Ethical and economic issues in the use of zero-emission vehicles as a component of an air-pollution mitigation strategy

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ABSTRACT: *The air pollution generated by motor vehicles and by static sources is, in certain geographic areas, a very serious problem, a problem that exists because of a failure of the marketplace. To address this marketplace failure, the State of California has mandated that by 2003, 10% of the Light-Duty Vehicle Fleet (LDV) be composed of Zero-Emission Vehicles (ZEVs). However, the policy-making process that was utilized to generate the ZEV mandate was problematic and the resulting ZEV mandate is economically unsound. Moreover, an ethical analysis, based primarily upon the work of John Rawls, suggests that implementation of the California ZEV mandate is—in spite of the wide latitude that ought to be given to policy decision makers—unethical.*

A more ethical and economically efficient approach to the pollution caused by marketplace failure is one that relies on market incentives and thereby achieves the desired improvement in air quality by appealing both to the self-interest of motorists and to those businesses that are directly or indirectly involved with the automobile industry. Such an approach would take better advantage of the creative forces of the market and improvements in technology over time and avoid the infringements on individual liberty and fairness embodied in the ZEV mandate.

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INTRODUCTION

Economists recognize that air pollution resulting from automotive emissions is an example of market failure: an inefficiently high level of pollution from driving resulting from the fact that consumers are not responsible for the full costs of their driving activities, *i.e.,* automobile users are not required to pay for the harm inflicted on the environment as a result of automotive emissions. Economists argue that it is appropriate for the government to introduce a remedial intervention in order to correct for this market failure. There is significant disagreement, however, among economists and policy makers as to the form such an intervention should take. This is, in part at least, because different groups have different views concerning the very nature of the automobile.

At one end of the spectrum are groups like the American Automobile Association which acts as a lobby for its members in the driving public. At the other end are radical environmental groups and activists which regard the internal-combustion-engine powered automobile with disdain. One such activist, Lewis Mumford, is credited by Fleming[1] with a description of the automobile as the:

> true Frankenstein's monster of the 20th century, only surpassed in its destructive potential by the Hydrogen Bomb, but more dangerous because more complacently indulged.[1 (p. 80)]

It is our view that the use of government policy to force the adoption of one technology (*e.g.,* the electric vehicle) over another technology (*e.g.,* the internal combustion vehicle) is unethical because it overrides consumer preferences and limits the choices and thereby the liberty of members of society. It is also unethical because it disregards the effect of the Zero-Emission Vehicle (ZEV) mandate on a number of segments of society. Moreover, the ZEV mandate is profoundly wasteful compared with other methods of achieving the same pollution reductions, harming a number of segments of society, including the poor, and in general, negatively affecting the economy.

Background

When is a policy decision unethical? John Rawls,[2] in his *Theory of Justice*, puts forth principles that provide a useful framework for understanding why the proposed ZEV mandate is ethically unsound. The Rawlsian analysis presented here supports the view that taxes on emissions and other incentives are ethically sound.

Rawls' ethical framework places high priority on liberty. Still, liberty can, under Rawls, be inhibited if such inhibition is undertaken to increase aggregate liberty. That is, an individual's or group's liberty can be decreased if doing so increases the total store of liberty available to all. The prohibition on yelling "Fire!" in a crowded theater where no fire exists, for example, might decrease the liberty of the thrill seeker yelling "Fire!," but it increases the total store of liberty for all involved, namely, the theatergoers, because it entitles them to watch their movie free from such dangerous

(and false) distractions. Rawls, then, is not a libertarian; he does allow for restrictions on individual liberty. At the same time, however, his framework does not allow for arbitrary restrictions on liberty. Any restrictions must be justified by their contribution to the good of society as a whole and—especially—to the maintenance and the improvement of the position of the worst-off in society.

The worst-off are central in *A Theory of Justice*, as Rawls proceeds from what he calls the "Original Position". He asks what sort of society would we seek to establish if we did not know who we would be in that society, if we approached the issue while our own fates were hidden behind a "veil of ignorance." With our eventual circumstances hidden, we would have to consider what actions and decisions would benefit *all* members of society, and benefit society as a whole. In this Original Position, we would inevitably have to take care that provisions are made for the worst off in society, since we might very well be the worst off. Thus, a Just Society, from the objective standpoint of the Original Position, is defined by actions and decisions that are undertaken so as not to hurt the worst off in society.

As for equality in Rawls' framework, wherever an inequality of opportunity exists, such inequality must not harm those with less opportunity. For example, those with a greater store of natural talents might be allowed to have more wealth, more prestige, and more power than those with a lesser store of such talents, provided that this inequality does not damage those with the lesser store. Thus, Rawls would accept the view that the rich can have their wealth, provided that they invest it and thereby create jobs for those less fortunate. Similarly, disparities in power are acceptable provided that those with more power do not use it for selfish interests. This avoids the problem of a society being geared to benefit those with natural abilities simply because they were lucky enough to be born with greater intellectual abilities, or to families of greater wealth, prestige, and so on.

