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Abstract:

Public policy analysts advocate a tradeable emission permits scheme to regulate and reduce greenhouse gas emissions. Their argument is based primarily on the theoretical advantages of a market-based scheme compared to a conventional command-and-control scheme: greater efficiency and increased incentives to develop new control technologies. Experience with an existing tradeable market scheme for conventional industrial air pollutants, however, illustrates the practical difficulties that can arise. In addition to potentially formidable obstacles posed by the need for effective monitoring and enforcement, other problems are institutional: The legislature may be slow to give clear authority for market-based regulations, and regulators used to more conventional regulatory schemes may be hostile to the market. As a result, the market-based program may be burdened with severe regulatory restrictions. Industrial firms, which often distrust regulators' intentions and the ability of the market to produce emission credits in the future, withhold credits from the market. A half-hearted approach to market-based regulation virtually guarantees market failure.

Introduction

After years of scientific and public policy debate, industrialized nations and international organizations are evaluating policy proposals to address the causes of global

warming (Energy 1989). Some government officials and numerous economists have promoted the use of economic incentives, such as tradeable emissions permits, to limit greenhouse gas emissions (Swisher and Masters 1989; Dudek and LeBlanc 1990; Stewart and Wiener 1990). Their arguments are based largely on the efficiency gains predicted by economic theory.

Given the potentially huge ecological, social, and economic stakes (Climate 1990), public policy cannot rely solely on economic models using idealized assumptions about firm behavior and market dynamics. Rather, policy makers must evaluate proposed regulatory schemes under real-world conditions of scientific uncertainty, large information costs, limited administrative resources, and non-economic behavior. They must carefully scrutinize claims about relative advantages and disadvantages of different regulatory approaches. It is especially important for policy makers to consider the institutional, legal, and political constraints on proposed reforms. Problems in implementation and enforcement, rather than with economic theory, are often the most serious obstacles to successful regulation.

A natural place to begin an evaluation of proposed economic incentives for regulating greenhouse gases is with existing economic incentive-based regulatory schemes. Several industrialized nations employ economic incentives to regulate air and water pollution, but most of these

countries use emission charges. The United States is one of the few countries to use a tradeable emissions approach in its pollution programs (Clean 1991; Hahn and Hester 1989a; Tripp and Dudek 1989).

One of the most important emissions trading programs in the United States involves industrial air pollutants regulated under the federal Clean Air Act. In that program, which is the subject of this study, new industrial sources may, after installing certain mandated controls, purchase air emission reductions from existing sources to meet emissions limitations. Most states have adopted regulations authorizing air emissions trading under the federal program, but California's scheme is probably the most sophisticated and widely used. Even though California's tradeable permit program does not cover greenhouse gases, the program's successes and failures should illumine the operation of a proposed trading program for greenhouse gases.

The Evolution of California's Tradeable Emissions Program

California regulators developed a tradeable emissions program in accordance with federal policies designed to maintain air quality and permit economic growth in "dirty" air basins. The program was not conceived at a single moment, but evolved (and is still evolving) in response to federal requirements and state policies. It has not established a fully functioning market, in which all firms may freely trade emissions to achieve a cost-effective

distribution. Rather, the program allows trading to supplement an existing command-and-control scheme.

Federal Tradeable Emissions Policy

Because state air pollution programs are subject to federal requirements, and because the air emissions trading program originated with the federal Environmental Protection Agency (EPA), a brief description of the federal program will provide useful background.

The 1970 federal Clean Air Act evinced Congress' deep distrust of industry and regulators. By imposing stringent air quality goals and short deadlines, Congress hoped to force industry quickly to develop new pollution control technologies for several common industrial and automotive pollutants. Congress gave little consideration to the magnitude and distribution of control costs.

Congress' strategy was for EPA to set nationally uniform ambient air quality standards and for state or local agencies to set source-specific emission limitations that would achieve the standards in each air basin. Congress, however, gravely underestimated the difficulties that underfunded, technically unsophisticated state agencies would have in designing and implementing programs to meet EPA's air quality standards. In addition, congressional deadlines for developing the implementation plans were unrealistically short. Consequently, state implementation plans, which detailed source-specific emission limits, were often based on inadequate air quality and emissions data,

primitive dispersion models, and extremely limited information on control costs. Many state agencies simplistically established uniform emission limits without regard to the variability of implementation costs. The resulting emission standards were unavoidably not cost effective (Roberts and Farrell 1978).

By its own criteria, the federal air pollution program was a bleak failure. Dozens of urban areas substantially failed to meet the 1975 deadline to attain federal air quality standards. The government's frustration with the pace of achieving its environmental goals, however, was partly tempered by the 1973 oil embargo, a downturn in the national economy, and a growing perception that environmental policies were expensive and possibly a significant drag on local and national economies. These developments heightened the government's sensitivity to the magnitude of pollution control costs and led both EPA and Congress to appreciate the importance of more cost-effective regulatory approaches.

