ECONOMIC INSTRUMENTS FOR VEHICLE EMISSION REDUCTIONS IN CALIFORNI

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INTRODUCTION

Government may choose from a variety of regulatory and economic instruments to achieve major reductions in vehicle emissions and energy consumption. Historically, countries with market economies have primarily chosen to use direct regulation, mostly prescriptive and uniform performance standards. Recently, the use of economic instruments has been gaining favor as a more efficient means of achieving the same goals. Most attention has been centered on those economic instruments that alter price signals to incorporate energy and environmental externalities -- relying on taxes, rebates and subsidies -- but California has tentatively embarked on a different path: the use of marketable credits. Marketable credits appear to be a more effective economic instrument for achieving large emission reductions than fuel and vehicle taxes (and rebates), and present a robust framework for guiding transportation energy and environmental choices in the 1990s and beyond.

OVERVIEW OF THE 1990 CALIFORNIA VEHICLE EMISSIONS CONTROL PROGRAM

In response to the continuing air pollution problems of the state, the California Air Resources Board (CARB) adopted a set of much more stringent vehicle emission standards in September 1990. New-vehicle tailpipe emission standards are the heart of the CARB initiative. As shown in Table 1, automobile tailpipe standards for hydrocarbon emissions (expressed as non-methane organic gases) measured at 50,000 miles were tightened incrementally from today's 0.39 grams per mile gradually down to 0.062 in 2003. Tighter emission standards were also set for nitrogen oxides,

carbon monoxide, formaldehyde (methanol vehicles only), and particulates (diesel cars only), for light and medium duty trucks as well as for cars. CARB is establishing equivalency factors between different fuels and vehicles to accomodate alternative-fueled vehicles.

Table 1: California Average Automobile Emission Standards for Hydrocarbons*, 50,000 miles, grams/mile

Year	Emission Standard
1994	0.250
1995	0.231
1996	0.225
1997	0.202
1998	0.157
1999	0.113
2000	0.073
2001	0.070
2002	0.068
2003	0.062

*Measured as non-methane organic gases.

Motor vehicle manufacturers will be allowed to average emissions across their vehicle fleet to meet the standard, to bank emission credits when they beat the standard, and to sell (i.e. trade) excess emission credits to other manufacturers who are not meeting the standards. By trading emission credits, a market is created for emissions, and thus CARB has created marketable credits.

Several constraints were imposed on the averaging, banking and trading of emissions. First, the vehicles must be certified as falling into one of five hydrocarbon emission categories -- zero emission, under 0.04 g/mi (labeled as ULEV or "ultralow emission vehicle"), under 0.075 (low emission vehicle), under 0.125 (transitional low emission vehicle), and under 0.25 -- and the emissions averaging is based on the upper bound emission number in that category (i.e. 0, 0.4, 0.075, 0.125, and 0.25) (see Table 2). The only effect of this categorization is that actual emissions will be somewhat less than reported "average" emissions. Another restriction imposed for the sake of administrative simplicity is that each hydrocarbon emission category has a nitrogen oxide, carbon monoxide, and formaldehyde standard assigned to it. The formaldehyde standard applies only to methanol vehicles.

Table 2: Emission Standards at 50,000 Miles, grams/mile

VEHICLE CATEGORY	HC	NOx	CO	BENZENE	FORMAL-DEHYDE
CURRENT	0.39	0.4	3.4	none	0.015
Conventional	0.25	0.4	3.4	none	0.015
TLEV	0.125	0.4	3.4	none	0.015
LEV	0.09	0.2	3.4	0.002	0.015
ULEV	0.04	0.2	3.4	0.002	0.008

Note: Standards for 100,000 miles are 20-25% higher for HC, NOx, and CO

TLEV = Transitional low emission vehicle
LEV = Low emission vehicle
ULEV = Ultra-low emission vehicle

A second constraint is that emission credits lose their value over time when they are banked: they would lose 50% of their value at the end of the following model year, another 25% after the following model year, and all of their value after the following year. This constraint is well justified by the fact that standards are being continually tightened, and it would be counterproductive to allow vehicle suppliers to bank credits when emissions are less stringent, for use at a later date when emissions are more stringent.

A third and very important constraint is that 2% of all vehicles supplied by each major manufacturer to California must have zero emissions in 1998, with that proportion increasing steadily to 10% in 2003. The motivation behind this rule is to make certain that vehicle manufacturers make progress in designing electric, hydrogen, and/or fuel cell vehicles, assuring that the Los Angeles area's goal of transitioning to zero emitting vehicles is attainable in a more timely manner.