Following on this is Rawls' Difference Principle, which provides the means to pass upon the ethical content of a rule, policy, or decision: any rule, policy, or decision, must always be considered from the perspective of the worst off in society. This holds true for issues relating to either equality or liberty: any rule, policy, or decision that further disadvantages the worst off is, *cet. par.,* unethical. Any inequality or inhibition of liberty that harms the worst off is, *cet. par.,* unethical. This allows one to accept, and even embrace, inequalities of liberty, opportunity, and wealth, provided that these inequalities, at minimum, do not damage the poor.

Thus, if the ZEV mandate hurts the worst off, even if on its face it treats all people and groups equally, then it is unethical. Indeed, the ZEV mandate hurts many segments of society, including the poor.

The air pollution problem and the ZEV mandate

The unhealthy ozone and smog-producing emissions that pose concerns for the environment and the community are hydrocarbons (HCs), carbon monoxide (CO) and oxides of nitrogen (NO_x).[3] Nationwide, automotive emissions were the largest source

of these pollutants in the mid-1960s.[4] Concerns over automotive emissions led to (among other legislative changes) the Clean Air Act Amendments of 1965, 1970 and 1977. These, respectively, set national emission standards for new automobiles, established a federal-state procedure (based on state-designed State Implementation Plans) to plan for and monitor progress toward achievement of nation-wide air quality standards, and categorized Air Quality Control Regions (AQCRs) into attainment and non-attainment regions according to the success achieved in reaching the uniform air quality standards.[5]

The enforcement effort of the Environmental Protection Agency (EPA) has focused on the regulation of emissions from new automobiles. Physicist Marc Ross[6] reports that, since 1981, laboratory measures of CO and HCs emitted per mile have been reduced to a maximum of four per cent of their mid-1960s levels. Ross also indicates, however, that actual roadway measures of CO and HCs are roughly five times greater than lab levels and actual measures of NO_x are roughly twice as great as lab levels. Ross explains this discrepancy in terms of the differences between laboratory conditions and real-world conditions and explains that vehicular emissions control devices tend to become less effective over time. Ross makes the further point that the number of vehicle miles driven has tripled over the last thirty years. The net effect of all of these factors, he says, has been a net reduction of CO and HCs emissions of 50 percent and an increase in NO_x emissions of twenty percent.[6]

Despite the fact that California was the first state to address its air quality problems with governmental regulations—and despite the fact that California's regulations for today and the future are more stringent than federal air-quality regulations—it is generally agreed that the Los Angeles air basin has air-quality problems and will be one of the most intractable areas of the country with respect to compliance with uniform national air-quality standards.[3]

Why is the Los Angeles or Southern California air quality so poor? James Lents explains,

> As a result of a bowl-like ring of mountains, stagnant but balmy air, an inversion layer that keeps polluted air close to the surface, and the second-largest population of any metropolitan area in the nation, the Los Angeles region's air pollution levels exceed those everywhere else in the nation and sicken many residents.[7 (p. 42)]

Zero-Emission Automobiles

Dr. Lents, executive officer of the California's South Coast Air Quality Management District (SCAQMD), which is responsible for the greater Los Angeles area, is an advocate of electric cars. He reports that his agency outlined a plan in 1987 that placed heavy emphasis on electric cars in order to improve the region's air quality. He recalls, "… In 1990 the California Air Resource Board [CARB] took the bold step of adopting a *technology-forcing* regulation that required automakers to produce zero-emission vehicles (commonly known as electric vehicles) for sale in California…" [Emphasis in

original.][7 (p. 41)] Strictly speaking, there is no such thing as a zero-emission vehicle: the electricity that powers the vehicle generally creates emissions at the power plant when the electricity is generated. A zero-emission vehicle is defined as one that does not emit pollutants at the vehicle itself. De Neufville, Conners, and colleagues[8] highlight a key issue which gives rise to many of the economic and ethical issues addressed in this paper: the "technology-forcing" aspect of the ZEV mandate. They argue,

> The measure is unprecedented. Previous environmental mandates, such as the Clean Water Act, required the public to adopt the best available technology—whatever that turned out to be in different cases—for reducing pollution. The California rules, however, require a specific experimental technology, and mandate a tight schedule.[8 (p. 32)]

They also question the policy making process that led to the ZEV mandate:

> One supposes that such a mandate would have been preceded by a comprehensive analysis. Yet no investigation of the overall performance or effectiveness of electric vehicles—either by themselves or compared with others—has been undertaken. Our research group found that available material either deals with just one element of the system, such as batteries, or is obviously partisan, coming from enthusiasts—such as electric utilities—with a stake in the outcome.[8 (p. 32)]

Engineers de Neufville, Conners, and colleagues[8] agree with Lave, Hendrickson and McMichael [9] and point out the current selection of battery technologies makes electric vehicles a poor choice for consumers.

