTROLS
FLEXIBLE URETHANE FOAMS	—CFC Recovery —Substitution (Methylene Chlroide)
SOLVENTS	—Reduced Vapor Loss —Increased use of reclaimed material —Substitute Solvents
RIGID FOAM	—CFC Recovery —Substitution (Pentane)
MOBILE AIR CONDITIONERS	—Recovery at Service or Salvage
CHILLERS	—Different Test Gases
HOME REFRIGERATORS AND FREEZERS	—NONE
RETAIL FOOD REFRIGERATION	—Substitutes for Leak Testing —Substitute Refrigerant (CFC 502)
MISCELLANEOUS	—NONE

not yield substantial emissions effects until far beyond the study's 10 year horizon.

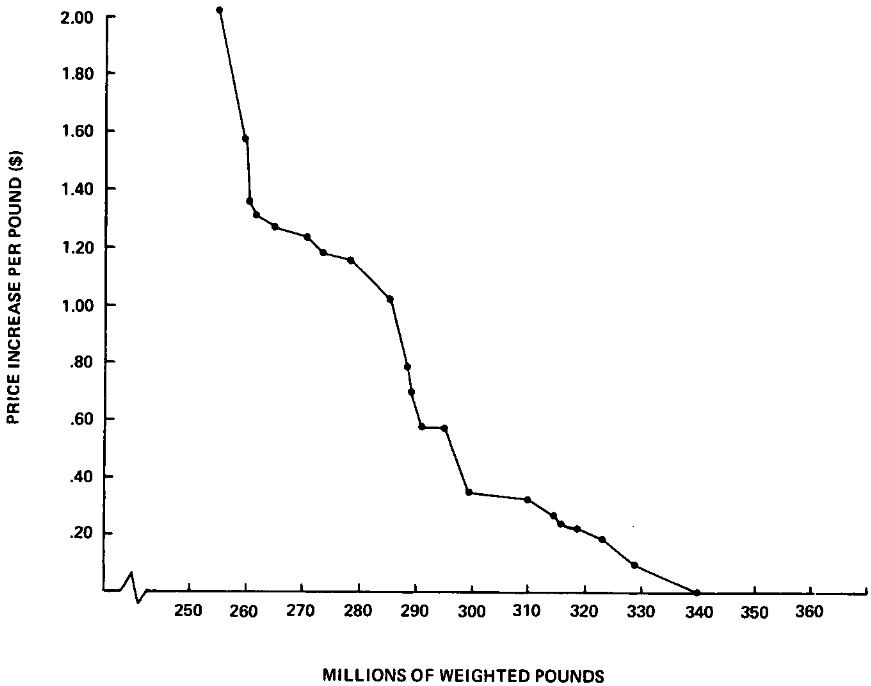
The cost of each control option was estimated using an engineering-cost approach for typical facilities in each application area. CFC use reduction by category was computed against baseline projections determined from available trends and forecasts of activity in each application. Using these data, a series of annual demand curves were generated, assuming that firms would act as cost minimizers, adopting those CFC use reduction measures that would be economical at each hypothetical CFC price level. Since CFCs are inputs to the production of other products, a full specification of the derived demand for CFCs also required specification of the final product demand curves. In most instances these were assumed to be completely inelastic in order to insure that regulatory costs were not underestimated. Because CFCs constitute an extremely small percentage of the final product cost, even at very elevated prices, this assumption would not yield results too far from the truth.

Figure 3 is an example of the type of demand curves which were generated. The graph summarizes the demand for all CFCs considered, weighted by their potential to deplete ozone.[7] The vertical axis is the

7. All subsequent references to pounds of CFC are intended to indicate pounds weighted for potential to deplete ozone.

FIGURE 3

DEMAND CURVE FOR CFCs—1980



price increase per pound of CFC 111 and the horizontal axis is the total number of pounds. The points on the graph indicate the prices at which different CFC users would find it less costly to substitute for CFCs or employ technological controls.

These demand curves provide the basic tool for evaluating economic incentives policies. According to Figure 3, a tax of one dollar per pound of CFCs would reduce use by 54 million pounds in 1980, from 340 to 286 million pounds. Equivalently, a production limit set at 286 million pounds would increase the CFC price by roughly one dollar per pound in 1980. As the demand curve shifts to the right in subsequent years, the price would increase.

The basic model was used to evaluate a number of policy options, three of which are described here. The first is a mandatory control scenario.[8] Rand selected a benchmark set of mandatory control measures:

—Recovery and recycling of CFC in flexible foams;

8. PALMER, MOOZ, QUINN & WOLF (1980), *supra* note 6.

—Equipment standards for cleaning and drying;
—Conversion to R-22 test gas in the manufacture of chillers and retail food refrigeration systems; and
—Conversion to CFC-502 refrigerant in medium temperature retail food refrigeration systems.

