

**VEHICLE SCRAPPAGE PROGRAMS:
ARE SOME SECTORS OF SOCIETY PAYING MORE FOR CLEAN AIR?¹**

Susan Shaheen, Randall Guensler, PhD, and Simon Washington², Institute of Transportation Studies,
University of California, Davis, CA

ABSTRACT: Policy studies frequently focus on evaluating program efficiency, whether the overall costs of a program are likely to increase or decrease as a result of a program change. In environmental policy analysis, little attention is typically dedicated to the evaluation of how policies will redistribute environmental costs and benefits among various socioeconomic groups. Yet, almost any strategy designed to reduce overall program costs is also likely to reallocate costs. Some individuals' share of the total costs will increase while other individuals' share of the total costs will decrease.

One source of potential distributional inequities in environmental policy is that the economic costs of emissions controls are typically passed directly to consumers through higher prices. When needs-based concepts of equity are brought into play, it is easy to argue that when all costs are passed directly to consumers, certain socioeconomic groups will pay more than their 'fair share' relative to the socioeconomic distribution of benefits. Another source of potential distributional inequity is the inconsistency that often exists between projected and realized costs and benefits of a program.

Vehicle scrappage programs are designed to obtain emission reductions through the early retirement of older, high-polluting vehicles. The emissions offset from retired vehicles is used to offset emission increases at industrial sites. Hence, when the cost of controlling emissions from vehicles is lower than the cost of controlling emissions at the industrial site, the same emission reductions can be achieved but the overall costs of emission control are reduced.

This paper first discusses the potential emission control efficiency gains that are expected to result from vehicle scrappage programs. Then, the potential distributional impacts of scrappage programs and the policy implications arising from the implementation of scrappage programs are discussed.

INTRODUCTION

The United States and many countries across the world share similar air quality problems, including: urban smog, carbon monoxide hot spots, smoke and particulates, ozone layer depletion, acid rain, toxic air contaminants, etc. Typically, the major contributors to these problems are stationary emission sources, such as electric utilities, refineries, incinerators, etc., and mobile sources, such as automobiles, buses, heavy-duty trucks, and construction equipment. Mobile sources in general contribute approximately 20 percent to 80 percent of air quality problems, depending on the specific pollutant, the level of technological development, the level of source activity, and seasonal and geographical features. Consequently, transportation is the focus of a great deal of air quality legislation. Specifically, the control of carbon monoxide emissions and emissions of ozone pre-cursors (hydrocarbons and oxides of nitrogen) have been of particular concern.

The U.S. Clean Air Act (the Act), as Amended in 1990, introduced more stringent emissions requirements for the transportation sector. The Act also requires that transportation and air quality plans be coordinated, and

¹© Shaheen et. al.

²Susan Shaheen is a PhD student in ecology at the University of California, Davis (UC Davis) and a research assistant at the Institute of Transportation Studies-Davis (ITS). Randall Guensler has a PhD in civil engineering from UC Davis and is a research engineer at ITS. Simon Washington is a PhD student in civil engineering at UC Davis and is a research engineer at ITS.

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furthermore, that these plans demonstrate compliance with National Ambient Air Quality Standards. These requirements present a great challenge for vehicle manufacturers, metropolitan planning organizations, transportation planning agencies, and air quality management districts in ensuring conformity between transportation and air quality programs.

The Act requires new and modified stationary sources of air pollution to obtain 'emission offsets.' When new companies are constructed or existing companies expand their operations, thereby increasing emissions, the company must arrange for emission reductions at their facility or at another facility in an amount that more than compensates for their proposed emissions increase. In response to the offset requirements, many local agencies and industries have proposed to allow the creation of mobile source offsets; a system where emission reduction credits from mobile sources would be allowed to compensate for the emission increases at stationary source.

The creation and use of mobile source offsets are not widespread to date. However, mobile source emission reduction credits have been used in some areas to allow industries to delay compliance with new regulations (to increase planning time and reduce overall technology costs). The proposed widespread use of mobile source emissions offset programs, however, is currently being debated. Perhaps the most prominent example of the use of mobile source offset is the vehicle scrappage program.

