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TRADABLE AIR POLLUTION PERMITS IN THE OVERALL REGULATORY SYSTEM: PROBLEMS OF REGULATORY INTERACTIONS

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ABSTRACT

Because many environmental problems are associated with the production and use of energy, it is not surprising that the effects of policies in the two areas are often interdependent. This paper explores the interactions between the feasibility of an efficient market for emissions permits for sulfur oxides and the current state of air pollution, public utility and natural gas regulation. It shows how some of the opposition to tradable emissions permits can be traced to proposals to implement the reforms that redistribute wealth and the burden of regulatory uncertainty in ways that have greater economic impact than the potential efficiency gains of a market approach. It also examines how a tradable permits market and other regulatory reforms can be designed so as to avoid most of these problems.

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Since 1977, the Environmental Protection Agency has been developing and implementing an ever-widening number of so-called "controlled trading options" for air pollution control. The idea of these plans is to introduce a limited form of a market into the allocation of emissions among sources of air pollution. Starting with existing source-specific standards as a baseline, policies such as bubbles, emissions banks, netting and offsets allow firms to negotiate — within limits -- trades of emissions so as to find a way of satisfying air quality standards at lower total costs. These trades, once agreed upon by the parties, are then normally proposed to regulators as amendments to the existing set of source-specific standards.[1]

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A natural next step in reforming air pollution regulation would be to move all of the way to a true tradable emissions permits system. Regulators adopting tradable emissions permits in the purest form would no longer set source-specific technical standards as a baseline for further trades. Instead, the job of the regulator would be to set overall ambient air quality standards, to limit total emissions in each geographic region so that these standards were satisfied, to organize the market institutions that would be used to allocate emissions among sources, and to enforce the overall standard by detecting and fining sources that emit more pollutants than their holdings of permits allow.

In this paper we will not attempt a comprehensive analysis of the workability of an efficient market in tradable emissions permits. Our purpose is to explore the narrower topic of how the political feasibility and economic efficiency of tradable permits is affected by the _status quo ante_ of the regulatory environment in which permits markets are being developed. Before turning to this central issue, however, the principal attractions and potential problems of a market for emissions permits will be briefly summarized.

A pure tradable emissions permits system has a number of theoretical advantages, the most important of which are as follows.[2] First, assuming that businesses seek to minimize costs, a competitive market for permits achieves any given emissions target at minimum total cost. By contrast, environmental regulators are unlikely to possess sufficiently precise information about abatement technologies to find the minimum-cost strategy for achieving their environmental

objectives. Moreover, the separation of authority over different types of sources among federal, state and local regulators erects a barrier to finding efficient trade-offs of emissions between sources that are regulated by different governmental entities. A second advantage of tradable permits is that they ease the adoption of new abatement technology and the entry and exit of pollution sources. With source-specific regulation, every new source and every new abatement technology must obtain specific regulatory approval. This inhibits the adoption of more efficient technologies and restricts change by raising the cost of innovation. By contrast, a tradable permits system makes emissions more like other inputs to a production process, namely, they must be acquired through a market. To the extent that a permits market is "thick" — that is, characterized by easily arranged transactions at predictable prices -- the problem of acquiring new permits (or selling old ones) would not be materially different than the problems of participating in markets for labor, raw materials, land, or other inputs. The third advantage of tradable permits is that they avoid some of the costs of the regulatory process itself. Regulators no longer need devote most of their resources to identifying specific technical fixes for a long list of emissions sources, nor to undertaking a protracted case for changing standards for any particular source. Regulated firms need no longer undergo the costs of preparing materials to defend their positions in these same proceedings.

Whether these theoretical advantages are, in fact, practically available depends upon the validity of the assumption that a market for emissions permits will be feasible. Among the feasibility issues are legal questions relating to the establishment of an emissions baseline for sources from which trades can be made, and to the choice of methods for monitoring and enforcing the permits. There are also issues related to the economic performance of the market for permits. Competitive markets require a sufficiently large number of buyers and sellers such that none has a large enough share of the market to extract significant monopoly profits from it. Consequently, whether a permits market is feasible is in part an empirical question that turns on the number, geographic distribution and abatement cost functions of sources in a region, on the technical relationship between emissions and pollution, and on the specific legal and institutional features of the permits market. We have examined these issues for a specific pollutant (atmospheric sulfate particulates) in a specific airshed (Los Angeles), and concluded that it is likely that an efficient permits market could be designed to solve that particular problem.[3]

Unfortunately, legal, technical and economic feasibility are not the only issues to be resolved. Implementing tradable emissions permits faces further barriers because it must take place in a context in which other regulatory programs strongly affect the performance of a permits market and the attitudes of regulated firms, regulators, environmentalists, and the general public.

This paper examines three such interactions, each of which illustrates how existing regulatory policy affects the feasibility of an efficient market for emissions permits. One problem is that the current status of overall regulation establishes certain wealth

positions of firms that are subject to environmental regulation and that would have to participate in a permits market. How these wealth positions would be altered, if at all, by a permits market will affect the desirability of this reform to polluting firms, and hence the political resistance to it that they can be expected to put forth. Although inefficient, the present system of source-specific regulations establishes implicit property rights in emissions among old sources. A tradable permits program can threaten these wealth positions, and thereby can severely limit the range of politically feasible market institutions for implementing tradable permits. This problem is addressed in the next section.

A second issue of regulatory interaction is the relationship of environmental policy to energy regulation. Nearly all air pollution is caused by processing and burning hydrocarbon fuels. Consequently, policies affecting the price and availability of fuels will affect the severity of environmental problems and the cost of abating them. Section II of this paper examines the relationship between a tradable permits program in Los Angeles for dealing with sulfate particulates and the status of natural gas regulation. The price and availability of natural gas are the most important factors influencing the cost of abatement of sulfur oxides emissions in Los Angeles, and constitute the single greatest source of uncertainty in environmental policy in that region.