Before 1977, the+Clean Air Act prohibited major new facilities and major modifications of existing facilities in areas that had failed to achieve federal air quality standards, so-called nonattainment areas. Agency officials were concerned that this prohibition would substantially hinder industrial and economic growth in these areas. The agency was thus faced with apparently inharmonious goals of

and political demands for environmental protection and economic growth.

EPA's attempted to resolve this dilemma with its 1976 "offset" policy, under which firms could build new polluting facilities (or modify existing ones) in nonattainment areas so long as they employed strict controls on the new facility and offset all residual emissions with reductions at existing facilities (Emission offset 1976).

EPA defended the offset policy primarily on the ground that it would yield cost-effective emission controls and permit economic growth in nonattainment areas without damaging air quality. The policy was also viewed as a means to give existing facilities continuing incentive to design more efficient pollution control technologies (A market 1982; Hahn and Noll 1982a; Tietenberg 1985). Fixed emission limits, by contrast, gave firms no reason to develop control technologies that would reduce emissions below existing requirements. Indeed, investment in new control technologies could prove costly if a regulatory agency used the new technology as baseline for a new generation of emission limits.

Somewhat later, the offset program was touted as a mechanism to help achieve air quality standards. If purchasers were required to buy more credits than actually needed, the argument went, the air would be cleaned with each trade. Because there are not (and probably can never be) enough trades to have an impact, this justification has

proven to be illusory; at its best, the federal offset program is an air quality maintenance program (Margolis 1991).

Largely for historical reasons, EPA's current regulations are awkwardly divided into "banking," "offsets," "netting," and "bubbles." The banking program allows existing firms to reduce emissions below existing emission limits and to store the excess reductions as "emission reduction credits" for later use or sale. (Emissions trading 1986). Banking encourages firms to invest in new control technologies and recoup their investment upon subsequent sale or use of the emission reduction credits. A banking system can also reduce search costs for firms looking to buy credits; buyers can go to the bank for a list of potential sellers. In practice, relatively few firms have banked emission credits.

The offsets program is modelled after EPA's original program. A firm may construct a new major facility (or modify an existing facility) in a nonattainment area only if it installs stringent controls and obtains emission reductions from other sources to offset all residual emissions (Emissions trading 1986). Since 1976, roughly 2500 facilities in the United States have used offsets. However, more than 90% of these trades are internal, that is, trades with other sources owned by the firm building the new facility (Hahn and Hester 1989b; Margolis 1990).

EPA's netting program permits firms to modify existing facilities without undergoing the usual burdensome preconstruction review requirements and stringent emission controls so long as there is no significant net increase (i.e., above a specified threshold) in plant-wide emissions (Emissions trading 1986). In other words, netting relies entirely on internal trades from the same facility. If a firm cannot meet the emission limits through netting, it must follow the offset rules. Several thousand firms have used netting since 1974, with an aggregate savings of between $500 million and $12 billion dollars in control costs, as well as an additional $25-300 million saved through the use of simplified administrative requirements (Hahn and Hester 1989a; Hahn and Hester 1989b).

EPA policy also allows "bubble" trades, whereby a firm can increase emissions at one source without incurring additional regulatory burdens so long as it reduces emissions by the same amount at other sources within the facility (Emissions trading 1986; Liroff 1986). By 1986, EPA had approved 42 bubble trades, and state agencies had approved approximately 100 (Hahn and Hester 1989b).

Regulators distrust bubble trades because they think that firms use trades to evade emission controls. Historically, there have been few bubble trades in California, and at present very few local air pollution control districts permit them (Haber 1991).

Although Congress debated the use of economic incentives as a regulatory tool when it overhauled the Clean Air Act in 1977, it was unwilling to adopt them wholesale. Perceiving them as politically risky and perhaps as an unwarranted delegation of the public interest to private actors (Cook 1988), Congress chose instead to enact a modest program of economic incentives similar to one that EPA had adopted earlier. In 1990, Congress amended the Act to authorize a larger range of market based incentives.

The Development of California Policy

EPA's 1976 offset policy encouraged state officials--who are primarily responsible for enforcing federal air quality standards--to experiment with offsets (Liroff 1980). California was one of the first states to employ offsets. Although the state Air Resources Board adopted an offsets policy in late 1976, the primary initiative for emissions trading came from local air pollution control districts in nonattainment areas. The trades were ad hoc arrangements necessitated by the federal ban on new sources of emissions in nonattainment areas. They revealed problems that continue to plague the current trading system.

One of the earliest trades in the South Coast Air Quality Management District (SCAQMD) was prompted by a 1978 permit application to build a cement terminal at the Port of Long Beach. The Port quickly found offsets for nitrogen oxides and hydrocarbon emissions from a firm that anticipated that regulators would soon demand reductions

anyway; by trading the offsets, the firm could recoup the costs of installing new mandatory controls. The Port had greater difficulty finding offsets for other pollutants. Some potential sellers wanted to retain potential reductions for their own future use. A few firms were also concerned that being identified as having the capacity to reduce emissions would cause regulators to require additional reductions (A market 1982).