Vehicle scrappage programs focus on older automobiles, which are generally thought to be high polluting and to contribute a disproportionately large amount of total emissions from the fleet. Industries that participate in such programs receive emission reduction credits by purchasing and retiring these 'dirty,' older vehicles from the vehicle fleet sooner than they would have been otherwise. In theory, the difference between scrapped and replacement vehicle emissions is claimed as a reduction. On June 1, 1990, UNOCAL instituted the first vehicle scrappage program, titled: the Southern California Retired Automobile Program (SCRAP). Over a period of one year, UNOCAL implemented the SCRAP program in the Los Angeles air basin. UNOCAL purchased, crushed, and recycled nearly 8,400 pre-1971 vehicles under their program. Because the engines and bodies were crushed and recycled, they could never be used to extend the life of other vehicles in the fleet, ensuring permanent retirement. Laboratory emissions tests performed on a subset of UNOCAL's participant vehicles indicated that scrapped vehicles were indeed 'dirtier' than average fleet vehicles, and that real emission reductions were apparently achieved by their program.

Vehicle scrappage programs appear to be an effective means of achieving emission reductions, even though there are still a number of unresolved technical issues surrounding the magnitude and permanence of the projected emission reductions. However, in evaluating scrappage programs, several concerns arise. First, emission reductions are temporary in nature. We must consider how long 'scrapped' vehicles would have remained in the vehicle fleet, and furthermore, how much they were driven. Second, the benefits of vehicle scrappage programs are questionable due to extreme uncertainty in modeled emission reduction estimates. It is difficult to estimate reductions because there are a number of variables that are problematic to quantify, such as: emission levels of scrapped vehicles under normal driving conditions, vehicle-miles-traveled for retired vehicles, emission levels for replacement vehicles, and vehicle-miles-traveled for replacement vehicles. Third, scrappage programs are not likely to be *equitable* to all segments of society. The potential inequity arises because lower income segments are likely to pay a greater share of the cost of emission reductions than will middle and high income groups, and furthermore will likely receive less than an equal share of the benefits.

New vehicles are generally purchased by upper middle-income to upper-income individuals, while older used vehicles are generally purchased by low-income to lower middle income individuals. New vehicles are generally 'retired' to the used car market by individuals desiring an even newer replacement vehicle, while older vehicles continue to be re-sold down the 'economic ladder' until the vehicle is no longer street worthy. Although most proposed vehicle scrappage programs are voluntary and do not require individuals to scrap their

vehicles, widespread implementation of scrappage programs is likely to decrease the supply of vehicles in the used car market. This decrease in supply coupled with a relatively constant vehicle demand is likely to result in higher prices for these vehicles. Because low income individuals have few transportation options, they are faced with either paying higher prices for used vehicles, or choosing an alternative mode of transportation. In either case, the low-income individual has paid a high price - either monetarily or through a loss of mobility.

Attaining cleaner air and reducing greenhouse-gas emissions are objectives shared by many policy makers, planners, and industries in the United States and across the globe; nevertheless, in developing new technologies and strategies for reaching these goals, programs must be equitable and efficient. This paper explores social equity in vehicle scrappage programs, focusing on the indirect effects on lower income segments. Through this process, the need for in-depth analysis of policy effects on all sectors of society is addressed, emphasizing that environmental policy must be both equitable and efficient.

VEHICLE SCRAPPAGE PROGRAMS

UNOCAL implemented the first vehicle scrappage program, known as the Southern California Retired Automobile Program (SCRAP), in Southern California on June 1, 1990. UNOCAL solicited owners of registered 'dirty' (i.e., pre-1971) vehicles to voluntarily relinquish their cars to be scrapped in exchange for a \$700 check. UNOCAL purchased and scrapped 8,736 'dirty' vehicles in the South Coast area during a four month period (UNOCAL 1991; Guensler 1992; Hsu and Sperling 1994). Many scrappage programs similar to the UNOCAL program have been implemented or are being implemented in other regions, such as the Illinois Cash for Clunkers program sponsored by the Illinois Environmental Protection Agency, General Motors, and the Environmental Defense Fund (EDF 1994).