Fourth, emission averaging will not be allowed for medium duty vehicles. Instead, a specified percentage of each manufacturer's vehicles would have to meet a set of categorical standards; trading of credits for vehicles in each category would be allowed within and between companies.

Since it is anticipated that some vehicle suppliers will decide to meet the lower standards using alternative fuels, CARB

sought to make sure that fuel would be available for those non-petroleum vehicles. Thus CARB requires, as part of the overall package of new rules, beginning in 1994 in the Los Angeles area and in 1997 statewide, that gasoline suppliers be required to make available clean alternative clean fuels -- defined to include alcohols, LPG, and compressed natural gas -- at a specified number of fuel stations. The total number of retail fuel outlets required would be determined with respect to the number of alternative fuel vehicles being sold. The minimum required in the Los Angeles area for each liquid fuel will be 90 in 1994, 200 in 1995, and 400 in 1996, and for the rest of the state the minimum required will be 400 in 1997. The required number of compressed natural gas stations will be determined strictly by formula, based on the number of CNG vehicles sold. (The total number of retail fuel stations in California is about 15,000.)

This new CARB vehicle emissions control program is revolutionary not only because of its stringency, but also because it veered away from uniform emission standards. This use of marketable credits came about not for ideological reasons, but because CARB found that marketable credits were a means to ease opposition from the automobile industry to the stringent emission standards they were proposing. CARB found, via a year-long series of workshops and public hearings, that the flexibility inherent in emission credits was attractive to an industry that until now has been forced to accept uniform emission standards. This new marketable credits program creates, for the first time anywhere in the world, a market for emission reductions from motor vehicles.

In the following sections, the range of government options for reducing emissions and energy use will be explored, with the intent of understanding the alternatives to marketable credits that are available to governments, and the various configurations and designs of marketable credits for regulating vehicles and fuels. The advantages and disadvantages of the different approaches are assessed, including California's hybrid program. It is suggested that, in practice, marketable credits constitute perhaps the most effective and economically efficient approach for reducing pollution and energy use in vehicles, and that marketable credits present a robust framework for guiding fuel and vehicle choices in the 1990s and beyond.

GOVERNMENT INTERVENTION

Government intervention in the transportation sector on behalf of energy and environmental goals may be categorized as falling into the three following approaches: informational, direct regulatory instruments, and economic instruments (OECD/IEA, 1989).

Informational initiatives include labeling of energy efficiency and emissions on vehicles in order to induce buyers to incorporate that information into their purchase decision. The effect of such programs is generally minimal, but they can serve as an important adjunct to, and to create political support for other initiatives.

DIRECT REGULATION

In the United States and other market economies, most government initiatives to improve petroleum consumption and reduce emissions in motor vehicles have relied, until now, on direct regulatory instruments. The distinguishing feature of this approach is that public policy objectives are achieved by placing direct controls on behavior; that is, directing people to act in specified ways through legislation and administrative commands (Cook, 1988:20). Rules and standards are the principal tools of control. This approach gained prominence in the U.S. as in the 1960s as part of the expanded governmental interest in controlling safety and environmental quality; it is an innovation that was and is promoted by lawyers and engineers, whose disciplinary paradigm is one of right and wrong and highly specific rules of conduct and design.

Prescriptive standards are the most extreme example of this form of intervention. In this case, government prescribes in very specific terms the required behavior of an organization or individual: for example, the required installment of exhaust gas recirculation (EGR), or a requirement that gasoline contain 2.0% oxygen. Prescriptive standards, as suggested by the examples above, may be applied to both fuels and vehicles, and indeed commonly are. Production mandates -- where, for instance the production of a certain number of a prescribed type of vehicle or fuel is mandated -- are a variation of a prescriptive standard. Prescriptive standards are sometimes referred to as "command and control", a label that has also been applied loosely, and less accurately, to other forms of direct regulatory instruments.

Emissions and energy use can also be directly regulated using performance standards. These are more flexible than prescriptive standards, since the vehicle manufacturer has the option of meeting the standard with whatever technology in whatever configuration they desire. The least flexible performance standards are those that require every vehicle (or fuel composition) to meet exactly the same standard. Vehicle emission standards in the U.S., including California, are currently of this type. Performance standards have not yet been applied to fuels. The disadvantage of uniform performance standards is that they ignore differences in the marginal cost of emission and energy efficiency improvements across vehicle types.