Firms seeking offsets in the Bay Area Air Quality Management District (BAAQMD) ran into similar problems. In 1978 Wickland Oil Company sought a permit from the BAAQMD to construct a petroleum terminal. After 2 and 1/2 years of negotiation, the district granted the permit on the condition that the company obtain offsets for hydrocarbon emissions by installing pollution control equipment in a nearby dry cleaning plant. The process was lengthy in part because it was difficult to quantify emission increases from the new facility and emission reductions from offset sites. It was also lengthy because Wickland found it difficult to locate firms willing to sell their offsets; the delays reportedly cost the company $6 million, approximately one-fifth of the entire project cost (A market 1982).

In 1979, the Pacific Gas and Electric Company (PG&E), a major utility, sought a permit from the BAAQMD to expand a power plant. Like Wickland, PG&E found few willing sellers; most firms candidly stated that they wanted to retain potential offsets for their own expansion. PG&E, however,

eventually found an adequate amount of offsets; the total offset cost of $1.3 million was a fraction of the projected $20 million cost of installing more stringent controls on existing PG&E facilities (A market 1982).

These trades demonstrated the huge potential savings that could accrue from a system of tradeable emission permits, but they also revealed the substantial difficulties in locating potential sellers and the predilection of firms to hoard potential reduction credits.

To promote trading, the California legislature enacted a statute in 1979 authorizing local air pollution control districts to establish a registration system under which emissions reductions could be banked for later use as offsets. Industry actively supported this legislation because it felt that the existing ad hoc trading system created great uncertainties and search costs that inhibited trading (A market 1982).

Almost immediately, the BAAQMD and the SCAQMD adopted trading rules and established emissions banks. At present, nearly two dozen air pollution control districts in California--virtually all of the nonattainment areas in the state--have adopted regulations governing offset trading for major new or modified sources. Approximately half of those districts have also established emissions banks (Emission credit 1988).

Administration of California's Emissions Trading Program

California's tradeable emissions policy is administered entirely by local air pollution control districts, with relatively little state or federal oversight (Menebroker 1991; Haber 1991). Each district has its own emissions trading and banking regulations. Because mobile sources of air pollution are under the jurisdiction of the state Air Resources Board, the districts' regulations are primarily concerned with industrial and commercial facilities, and not automobiles and trucks. In practice, emissions from mobile sources are rarely traded.

None of the districts has established a pure commodities market in emission credits. First, the emissions trading market supplements a well established, comprehensive command-and-control regulatory scheme. As required by federal regulations (and even stricter local regulations), new and expanded sources must still install stringent pollution controls known as "best available control technology." Offsets can be used only for residual emissions after these controls are installed. Second, there are numerous restrictions on emissions trades. Only new and modified sources can be buyers; there are no trades between existing firms. In addition, district regulations frequently restrict trades to firms in the same industry. Third, in contrast to most commodity transactions, proposed offsets and emission reduction credits are subject to public review and comment and agency approval (Emissions trading 1986).

The following sections examine two districts that have established emissions trading programs: the South Coast Air Quality Management District (SCAQMD), which includes the Los Angeles Basin, and the Bay Area Air Quality Management District (BAAQMD), which includes San Francisco and the metropolitan area surrounding the San Francisco Bay. Both of these areas are designated nonattainment areas--that is, they have not achieved federal or state air quality standards for certain pollutants and thus may not permit additional emissions. Nonattainment areas have been the most fertile ground for offset trading; generally, new or expanding firms must obtain emission reductions to operate (Hahn and Hester 1989b). Ironically, the political and legal pressure to reduce emissions and achieve air quality standards in nonattainment areas guarantees greater regulatory intrusion, which undermines emissions trading.

South Coast Air Quality Management District (SCAQMD)

Before it adopted new regulations in June 1990, the SCAQMD had the

> most developed and well functioning [offset market] in the country. There was a well established set of procedures and policies that were generally applied uniformly by those engaging in offset trades. ... SCAQMD staff had a good understanding of their offset regulations and had become adept at processing emission offset documentation packages (Margolis 1990).

As advertised, the program has permitted some economic growth (although the precise impact of the offset program on economic growth is difficult to assess quantitatively) with slight, but not insignificant, injury to air quality. The damage to air quality was not due to emissions trading as such, but to regulations that set emission thresholds, below which offsets were not required (Emission credit 1988).

Hahn and Hester cite three reasons for this relatively successful market, each of which points to a strong demand for offsets (Hahn and Hester 1989b). First, the district has imposed stringent emission limits on existing sources. These limits have made it difficult for a firm to use emission reductions from its own sources; because existing sources already installed stringent controls (or cannot get credit when they later reduce emissions), new and modified sources are more likely to need offsets from other firms. Second, in recent years the district has adopted relatively low offset thresholds, thereby increasing the number of new or modified sources that require offsets. Third, the district is a region of strong economic growth, and firms find it desirable to locate, expand, or modify facilities there.