> Of course, we can only speculate on the future of battery technology. Breakthroughs are possible, and should be sought. Advances cannot be guaranteed, however. It is entirely possible that the kind of cost-effective batteries needed to achieve the desired range for electric vehicles in the United States may simply not be available in our generation. An attempt to legislate the results of the research and development process is therefore unrealistic and unworkable.[8 (p. 34)]

Irrespective of the actual outcomes of the ZEV mandate in creating a cost-effective strategy for reducing air pollution and improving the health of the citizens of Southern California, it is argued here that to make such a large commitment of resources to the task based on an unproven technology, and without the benefit of comprehensive and objective analysis, is socially irresponsible. Because this unproven technology carries with it the strong possibility of harming many segments of society, including the poor, it is unethical.

ZEVs do not decrease pollution

A number of critics of the ZEV mandate have questioned the technical and economic feasibility of electric vehicles, as well as their ultimate environmental benefits. A 1994 study by the EPA[10] questions the environmental benefits of electric vehicles. The report

reviews the plain fact that "zero emission vehicle" is really a misnomer when applied to electric vehicles. The task of recharging the battery power source requires the generation of electricity from power plants. These facilities generate power from nuclear or hydroelectric sources and from the burning of fossil fuel matter, such as oil or coal. Typically, clean-fuel source generating capacity is fully utilized. Extra burdens placed on the system by the need to recharge automotive batteries are likely to require the burning of oil and coal which create their own negative environmental consequences.[3,8] It is the case, however, that if the power generating facilities are located outside of the heavily polluted area that it services, the use of electric cars may lead to a more favorable geographic redistribution of the pollution.

And then again, maybe not! The electricity 'crisis' in California in 2001, which was fueled more by distributional problems than by any real shortage of electricity, clearly showed that the electricity distribution network in California might not be adequate to meet the increased demand for power that would occur as a result of the need to fuel ZEVs. One consequence of this is that any emergency generation capacity brought online to help the Los Angeles area meet its power requirements in the short-to-medium term may well have to be located in close proximity to where it is needed. Emergency power plants are typically diesel or gas-turbine powered, and would thus not help lighten the pollution load in the affected area. In short, because the electricity that would have to be generated to power ZEVs would probably have to be generated locally (which will lead to local pollution) the notion that ZEVs will ameliorate bad air quality on a local basis is probably a chimera.

The 1994 EPA report compares the per-100-miles emissions from a new, gasoline-fueled vehicle to the emissions necessary to generate the electric power for 100 miles of ZEV travel. The fossil-fueled car emits about 354 grams of carbon monoxide and 1.18 grams of nitrogen oxides. The electric car was responsible for the stationary power plant's generation of 393 grams of carbon monoxide and 1.49 grams of nitrogen oxides. (Of course, the results are sensitive to the vintage of the facilities, technology employed and fuel sources utilized by the electric generating facilities.) The report projects that fossil-fueled vehicles can be expected to improve over time as internal combustion cars utilize cleaner fuels, *e.g.,* reformulated gasoline.[10]

A study by Lave, Hendrickson and McMichael[9] raises further questions as to the environmental benefits of electric vehicles. They argue that the smelting of lead necessary for the production of lead acid batteries releases sixty times the lead into the environment per mile driven as was the case from the lead released from the use of leaded gasoline, which is now prohibited on environmental grounds. If recycled lead is used in the lead acid batteries, the ratio is five to one. (Also, presumably, there will be many more batteries per vehicle than is the case with gasoline cars. Even if recycled lead is used in the car batteries, the net increase in the number of batteries will result in more "new" lead being produced for other competing uses of lead.) These lead emissions, Lave, Hendrickson and McMichael point out, damage the environment and human health. Lead, a neurotoxin, has been associated with decreased cognitive function and behavioral problems among children. They also point out that although

other non-leaded batteries are under development, they are much more expensive, highly toxic, or not sufficiently developed to be feasible in the foreseeable future.[9]

This view is echoed by a section from a document dealing with electric vehicles from EPA's Internet site:

> Potential health or safety risks associated with widespread electric vehicle use have not yet been fully evaluated. Many vehicle batteries contain toxic elements or produce toxic emissions which could make battery production, transport, use, and disposal a significant solid-waste issue. The United States must consider how to safely dispose of or recycle these batteries.[11]

The Cost of the ZEV Mandate

Some numbers will serve to indicate the magnitude of the economic stakes involved in making the decision to impose the ZEV mandate. At the time of the imposition of the ZEV mandate, for example, Ford Motor Company prospectively estimated that it would need to spend $2 billion in the late 1990s to meet the California ZEV mandate. SCAQMD's comprehensive program to improve air quality in this region has been estimated at $16.4 billion per year in year 2000 dollars. That amounts to about $3400 per household per year (in year 2000 dollars) in the Los Angeles basin.[12]