As represented in Figure 4, this benchmark set of controls would yield a cumulative reduction of 608 million pounds from 1980–1990 at a present value resource cost of $185.3 million 1976 dollars.

FIGURE 4

EXAMPLE RESULTS

Control Option	Present Value of Resource Costs 1980–90	Total CFC Reduction 1980–90 Pounds	CFC Price Increase Per Pound		Present Value of Transfers 1980–90
1. MANDATORY CONTROL BENCHMARK	$185 ($10^6$)	608 (10^6)	——		——
2. ECONOMIC INCENTIVES EQUIVALENT TO (1.)	$108 ($10^6$)	610 (10^6)	$.70		$1,720 ($10^6$)
3. PRODUCTION AT 1980 LEVELS	$275 ($10^6$)	1,200 (10^6)	$0.09 0.94 2.80	(1981) (1985) (1990)	$1,829 ($10^6$)

The second option is an economic incentives approach that would yield a cumulative CFC reduction equivalent to the mandatory control case. An economic incentives strategy which increased the CFC cost by about 70 cents per pound would yield the same level of reduction at a total real cost of about $108 million dollars, about 40 percent less than the mandatory controls.[9]

These calculations, however, illustrate the difficulty of doing this type of ex ante comparison as much as they illustrate the efficiency of a market based approach. We could develop a mandatory control set that would be just as efficient as the market solution from the standpoint of the model: we would simply take the market solution control measures and make them mandatory. Rand assumed that some of the control measures—

9. *Id.*

primarily those associated with substitutes—were not realistic mandatory options because they were not enforceable. Because of the many small users and the widespread availability of CFCs, some argued that meaningful enforcement of a mandatory use ban of CFC in certain applications would not be feasible. The entire efficiency gain of the market approach is generated by the exclusion of these "non-enforceable" options from the mandatory set. At the same time, the analysis omits the key savings of a market approach—that is, the ability within each use area for the individual firms to optimize their selection of technology. This comment is not a criticism of the Rand work; omissions of this type are inherent in the nature of these kinds of analyses.

Recognizing these limitations, the 40 percent cost advantage for the market based approaches is still significant and was a major factor in encouraging further serious attention to this policy option. At the same time, the market based approach was predicted to incur $1.72 billion dollars in transfer payments due to higher prices which, according to the assumptions of the model, would ultimately be borne by consumers of the final products.

A more extensive level of control is used in the third case which is based on a hypothetical regulation that would limit CFC production to the 1980 level of 340 million pounds. In order to simulate this degree of control toward the latter half of the decade, some of the model's assumptions about fixed technology and perfectly inelastic demand were relaxed. This policy option was projected to reduce CFC production by 1200 million pounds from 1980 to 1990, at a present value resource cost of $274.7 million dollars.[10] Transfer payments would amount to $1.83 billion dollars; the price premium for a weighted pound of CFC would increase to $2.80 by 1990. In comparison, the base price of CFCs 11, 12 and 113 were $.34, $.52, and $.78 per weighted pound, respectively. Had the policy been instituted, by 1985 more than half the price of CFCs would be comprised of the transfer payment resulting from the production cap.

Rand evaluated a number of other scenarios and provided a wealth of data on CFC markets and potential economic consequences of CFC regulation. Based on these studies, a number of conclusions could be drawn:

First, economic incentives would result in significant transfer payments from final consumers. Indeed, these transfer payments would be several times the magnitude of the actual resource costs of CFC controls, as illustrated in the examples just discussed. And despite real resource savings, all use segments would experience greater total costs under an

10. PALMER & QUINN (1981, Contract No. N-1656), *supra* note 6.

economic incentives approach than under a comparable mandatory regulation scheme.

Second, there are relatively few options for reducing CFC use in the near future. This is particularly true in areas such as refrigeration where there are presently no viable substitutes.

Third, even where substitutes were available potential problems existed. Some of the substitutes were themselves the subjects of ongoing scientific and regulatory review for possible health and environmental effects. This raised the possibility that economic incentives for CFC reduction, without concurrent regulations on other products, could induce the use of undesirable substitutes. This outcome would be true, of course, for some forms of mandatory regulation as well.

Fourth, under an economic incentives approach, the initial allocation of costs among industries using CFCs would be very different than under a mandatory control scheme. Certain users do not have viable substitute or control options. They would probably not face mandatory regulation but would incur transfer payments associated with the economic incentives policies being considered.

Finally, it is at least arguable that, given the steep marginal cost curve for controlling CFCs, a tax policy would have advantages over a marketable permit system. Under a marketable permit system the transfer payments would be very sensitive to small changes in the level of CFC production allowed. On the other hand, small changes in the tax rate would not significantly affect the level of control. Therefore the tolerance for error might be greater in a tax approach.