Historically, vehicle scrappage programs have been touted as having great potential for achieving mobile source emissions reductions at relatively low cost. After all, UNOCAL was willing to finance the vast majority of the SCRAP program costs. Indeed, the United States Environmental Protection Agency (U.S. EPA) staff in the Office of Policy Analysis and Research cite scrappage programs as fine examples of emission control strategies 'that work.' In fact, EPA has recently distributed guidance to states and private industries to assist in establishing scrappage programs. Moreover, there are scrappage programs under considerations in dozens of locations across the nation (Alberini, et al. 1993). Consequently, it is often assumed a priori that the benefits of scrappage programs are likely to exceed their costs. It is important to note, in this study, that a primary motivation on the part of UNOCAL in implementing their scrappage program was to delay compliance with an existing prohibitory rule, where the specific benefits associated with the compliance delay were calculated internally by the company to exceed the program costs (Guensler 1992). This point, however, should not be construed to imply that the benefits of similar scrappage programs would exceed compliance program costs to other companies in different situations. Nevertheless, the other programs have not appeared to be much less favorable than UNOCAL's program at reducing compliance costs in the short term (Washington 1993). In addition to obtaining emission reduction credits, UNOCAL received tremendous public relations benefits from the implementation of their scrappage program in Los Angeles. However, because the emission reduction estimates are uncertain, it is difficult to assess the true benefits or efficiency of scrappage programs (Guensler 1992; Washington 1993; Hsu and Sperling 1994).

Uncertainty in Quantifying Emission Impacts

If a vehicle is removed from the fleet before its natural retirement date and is replaced by a cleaner vehicle, and no change in vehicle activity is induced (i.e. the vehicle undertakes the same number of trips and travels the

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same number of miles under identical operating conditions), a reduction in emissions should result. However, because an older vehicle would likely have been retired from the vehicle fleet in the near-term anyway, the emissions reductions only accrue for what would have been the remaining life of the scrapped vehicle. The remaining life span of the vehicle is the central issue in discussions of whether emission reductions associated with retirement programs are 'surplus' reductions or in excess of the emission reductions, which would have occurred in the absence of the scrappage programs that have already been accounted for in air quality management plans (Guensler 1992; Washington 1993).

By retiring older vehicles, it is likely that the South Coast region (and other regions that have implemented similar programs) have achieved surplus emission reductions, albeit for a limited time. Nevertheless, determining the quantity of emissions reduced by the UNOCAL program is extremely difficult for several reasons. First, there are many uncertainties involved in the relevant emission-related vehicle activity variables associated with the retirement of each vehicle.

"To quantify the emissions reductions resulting from an automobile accelerated retirement program, six determinations need to be made with a reasonable degree of certainty: 1) how much earlier were the old automobiles retired than they otherwise would have been without the program? 2) how much would the automobiles have been driven if they had not been retired? 3) what were the emissions levels of the retired automobiles? 4) how were the vehicle-miles-traveled of the retired automobiles replaced? 5) how many vehicle-miles-traveled will occur on the replacement automobiles, where there is one? and 6) what will be the emissions levels of the replacement automobile, where there is one?" (Hsu and Sperling 1994)."

UNOCAL hired a marketing research firm to survey SCRAP program participants to obtain answers to questions similar to those above. Results of the survey revealed that 91 percent of the respondents did not plan to scrap their vehicles, while the remaining nine percent had intended to scrap their automobiles prior to solicitation by UNOCAL. However, because a longer life expectancy would make vehicles more valuable with respect to emissions reduction credits, an affinity for over reporting may exist (Hsu and Sperling 1994). Hence, the results of this survey are questionable and may be biased.

In fact, "...the modest buy-back prices of the UNOCAL program and other proposed programs (\$500 - \$900) may well ensure that a biased sample is obtained in a scrappage program; why would automobile owners turn in their old automobiles for such modest sums of money if they had been driving it regularly? (Hsu and Sperling 1994)."

Although it may be possible to obtain less biased survey results, a significant amount of uncertainty is still likely to exist with respect to the emission reductions of each vehicle.

Emissions Modeling Uncertainty

In addition to the uncertainties associated with the assumed activity of scrapped vehicles, there are tremendous shortcomings with current emissions modeling approaches. Hence, the current models cannot be used to adequately quantify the emissions reductions associated with changes in consistency of the vehicle fleet brought about by scrappage programs.