There is also a relatively high level of uncertainty associated with making environmental policy by mandating an unproven technology without the benefit of objective, comprehensive analysis. Consider that in the mid-1990s, years after the 1987 plan for electric vehicles and the 1990 legislative mandate to implement that plan, but before the actual deadlines were reached, CARB hired the Rand Corporation to evaluate its policy. Rand investigators Dixon and Garber state in their final report,

> The long-term economic effects of the ZEV mandate cannot be pinned down at all precisely. As suggested by various scenarios we used to calculate NCERs [Narrow Cost-Effectiveness Ratio], the mandate might be very beneficial or very detrimental. In short, the ZEV mandate could turn out to be a very great success or a great failure.[13 (p. 39)]

After that report was issued, CARB did away with the intermediate targets calling for two percent of the cars sold in California to be ZEVs in 1998, escalating to ten percent by 2003. However, the ten percent ZEV requirement by 2003 remains intact.

The Economic Viability of ZEVs

The economic feasibility of electric vehicles is another important issue. As economist Kazimi[14 (p. 265)] has written, "Simply mandating sales does not fully address the problem of ambient air quality. It still is not known who will purchase the vehicles, where they will be living (highly polluted or cleaner regions), or how much they will drive the vehicles once purchased." A multi-year study utilizing quantitative models to project manufacturing costs, "mass-produced" electric vehicles would cost about twice as much as comparably-sized internal-combustion vehicles.[8] However, electric vehicles

will have only about one half of the driving range. The study reports that these results are borne out by actual experience in the United States and Europe. Those figures are also consistent with the findings reported by Beaton, Bishop, and colleagues.[15] In addition, the replacement of electric vehicles batteries significantly increases the lifetime costs of owning an electric vehicle.[8] Such batteries wear out after about 500 daily recharging cycles, leading to a typical battery life of one and a half to two years. Even taking into account the projected price reductions of producing these batteries on a larger scale, the likely cost of replacing these batteries would be several thousand dollars for each of the times that a replacement would be necessary.[8]

If they are more expensive to produce, have half the range and require frequent and expensive battery replacement, how are electric vehicles then to be sold in order to meet the ten percent ZEV mandate? Manufacturers and retailers will have to accept a major discount below manufacturing and marketing costs. De Neufville, Conners, and colleagues[8] estimate a discount of $10,000 to $20,000 per vehicle. Kazimi[14] finds that the discount must be at least thirty percent. Beaton, Bishop, and colleagues[15] cite an example of a Chrysler electric vehicle minivan that was to be sold in 1998 (the original start date of the ZEV mandate) for $18,000 despite its $45,000 manufacturing costs. Of course, if a car manufacturer is to offer, for example, a $20,000 discount on ten percent of the cars that it sells in California, it must recoup that $20,000 on the other ninety percent of new cars that it would sell in California. Some simple arithmetic suggests that there would have to be a "surcharge" on non-ZEV vehicle sales averaging about $2,200.[a]

This increased price for the vast majority of available new cars may have some perverse effects on air quality. First, McKenna[16] and Gruenspecht[17] suggest that as new car prices increase to subsidize ZEVs, consumers are more likely to retain their older vehicles that are more likely to be high emitters. In fact, Gruenspecht estimates that this perverse effect alone will make the ZEV mandate a net environmental liability and "will make the air in California dirtier rather than cleaner for the foreseeable future."[17] Second, Kazimi[14] finds that the purchase of limited range electric vehicles in multi-vehicle households will create a usage trade-off leading to a greater relative reliance within the household on the conventional-range, older, higher emitting vehicles. Third,

a. It is noted that such simple arithmetic may be *too* simple. If the discount necessary to achieve the ten percent ZEV mandate is viewed as a tax on the sale of non-ZEV units, then basic economic analysis shows that the economic burden of the tax will be borne, at least in part, by the manufacturer and seller of non-ZEV units in the form of profits not earned on units not produced and sold. Raising the price of the non-ZEV units will, of course, reduce the quantity demanded and sold. This will reduce the size of both the consumers' and the producers' surpluses and it will cause the discounts on the ZEV units to be spread over a smaller number of non-ZEV units. (Consumers' surplus is the sum of the excess of what each consumer is willing to pay for a certain quantity of a product over the market price for that quantity. Producers' surplus is the sum of the excess of the market price for a given quantity of product over the minimum price that each producer would accept for that quantity.) In short, economic theory predicts that the discount necessary to market the ZEV units will not be fully recovered by the sellers and that the buyers of non-ZEV units will, in effect, pay part of the discount. (The exact proportion of the economic burden of the discount borne by the sellers and buyers of non-ZEV units depends on the price elasticity of demand and the price elasticity of supply of non-ZEV units.)

as electric-vehicle owners drive with weak batteries, prone to power exhaustion due to the limited range and the dearth of locations to recharge on the open road, electric vehicles will slow down or become disabled, creating increased traffic congestion.[15] As Lave[18] points out, this, in turn, increases per-mile emissions from gasoline powered vehicles (and, presumably traffic accidents).