In practice, it is easier and considerably less expensive to reduce emissions from some vehicles than others; thus, uniform emission standards, by requiring every vehicle to meet the same standard, are highly inefficient and costly to industry and therefore consumers.

Performance standards can be made more flexible by allowing averaging of the regulated attribute across each manufacturer's fleet of vehicles. Indeed, this is exactly what is done with Corporate Average Fuel Efficiency (CAFE) standards. However, even averaged standards are economically inefficient since the marginal costs vary from one manufacturer to another, especially smaller manufacturers that specialize in certain types of vehicles; that is, recreational, sports, small, and luxury vehicles all have fundamentally different energy efficiencies. It is economically irrational to expect manufacturers specializing in only a few lines of vehicles to have to meet some average standard.

A third type of direct regulatory instrument that in theory could be used with vehicles and fuels, but are not well suited in practice, are permits to sell fuels or vehicles and to operate "smog" inspection stations. They have the following shortcomings and problems: they are not suited to an activity involving many distinct activities (as in millions of vehicles), they restrict entry into the market by newcomers, are not connected with concepts of economic efficiency, and are difficult to adjust to shifting economic, technological, and political conditions, and new information.

ECONOMIC INSTRUMENTS

Economic instruments are also referred to as market-based and incentive-based approaches. Two different types of economic instruments exist. One set of instruments are used to make existing market arrangements operate better by manipulating key attributes of the market, particularly prices. The second set of instruments create market-like arrangements that mimic real markets in the way they generate incentives. The emphasis of both approaches is on decentralized decisionmaking driven by self-interest, but guided by the regulating body through its structuring of incentives.

The first approach, using existing markets better, typically involves the use of taxes, fees, and subsidies. One example is Sweden's recent imposition of a tax on gasoline to account for pollution.

A second example is the "fee-bate" concept, whereby a rebate and fee schedule is established for new car sales: buyers receive a rebate if the car they purchase has lower emissions and/or

better fuel efficiency than average, or pay a fee if the vehicle emits more pollution and/or uses more fuel than average. The size of the fee and rebate is proportional to how far the vehicle is above or below the average. The effect of a fee/rebate program is to provide an incentive for individuals (and organizations) to purchase cleaner-burning and more fuel-efficient vehicles (including alternative fuel vehicles), and for vehicle manufacturers to develop and sell such vehicles.

Fees, rebates, taxes, and subsidies are an attempt to make the market system work "better" by incorporating energy and environmental externalities into the market prices seen by industry and consumers. The principal challenge for regulators in designing programs to incorporate externalities into fuel and vehicle prices is to determine the appropriate magnitude of those fees, rebates, and subsidies needed to elicit the desired improvements.

Proposals to make the system work better -- by incorporating externalities -- are conceptually attractive and potentially highly effective, but politically difficult to implement, especially in the U.S. where automobiles are seen as necessities and not luxuries, unlike in most parts of the world. Legislators and regulators are wary of these proposals that directly influence prices because they are reluctant to impose direct financial transfers on consumers, particularly when these transfers can be labeled as taxes.

In addition, regulatory agencies are reluctant to introduce these proposals because they would have to seek new authority and because very large financial transfers (or taxes) would be needed to compel changes of the order sought by the regulators.

The reason that large financial transfers would be needed is because the price elasticity of demand for transportation fuels is relatively low. Studies of historical data in the U.S. find short term price elasticities of about 0.1-0.3 and long term elasticities of about 0.7, suggesting that fuel prices need to be roughly tripled to reduce emissions (per vehicle) by half. The use of marketable credits in California aims to reduce vehicle emissions from new cars over 80%, from 0.39 grams/mile to 0.062 g/mi in 2003 -- a much greater effect than could be accomplished with even a tripling of fuel prices (although it will take 10 years or so after 2003 for enough new cars to be on the road to actually achieve 0.062 across the entire fleet).

Fuel price elasticities are likely to remain rather low, for the following reasons -- fuel constitutes a relatively small part of the total cost of owning and operating motor vehicles, vehicles are becoming more energy efficient (and thus fuel cost becomes even less important), and income is growing in most countries. Thus marketable credits will continue to be more

effective (though not necessarily more economically efficient) at reducing pollution and energy use than those economic instruments that alter prices.