Despite this assessment, SCAQMD's offset trading program seems anemic. The district receives more than 20,000 permit applications annually, the vast majority of which are to expand existing sources (Nikkila 1991). Most of the firms submitting applications avoid the need for

offsets by installing control equipment designed to keep their emissions below the threshold. Most of the remaining firms use internal trades to meet SCAQMD requirements. A much smaller number of firms--only a handful in 1982 and fewer than 50 in 1989--complete offset trades (Nikkila 1991). To the extent there is a market in emission reduction credits, it is mostly intra-firm.

The small supply of "available" emissions credits is a principal reason for the paucity of inter-firm trading. The lack of an adequate supply can be traced to industry's unwillingness to sell credits and to restrictive regulations.

Many firms (other than firms that have closed their operations) are unwilling to sell emission reduction credits because they do not trust the market. Firms need emission credits to expand their existing operations, and they believe that the district will never increase the amount of allowable emissions and they doubt that the market will supply them in the future. Other firms distrust the SCAQMD. They fear, for example, that if they reduce emissions, the district will impose an emissions "cap" barring future increases (Margolis 1991). For these reasons, the majority of external trades are with firms that have ceased operations (Nikkila 1991; Weiss 1991). Such firms have little reason to withhold their credits from the market.

Virtually no emission reductions have come from innovative technologies. District officials acknowledged

that the district uses innovative technologies as the basis for new mandatory controls for all sources (Nikkila 1991). As a result, large well-capitalized firms (which are the companies most likely to develop new control technologies) are reluctant to introduce new control technologies that will be required at their other plants.

If prices for emission credits continue to rise significantly in the next few years, as some industry consultants believe, existing sources may be more willing to sell some of their emissions reduction potential (Margolis 1990). As long as prices are increasing rapidly, however, some sources will withhold their credits out of fear that prices will rise further, thereby making it much more expensive to acquire offsets later on.

Some of the SCAQMD's rules also effectively reduce the supply of emission credits. For example, before June 1990, the district's regulations required emission reductions from shutdowns to be traded "contemporaneously" to new or modified sources; emission reductions could not be banked for future external trades (although they could be banked for future internal trades). Although the new rules have eliminated this restriction (and thus increased the supply of credits somewhat), a recent decision to discount emission reductions from shutdowns by 80% keeps the supply small.

Demand for offsets is governed by several factors. Perhaps the dominant factor is the pressure for industrial growth. An offset market, in which only new or modified

sources are allowed to be buyers, can flourish only so long as new firms want to locate in the district or existing firms want to expand their operations. Industrial growth is affected by exogenous factors (such as the state or national economy), as well as environmental and land use regulations that discourage growth. For years, the district has enjoyed strong economic growth.

Another important factor affecting demand has been the existence of offset thresholds. So long as a new or modified source can keep its residual emissions below the threshold, it need not obtain offsets. In past years, most permit applicants in the SCAQMD kept their emissions below the threshold. The district's new rules, however, have reduced that threshold to zero (although firms may apply for a small exemption). This change is likely to increase demand somewhat since virtually all new or modified sources will be forced to seek external offsets if they cannot find internal trades.

Demand may also be depressed by regulations requiring all new and modified sources to employ stringent controls, regardless of the availability of less expensive offsets. Whether this factor significantly affects demand depends on whether the cost of controls is greater than the cost of acquiring offsets. There are no good data on the importance of this factor.

Transaction costs for trades are significant and probably are a drag on the market. One industry consultant

estimated that the cost of locating and negotiating with a seller, undertaking appropriate engineering studies, and securing SCAQMD approval runs from $15,000-30,000 per trade. A seller's costs are comparable. Since a typical trade may involve credits costing $200,000-300,000, the out-of-pocket transaction costs are from 10-30% of the total cost (Weiss 1991; Margolis 1991). The size of the transaction costs helps to explain why most trades are internal (Hahn and Hester 1989a).

Another source of transaction costs is regulators' resistance or indifference to the tradeable emissions program. By demanding more information and making decisions slowly, regulators can make trades expensive. In a 1982 study of the SCAQMD program, some regulators expressed strong reservations in giving firms a property right to pollute (A market 1982). More recently, a brokerage firm commented that

> unpublished policies, on-the-spot policy interpretations and a visceral fear that industry was strongly benefitting from emissions trading has resulted in unreasonably high hurdles being placed before emission credit creators, buyers and sellers. The effect of regulators "changing the rules in the middle of the game" has added further confusion and frustration with the credit trading system. After all, it is not just the cost of the emission credits which is a concern to industry, it is also the hassle and

regulatory uncertainty which puts the system under suspicion (AER*X 1988).

Other industry consultants, however, maintain that regulatory delays normally are not due to offset issues (Weiss 1991).

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Although emissions trading in the SCAQMD market has been lackluster, it is worth noting that there is a movement to implement a full-scale emissions trading program. Driven by pressing statutory deadlines to submit a new plan to attain national air quality standards, district officials, some industry representatives, and some representatives of environmental groups have been meeting to decide whether they can reach a consensus on the design of the program and, if so, to draft proposed regulations (Nikkila 1991).

Bay Area Air Quality Management District (BAAQMD).