The third example of regulatory interactions is the effect of public utility regulation on the performance of incentive-based reforms. Approximately half ot sulfur oxides emissions in Los

Angeles, and a larger proportion in some other regions, is from electric power generation facilities. Electric utilities are heavily regulated by public utilities commissions, which control prices and profits by making decisions about the amount of costs that a utility is permitted to recover from its ratepayers. Whether an electric utility will respond to an incentive-based regulatory reform like tradable emissions permits in an efficient manner depends upon the treatment of various forms of environmental costs and incentives by public utility ratemakers. This topic is examined in Section III.

Because institutional problems are man-made, they pose no insurmountable barrier, in principle, to the implementation of tradable emissions permits. Nevertheless, they illustrate that reform of one domain of regulation can easily be frustrated by other regulatory policies, and that the feasibility of effective reform can depend upon dealing simultaneously with other sources of inefficiency in the overall structure of regulation. In particular, for the case of tradable permits for sulfur oxides emissions in Los Angeles, erstwhile reformers must take account of these issues to bring off a successful reform.

I. EXISTING STANDARDS AS CONSTRAINTS ON REFORM

The genesis of EPA´s controlled trading options is in the dilemma facing regions that are not in compliance with ambient air quality standards. In these regions, no additional emissions can be created; however, a zero emissions standard for new or expanding sources would essentially preclude any economic expansion as well as

the possibility of competitive entry. Hence, environmental regulators developed the offset policy, a procedure whereby new and expanding sources of pollution could satisfy the zero-emissions requirement by abating pollution elsewhere in the region, rather than constructing a facility that actually produced no emissions. The major constraint placed upon these firms was the requirement to satisfy the new source performance standards (NSPS). In regions that were not in compliance with federal ambient air quality standards, the NSPS require achievement of the Lowest Achievable Emissions Rate (LAER). This is distinguished from the Best Available Control Technology (BACT), which is applied to new sources in regions that are in compliance with ambient air quality standards but that are so-called PSD (Prevention of Significant Deterioration) regions. The distinction between LAER and BACT, although of debatable practical significance, was intended to convey the policy intention that firms would not be allowed to reduce emissions from old sources to satisfy the zero-emissions limit in polluted regions until every conceivable technical control had been applied to the new facility. As a political matter, the point was to assure environmentalists that tradability of emissions permits would not be a vehicle for introducing a significant relaxation of emissions limits or for undermining the possibility that a region would achieve air quality objectives.

The precursor of controlled trading was the bubble policy. Regulators normally set standards for each point at a facility where emissions escape; hence, a complicated production facility can have numerous separately regulated sources. The bubble policy allowed a firm to treat all of the sources at one facility as if they were one combined source, and adopt any technical methods that would reduce total emissions — even if that meant allowing emissions to increase at some of the sources. In essence, this permits a single plant to be treated as a tiny tradable permits market. in which the owners of the plant can make trades of emissions among sources as long as the result is a reduction in total emissons.

The offset and bubble policies had two important consequences. The first was that they gave de facto, although implicit, recognition to the fact that giving a firm a permit to operate if it is in compliance with regulatory standards conveys a limited property right. Standards, once promulgated, establish the share of a firm in the overall emissions limit for a region, just as a real estate acquisition conveys to the firm a share in the total amount of land that is zoned for a particular use. Of course, the limitations and conditions -- and the degree of security in the property right -- differ between permits to emit and title to the land,[4] but because having a permit is clearly superior to not having one (indeed, it is essential to operations, just as is having rights to use the land), the permit constitutes a valuable asset to a firm.

Making permits tradable, even in the limited form allowed in the bubble policy or the offset policy for new sources, enhances their value. If standards at a plant are economically inefficient in that marginal abatement costs differ among sources, bubbles allow the firm to shuffle permits among its sources so as to reduce total compliance costs -- and hence enhance the value of the company. And, as long as

incremental abatement costs at old sources are lower than they are for new sources that are in compliance with NSPS — a condition that is guaranteed by the LAER standard — the offset policy enhances the value of permits by allowing them to be sold for more than the counterbalancing costs of further abatement.

The significance of the property rights that are implicit in emissions permits is that they play a major role in determining the politics of changes in environmental policy. To the extent that political participation -- and hence the feasible set of changes in policy -- is determined by the economic stakes in the policy of various parties that are affected by it, the very existence of a standard-setting process establishes constraints on feasible reforms. Ackerman and Hassler have argued that the new source performance standards for coal-fired power plants were written into the Clean Air Act Amendments because of the beneficial effect the standards would have on eastern coal interests and the value of established firms already holding permits.[5] Crandall adds the additional insight that the winning political coalition for NSPS included Northeastern and Midwestern interests that were trying to slow the growth of the Sunbelt states.[6] These are specific examples of a more general feature of the existing approach to air pollution regulation: source-specific standards, although they are something to resist when they are being written, can become a valuable asset to an established firm because they give old sources a cost advantage over new ones, erect an entry barrier to potential competitors, and, with controlled trading options in place, may eventually be sold for more than the cost of an offsetting amount of further abatement. Any reform proposal that undermines these valuable attributes of existing permits is likely to face resistance from industrial polluters who already hold permits.