Alternative Approaches to Improving Air Quality

If the approach utilized by CARB is not appropriate to the task of improving air quality in Southern California, what alternative approaches should have been—and should now be—applied? We suggest that a far more efficient and effective approach would be to concentrate on air-polluting vehicles, rather that upon trying to reduce further the already very low pollution levels of new vehicles in the light-duty fleet. Beaton, Bishop, and colleagues[15] utilized remote, roadside emissions sensors at different California locations to collect HC and CO emissions data on over 66,000 vehicles. They find that the "cleanest" half of the cars tested were responsible for less than ten percent of the CO and HC emissions. At the other end of the spectrum, seven percent of the vehicles (deemed "gross polluters") tested were responsible for half of the overall CO emissions, and ten percent of the vehicles contributed half of the overall HC emissions. Although there was some positive correlation between the age of the car and the level of emissions, the relationship was not as strong as might be expected. They found that the most polluting twenty percent of the newest cars contributed more emissions than the cleanest forty percent of vehicles from any model year, including those model years that predate the introduction of catalytic converters in 1970. That is, "differences in emissions within a model year are greater than differences between the averages of the various model years."[15 (p. 991)] They find that the distribution of emissions results is comparable to results drawn from other areas of the United States and from other countries.

At two Los Angeles area locations, gross polluting cars were pulled over during a two-week period. The drivers were asked to subject their cars to a California Smog Check—the conventional tailpipe emissions inspection required at registration renewal. Of the 307 participants, 126 (41%) showed evidence of deliberate mechanical tampering and 77 others (25%) had defective or missing equipment (*e.g.,* missing air pump belts) that "may not have been the result of tampering."[15 (p. 991)]

Beaton, Bishop, and colleagues[15] go on to support the value of emissions control policies that focus on auto inspections, repair and maintenance. They provide numerical evidence to buttress their conclusion that an inspection, repair and maintenance approach is more cost effective than strategies which address auto emissions through transportation-control efforts (*e.g.,* mandating employee carpools), developing alternative and reformulated fuel programs, setting up scrappage programs to buy back and scrap older cars or by focusing, as California and, to a lesser extent, the EPA do, on increasingly stringent emission regulations for new cars. They conclude, "Policies that treat all vehicles equally, or that target new vehicles, are likely

to be less cost-effective than those that recognize the overriding importance of maintenance and that target poorly-maintained vehicles regardless of their age."[15 (p. 992)]

While neither explicitly accepting nor rejecting their specific recommendation, the remote sensor findings[15] do strongly suggest that CARB's approach, aimed at making further improvements on the already dramatically improved level of new car emissions, is unlikely to be cost-effective. Bedard, an editor of *Car and Driver,* who has often written on the ZEV mandate, states "CARB's ZEV requirement would lower smog-producing emissions at a cost of $900 a pound when other measures cost anywhere from 20 cents to $15 a pound."[19 (p. 23)]

Auto Emissions Regulation and Liberty

Recent decades have witnessed the passage of the original Clean Air Act, the subsequent passage of amendments to that legislation, the empowerment of the EPA to enforce the provisions of those acts, and the continued popular support of efforts to reduce pollution. These public actions show clear evidence of society's political support for the government to lead the way in achieving improvements in air quality through reductions in automotive (and other) emissions. Given this political mandate, governmental officials must decide what approaches should be taken to achieve the desired reductions in emissions.

There exists a spectrum of policy options that offers consumers and entrepreneurs different degrees of choice or liberty over their contributions to reductions in emissions. The regulatory approach, found at one end of the spectrum, is the approach taken by CARB: a governmental mandate of a particular emissions-reduction technology. Of course, when a government agency mandates a particular solution, there is much less opportunity for entrepreneurs to make choices as to how transportation products and services would be created or re-designed to reduce emissions. There is far less choice, less liberty, for the consumer to decide what type of transportation alternative to adopt and what role the automobile is to play in satisfying overall transportation needs as part of a plan for consumers to do their part in the societal effort to reducing pollution.

At the opposite end of the spectrum is a policy view that suggests that consumers and entrepreneurs should be unfettered in their transportation choices.[b] This approach, it may be argued, carries liberty to a libertarian extreme and may be criticized for its ultimate effect of neglecting the social objective of serving the overall community's need to limit environmental pollution and its attendant consequences.