The second type of economic instrument, creating new market-like arrangements, includes the assignment of tradeable pollution licenses and permits, and marketable credits. Licenses and permits may work well with a limited number of sources -- indeed, they are increasingly being used with stationary sources such as for sulfur oxides from powerplants -- but not with millions of vehicles. Marketable credits are better suited to motor vehicles.

Marketable credits, as illustrated by the California program, are created by setting standards, and allowing vehicle (and/or fuel) suppliers to average around the standard; if they do better than the standard, then they are allowed to bank and trade those excess credits, thus creating a market -- with marketable credits as the currency -- for whatever attribute is being regulated. In California, essentially only hydrocarbons are being traded -- other pollutants are bundled with hydrocarbons -- but the program could be expanded to unbundle the other air pollutants, and to allow trading of those other pollutants, as well as the trading of greenhouse gases, energy use, and even the energy security attributes of the fuels.

Averaging and banking of attributes are not essential components of marketable credits, but they provide much more flexibility, and lead to much greater efficiency in attaining standards. Banking and averaging procedures could be applied to uniform performance standards, such as those for vehicle emissions, whether or not marketable credits (i.e. trading) are allowed. But averaging and banking are especially important in creating a workable and efficient marketable credits system.

With averaging, vehicle manufacturers have the flexibility to average emissions across their fleet of vehicles. Vehicle suppliers would reduce emissions to a lower level in those vehicles where the cost of reducing emissions is less and not reduce emissions as much in other vehicles where the cost would be greater, as long as the average for all vehicles was below the standard.

A new averaging standard needs to be lower than an unaveraged uniform standard in order to gain the same net reduction -- because the unaveraged standard is a ceiling and thus all vehicles emit under the standard, resulting in an average emission rate that is actually considerably lower than the standard.

Emission banking allows manufacturers to bank emissions from years when they outperform the average for use in years when they

fall short. Banking is especially critical to trading schemes; banking rules allow trades to occur when and where they are needed and desired. Emission banking also provides an incentive to introduce new technologies and products sooner in anticipation of continuing tightening of emission standards.

The heart of a marketable credits scheme is the trading of attributes (i.e. excess emission credits). It allows those manufacturers who prefer to focus on large vehicles and other types of vehicles that tend to produce more emissions (or other undesired attributes) to continue to do so -- but to do so they would have to buy credits from manufacturers who sell low-emitting vehicles that better the standard.

COST SAVINGS OF MARKETABLE CREDITS

Emission and energy reductions are achieved less expensively with averaging, banking and trading of attributes than with direct regulaltion since industry has the flexibility and incentive to reduce emissions and energy use in the most cost-effective manner possible.

Unfortunately, no up-to-date reliable estimates have been calculated of the economic benefits of marketable credits. The only known study was conducted for the U.S. Environmental Protection Agency in 1984; it estimated the cost savings associated with emission averaging and trading, but not banking (McElroy et al., 1984). They calculated that the differences in emission control costs to automakers between a regime of uniform emission standards and a regime allowing emission averaging and trading between companies, for equivalent reductions in total emissions, was 25%. That is, if the four U.S. and four major foreign automakers had been allowed to use averaging and trading to meet emission reduction requirements, their costs for doing so would have been 25% less.

The calculations were made using 1981 emission standards, forecasted vehicles sales for 1984-90, the vehicle and market mix prevailing in 1981, and based on a set of emission control cost functions derived from a statistical analysis of 1979-82 certification data and unreported estimated cost functions. The analysis is simplistic and out-of-date, relies on a poor data base, and uses aggregated data in a manner that underestimates the cost savings. My sense is that with the tighter standards and higher marginal costs of the 1990s, cost savings for emission trading and averaging would be much greater. (A major study of these cost savings is currently being conducted at the Institute of Transportation Studies at UC Davis, with funding from the California Institute for Energy Efficiency).

Nonetheless, even if we accept that low 25% estimate, along

with estimates that the current marginal cost for emission control is as much as $946 per vehicle in 1985$ (Kappler and Rutledge, 1985), we find that emission averaging and trading would generate cost savings of $300 million per year in California and $3 billion for the U.S.