Of course, the importance of the constraints created by existing regulation turns on the empirical significance of the wealth held in permits compared to the reductions in overall abatement costs that a market in permits could produce. Our work on the likely effects of implementing tradable emissions permits for sulfur oxides emissions in Los Angeles indicates that the wealth inherent in permits is indeed quite large, probably much larger than the efficiency gains to be captured by the system. Figure 1 shows the demand curve for a permit to emit a ton of SO_2-equivalent in Los Angeles for one day. The demand curve is calculated by estimating the abatement cost function for each source category in Los Angeles, and solving for the cost-minimizing distribution of emissions among sources for each ceiling on total emissions (abscissa of Figure 1 is possible ceilings on total emissions). Underlying these calculations are two assumptions: that the market for permits is competitive and hence achieves a given emissions target at minimum total cost, and that use of natural gas as a boiler fuel is somewhat constrained below the market-clearing quantity at deregulated prices, as has been the case during the early 1980s owing to the remaining vestiges of price and allocation regulation of natural gas. The standards currently in place allow approximately 350 tons per day of SO_2-equivalent to be released into the atmosphere in Los Angeles. As can be seen in the figure, at 350 tons per day, a permit to emit one ton for one day

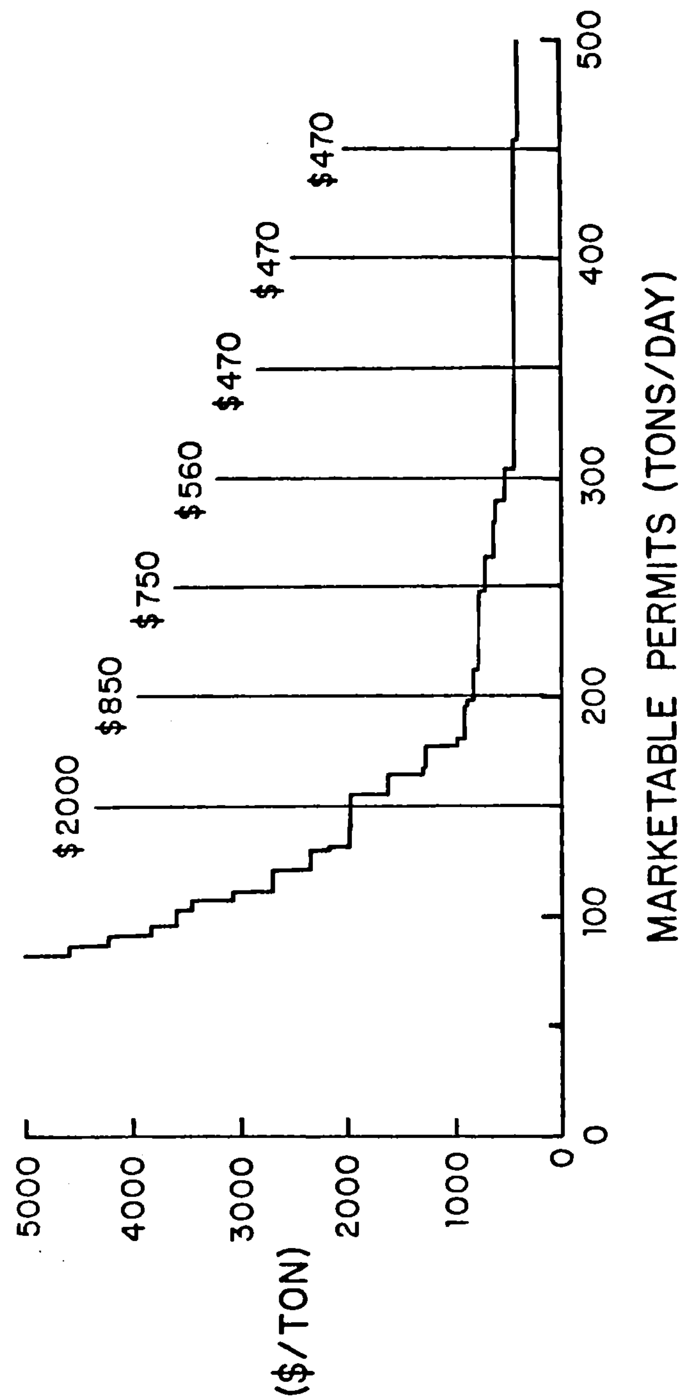

FIGURE 1

MARKET DEMAND FOR PERMITS TO EMIT SULFUR OXIDES IN LOS ANGELES

BASED ON ACTUAL 1980 AVERAGE AVAILABILITY OF NATURAL GAS would be worth $470, which translates to a permit value of over $170,000 if the holder can emit a ton per day for an entire year. Thus, the cumulative value of permits to emit 350 tons per day for a year is approximately $60 million. By contrast, total annual compliance costs under the distribution of permits by a market would total an estimated $123 million, and the efficiency gain from a market — the reduction in estimated compliance costs from correcting current inefficiencies — would be less than $10 million.[7] The significance of these numbers is that to date sulfur regulation in Los Angeles has created a new property right -- a permit to emit -- that is half as valuable as the compliance costs that have been undertaken to meet the standard, and that is roughly ten times as valuable as the short-run efficiency gains to be derived from making it freely tradable.

These numbers provide the basis for the resistance of industry to the most straightforward methods for introducing incentive-based approaches to environmental regulation: either an emissions tax or an auction of emissions permits. According to our calculations, the 1980 concentration of sulfate particulates in Los Angeles could be obtained if all standards were abandoned and a emissions tax were adopted equal to approximately twenty-five cents per pound of SO_2-equivalent emissions. Alternatively, the state could auction off permits to emit 350 tons per day. The net result of either policy would be to transfer approximately $60 million a year from existing pollution sources to the state with no attendant improvement in air quality and with only a few million dollars of reduction in total annual expenditures on abatement.

Allowing present polluters to keep all $60 million per year in the value of existing emissions is not, of course, a firm political constraint on the feasible set of environmental reforms. It is more of a factor to be considered in the design of a process for implementing tradable permits. The current approach, which uses existing standards as the baseline from which trades can be made, is politically attractive because it essentially grandfathers the wealth position of current permit holders. Unfortunately, simply to grandfather permits and let polluters arrange trades is not the most efficient way to organize a market: it requires bilateral negotiations, it does not produce a mechanism whereby transactions terms become matters of public record (and hence convey meaningful information to potential participants in the market), and it can cause severe market structure problems. In Los Angeles, our calculations indicate that the strategy of grandfathering produces a market that is highly concentrated on the demand side.