The BAAQMD has had an emissions trading program for over a decade. With 2000 construction permit applications submitted annually, the district has the potential to develop a flourishing market.

In fact, the offset trading program is moribund. The district receives only 3 to 4 applications annually to bank emission reduction credits, far fewer than in the SCAQMD (Margolis 1990; Swanson 1991a). A few firms (principally utilities and refineries) use netting or withdraw banked credits each year for internal trades, but no firm has sold credits to another firm since the Wickland Oil trade in 1979

(which predated the formally adopted trading program) (Swanson 1991b; Appel 1991).

The principal obstacle to trading in the BAAQMD is an inadequate supply of credits available for sale; from the beginning of the program, firms with the potential to reduce emissions or which had registered emission reduction credits hoarded their reductions (A market 1982; Appel 1983). John A. Swanson, the BAAQMD Director of the Permit Services Division, states that many firms retain reduction credits for themselves because they want to preserve the option to expand, and they are concerned that there will not be adequate emission reduction credits available in the market (Swanson 1991a). According to industry consultants, firms believe that the pool of tradeable emission credits will not increase but that demand will increase. Existing emission credits thus are "critical assets for expansion." One industry consultant stated that a firm would no more sell its emission credits than it would its land; only firms that are liquidating or moving out of the district are prepared to sell their credits (Wolf 1991; Appel 1991). Despite some economists' predictions (Misiolek and Elder 1989), there is no evidence that existing firms are withholding credits from new firms to obtain a competitive advantage (A market 1982; Tietenberg 1985).

Firms are equally unwilling to invest in additional control technologies to bank the resulting emission reductions (Appel 1991). Firms fear that emission credits

are always vulnerable to regulatory devaluation or outright confiscation, especially where, as in the BAAQMD, the air quality does not meet federal and state air quality standards and regulators are always under political and legal pressure to reduce emissions further. Repeated changes in the district's rules and constant attacks by environmental groups heightened industry's fears.

Moreover, such investments are risky, even speculative. The economy must be sufficiently strong and the regulatory rules sufficiently conducive to produce trades to ensure an adequate return on investment at some unspecified time in the future. Innovative control technologies pose even greater risks. Consequently, most banked credits come from firms that have permanently closed a facility, and the only credits for sale are those from firms that are closing all of their operations in the district (Appel 1983).

BAAQMD's Swanson points out that the district's rules also discourage offset trades. For example, under current BAAQMD rules, the offset ratio increases with the distance between the new source and the source providing the emission reduction credits. The purpose of the rule is to ensure that trading does not result in local "hot spots." The rule effectively creates numerous small markets, rather than a single district-wide market, thereby dramatically reducing the opportunity for liquidated firms to sell their credits (Swanson 1991a; Wolf 1991). Other rules restrict use of reductions from shutdowns to new or modified sources in the

same industry and heavily discount proposed reductions (Monthly 1991). The impact of these rules is to reduce supply even further.

Some district officials attribute the paucity of external trades to offset thresholds. Bill deBoisblanc, the BAAQMD New Source Review Chief, observes that under the district's rules, new or modified sources with emissions below a specified threshold need not secure offsets from other firms. Data collected by the district show that 80% of the new emissions do not trigger the offset or netting requirements (Proposed 1991). BAAQMD officials believe that firms carefully design their facilities to avoid the offset threshold (deBoisblanc 1991; Swanson 1991b). Regulators anticipate that more firms will seek offsets when the district revises its regulations to eliminate the offset thresholds (deBoisblanc 1991).

Some industry consultants believe that the proposed rule eliminating offset thresholds will increase demand. But other consultants point out that during the economic boom of the last six to eight years, when the demand for credits should have been its greatest, there were no external trades (Appel 1991). While offset thresholds depressed demand to some extent, high land and labor costs, as well as widespread public opposition to new industrial facilities, precluded any real increase in demand for inter-firm trades (Appel 1991; Wolf 1991)

Rules requiring stringent controls for most new and modified sources, regardless of the availability of offsets, probably also depress demand. Mandatory pollution controls reduce the need to acquire offsets if the controls are more expensive than offsets. Under the district's proposed rules, all new and modified sources would be required to install BACT controls.

Transaction costs probably are not to be blamed for the total absence of offset trading in the BAAQMD. Concededly, there are significant transaction costs because district officials carefully scrutinize proposed emission credits to ensure that only legitimate reductions are banked (Swanson 1991a; Wolf 1991). While some regulators initially resisted the program (A market 1982), industry consultants now believe that regulators are knowledgeable and cooperative, and that the permit approval process, which may take four to ten months, is neither unduly slow nor expensive (Wolf 1991). Moreover, by requiring firms to bank reductions within 18 months of the reduction or lose the credits, district regulations help to reduce the costs of identifying potential offsets.

Evaluation of California's Emissions Reduction Trading Policy

California regulators adopted a tradeable emissions policy because they had no choice. Although neither federal nor state law explicitly requires district officials to adopt such a program, it would have been politically

unacceptable for environmental regulators to ban industrial and economic growth because their districts did not meet air quality standards. In principle, an offset policy allows regulators to reallocate emission limits relatively easily and cost-effectively among new and old pollution sources.