ALLOCATION SCHEMES

Since the quantitative estimates seemed to suggest that an economic incentives approach was a viable and possibly advantageous mechanism for controlling CFCs, Agency economists and regulatory analysts continued to devote considerable attention to this option in the months prior to the publication of the ANPR. At that stage attention focused on how such a mechanism would be implemented in order to further define the strengths and weaknesses of the approach. One basic consideration, which heavily influenced the subsequent work, concerned the legal status of certain options. It was the staff opinion, although not universally shared, that EPA did not have the authority to either impose a CFC tax or to auction permits, although the Agency could distribute marketable permits. For analytical purposes staff work proceeded under the assumption that neither the tax nor auction options were open. This decision created two problems. First, as discussed previously, there may be reasons to prefer a tax scheme to permit systems. More importantly, the Agency would have had to develop an allocation scheme that would ultimately determine how the large transfer payments would be distributed.

Many variations of allocation mechanisms were considered, but ultimately three types of policies received the greatest attention: allocation to manufacturers, allocation to first line buyers, and allocation to end users (Figure 5). Allocations in each case would have been proportional to historical use or production measured over some time interval. None of these approaches changed the nature of the theoretical market solution predicted by the Rand model. Consumers would still wind up bearing the ultimate cost of the CFC permits and the same production, employment and use decisions would occur. The three approaches differed markedly in administrative complexity and cost, and had very different distributional consequences.

FIGURE 5

ALLOCATION OPTIONS

Allocation To:	No. of Firms	Comments
MANUFACTURERS	5	Administratively simple; results in large wealth transfer to a few major firms
END USERS	About 200,000	Widest allocation of transfers, many small firms would benefit; complex administrative problem
FIRST LINE USERS	4000–5000	Intermediate level of complexity; inequalities in treatment of similar firms due to differences in distribution patterns

Allocation to manufacturers would be the simplest administratively, since there are only five domestic manufacturers, and imports are relatively insignificant. According to Rand's estimates, the wealth transfer in the case of a production cap at 1980 levels would more than offset any losses the manufacturers would incur from the reduced value of their CFC production assets.[11] Stockholders in these firms would thereby realize a net increase in their equity value. However, the large and visible transfer to a few large firms raised a number of concerns about equity despite the relative ease with which this option could be implemented.

At the opposite extreme, permits could be allocated to end users,

11. PALMER & QUINN (1981, Contract No. R-2806), *supra* note 6.

defined as those who actually produce or service a product. These would include manufacturers and servicers of refrigeration and mobile air conditioning equipment, foam blowers, solvent users and so forth. This scheme would distribute the transfers the most widely of any of the three options and to a large number of small firms, although some of the final users, such as automobile manufacturers, would still be extremely large. At the same time, allocation to end users would create an administrative nightmare for the Agency. As many as 200,000 firms might be involved in total. The Agency would have to gather and verify CFC purchase records for these firms in order to make the initial allocations, as well as rule on an endless series of special cases and appeals.

A seemingly better solution was the intermediate case of allocation to first line purchasers—those who bought CFCs directly from the manufacturers. Such purchasers number about 4000–5000, presenting a more manageable, although by no means trivial, administrative problem for an Agency that does not regard its mission as that of economic regulation. There would, however, be some potentially controversial inequities. Due to differences in market and distribution structures, similar firms would get treated very differently. For example, among foam blowers significant regional differences exist. Those in one part of the country deal directly with the manufacturer while those in another part work through a large distributer. Within any particular industry segment, larger firms are more likely to buy directly from manufacturers than smaller firms and hence would be more likely to capture the transfers associated with the permits.

These three approaches suggest the kinds of problems that would have to be grappled with, should the Agency ever implement a marketable permit system. Other related issued were also being considered at the same time. For example, should permits be issued as perpetuities or should they have a time limit associated with them? How should we treat imported products that already contain CFCs or have used CFCs in their production process? Allocative mechanisms other than those discussed here were also analyzed. At the time the ANPR was proposed, the Agency had no preferred mechanism for implementing a marketable permit policy in the event that CFC regulation was undertaken, nor had the Agency determined that the permit concept was a viable regulatory approach.

The Agency received over 2500 comments on the ANPR. CFC manufacturers and users had a variety of responses. Many of the comments had to do with the scientific and international aspects of the ozone depletion issue. With respect to the use of economic incentives, industry's reaction was very negative. Some of that negativism could be attributed to a lack of understanding and general confusion surrounding the use of economic incentives. The policy was relatively novel and many were concerned that only the wealthy firms would be able to afford CFC permits, while smaller firms and those with capital availability problems would be precluded from the permit market. Those concerned envisioned hoarding permits and black markets for CFCs.