If the only feasible market institution for implementing tradable permits were the method of grandfathering and letting polluters orchestrate trades by negotiating from the baseline of current emissions, the prospects for this reform would be gloomy. Fortunately, an alternative is available: a "Zero Revenue Auction." The details of this arrangement are presented elsewhere; however, the basic idea is to allocate permits provisionally on the basis of current emissions, but to require all firms to submit a demand curve for permits, the sum of which will then be used to make the final allocation.[8] The market price of a permit is determined by the intersection of the cumulative demand curve with the ceiling on total emissions. Each firm then pays an amount equal to the permit price times its final allocation, and receives back an amount equal to the price times its provisional allocation. Net payments to the state are zero for all firms taken together, and for each firm, a net payment differing from zero represents an improvement from the <u>status quo ante</u> in terms of the sum of abatement costs plus net permit payments as long as the firm truthfully reports its demand curve. This institution preserves the wealth inherent in existing permits, provides a thick market with low transactions costs, results in a public price signal for future reference by firms contemplating entry or expansion of polluting facilities, and attacks the market structure problem by placing all firms on the same (demand) side of the market. Its only drawback would be that it is somewhat more difficult to understand than simple grandfathering, and has the feature that participation in the market is coerced, rather than voluntary -- although firms could guarantee a final allocation equal to the provisional one at no net cost by reporting a perfectly inelastic demand at the provisional quantity. Thus, it would appear that the barriers created by current regulations can be worked around.

II. NATURAL GAS REGULATION

The calculations in the preceding section were based upon a specific assumption about the availability of natural gas. That price regulation of natural gas at the wellhead has led to excess demand is well documented.[9] And, as regulation of natural gas (especially new

discoveries) has relaxed, supplies have increased. Natural gas is especially attractive for use in regions suffering from heavy air pollution, for it is exceptionally clean burning. For the problem at hand — sulfate particulates controls in Los Angeles — it is attractive because it contains virtually no sulfur. Hence, substitution of gas for oil — the principal fuel burned in Los Angeles boilers — is the least expensive abatement strategy available for any source that can burn gas instead of oil.

The importance of the availability of natural gas is illustrated by Table 1, which shows the annual abatement cost for satisfying various limits on total emissions under three different assumptions about the availability of natural gas. The "Low" and "High" natural gas cases pertain to two different projections of the supply of natural gas that were made in the mid-1970s.[10] The low availability case represents the predictions then being made about gas supplies in the 1980s, and reflects the view then common that gas supplies would continue to dwindle. Shortly before the development of the "gas bubble" in the late 1970s, gas supplies in Los Angeles were approaching this level.

The high supply case represents a relatively minor shortfall of supplies from market-clearing quantities at deregulated prices. It is much closer to the reality of 1980 -- the middle column of the table — than the low availability case. All three cases presume that existing regulations regarding priorities of user classes, rather than the market, will be used to allocate gas. This assigns highest priority to residential users, and lowest priority to electric

TABLE 1

ANNUAL ABATEMENT COSTS
(In Millions of 1977 Dollars)

SULFUR OXIDES EMISSIONS (tons/day)	NATURAL GAS SUPPLY		
	Low	Actual 1980	High
150	622	182	109
200	566	158	93
250	524	144	81
300	487	131	72
350	459	123	64
400	440	114	56
450	424	106	49

generation facilities. In the low and high availability cases, we assigned gas to categories of users according to these priorities. The 1980 case reflects the average pattern of use that actually took place, which may have departed slightly from the assignment we have assumed to the extent that supplies and demands varied through the year. In each case we have assumed that the price of natural gas equals the BTU-equivalent price of high-sulfur residual fuel oil. In fact, gas prices have been somewhat lower than this, so that the availability of natural gas has produced even greater cost savings than are shown in the table.

As discussed above, emissions in Los Angeles currently range between 325 and 350 tons per day, annual average. This brings Los Angeles essentially into compliance with the relevant federal ambient air quality standards for SO_2 and for total suspended particulates. However, approximately a third of the degradation in visibility in Los Angeles is still due to sulfate particulates, and sulfur compounds are a major component of local incidences of acid rain and acid fog. Consequently, the state has set an ambient air quality standard for sulfate particulates that is substantially more rigorous than the federal standards, and that would require a reduction in emissions to an estimated 150 tons per day. Alternatively, a reduction to 250 tons per day would cause the region to be out of compliance with the state standard about three weeks per year. By contrast, existing standards under the assumption of low natural gas availability -- the conditions that were threatened in the mid-1970s -- would produce emissions of about 420 tons per day. These various outcomes — from existing standards and low natural gas to compliance with state ambient air quality standards -- explain the motivation for the range of emissions ceilings considered in Figure 1 and Table 1.

As is apparent from Table 1, the effect of the availability of natural gas is dramatic. Achieving the state standard under the high-availability case is approximately one-fourth as expensive as maintaining the status quo if natural gas supplies are curtailed to the low-availability case. Or, if gas supplies increase from the actual 1980 case to the high-availability situation, state standards can be satisfied while simultaneously reducing compliance costs by an estimated $14 million. Obviously, the future of environmental policy in Los Angeles -- and in other regions in which natural gas can be an important substitute fuel for coal or oil -- depends heavily on the availability of natural gas.