ASSESSMENT OF THE CARB MARKETABLE CREDITS PROGRAM

The CARB initiative is bold and innovative, representing a major break from the past and from the continuing national (U.S.) approach of uniform emission standards. It is limited, though, in its scope, and falls short of being a pure marketable credits program in the following way: all automobile tailpipe emissions are bundled together under the hydrocarbon standard for purposes of averaging, banking and trading; non-tailpipe emissions were not included in the marketable credits program; energy and greenhouse gases are ignored; and sales of prescribed percentages of zero emission vehicles (i.e., electric vehicles) are mandated.

The bundling of emissions was an expedient procedure used to simplify administration. The economic efficiency losses are probably small, but have not been analyzed. Evaporative (non-tailpipe) emissions were left out, even though they apparently account for over half the hydrocarbon emissions from new vehicles, because of large car-to-car variablity as the car ages, and inadequate data. Energy consumption was ignored because the State does not have authority to directly regulate vehicle energy efficiency, but CARB could possibly regulate greenhouse gases, and therefore indirectly regulate energy efficiency. The importance of integrating regulation of emissions and energy is growing as alternative fuels become a more viable option. Each fuel has a very different combination of energy and environmental attributes; to treat air quality attributes independently of greenhouse gas, energy security, and energy efficiency attributes is bad policy that leads to investments and choices that are not in the public interest.

To deal with this problem of assuring that clean alternative fuels are introduced in a rational and cost-effective manner, CARB opted not to use economic instruments. As described earlier, CARB is mandating that gasoline marketers make "clean" alternative fuels available at a prescribed number of stations. CARB has the authority which it has not exercised to establish a marketable credits program for suppliers of transportation fuels, whereby attributes of fuels could be traded among petroleum, natural gas, methanol, LPG, and electricity suppliers. A limited marketable credits program for fuel suppliers was proposed by CARB early in the rule-making process, but was abandoned because of opposition from the oil industry and a sense that the proposal needed further study.

A marketable credits program, or a more prescriptive program, is needed to overcome coordination ("chicken and egg") obstacles that discourage vehicle suppliers from manufacturing alternative-fueled vehicles, and fuel suplliers from marketing alternative fuels. CARB halfheartedly chose to mandate fuel availability as the means of addressing the fuels problem, but more effective and efficient instruments are available as indicated below.

(see Sperling et al, 1991 for analysis of marketable credits for fuels).

A conceptually pure marketable credits program would integrate the trading of credits between vehicle and fuel suppliers, but that would require considerably more analysis and innovation.

Fuel Supply Regulation

To incorporate a geographical element into the system it is necessary to involve fuel suppliers -- to allow fuel suppliers also to average, bank and trade credits. Region-specific strategies are desirable because the magnitude and nature of the pollution problem varies greatly from one region to another. For instance, some regions have major pollution problems while others do not. In some cities, the most serious air pollution problem is high carbon monoxide concentrations, while in others the more critical problem is ozone. Even for those cities with ozone problems, the controlling constituent in some is hydrocarbons, while in others it is nitrogen oxides.

Region-specific strategies are possible with fuels regulation because the fuel purchased within a region is consumed within that same region. Vehicles purchased within a region, in contrast, can be readily sold or transferred to another region, a right that government is unlikely to restrict. Thus fuels-based regulations are amenable to region-specific strategies, whereas vehicle-based regulations are not.

The administration of a fuels regulation program would probably be more difficult than a comparable program for automotive emissions, principally because there are many more fuel suppliers than vehicle suppliers and because of the multiple fuel supply industries. There is also less experience with fuels regulation. The only current regulation of fuels is through spot checks of vapor pressure, lead content, and the use of oxygenated blends in some areas (e.g. in Denver to reduce wintertime carbon monoxide).

Fuel regulation would involve hundreds of fuel marketers, and include not only petroleum marketers (who probably would also market methanol, ethanol, and possibly LPG), but also

distributors of natural gas and electricity. Fuel regulation would presumably occur at the bulk distribution terminals in the case of liquid fuels, which is the point at which excise and sales taxes on gasoline and diesel fuel are currently collected. Natural gas and electricity regulation would be much simpler since only one supplier operates in any geographical region (they are regulated monopolies) and because the activities of these companies are already heavily regulated and closely monitored.

While fuels regulation is not as familiar as vehicle emissions regulation, and will be more complex administratively, there is no reason to believe it is unworkable. Indeed, as documented by Hahn and Hester (1989), the very successful experience with trading and banking of lead rights for use in gasoline in the 1980s -- at one point, over 50% of all lead rights were being traded -- suggests that fuels regulation would not be onerous nor exceptionally difficult.