Two policy approaches considered here seek a more moderate position along the liberty/regulation spectrum and involve government regulation to reduce emissions utilizing market-based incentives, and they are: (a) setting emissions targets and letting the market decide how to meet them, and (b) an emissions-tax.

b. This notion of the existence of trade-off between individual choice or liberty versus the need to impose limits on choice in order to meet common or community objectives is a theme developed by communitarians such as Taylor[20] and Etzioni.[21,22,23,24]

(a) ***Setting emissions targets and letting the market decide how to meet them.*** This approach would be represented by the governmental authority's issuance of a regulation to achieve a reduction in automotive emissions by some specified future date. Such a mandate might impose a particular percentage reduction in emissions for all newly produced cars of a given model year. Any car manufacturer whose overall model year fleet did not achieve the mandated percentage emissions reduction would be subject to significant fines or other penalties. Such fines or penalties would provide these manufacturers with an economic incentive to undertake whatever research was necessary into the various possible approaches of re-engineering the motor, emissions-control system, fuel source or other such variables.[c] To the extent that such a mandate leads to a variety of new car designs featuring different innovations in the motor, emissions-control system, fuel source, etc., consumers would have greater choices in the market for new cars to meet their individual transportation needs, as well as, the desire of the community at large to reduce emissions. (Note that this first approach is comparable to the strategy utilized by policy makers in the 1970s and 1980s to achieve the increased fuel economy mandated by the Corporate Average Fuel Economy (CAFE) standards. And in a manner similar to what was done with the CAFE standards, this approach could allow for continued decreases in emissions for newly produced automobiles in subsequent model years.)

As part of this approach, the governmental authority could (and should, in our opinion) also impose a standard of emissions for previously produced cars already on the road. It is worth noting that properly maintained automobiles, even old ones, do not generate large amounts of pollution. Any individual car that failed to meet the standard would again be subject to fines or other penalties that would be scaled to the degree of non-compliance with the standard and the number of miles driven.

(b) ***Emissions taxes.*** The second approach is to rely on a system of emissions taxes. Consumers of all automobiles, new and used, would be subject to a tax based on the level of emissions that the car generates. The tax liability would depend on the level of emissions per mile and the number of miles driven. Consumers wishing to reduce their tax liability would be in the market for cars with better emissions performance. The emissions tax would offer producers a greater incentive to develop lower emission cars and to continue over time to improve emissions performance.[d] As

c. This assumes, of course, that adequate lead-time was allowed by the enabling legislation to carry out such major redesign efforts.

d. In recent years there has been an increase in research into the different technologies directed at reducing automotive emissions. The variety of these efforts and their engineering foundations have been described by Calvert, Heywood, *et. al.* ,[3] Ross,[6] Nicholson,[25] Wald,[26] Singer[27] and Krebs.[28] In addition to the development of electric vehicles, these sources discuss alternative technologies such as hybrid engines (a gasoline engine working with an electric motor/generator, such as the Honda Insight and the Toyota Prius currently available for sale); alternative fuels such as natural gas, hydrogen, methanol, dimethyl ether; fuel cells which combine hydrogen (directly or converted from methanol, gasoline, or other fuels) with oxygen to generate electricity; the greater use of plastic materials; and, various modifications to internal combustion vehicles, such as direct fuel injection, electronic sensors to regulate the mixture of fuel and air, more durable, and otherwise better performing coatings and designs for catalytic converters, and catalytic coatings on car radiators that improve the quality of the air that is not used in combustion.

technology improves over time, a greater range of re-engineered options would exist to lower emissions on new and existing cars.

Emissions taxes would also offer consumers a continuing incentive to make behavior adjustments. Consumers would have any number of choices. Perhaps different fuel formulations might offer lower levels of emissions, and lower taxes. Frequency of car maintenance, particularly of the emissions-control system, may be an effective strategy for some consumers. Purchasing a car with better emissions performance would be better for some consumers. It may well occur that if a sufficient number of drivers were facing emissions taxes that they considered "too high," there could arise a profitable opportunity for automobile manufacturers or entrepreneurs to design retrofit emissions-control devices that are as good as, or superior to, those installed in those cars when they were new.

Consumers would have additional options to reduce their tax liability. Over time they could reduce their commutes by looking for a job closer to their residence or by looking for a residence closer to their job. There would be a greater incentive to join car pools or utilize mass transportation. Miles driven could be reduced by a flextime arrangement that allows an employee to work only four longer days per week rather than the conventional five days per week. Some may opt for fewer shopping trips, each yielding a larger volume of purchases.