Environmental compliance costs will also depend upon the price of natural gas. Several studies have been undertaken to forecast the effect of total deregulation of natural gas on its price. These studies provide a variety of estimates, but most predict that, if gas were deregulated in the early 1980s, by 1990 the price would rise, but not all the way to the BTU-equivalent price for very low-sulfur residual fuel oil (.25 percent sulfur content) that is now required in Los Angeles for electric utilities. For example, the forecast by the Office of Policy, Planning and Analysis of the Department of Energy forecasts a 1990 price slightly less than halfway between high-sulfur and low-sulfur residual fuel oil prices, whereas the Energy Information Administration in the same department forecasts that gas

will never reach even high-sulfur residual fuel oil prices in most parts of the country.[11]

The cost of compliance with environmental regulations depends crucially on the cost of natural gas in relation to residual fuel oil for those firms that can make the substitution. Table 2 illustrates this point by showing our estimates of the market-clearing price of a permit to emit a ton of sulfur in Los Angeles under four different assumptions about the price of gas in a deregulated environment and under the three cases discussed above in which the price of natural gas is below the market-clearing level but supplies are partially curtailed (the high, low and actual 1980 cases). The price of a permit in competitive equilibrium equals the marginal cost of abatement; hence these price differences directly reflect the effect of natural gas prices and availability on abatement costs.[12]

A firm that is subject to environmental regulation faces several sources of uncertainty in relation to the natural gas situation. There is an underlying uncertainty created by the presence of regulation during the past twenty years. By artificially restraining wellhead prices, and by causing a shortage, regulation has deprived firms of information about the performance of a deregulated market. Consequently, uncertainties about the future under deregulation are greater than they otherwise would be. Finally, there is uncertainty about the future state of gas regulation. Whereas the current policy is gradually to move towards full deregulation, it is by no means certain that gas will never again be regulated. The history of the past forty years is one of episodic swings between more

TABLE 2

PERMIT PRICES WITH AND WITHOUT NATURAL GAS DECONTROL[a]

Tons/Day	Case 1 (2.5%S)	Case 2 (1.0%S)	Case 3 (0.5%S)	Case 4 (0.25%S)	"High"	"Actual"	"Low"
150	650	650	650	650	1000	2000	3600
200	80	250	350	470	810	850	2720
250	80	250	350	470	470	750	2020
300	80	250	350	470	470	560	2000
350	80	250	350	470	420	470	1300
400	80	250	350	470	420	470	940
450	80	250	350	470	420	470	850

[a] Prices are in 1977 dollars per ton of SO_x equivalent. The four cases represent four assumptions about natural gas prices under decontrol. The numbers in parentheses are the sulfur content of the residual fuel oil at which the natural gas price is assumed to equilibrate. The "High" and "Low" cases represent conditions of high and low natural gas supply under the status quo (i.e. no decontrol). "Actual" corresponds to actual 1980 fuel use patterns.

and less regulation.[13] In mid-1982, the two major California gas utilities were publicly advocating a national ceiling price for natural gas.[14] In addition, there is further uncertainty about how severely gas supplies would be curtailed by a renaissance of gas regulation in the future, and how use priorities might be established if shortages like those that developed in the mid-1970s were to return.

These uncertainties affect the desirability of a tradable emissions permit system as seen by polluting firms. In a pure tradable permits system, the total number of permits that are issued constitutes a fixed upper bound to emissions. Hence, all of the uncertainty in the price and availability of natural gas is translated into uncertainty about the cost of compliance with environmental regulation. Regardless of the supply of natural gas, under the pure permits system none of the uncertainty over gas would translate to uncertainty about the air.

The standard-setting system of environmental regulation as practiced today is quite different. Source-specific standards are usually input standards: a firm must install a scrubber, or use a low-sulfur fuel. Because the availability of natural gas is uncertain, regulators do not require its use. In Los Angeles, for example, they require that some sources burn gas if it is available, or if not, use low-sulfur residual fuel oil. For electric utilities, the basic requirement is to use residual fuel oil that has .25 percent sulfur content by weight. This means that total emissions under current standards are dependent on the availability of natural gas.

The 1977 standards, for example, would produce about 420 tons per day of SO_2-equivalent under the conditions of gas availability that threatened to emerge in the mid-1970s, but are producing only about 350 tons per day now, and might result in as little as 250 tons per day if gas were totally deregulated. This means that in the current regulatory environment, both environmental quality and total abatement costs bear some of the uncertainty of natural gas availability. Thus, to make tradable the permits that are implicit in some baseline rate of emissions changes the distribution of the burden of this uncertainty by placing more of it on polluting firms.

Tradable emissions permits systems can be designed to avoid this problem, but the solution is surely a move away from the pristine market solution. There are two basic avenues by which the problem can be approached. One is to have the face value of a permit (e.g. the quantity of SO_2-equivalent emissions that it allows) depend on the availability of natural gas. A permits market would then be a series of contingent claims markets, subject to a continuing regulatory determination of the state of natural gas supply that has emerged and hence the emissions value of the permits. The variability in total emissions under existing standards could then be incorporated directly into variability in permit values. This, of course, is easier postulated than executed. It greatly complicates the permits market, and introduces what is sure to be a time-consuming, expensive and controversial process -- determining the state of gas availability.

The second alternative is to overlay gas usage requirements -- a system of regulations -- on the permits holdings. The permits

market would be relied upon to establish long-run allocations of emissions that would apply under pessimistic assumptions about gas availability. In the short run, holders of these permits might be subjected to additional gas-burning requirements if gas is available, as is now the case. As long as gas is less expensive than low-sulfur oil, this is not likely to be resisted by regulated entities. Nevertheless, such a system will not allow the market to produce a given level of total emissions at minimum cost. The reason is that gas-burning standards are unlikely to achieve minimum cost even if that is the regulatory objective for the same reasons that current regulations do not produce a minimum-cost solution. Regulators are simply unlikely to possess sufficient information to enable them to simulate a competitive market in their regulatory requirements.

Perhaps a more likely approach is to adopt a permits system that effectively puts a firm ceiling on emissions, but which also has a standard procedure for adjusting the number of outstanding permits. Environmental policy to date has tended to accept an absolutist rhetoric with respect to air quality objectives: that air quality targets should be set on the basis of health standards and other gross effects, and independently of compliance costs. The artifacts of this approach are uniform national ambient air quality standards for major pollutants, despite substantial regional differences in the difficulty of achieving them, and nationwide NSPS that are uniform except for usually minor differences between PSD regions and nonattainment areas.

As a conceptual matter, the alternative is to approach environmental policy more as a matter of practical economics.