Since each type fuel emits differring quantities and types of pollutants, the regulation of fuels as well as vehicle emissions would require that ratings be developed for each fuel that indicate the relative harm of pollutants associated with each fuel. Emission equivalency values would be assigned to the different fuels. Ozone reactivity ratings have already been developed for comparing the relative contribution of each type of fuel to ozone formation. In the case of fuels, a rating would be assigned to each carefully specified fuel: for instance, gasoline might be rated 1.0, "reformulated" gasoline 0.9, methanol 0.6, natural gas 0.4, and electricity 0.2. Each fuel supplier would be required physically, or via purchased or banked credits to supply a slate of fuels that on average meets a rating established by the regional or state air quality regulator.

This regulation of fuels creates the opportunity to develop region-specific strategies in two ways: the equivalency values can be adjusted to reflect the unique aspects of pollution in that area, and the average rating required of each fuel supplier could be raised or lowered depending upon the severity of the problem in that area.

Thus, in Los Angeles the average rating imposed on each fuel supplier might be 0.5, while in San Francisco it might be 0.9. Similarly, because methanol is relatively more effective at reducing ozone in NO_x-rich atmospheres than in hydrocarbon-rich atmospheres, the rating asigned to methanol might be lowered to 0.5 in NO_x-rich Los Angeles and raised to 0.7 in hydrocarbon-rich regions such as Houston. Or, because natural gas vehicles emit very low levels of carbon monoxide, natural gas might be given a low rating of 0.2 in regions such as Denver that have serious carbon monoxide problems.

In fuels-based regulation, each fuel supplier would

determine the most cost-effective manner for meeting the specified average rating. If it is expensive for an oil refiner to reformulate gasoline to reduce its emissions -- because of the design of its refineries -- or the average rating is set lower than that achievable with reformulated gasoline, then credits could be purchased from another company which can meet the required rating at less cost. Or the oil refiner might choose to sell natural gas or even electricity itself at its own stations.

Over time, the standards would be gradually tightened on a predetermined schedule (with periodic mid-course adjustments). Fuel suppliers could plan their investments with this schedule in mind; smaller refiners less willing or able to invest in refinery modifications might move more quickly toward alternative fuels, and sell their emission reduction credits to larger refiners who might prefer to focus on reformulated gasoline. Likewise, some automakers might prefer to stick with improving gasoline engine technology, including multifuel engines; they would buy emission reduction credits from other companies that sell much lower-emitting EVs and single-fuel natural gas and methanol vehicles.

One last, but important refinement, would be to design the fuel rating to incorporate other social goals such as reduced emissions of greenhouse gases and toxic gases, and greater energy security. This could be accomplished by converting the emission rating for each fuel into a social index; for instance, the rating for domestically-supplied natural gas would be set at 0.3 instead of 0.4 because natural gas vehicles emit fewer greenhouse gases and the gas is domestically produced.

The incentive-based regulatory concept presented here for fuels is not unknown to government or economists. An Advisory Board on Air Quality and Fuels to the California legislature, composed of high level government and industry representatives, recommended in its October 1989 final report that a fuel regulation program be established similar to that described above. Labelled "fuel-pool averaging," the intent was to propose a program that was fuel-neutral. Details were not provided.

CONCLUSION

CARB has taken a huge first step away from a command-and-control approach in regulating vehicle emissions and toward an incentive-based approach. CARB is to be commended for its considerable creativity and perseverance, especially when viewed in terms of the lack of innovation and change at the national and international level (OECD, 1989).

Economists have long argued for the use of market-like structures in reducing emissions. Slowly, their arguments have been accepted over the past decade by regulators of stationary

source emittors (Cook, 1988; Hahn, 1989). But the use of incentives in regulating transportation fuels and motor vehicle emissions has been virtually ignored, by researchers and regulators, with the exception of the brief lead trading experience mentioned earlier. What has changed that compels a reexamination of incentive-based regulation is the difficult and unavoidable issue of determining which alternative fuels should be introduced and when.

While definitive analyses of the economic benefits have not been made, and the costs and difficulty of administering and enforcing a trading program are not known, marketable credits nonetheless appear to be a more effective economic instrument for achieving large emission reductions than fuel and vehicle taxes (and rebates), and present a robust framework for guiding transportation energy and environmental choices in the 1990s and beyond.

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