With respect to the kind of car the consumer purchases, be it internal combustion, electric, or hybrid, the kind of fuel source that the car utilizes, be it conventional gasoline, reformulated gasoline, natural gas, hydrogen, electric, etc., or the behavior adjustments that consumers make to reduce their emissions and consequent tax liability, consumers are given responsibility over important choices that would significantly affect their lifestyles, as well as helping to create a cleaner environment. Again, under the emissions-tax approach, the consumer enjoys much greater liberty than would be the case under a ZEV mandate, yet would still be offered incentives to assist in the attainment of the community's environmental goals.[e]

The remote sensor findings presented by Beaton, Bishop, and colleagues[15] provide additional support for an emissions-tax approach. If a small minority of automobiles is responsible for most of the emissions problem, if the age of the car is not always a reliable predictor of its emissions performance, and if a majority of gross polluting cars are such because of poor maintenance or equipment tampering, then policy should attempt to identify which cars are the gross polluters and impose a penalty—an emissions tax—on each vehicle that is proportionate to the level of emissions that it contributes.

e. A reliance on market-based incentives, implicit in emissions taxes, has received considerable attention in the environmental ethics literature. Authors who have written in the environmental ethics area that are sympathetic to a positive role for market incentives in achieving environmental goals are Baxter,[29] Bowie,[30] Freeman[31] and Morgenson and Eisenstadt.[32] Among the authors who are more suspicious of the role of market forces in achieving environmental goals are Callicott,[33] Hoffman,[34] Leopold,[35] Sagoff,[36] Steidlmeier[37] and Taylor.[38]

Such an emissions tax would be consistent with the standard economic prescription for dealing with pollution or some other like offending activity: tax the polluting activity by an amount equal to the value of the economic harm that is done as a result of the offending activity.[f] A unit tax rate on automotive emissions would be based on the rate of emissions of CO, HCs, and NO_x or other offending matter that is released per mile driven.

There are other issues with an ethical dimension implicit in an emissions-tax. First, there is an argument that may appeal to our sense of justice. In a competitive market system, different wages are paid to different individuals in proportion to the marginal value of goods and services that the individuals produce. Everything else being equal, if I, through my decisions as to car model purchased, car repair and maintenance, whether to tamper with pollution-control accessories, miles driven, *etc.* cause twice the vehicle emissions as my neighbor, should I not have to pay twice the emissions tax? This would fit in well with the Rawlsian framework as we are applying it here. Rawls' notion of justice as fairness requires that the rules of justice are those rules accepted by a group of people living with one another on equal terms. This means that they must accept that the rules (in this case, the rules that define a competitive market system) apply equally to everyone and in every case. Therefore, if different wages are paid to different people in proportion to the marginal value of goods and services produced (given a competitive market system), then different tax amounts ought also apply to different people in proportion to the marginal cost of decisions relating to car purchased, tampering, etc.

Emissions Taxes: Justice and Ethics

Another ethical issue relating to the various strategies for reducing emissions and improving environmental quality can be framed in terms of the standard economic analysis of externalities. When the price the consumer pays for a good or service (personal automotive transportation in this case) does not reflect the true costs of the resources utilized to provide that good or service, in the absence of appropriate government remedies, negative externalities (in this case, the release of emissions into the air) are created. Hence the consumer is, in effect, subsidized and thus induced to consume more personal automotive transportation than the quantity that is economically efficient, *i.e.,* the quantity that best strikes a balance between the benefits and costs to society. The subsidy is actually being provided by those who must suffer the ill effects (*e.g.*, as a result of reduced health status or a diminished ability to

f. Admittedly, it may not always be possible to arrive at precise measures of the economic harm that results from polluting activities. However, reasonable approximations may normally be made. Often, policy makers may attempt to "back in" to an appropriate unit tax on a polluting activity. Based upon information from the scientific community or the political process as to how much pollution can be tolerated, the magnitude of the unit tax is adjusted until it leads to a tolerable level of the polluting activity. Note that the idea that an appropriate anti-pollution policy is to tax the polluting activity by an amount equal to the economic harm posed by the activity was first advanced by British economist Pigou.[39]

appreciate the intrinsic value of the environment) of the externality. The ill effects of automotive pollution are disproportionately borne by the poor. A considerable body of literature has developed in this "environmental justice" area in the last decade, most of it suggesting that the poor and ethnic minorities face a greater relative probability of living in neighborhoods that make them more susceptible to harm from environmental pollution.[g]

It is not difficult to see how this involuntary subsidy at the expense of the victim of the externality and for the benefit of the individuals generating the externality can give rise to ethical objections. The ZEV strategy, even *if* it is effective in reducing overall emissions, still would target only a relatively small minority of newly produced cars (as of 2003 and beyond). The drivers of all post-2003 non-ZEV vehicles and the drivers of nearly all pre-2003 vehicles are still not responsible for paying the full costs for their transportation. They are, surely without realizing or intending it, responsible for extracting this involuntary subsidy from those adversely affected by emissions. Hence, under CARB's ZEV program, there is still an unethical cross-subsidization from the victims of automotive emissions to the consumers of any vehicle responsible for incremental emissions as incremental miles are driven. Of course, it is also true that to the extent that ZEV vehicles rely on battery power, and the recharging of batteries creates air pollution at the source of the electricity generation, the ZEVs do very little to offset this unethical cross-subsidization of automobile consumers by those who are victimized by automotive emissions. This ethical lapse is compounded, as discussed above, because the victims of the environmental degradation are disproportionately poor.