According to this approach, environmental policy objectives, such as ceilings on total emissions and ambient air quality standards, ought to depend in part on costs. Higher abatements costs owing to rising prices or, under regulation, declining availability of natural gas ought to affect the objectives of the policy. Source-specific standards, by letting changes in natural gas supplies affect air quality as well as compliance costs, actually do this, and are not really consistent with the absolutist position taken in environmental legislation.

As time progresses, it is likely that numerous factors will change the politically determined goals of environmental policy. Natural gas issues are part of the larger issue of the costs of abatement. In addition, knowledge about the effects of pollution and the attitudes of citizens about the social priority to be given environmental policy are also likely to change over time. Consequently, there is likely to be persistent uncertainty about the stringency of environmental regulation for many reasons. One natural way to accommodate this uncertainty is to focus the regulatory process on periodic reappraisals of ceilings on total emissions.

Periodic revision of the Clean Air Act, occasioned by the sunset provision of the law, does this only imperfectly. for it focuses attention on general statements of policy and the approach to regulation, rather than the actual choice of an environmental policy objective. An alternative approach is to have a regular expiration date for some significant portion of permits in each region in which a tradable emissions policy is adopted. Regulators would undertake a

formal regulatory process to decide how many new permits would be created to replace the expiring ones. Evidence would be taken on changes in compliance costs (including the availability of natural gas), new knowledge about the effects of pollution, and additional information about the relationship between emissions and air quality, as well as in overall policy objectives as enunciated in current versions of the statutes. Because these proceedings, including subsequent predictable legal challenges, would consume considerable time, they would be undertaken only every few years. For example, a permit life of ten years could be adopted, with half of the permits expiring every five years.

This approach could be combined with the Zero Revenue Auction described in Section I. Here new permits would be provisionally allocated on the basis of holdings of expiring permits, but an auction process would be used to reallocate them.

The system of periodically expiring permits does not fully address the problem that natural gas regulation creates for the implementation of tradable emissions permits. In the short run, at least, emissions ceilings would be fixed, and exogenous shocks to the system would be absorbed completely by changes in compliance costs. But the proposal does focus the attention of the regulatory process on periodic reassessment of emissions ceilings in light of new information about the costs and benefits of regulation.

III. PUBLIC UTILITY REGULATION AND ELECTRIC UTILITIES

The generation of electric power in thermal facilities that burn coal or oil is arguably the most important source of air pollution. Certainly for sulfur oxides emissions this is the case; approximately half of the sulfur oxides emitted in Los Angeles is the result of combustion of oil for generating electricity.[15] Obviously the performance of any approach to controlling air pollution will depend heavily on its effectiveness with respect to emissions by electric utilities.

Incentive-based approaches to environmental control rely upon the cost-minimizing objective of regulated firms to achieve an efficient allocation of abatement responsibilities among sources. The assumption that electric utilities will minimize costs, however, is debatable. One reason is that public utility regulation is interposed between the actual technical opportunities and real costs of a utility and the amount of revenue that a utility is permitted to extract from its customers. If utility regulators are more likely to allow some kinds of costs than others, or are willing to let utilities earn greater profits on some kinds of assets than others, the utility regulatory process will cause the regulated firm to depart from cost-minimizing choices of technology and operating methods.

In general, public utility regulators have been quite deferential to environmental regulation. In California, for example, the Public Utilities Commission has adopted the policy that a utility facility is not to be regarded as an electric generation plant and a separate pollution abatement plant, but that for purposes of

ratemaking they are to be considered one and the same, with identical principles of cost recovery applied to each activity.[16] For most categories of environmental expenses, this approach means that public utility regulation distorts incentives no more than for other utility activities. But for tradable permits, the policy of identical ratemaking principles can be disastrous, depending on how the policy is implemented.

In most states the original cost approach is used for incorporating the costs of capital investments into the rate base of a regulated utility. Firms are allowed to recover annual depreciation plus a profit that is calculated by multiplying the allowed rate of return and the current depreciated book value of the original expenditure on capital facilities which the regulators have declared to be "used and useful" for public utility purposes. An alternative is the replacement cost method, whereby the book value of the asset is adjusted to account for inflation and changes in technology that would cause the actual value of an old facility to depart from its depreciated original cost. As a practical matter, the two approaches yield essentially the same results, for states using a method that produces lower estimates of the current value of capital assets tend to adopt allowed rates of return that are compensatingly higher.[17]

The neutrality of ratemaking methods is not likely to carry over to tradable emissions permits unless they are allocated by auction. If grandfathering is used, the initial position of the utility will be permits that had zero acquisition cost, and hence that must be carried on the books in original cost states at zero value.

No adjustment of the rate of return allowed on this asset can produce anything other than a zero profit allowance.

A second problem is the treatment of capital gains and losses in utility accounts. Most states use the principles in the Uniform System of Accounts established by the Federal Power Commission. This requires that any gains or losses from the sale of an asset, calculated as the difference between sales price and book value for ratemaking purposes, be passed on to ratepayers through adjustments in utility prices.[18] In original cost states, this amounts to a 100 percent tax on the sales revenue if a utility decides to sell a grandfathered permit. In practice, if a utility sold permits for the purpose of making further abatement expenditures, its revenue requirements would change by the difference in operating expenditures plus the profit on investments for additional abatement and the revenue from permit sales. Obviously, this would be negative if the utility faced lower marginal abatement costs than was typical in the airshed. Hence, the capital gains provisions provide an important disincentive to make warranted further expenditures on abatement.

Periodic auctions provide an appropriate incentive structure for utilities. Expenditures on multiyear permits enter as capital assets on which the firm can earn profits, and the periodicity of the auctions keeps the book value of the permits near market value even in original cost states. The problem, of course, is that a standard auction faces the same resistance among utilities and their regulators as it faces elsewhere: the auction increases the capitalization requirements of the utility, even if it changes neither the operating

capacity of the utility nor its abatement expenditures and emissions. The problem is somewhat worse in the utility sector, however, in that it would be the source of political opposition within the government (the utility regulators). Moreover, since the increase in interest rates in the early 1970s, utilities have normally faced higher marginal capital costs than their average cost of capital. This leads to even more resistance to new capitalization requirements.