More generally, there was considerable concern that the imposition of a permit system would lead to significant changes in the structure of CFC use and distribution industries. Even in areas such as distribution, which analysts believed would be less likely to be harmed than other CFC sectors,[12] many small firms apparently believed that a permit system would provide an opportunity for larger firms and even manufacturers to take over their markets.

It may be that some of the concerns regarding industry structure were not justified; however, researchers had not done detailed analyses of these issues, and in the face of considerable skepticism could offer only theoretical arguments. In other areas analysis had previously addressed the comments' concerns in considerable detail, but without apparent effect. For example, there was concern that a CFC production cap would limit CFC availability for refrigeration and air conditioning applications, where there were no available substitutes. But precisely for this reason, the Rand analysis had shown that these uses would be the least affected by a production cap, except for some substitution among CFCs and some conservation efforts in testing and servicing. Consumers would pay higher prices, but for example, by 1990 this would amount to a price increase of about seven dollars for home refrigerators and six dollars for mobile air conditioners.[13]

Industry was also uncomfortable with the various allocation schemes. Ironically, not even those who would gain through the allocation scheme favored the permit system. For instance, CFC manufacturers argued that they did not want the permits to be allocated to them because they did not want the responsibility of choosing who would get the CFCs and who would not. The manufacturers felt they would be too visible and it was not worth reaping the ill-will they believed the permit system would create.

CFC users were concerned not only because they feared a lack of availability with no viable substitutes but also because, even if CFCs were available to them, there was a significant degree of uncertainty surrounding future CFC prices. For instance, some argued that they would be reluctant to make significant investments in recovery and recycling

12. *Id.*
13. *Id.*

technologies and other CFC reducing expenditures based solely on Rand's projections of future CFC demand and price.

In general, industry was reluctant to be subject to a new regulatory approach. Although mandatory controls might be less efficient than economic incentives, the former approach was a known entity. Industry understood its ramifications and felt more comfortable with it than with the unknowns associated with the more innovative regulatory approach.

CONCLUSIONS

In the Spring of 1982, the National Academy of Sciences (NAS) published an update on the causes and effects of stratospheric ozone reduction.[14] NAS projected that "if production of CFCs continued into the future at the rate existing in 1977, the steady state reduction in total ozone, in the absence of other perturbations, would be between five percent and nine percent."[15] In 1979 NAS had predicted a most likely ozone depletion of from 15 percent to 18 percent.[16] Intensive scientific study of the issue is continuing, and EPA is funding significant parts of this effort. In light of the updated information, as well as the economic analyses described above and responses to the ANPR, the Agency is currently determining what actions if any, should be undertaken in the near future. Regardless of whether further regulation of CFCs is ultimately undertaken, we believe that the analysis of the CFC marketable permit scheme has contributed significantly to understanding of this regulatory tool. We have certainly learned some important lessons:

- Initially, and for considerable time thereafter, EPA focused predominantly on the efficiency gains in looking at economic incentives policies. By the end of the present round of analysis the transfer payments had come to draw most of the attention. We did not anticipate this development and as a consequence were not as well prepared for it as we might have been.
- Our thinking tended to ignore short-run transition effects, focusing instead on equilibrium type analysis. This is true of most regulatory analyses, but was perhaps more of a problem in this case because of the relatively unique nature of the regulatory transition being contemplated.
- On the positive side, economic arguments and analyses have had an important impact on the Agency's deliberations. Agency decision makers have been willing to consider relatively novel ap-

14. *Id.*

15. NAT'L ACADEMY OF SCIENCES, CAUSES AND EFFECTS OF STRATOSPHERIC OZONE REDUCTION: AN UPDATE (1982).

16. *Id.* at 31.

proaches where they are supported by good analysis and are presented effectively.

- On the negative side we grossly underestimated the difficulty of introducing and explaining the marketable permit concept to potentially affected parties. The ANPR, in the absence of other mechanisms for public information, was not a good vehicle for introducing the idea. The agency has been successful in introducing the bubble and offset concepts in air quality control. But in these examples the measures were introduced as reforms which could lower regulatory costs relative to existing standards which set absolute limits on emissions for each source. The CFC permit systems we were considering would have increased costs to most parties (except the permit owners) relative to mandatory controls, and the ANPR gave no indication of who the ultimate winners might be. The fact that real resource costs would be lower was not viewed as a significant consolation. In light of this, and the relative novelty of the approach, we should not have been surprised that the concept described in the ANPR met with widespread antagonism and misunderstanding. These problems were further aggravated by the absence of specifics in the ANPR as to how the policy would be implemented.