Research suggests that there are a number of problems with the current mobile source emissions models: 1) existing models neglect important emissions-producing activities, 2) existing models are based upon inappropriately drawn statistical inferences from data collected, 3) existing models are based upon data

collected from a non-representative sample fleet, and 4) existing models link uncertain emission rates with questionable vehicle activity estimates (Guensler 1993). Although new emissions modeling techniques have been proposed, they are not likely to reduce all of the uncertainties associated with these analytical approaches. Consequently, it will be difficult to gain a truly accurate assessment of the benefits of emissions reduction policies in the near future.

In summary, it is very difficult to predict the emission reductions associated with vehicle scrappage programs, and even when emission reductions are estimated using the most recent modeling tools and assumptions, the modeling results are surrounded by large uncertainties (Guensler 1993). Determining the magnitude of emission reductions from scrappage programs using current modeling techniques is difficult, if not impossible. Furthermore, the published analytical results that praise the emission reduction successes of such programs are highly speculative. Given the many uncertainties associated with the emission benefits of scrappage programs, it seems even more important to undertake a study of the potential distributional impacts of such policies on society.

DISTRIBUTIONAL IMPACTS OF VEHICLE SCRAPPAGE PROGRAMS

It is important for analysts to evaluate the efficiency and the distributional impacts of proposed programs prior to widespread implementation. Traditionally, analysts have focused on benefit-cost analyses to evaluate the efficiency of policies. In benefit-cost analyses, programs are deemed beneficial when program benefits exceed program costs or where net present worth is maximized. However, unless distributional analyses are performed, we cannot make determinations about fairness of proposed policies, that is, who benefits and who pays (and how much) for the program in question.

Often, analysts are hesitant to evaluate the distributional impacts of programs. Distributional studies focus on the issue of equity or fairness, and it is difficult to establish a definition of equity that is widely accepted by any community (Cameron 1994). The concepts of fairness in distributive justice arise from philosophical differences between individuals at the core and operational levels. Metaethics, epistemologies, core values, concepts of moral standing, and concepts of distributive justice vary greatly between cultures, communities, and individuals, and can even be inconsistent within individuals.

"For many people, equity refers to their own (often private) definition of fairness, whereas for others equity may mean equal treatment or the distribution of income. Because equity has become such a popular word in transportation planning, some efforts at presenting an operational form of the concept seem justified" (Lee, 1978).

For example, to evaluate an equitable allocation of resources, one's concept of fairness might be based upon equality of distribution, distribution according to need, distribution according to fees paid, etc. (Rescher 1966). Notwithstanding the potential conflicts that arise from individual differences in fundamental concepts of equity, it is also difficult to estimate the distributional effects of government programs on society. In the emissions reduction area, it is especially challenging to determine the distribution of air quality benefits across income groups in any region. For example, benefits of improved air quality result from reduced population exposure to high pollutant concentrations. Projected changes in pollutant exposure are dependent upon numerous modeling linkages: population and land use models, vehicle activity models, emission rate models, chemical interaction models, meteorological models, and pollutant dispersion models. Finally, after estimating the distribution of benefits, the costs of a program must be distributed. Despite the difficulty in generating cost assessments, many public policies have significant impacts on the distribution of income in a society and these impacts should be presented along with efficiency determinations (Harrison 1973). Even if equity impacts are approximate, a

crude assessment is better than no understanding of the distributional impacts of a policy at all.

Incorporating Equity Analysis into Policy Evaluation

It has been assumed that programs such as UNOCAL's SCRAP program result in positive air quality benefits at a relatively low cost. This assumption, however, is offered without detailed analytical assessment of the algorithms utilized in the impact assessment models and the variables employed in analysis. Not only are the total emissions reduction benefits claimed by these programs questionable, the distributional impact assessments by income group are non-existent. Distributional impact evaluations of scrappage programs should be incorporated into the policy evaluation process before these programs are widely implemented. It is important that communities understand the benefits and costs that a program is likely to have on a region as a whole, as well as the potential impacts on particular 'groups' of individuals.