The Zero Revenue Auction is sufficiently far from any institution that public utility regulators have ever had to face that it is somewhat uncertain how they would treat the permits acquired through it. Certainly any net sale of permits by a utility would most likely be subjected to the provisions for total capture of capital gains. Because the Zero Revenue Auction also produces a final allocation based upon a publicly determined market process, it would be natural to use it to value the final permit holdings of the utility for ratemaking purposes. The problem is that if the new permits are to be regarded as acquired at these prices, it is also natural to regard the provisional allocation to have been sold at these prices -- and, because they were grandfathered, to be subject to total capture by ratepayers. If so, the firm would have to make a net reduction in rates, equal to the difference between gross sales of the provision permits and the profits allowed on the gross purchase of new permits. Like the standard auction, this succeeds in decapitalizing the firm.

In replacement cost states, none of the problems described above would arise. The current price of permits would be used to readjust their value for ratemaking purposes. Their sale would generate a cash reserve for undertaking offsetting abatement investments, for other investment purposes, or for transfer to nonutility accounts in what amounts to a reduction in the capitalization of the utility.

The obvious solution to the problem is to convince original-cost states to adopt replacement-cost methods for evaluating emissions permits. Unfortunately, there are reasons to doubt that utility regulators will be enthusiastic about this proposal. The history of the original-cost approach is grounded in the reluctance of utility regulators to introduce any element of speculation into utility planning, or to allow intangible assets to enter the rate base in any significant amount.[19] For example, regulators do not want utilities to speculate in land acquired for facilities and rights of way; hence the tendency to want all capital gains on land transactions to be passed through to ratepayers.

The argument that will be used against allowing emissions permits to enter the rate base at replacement cost will be like the argument for recapturing speculative land gains. The utility paid nothing for the permit other than costs that were already allowed in participating in the environmental regulatory process and complying with the resulting regulations. Rising permit values are a windfall gain that ought not to be capitalized in the assets of the firm, and that should be returned to ratepayers if ever captured through sale.

The counterargument is that utilities ought to face the proper incentive to strike the most efficient balance between emissions and abatement. But similar arguments about assets such as land and water

rights and about other intangible assets have been unsuccessful in the past, since they have conflicted with the overall aim of regulators to hold down utility prices to consumers. Thus, it is entirely plausible that <u>any</u> method of allocating permits and making them tradable will result in public utility decisions that remove much of the incentive for participation by utilities.

In the specific case of sulfur oxides emissions in Los Angeles, public utilities have been forced to engage in more extensive abatement than have most other sources.[20] Hence, we would expect that in a grandfathered system, utilities would seek to increase permit holdings, rather than decrease them. They would then use permits to increase the sulfur content of the fuel used in electric generation facilities. Their expenditures on a net increase in permits would then allow a reduction in fuel costs, and could be treated as a capital expenditure on which the firm could earn profits. Regulators would not need to let the "old" (grandfathered) permits into the rate base in order for utilities to face appropriate incentives in deciding how many additional permits to acquire. Thus, the Zero Revenue Auction, with public utility regulators allowing only the net change in permit holdings at the auction price into the rate base, poses no special problems for this specific case.

This happy state of affairs depends on an initial situation in which utilities are overregulated. States in which utilities ought to abate more relative to other sources and that use original cost as the method for evaluating assets face a significant political problem in trying to implement tradable emissions permits.

IV. CONCLUSIONS

Walt Kelley, the author of the famous carton strip, "Pogo," once gave the immortal line to one of his characters: "We have met the enemy, and they are us." The problem of regulatory interactions deserves such a line. Other aspects of regulatory policies can create serious political problems in trying to implement a reform in any particular area and can lead to an inefficient market outcome.

Tradable emissions permits are clearly an idea on the ascendency. The Environmental Protection Agency continues periodically to issue policy guidelines that expand the applicability of the concept, and that reduce the bureaucratic barriers to implementing it. The California Air Resources Board is actively pursuing the possibility of experimenting with a full-blown market for sulfur oxides emissions somewhere in the state. Yet these initiatives face serious opposition because of their relationship to other regulatory policies: the constraints imposed by new source performance standards, the implicit wealth created by existing permits, the uncertainties in the future of fuel supplies and prices owing to regulation in those areas, and the practices of utility regulators that are likely to guide the decisions about how permit values will be incorporated into the rate base of electric utilities.

The solution to these problems in a technical sense is straightforward. In our work on designing a market for controlling sulfur oxides emissions in Los Angeles, we have demonstrated how the wealth distribution issue can be directly incorporated into the design of a permits market. The Zero Revenue Auction can distribute permits

efficiently and accomplish whatever wealth distribution regulators would like to have. The uncertainties about the effect of the state of natural gas regulation (and regulation of other fuels should it be reinstated) can also be taken into account in designing a market institution that lets the burden of bearing this uncertainty be periodically reviewed in a more flexible regulatory regime. Finally, utility regulators can adopt replacement cost methods or other cost-accounting techniques that give utilities appropriate incentives to participate effectively in an emissions permit market.

These solutions require that tradable emissions permits be implemented in a manner that is a more comprehensive departure from the status quo than are the controlled trading options that have been developed by EPA. The evolution of controlled trading seems to be to expand gradually the range of allowable trades. Two examples are the extension of the bubble concept to multiple plants, and the evolution of the offset policy to emissions reduction banks. This incremental approach deals effectively with only one of the issues raised in this paper: it preserves the wealth created by current standards by using them as a baseline from which trades can be made. On pure efficiency grounds, the merits of the incremental approach can be questioned, for there are reasons to believe that the resulting permits market will not produce a competitive allocation of permits and, hence, will not minimize abatement costs or substantially facilitate the process of technical and economic change. But even in the absence of these structural problems, the issue of interactions between permits markets and energy regulation -- fuels and utilities -- remains. Without explicitly designing a permits policy to account for these problems, the benefits of this reform are likely to be substantially less than they could be.