The districts purportedly designed their emissions trading policies not only to accommodate industrial growth and maintain air quality, but also to spur the development of new control technologies. They hoped that the demand for offsets would provide sufficient economic incentive for firms to invest in research and development of new controls.

These twin goals--cost effective reallocation of emission limits to permit entry of new firms (or expansion of existing ones) and the development of new control technologies--depend on the ability of the regulatory agency to create and maintain a competitive market in emission reduction credits (Hahn and Noll 1982b; Roberts 1982). The agency, however, must contend with political constraints and the practical limitations of this unusual commodities market.

Political Constraints

Severe political constraints hindered efforts to adopt an emissions trading program in California. Pressure to maintain the conventional command-and-control approach, while not inexorable, has delayed and undermined the program from the beginning. In the absence of strong direction from

Congress, EPA, or the state legislature, local districts have moved hesitantly to adopt economic incentives.

First, officials at all levels of government have been reluctant to adopt a full-scale emissions trading program because it would radically restructure regulatory practices and disrupt longstanding expectations. In its idealized form, a tradeable emissions policy rejects centralized regulatory controls, thereby reducing the agency's role to a monitoring and enforcement function.

The policy, moreover, was initially developed and advocated by economists largely outside the existing regulatory culture. Although theoretically validated, the policy had not been evaluated under real world conditions. Under these circumstances, legislators and regulators could not be expected to support full implementation of such a policy. Instead, Congress, EPA, and local districts have been unwilling to drop existing regulatory practices--such as requiring all new sources to install stringent controls regardless of the availability of offsets--that dilute the impact of economic incentives (Tietenberg 1980). Trading is limited to new or modified firms acting as buyers and existing firms acting as sellers; there is no trading permitted between most sources.

Second, industry's support of a tradeable emissions policy has been lukewarm. While nominally in favor of more cost-effective regulations, industry's enthusiasm has been tempered by the possibility that it would have to purchase

what has been previously free--the right (or license) to emit pollutants up to a specified limit. Some scholars conclude that industry officials often do not understand the economic arguments advanced for market-based regulations (Kelman 1981). In addition, many firms would rather install identifiable controls than deal with the uncertainty of the market (in a sense, they believe that they will be better able to minimize regulatory costs in the political arena than in the market). Industry may also have felt that the frankly anti-regulatory policies of the Reagan administration were more promising than the market-based reforms proposed by the prior Carter administration (Meidinger 1986). Only as it has become clear in the last few years that federal and state laws would require additional significant reductions in total emissions has industry warmed to the offset program and to market-based pollution control strategies in general.

Third, legislators and regulators have been receptive to objections from some environmental groups and some regulators that it is morally wrong to create property rights in pollution (Levin 1982; Cook 1988; A market 1982). At least as potent in the political sector are arguments that market-based regulatory schemes based would be difficult to administer and enforce (Meidinger 1986). While these objections have not been powerful enough to block the adoption of a tradeable emissions program, they delayed implementation of the policy for several years and may have

prompted regulators to retain many of the basic command-and-control requirements (Hahn and Noll 1990; Maloney and Brady 1988).

As a result of these factors, California's emissions trading program is a relatively small part of a conventional standard-setting program. Rather than creating a market in which all firms can buy or sell emission credits, California regulators have grafted a relatively narrow offset trading scheme onto a comprehensive command-and-control program (Noll 1982; Hahn 1989). As Hahn has emphasized, political institutions, the demands of private actors, and the apparent imperative to preserve the status quo work together to hinder more thoroughgoing reform (Hahn 1989). As recent developments in the SCAQMD suggest, the proponents of market-based controls may ultimately prevail, but the path to reform will be slow.

Market Performance

The success of an emissions trading scheme is also strongly affected by the practical limitations of the market. California's experience suggests that there are formidable obstacles to achieving the ideal competitive market.

A competitive market requires an adequate number of buyers and sellers, sufficient incentives to buy and sell credits, and moderate transaction costs (Hahn 1984; Hahn and Stavins 1991). Yet it is difficult to ensure these preconditions. The districts' rules and practices, the

perceptions of industrial managers, and the vagaries of national and local economies conspire to limit the number of trades.

The demand for emissions credits is directly tied to the design of the emissions trading program. For example, limiting trades to new or modified sources (thereby barring trades between unmodified existing sources) excludes large numbers of potential buyers. The BAAQMD rule that increases the offset requirement for relatively distant sources of new emissions and reductions has also made it impossible for certain sellers to find any buyers. By requiring all new or modified sources to install stringent controls and establishing thresholds that excluded important categories of new emissions from the trading program, district regulations depressed demand and allowed overall emissions to increase.

The pressure for economic growth in Southern California has been an important factor in generating the demand necessary to sustain an emissions trading market. Economic growth, however, is not necessarily sufficient to guarantee adequate demand. In the SCAQMD there have been at most only a few dozen inter-firm trades annually, and in the BAAQMD, substantial economic growth for several years was not enough to generate a single external trade.