The emissions tax works through the price system and forces automobile consumers to pay a price for their transportation services that more nearly reflects the full costs of those services, thus reducing or avoiding this unethical involuntary cross-subsidization leading to excessive and inefficient consumption levels. An emissions tax—because it will eliminate the excessive driving caused by the subsidizing of driving—will give back the involuntary subsidy from those whose health status already places them in a disadvantageous relative position and from those who are sensitive to the resulting loss in intrinsic environmental services. This is an ethical good.[h]

In explaining his notion that there is a threshold of basic rights that is due to everyone in a just society, Rawls states, "Each member of society is thought to have an inviolability founded on justice, or as some say, on natural right, which even the welfare of everyone else cannot override. Justice denies that the loss of freedom for some is made right by a greater good shared by others . . . Therefore in a just society

g. See for example, Allen,[40] Boone and Modarres,[41] Boyce,[42] Bullard,[43] Friedrich,[44] Hunter,[45] Morello-Frosch, Pastor and Porras,[46] Sadd, et. al.,[47] and Szasz and Meuser.[48]

h. It should be noted that this Rawlsian ethical objection to ZEVs would perhaps be on an even stronger footing if the revenue raised from an emissions tax were utilized to compensate the victims of emissions-related externalities for the economic value of the harm that is done to them by the polluting activity. Although most economists raise efficiency-related objections to such a practice, three of the present authors have previously offered an efficiency and equity-based analysis supporting such a compensation approach. See Hodson, Englander and Englander.[49]

the basic liberties are taken for granted and the rights secured by justice are not subject to political bargaining or to the calculus of social interests."[2 (pp. 24, 25)] This is reinforced by his later statement, "…We think of a well ordered society as a scheme of cooperation for reciprocal advantage regulated by principles which persons would choose in an initial situation…"[2 (p. 29)] The involuntary cross subsidization of drivers by those whose health status and aesthetic preferences are sensitive to the environmental and health degradations caused by automotive pollution surely conflicts with these notions of a just and ethical society.

Conclusion

Technological advances in transportation, communications, and other areas have given us a greater wherewithal to provide for our basic needs. At the same time, the corresponding degradation in air quality resulting from automotive and other emissions represents a significant threat to our collective health, particularly in those areas with unfavorable geographic features and high population density. There has been an appropriate ethical response offered by many environmentalists to recognize this problem and to formulate governmental remedies to address this market failure. This ethical response is often conditioned by compassion for those individuals who are most vulnerable to the health consequences of such pollution. Many environmentalists also offer objections to what they see as an insufficient societal concern for the ethical virtues of carrying out a proper stewardship of our environment. Here it is the case, however, that intervening to correct market-misbehavior-induced air pollution by mandating ZEVs is a speculative and overly intrusive solution to that air pollution problem—a solution that will, if implemented, prove to be a significant detriment to individual liberty and to efforts to promote social justice. We believe that government policies to address the market failure that brought on the air pollution problem should be underpinned by rigorous, objective analysis, resulting in measures narrowly targeted to compensate for externality-based market distortions. Such strategies would provide individuals and companies the maximum opportunity to creatively develop and select options to alleviate the air pollution problem in an economically efficient manner, harnessing market forces and incentives based on individual self-interest.

As we have discussed, the 2003 California ZEV mandate is economically sub-optimal, and from the point of view of environmental quality, it is—at best, and if there are no more power shortages in California—a wash. (If the electricity distribution situation in California, arguably at capacity, becomes further strained by forcing ZEVs on California, it would be, with respect to the electricity supply, like throwing gasoline on a fire.)

Importantly, the ZEV mandate has a negative impact upon liberty: Do we want the government to be picking winners, reducing the individual's choice in the market place and depriving individuals of an opportunity to help meet consensus-based environmental objectives in a manner consistent with a broad array of lifestyle choices? Where government regulators are picking winners, society has the right to insist that the winners will be objectively selected on the basis of merit, and not on some other

basis, such as making policy on the basis of the regulators' personal *idée fixe*. It seems clear that the ZEV mandate was formulated on the latter basis.

Finally, the ZEV mandate overlooks an opportunity to achieve a greater degree of social justice in the course of correcting for environmental externalities. A basic flaw in a reliance on strict market forces in the automotive services market is that the consumers of these services do not bear the full costs arising from the consumption of such services. This failure creates an artificial inducement for consumers of automotive services to consume a greater than optimal quantity of such services and therefore create an artificially excessive level of pollution. Others, those whose health conditions make them particularly susceptible to environmental harm and those with an intrinsic appreciation of environmental quality, are the unwilling victims of a Rawlsian injustice (based on an application of Rawls' difference principle and the establishment of fair procedures from the 'Veil of Ignorance' in Rawls' Original Position) imposed by these automotive consumers. An emissions tax that imposes the full costs of automotive services on all automotive consumers (not just the consumers of those who drive a 'favored' type of vehicle) offers a more "just" (and more efficient) solution to this injustice.

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