The analysis in this paper focuses on a specific reform proposal, the implementation of tradable permits for sulfur oxides in Los Angeles. Yet this case illustrates a more general class of problems in trying to introduce changes in regulatory policy that contribute to economic efficiency. The economics literature on regulation correctly focuses on the efficiency implications of alternative regulatory regimes, and uses traditional tools of welfare economics to aggregate the benefits and costs of reform proposals to identify the most efficient policy. Typically these analyses assume that all other policies and institutions remain unchanged, and overlook the distributional impact of proposed reforms. The case study reported here illustrates two important points: (1) the contribution to economic efficiency of a proposed reform can be greatly influenced by the state of other regulatory policies, and (2) the effects of a change in policy on the distribution of wealth can be very large in comparison to the improvement in economic efficiency. To the extent that effective political resistance to a change in policy is motivated by the economic gains and losses of well-organized groups, successful reform may require that considerable additional work be undertaken to design a policy that not only contributes to economic efficiency but also provides some amelioration of the redistributional effects. Most often the method of amelioration that is considered is compensation; however, as this paper illustrates,

another potential candidate is to design the institutions of the reformed regulatory regime in a way that preserves some part of the old private equities. This strikes us as an approach that has received insufficient attention in the literature on regulatory policy.

FOOTNOTES

1. For a more complete discussion of the nature of these reforms and some problems with them, see Robert W. Hahn and Roger G. Noll, "Implementing Tradable Emissions Permits," in Reforming Social Regulation, edited by LeRoy Graymer and Frederick Thompson (Beverly Hills: Sage Publications, 1982).

2. For an interesting and thorough discussion of this approach, see John Dales, Pollution, Property and Prices (Toronto: University of Toronto Press, 1968).

3. Robert W. Hahn and Roger G. Noll, "Designing a Market for Tradable Emissions Permits," in Reform of Environmental Regulation, edited by Wesley Magat (Cambridge: Ballinger, 1982); and Glen R. Cass, Robert W. Hahn and Roger G. Noll, Implementing Tradable Emissions Permits for Sulfur Oxides Emissions in the South Coast Air Basin: Final Report to the California Air Resources Board (June 30, 1982).

4. For a discussion of the legal position of emissions permits, see James E. Krier, "Some Legal Aspects of Tradable Emissions Permits for Air Pollution in Southern California," Chapter 4, Vol. II of Cass, Hahn and Noll, supra Note 3.

5. B. A. Ackerman and W. T. Hassler, Clean Coal/Dirty Air (New Haven: Yale University Press, 1981).

6. Robert W. Crandall, "Controlling Industrial Pollution: The Economics and Politics of Clean Air," in Regulatory Reform in Public Utilities, edited by Michael Crew (Lexington, MA: Lexington Books, 1982).

7. The estimated compliance cost under a market arrangement is probably biased upwards, and the short-run efficiency gain from a market biased downwards, to the extent that control methods are available that have not been incorporated into our abatement cost functions. Only abatement methods for which we could obtain documentation in public sources have been included; this causes us to exclude changes in production processes that are available to firms but are trade secrets, and control methods available to sources that have not yet been regulated. In addition, long-run efficiency gains will be greater to the extent that the market stimulates cost-saving innovations in abatement technology and reduces barriers to economic change.

8. Hahn and Holl, supra Note 3.

9. See, for example, Paul W. MacAvoy, "The Regulation-Induced Shortage of Natural Gas," Bell Journal of Economics 4 (Autumn 1973):454-498.

10. Glen R. Cass, "The Sulfur Oxides Emissions Potential of the South Coast Air Basin in the Early 1980s," Appendix E, Vol. III of Cass, Hahn and Noll, supra Note 3.

11. Office of Policy, Planning and Analysis, Division of Energy Regulation, "A Study of Alternatives to the Natural Gas Policy Act of 1978," U.S. Department of Energy, November 1981, Document DOE/PE-0031; and Energy Information Administration, 1981 Annual Report to Congress, Volume 3: Energy Projections, U.S. Department of Energy, Document DOE/EIA-0173(81)13, February 1982. Both studies are based on the assumption of deregulation of gas in 1982.

12. The price of a permit in the first case -- a limit of 150 tons per day — is unaffected by natural gas prices in a deregulated natural gas environment because substitution of gas for oil burning is no longer a marginal abatement strategy at this emissions ceiling. At all other ceilings on abatement, the extent of gas burning is affected by its price.

13. For a history of the ever-changing politics of natural gas regulation, see M. Elizabeth Sanders, The Regulation of Natural Gas: Policy and Politics, 1938-1978 (Philadelphia: Temple University Press, 1981).

14. Los Angeles Times, August 7, 1982, p. 24.

15. Glen R. Cass, "Methods for Sulfate Air Quality Management With Applications to Los Angeles," Ph.D. dissertation, California Institute of Technology, 1978.

16. Decision 89711, California Public Utilities Commission 1977.

17. Walter Primeaux, "Rate Base Methods and Realized Rates of Return," Economic Inquiry 16 (March 1978):95-107.

18. Uniform System of Accounts, Federal Energy Regulatory Commission, 1973, pp. 101-110.

19. For a more complete discussion of the lessons for dealing with tradable permits to be found in the treatment of intangible assets by utility regulators, see James M. Gerard, "The Effects of Public Utility Regulation on the Efficiency of a Market for Emissions Permits," Chapter 5, Vol. II of Cass, Hahn and Noll, supra Note 3.

20. For a calculation of the change in permit holdings by utilities under various assumptions about the ceiling on total emissions and the availability of natural gas, see Hahn and Noll, supra Note 3.