In general, the supply of offset credits is governed by three factors: The reservoir of reductions that can be tapped by installing new controls, making process changes,

or closing part or all of a facility; agency regulations and practices that limit the availability of credits; and industry attitudes toward the emissions trading policy.

In California, most emission reduction credits that are available for trading come from sources that shut down. Relatively few emission reduction credits come from new control technologies or process changes (Haber 1991), and the supply of reductions that comes from process changes is shrinking as regulators discount claimed reductions and require stricter controls on existing sources (Margolis 1990). While the current price of credits may be too low to lead to innovation (Margolis 1990), it is doubtful that the current scheme would ever produce market conditions leading to significant innovation.

The supply of credits is significantly reduced by regulations, such as geographical restrictions on trades or rules limiting credits to the same industry. But the principal reason that there are few credits available for trading is that firms tend to hoard credits. Firms believe that they will need additional credits--either because the district will demand new emissions reductions or the firms will want to expand--and that the market will be unable to supply credits at acceptable prices. While banking rules in the SCAQMD and the BAAQMD force firms to bank their actual reductions or forfeit them, firms have little incentive to make costly reductions now or trade their credits.

Numerous observers have blamed industry reticence on agency practices and policies that make emission reduction credits too insecure (Weiss 1991; Margolis 1991; AER*X 1988; Hahn and Hester 1989b). Unless firms are confident that regulators will not confiscate their reductions, they will be reluctant to bank emission reduction credits, invest in additional controls, make process changes (to create reduction credits), or even make trades (Hahn 1986).

Early in the history of the trading program, California firms expressed concern that banked credits were vulnerable to confiscation (A market 1982). Today, some districts confiscate a percentage of banked reductions to fund a "community" bank (California Clean 1990) or to achieve air quality standards. The SCAQMD's decision in June 1990 to discount most banked credits by 80% confirmed industry's fears about regulators' confiscatory tendencies (Margolis 1990).

Government regulators acknowledge that hoarding can be traced to the industry's lack of confidence in the predictability and stability of the emissions trading program (Werner 1991). But while they want to reduce uncertainty (and thus promote trades), they are adamant about the importance of retaining flexibility to respond to new information about, for example, the quantitative relationship between emissions and environmental quality (Werner 1991; Krinsk 1991). Thus, the permit system must achieve a balance between the need for secure property

rights and the need to adjust emissions as new information becomes available.

The California air pollution control districts have not struck that balance. The districts' rules change frequently and unpredictably, and regulators emphasize that they are free to readjust allowances as they deem necessary to achieve air quality goals. (Comments 1988). One observer states that these problems have been well known since 1980, but that districts have not taken steps to bolster industry confidence (AER*X 1988).

This may be the inevitable consequence when regulators accustomed to command-and-control techniques are responsible for creating stable market conditions. The temptation to seize market surplus to achieve other regulatory goals may be greater than the regulators can withstand.

The emissions trading market can be undermined by high transactions costs. While transaction costs are significant in California's emissions offset program, they are not responsible for the paucity of trading.

Because most trades are one-time affairs, many firms, particularly smaller ones, are unfamiliar with the emissions trading program (they are not used to thinking of emission reductions as a commodity) and must expend resources to learn about it (Haber 1991). In addition, especially in the early stages of the emissions trading program, buyers expended substantial resources to find and negotiate with potential sellers (Hahn and Hester 1989b). Today, however,

there are numerous professionals who are familiar with the market and the districts' rules and who can significantly reduce these search and negotiation costs.

There are costs in obtaining agency approval of emission credits. At a minimum, buyers must undertake engineering studies to quantify expected emissions and reductions. In some cases, especially in the early stages of the program, transaction costs were magnified because some regulators were hostile to market-based regulations.

An effective trading system, however, requires regulators either to scrutinize trades carefully or to monitor emissions closely to ensure that the market supply of emission reduction credits is not diluted with fake credits. In contrast to normal commodities markets, there is little self-policing by buyers. While regulatory scrutiny has increased over the past five years (Haber 1991), that scrutiny is essential for market stability.

Recommendations for a Greenhouse Gas Emissions Trading System

The principal lesson from California's experience with offset trading is that a half-hearted use of market incentives will not achieve the advertised goals of increased efficiency and technological innovation. By severely limiting the regulatory program's scope and freighting it with command and control regulations, federal and state regulators virtually incorporated market failure

into the regulatory design. An effective greenhouse gas emissions trading program should avoid these mistakes.

First, a much larger proportion of firms should be included in the program, thereby permitting trades between existing firms. Including all firms, however, may create unduly heavy monitoring and enforcement administrative burdens. To generate demand, existing sources (assuming, as is likely, emission rights will be allocated in proportion to current emissions), could be required to reduce emissions by a specified percentage. Firms would be free to install additional new controls, change their processes, shut down, or buy credits.

Second, exemptions should be minimized or prohibited altogether. Firms whose emissions only slightly exceed emission limits could purchase credits from a "community emissions bank" (funded by reductions from all existing firms) in the event they have difficulty acquiring small amounts of credits on the open market.