Although it may be difficult to analyze the separate effects of programs on different income groups in a region, it is possible to conduct such a study. In 1975, David Harrison published a book titled: *Who Pays for Clean Air: The Costs and Benefit Distribution of Federal Automobile Emission Standards*. Harrison's book presents the results of an empirical study of the Federal Automobile Emissions Control Standards required under the 1970 Clean Air Act. Harrison was one of the first individuals to study the equity impacts of the U.S. Clean Air Act on American society. Since the release of this study, the role of equity analysis has faded in and out of policy analysis. However, today, issues of environmental equity and environmental justice not only warrant our attention but have become the focus of many papers, conferences, and studies (see Cameron 1994).

Since the issuance of the environmental racism report prepared by the United Church of Christ Commission for Racial Justice in 1987, environmental justice issues have surfaced increasingly in the environmental community (U.S. EPA 1992). Nevertheless, it is critical that policy makers and society transition to a new paradigm in which environmental policy and 'environmental justice' are incorporated into the decision making process. The concept of environmental justice must envelop the environmental regulatory process. In order to make a difference in future policy making and planning, it must be more than just a 'buzzword.' The concept of equity must be operationalized into the public policy arena, especially when new emission control policies, such as the RECLAIM³ program, have the potential to further remove the public from the environmental decision making process (Guensler 1992). Equity or distributional impact analyses should be conducted in conjunction with benefit-cost studies. Efficiency analyses alone should not be tolerated by the general public, industries, or implementing agencies.

Distinguishing Between Concepts of Horizontal and Vertical Equity

In developing distributional impact studies, it is important to distinguish between two types of equity: 1) horizontal equity and 2) vertical equity (Lee 1978). Horizontal equity can be defined as "...equivalent treatment of individuals in equal circumstances" (Lee 1978). In essence, horizontal equity refers to traditional concepts of fairness. For example, suppose taxes are imposed on individuals in a community to build a mass transit station that will provide service to a light-rail line. Some individuals, who live within walking distance of the transit station, are likely to use this service on a regular basis. Other individuals, who live a considerable distance

³RECLAIM is a tradeable permit program within private industry.

from the station, are not likely to take advantage of the station regularly. Consequently, local residents are likely to receive a higher benefit from the new transit station than they actually pay for, while distant residents are literally paying for a service from which they only receive indirect benefits. This example illustrates the concept of horizontal equity.

Horizontal equity considerations may result, because air-quality impacts of a scrappage program might affect different geographical groups of people. For example, suppose a scrappage program is proposed by an electric utility. To increase their plant's emissions by five percent, they propose to remove five percent of emissions from 'dirty' vehicles in the local air basin. The benefits from the decreased emissions from vehicles are likely to accrue to all motorists and residents in the region, while the increased emissions from the powerplant are likely to impact those residents close to or immediately downwind of the power generating facility (Guensler 1992).

Vertical equity refers to the distribution of income among various sectors in society (Lee 1978). Vertical equity is often concerned with a more egalitarian distribution of income between income classes. The basic principle behind vertical equity is that the implementation of government programs should not re-distribute wealth in a way that makes anyone worse off (i.e., the policy should be *pareto efficient*). For instance, it appears - on the surface - that vehicle scrappage programs are *pareto efficient*, because it is assumed that the program result in reduced air pollution and improved air quality for individuals in the affected region. When we consider vertical equity, we want to know if the program costs will be distributed equally among income groups. As discussed earlier, there is reason to suspect that low-income groups will be burdened with higher used-car prices in the short-term, while high-income groups might be unaffected. In addition, if the power generating facility described above is surrounded primarily by low-income residents, then costs again weigh more heavily on low-income groups (i.e., horizontal equity). An equity analysis of vehicle scrappage programs should focus on Lee's concepts of both vertical and horizontal equity.

Equity Analysis of Vehicle Scrappage Programs

To evaluate the horizontal and vertical equity of vehicle scrappage program, the analysis should include the following components: 1) a study methodology, 2) criteria for evaluating the results of the study, and 3) an hypothesis in which to study the results of the study.