Third, command-and-control regulations--such as requirements to install controls regardless of the availability of credits--should play at most a minor role in the regulatory scheme. Because of the tendency toward policy inertia, using emissions trading as a regulatory supplement may preclude a more comprehensive role for emissions trading in the future. Political pressure for such controls, however, may be substantial. Many legislators and regulators will fear a loss of regulatory

authority to private firms, be suspicious of policy initiatives from other disciplines, and perhaps have moral or pragmatic objections to a regime establishing property rights in pollution. Nevertheless, because there is little existing regulation of greenhouse gases, legislators and regulators have a unique opportunity to create an entire regulatory program without the baggage of prior efforts. If the program is not created incrementally, there will be a political opportunity to make emissions trading the central element of greenhouse gas policy.

Fourth, it is essential to establish an adequate system to register credits and to monitor and enforce emission limits. If firms believed that cheaters would not be caught or that sanctions would be light, they would see little reason to buy credits. Demand, and perhaps the market, would atrophy. The need for effective monitoring is even more critical if firms trade frequently.

The responsibility to monitor emissions--that is, to ensure that firms observe emission limits and trade legitimate credits--could quickly overwhelm a regulatory agency's resources. Part of the monitoring burden could be shifted to the firms themselves, by requiring periodic reports on emissions or outside audits. Continuous emissions monitoring (which is required in the new acid rain program) would alleviate many concerns, but reliable continuous emissions monitoring systems are expensive and many firms may be unable to afford them. For many firms,

there may be no substitute for agency approval of each trade.

Fifth, firms' confidence in the trading scheme must be reinforced. California's experience with emissions trading demonstrates the importance and difficulty of inducing firms to sell emission credits. Firms fear that regulators (or legislators) will impose stricter emission limits or confiscate banked credits (Meidinger 1985). Although regulators may be less tempted to seize surplus greenhouse gas credits than conventional pollution credits--the regulatory and political focus is primarily on total emissions rather than on air quality--regulators' distrust of markets and political criticism of property rights in pollution may undermine the security of emission credits. Firms also doubt that the market will be able supply credits at a reasonable price when they need them to expand.

The task is to convince industry that neither the regulatory regime nor the political process will subvert the emissions market and that emission rights are relatively secure. It may be necessary to provide legally enforceable assurances protecting emission rights.

It may be unwise, however, to make emission rights too secure. There is little reason to believe that regulators have complete or accurate information about the relationship between emissions and environmental quality. Scientific knowledge about greenhouse gases is bound to improve over time, thereby potentially requiring important changes in

public policy. Moreover, as David Victor has observed, the inevitability of "changing socio-economic objectives and conditions" counsels against rigid regulatory goals (Victor 1991). Without some flexibility to adjust total emissions, regulators may be foolishly handicapped. Unavoidably, there are difficult tradeoffs between security of property and the need for regulatory flexibility.

Sixth, transaction costs should be minimized, although it is doubtful that the costs will substantially impair trading. There will be significant transaction costs if regulators review and approve each trade, but as suggested earlier, such costs may be unavoidable. Search and negotiating costs, by contrast, should decline as trading becomes commonplace.

Moreover, transaction costs for greenhouse gas trades should be somewhat smaller than costs for other industrial pollutants because there is no need to model the dispersion of greenhouse gases. While the emission of conventional pollutants can create local "hot spots" that threaten public health, greenhouse gases have only global thermal effects (Tietenberg 1989).

Transaction costs, however, will be impossibly high for small sources, such as automobiles and home furnaces, which are major contributors of greenhouse gases (Hahn and Stavins 1991). For this reason, some experts maintain that the emissions trading approach is fundamentally flawed and

should be rejected in favor of emission charges (Hahn and Stavins 1991).

While an emission charge scheme has certain advantages over a trading scheme, it also suffers well recognized shortcomings if the goal is to achieve a specified level of emissions at least cost (Hahn and Noll 1982b). However, if one were to abandon or relax this goal, an emissions tax for small sources would complement the tradeable emissions program. Regulators could impose on small sources a carbon tax designed to raise revenues, which could be used to buy and retire emission credits (Tietenberg 1989). Experience in other countries has shown, moreover, that such a tax might encourage consumers rapidly to adopt new technologies with smaller emissions (Tietenberg 1989).

Conclusion

The California emissions trading program has failed to establish a market in tradeable emission permits. While new or expanded facilities have saved a substantial amount of money through internal trades, virtually no firm that is continuing in business will sell its emission reductions to another firm. The market has never established itself in California because state and federal regulations have critically limited the supply of and demand for permits, and because polluting firms are skeptical that the market will function when they need credits in the future.

In some respects, establishing a tradeable emissions market for greenhouse gases should be simpler than for

conventional pollutants (e.g., there is no need for dispersion modelling and no need to accommodate an existing regulatory structure). However, the existence of almost countless small sources (e.g., motor vehicles) makes even an ideal tradeable emissions scheme only a partial solution.

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