The authors previously hypothesized that vehicle scrappage programs are likely to be *inequitable* to certain segments of society because lower income groups will pay more for reduced emissions than middle and high income segments due to the indirect effects of this program. Inequitable pricing is a likely consequence of this policy because of the program's effects on the used car market. In addition, the location of the source of increased emissions may have inequitable impacts upon income groups and/or geographical groups. Depending upon the location of the increased point source of pollution, equity impacts might accrue across income or geographical groups.

Noting that we must be able to test our hypotheses regarding the equity impacts of vehicle scrappage programs, we should develop some evaluation criteria. Criteria that can be used to evaluate the impacts of horizontal equity: 1) some persons in a regions pay for benefits they do not receive while others receive more than they pay for, and 2) some persons are paying more than their share (Lee 1978). There are two criteria that can be used to evaluate the impacts of vertical equity: 1) efficiency criterion and 2) equality of pricing criterion. Through the use of the efficiency criteria:

"One assumes that the size of the pot is fixed (there are no efficiency impacts), and the result of the

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policy labeled either favorable (low incomes gain at the expense of high), unfavorable (high incomes gain at the expense of low), or neutral (there are no net redistributive effects)" (Lee 1978).

With the second criteria, one focuses on the distribution of costs, benefits, and net benefits in proportion to income rather than efficiency (Lee 1978).

"Costs (taxes) that increase faster than income as a proportion of income are *progressive* as are benefits that increase less than proportionately; costs that increase less than proportionately or benefits that increase faster than income are *regressive*; and costs or benefits that are a constant proportion of income are *neutral*" (Lee 1978).

Because vehicle scrappage programs are voluntary and do not require individuals to turn in their 'dirty' vehicles, programs do not directly impose a cost on individuals who drive pre-1971 vehicles (the cut-off model year employed in UNOCAL's SCRAP program). However, vehicle scrappage programs will have an indirect effect on the automobile market; they will reduce the number of vehicles circulating in the used car market. This decrease in supply is likely to result in higher prices demanded for used vehicles, a class of automobiles that also is likely to incur higher inspection and maintenance costs, on average, than newer vehicles. Inspection and maintenance programs generally require that...

"Each vehicle owner bring his or her car to an approved inspection station, generally operated by the city or state, for measuring exhaust emissions of at least pollutant types hydrocarbon (HC) and carbon monoxide (CO). If emissions exceed the established standard for the pollutant and model year of vehicle the owner is required to have repairs made on the vehicle to bring the emissions into compliance with the standards" (Schwartz 1975).

Because lower income groups have fairly inelastic demands for transportation, they are likely to either pay the higher price demanded by the seller of the used vehicle, or choose an alternative mode of transportation. In the former case, lower income groups will pay an increased cost for a used vehicle that is induced by the scrappage program. The additional cost will result in the replacement of some other previously purchased item or service. In the latter case, low-income groups will be forced to choose an alternative form of transportation, such as mass transit. This alternative mode was not chosen prior to the scrappage program, and therefore was the least desirable alternative. These mode-switchers are now forced to bear transit costs, which may involve: significantly increased transportation time (increased in-route travel time, station waits, and mode transfer delay), significantly decreased leisure time, decreased employment opportunity and activity flexibility, and overall decreased mobility.

Quantitative Methodology

To test the hypothesis presented above, a study methodology should be developed that identifies data for analyzing the distributional impacts of the vehicle scrappage program on society. Since the hypothesis focuses on analyzing the impacts of the vehicle scrappage program on the used car market, quantitative methods should focus on changes in the regional used car market as a result of program implementation. In addition, air quality impacts across regions should be a focus. Analyses should attempt to answer questions such as: where are the scrapped vehicles driven; where do emission increases occur; and who are likely to be affected by the emission changes? To answer questions such as these, analysts need to develop and apply quantitative assessment methods.

Quantitative methodologies should be applied to identify various parameters to evaluate changes in the used car

market. For instance, recording the following changes in the used car market prior to and after the implementation of the program: 1) the number of vehicles available as a function of model year, 2) the number of vehicles by vehicle type (e.g., economy car, sedan, light-duty truck, etc.), 3) the average price by vehicle type and age, and 4) the operating and maintenance costs by vehicle type and model year. Once these parameters have been established, a data collection methodology should be developed for gathering the necessary data for analyses. In addition to obtaining vehicle information, it is important to obtain data on the income distribution of used car buyers. These data could be gathered by surveying customers at used car lots regarding their income level or reviewing census data. The Bureau of Census of the U.S. Department of Commerce reports vehicle age data by income (Schwartz 1975). Hence, it might be assumed that the national data is representative of the specific region for which a study is undertaken (Schwartz 1975). However, more detailed inspection and maintenance certification data could be collected from the Bureau of Automotive Repair. It would be fortuitous to collect this information periodically throughout the course of a study, which corresponds to the overall changes in the used car market (e.g., once a year after the program is implemented). Of course, it would be critical to collect income data at the beginning of the program or prior to the scrappage policy's implementation as well.

To estimate the impact of re-distribution of air quality impacts, we must rely on historic ambient air quality monitoring data, as well as collect new data after program implementation. Of significant importance in this data collection effort is to identify spatial and temporal distribution of air pollution before and after program implementation. These data, in conjunction with data on increased pollution from the stationary source, might provide enough evidence to explore the possible distribution of health impacts by location. Dose-response studies could be used to determine the health impacts of air pollution. In addition to exploring the horizontal equity impacts, if land-uses surrounding the point source are income segregated (a highly likely possibility), vertical equity concepts relating to health impacts can also be examined.

Thoughtful equity analyses depend upon the collection and evaluation of relevant data. Quantitative methods are powerful tools for analyzing the effects of vehicle scrappage programs on various sectors of society. In the future, the results of such studies might prove useful in encouraging the retention of a program or in creating an argument for relinquishing policies that result in inequitable impacts with respect to vertical equity, horizontal equity, or both.

CONCLUSIONS

On June 1, 1990, UNOCAL instituted the first vehicle scrappage program, titled: the Southern California Retired Automobile Program (SCRAP). In general, scrappage programs are directed at older, more polluting automobiles thought to contribute a disproportionate amount of emissions. By implementing a scrappage program that retires these older vehicles, polluters can receive emissions reduction credits. Hence, the difference in emissions between scrapped and replacement vehicles is claimed as reductions. Laboratory tests from the SCRAP program indicate that real emission reductions were likely achieved by the program.

It appears that vehicle scrappage programs may be an effective means of achieving emissions reductions. However, upon closer examination we see that: 1) emissions reductions are temporary in nature, 2) it is difficult to estimate reductions because there are a number of variables that are problematic to quantify, 3) the benefits of vehicle scrappage programs are questionable due to uncertainty in the models available for analysis, and 4) the programs may involve both horizontal and vertical equity considerations that impose disparate costs and benefits on society.

In addition to the many uncertainties associated with efficiency analysis of vehicle scrappage programs, little

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attention has focused on the distributional impacts of this policy on society. In this analysis, the authors addressed the importance of distinguishing between horizontal and vertical equity in distributional impact studies.

In this paper, the authors hypothesized that vehicle scrappage programs are potentially inequitable because lower income segments will pay more for reduced emissions than middle and high income groups due to the indirect effects of scrappage programs on the used car market. In addition, there may be horizontal equity concerns where increased point source emissions occur. And, depending upon income distribution by land-uses, there may be added vertical equity concerns. Consequently, it is important that appropriate evaluation parameters be identified and useful data collected in order to test these hypotheses. Quantitative evaluation tools are useful for assessing the vertical and horizontal equity of vehicle scrappage programs on society. If study methodologies are carefully constructed and data are thoughtfully analyzed, the results of such studies could be used to retain or relinquish various policies on the basis of their distributional impacts.

Although vehicle scrappage programs may place a disproportionate health and financial cost on lower income sectors of society, other market-based programs, directed at reducing mobile source air emissions, may be both more efficient and equitable. Hence, market-based programs have the potential of achieving mobile source emissions reductions at a relatively low cost; however, it is important that these programs are truly equitable and efficient in achieving reduced emissions. Consequently, it is critical that mobile source reduction policies be evaluated on the basis of efficiency and equity prior to widespread implementation to ensure the promotion of environmental justice in transportation and environmental planning. Clearly, these types of in-depth analyses should be commonplace in policy analysis.

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