Will Speeding the Retirement of Old Cars Improve Air Quality?

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Despite a substantial decrease in the past twenty-five years, motor-vehicle emissions continue to be a major contributor to air pollution in many urban areas. It is now clear that air quality objectives will never be met simply by setting increasingly stringent emissions standards for vehicles built in the future; something must be done about the emissions of vehicles built in the past.

Given that emissions from newer vehicles have already been drastically cut, policymakers are focusing on emissions from older cars—that is, 1980 and earlier model-year cars. These older cars often do not have advanced emission-control equipment; when they do, it sometimes no longer functions properly. Thus they tend to emit pollutants at much higher levels, on average, than newer vehicles.

Considering that pre-1980 cars make up only 18 percent of the vehicles in use in the United States and account for only 8 percent of total miles driven, they contribute a surprisingly large share of total motor vehicle emissions. On a typical hot summer day, they emit approximately 40 percent of the hydrocarbon, 40 percent of the carbon monoxide, and 25 percent of the nitrogen oxide emissions of the nation’s car fleet.

These statistics suggest that a potentially effective way to reduce hydrocarbon, carbon monoxide, and nitrogen oxide emissions in urban areas is to take older, highly polluting cars off the road. Accelerated vehicle-retirement (AVR) programs offer a new market-based opportunity to do this. These programs buy pre-1980 cars from their owners, usually at a price

ranging from $500 to $800, and then scrap the cars.

Because AVR programs remove polluting cars from the road, they are one way for private firms and states to fulfill their emissions-reduction obligations. Through AVR programs, firms that are looking for a lower-cost alternative to reducing their own pollution are given a mechanism to earn credits for short-term emissions reductions. AVR programs are also one of many options states are exploring to meet goals for air-pollution control.

At first glance, AVR programs may appear to be an attractive way to tackle urban air problems. However, there are questions about how effective buying and scrapping old cars will be in reducing emissions and how much AVR programs will cost relative to other policies to cut pollution.

In 1992 the President’s Commission on Environmental Quality (PCEQ) commissioned us to conduct a study of a small, one-time AVR program run in Delaware by U.S. Generating Company (USGen), an independent electric-power producer. In that study—developed jointly by PCEQ, Resources for the Future, and USGen—we tried to shed light on some of the controversial issues surrounding AVR programs.

**Issues in Evaluating AVR Programs**

Firms and agencies considering whether to operate an AVR program will want to determine the amount of emissions that the program has the potential to reduce. Making this determination is fairly complex, as it means forecasting the outcome of three events that cannot be observed directly: (1) the quantity of pollutants that each car would have emitted had it not been scrapped, (2) the quantity of pollutants emitted by cars bought to replace the scrapped cars, and (3) the number of cars that can be purchased through an AVR program at different prices. An uncertainty that affects the emissions-reduction potential of long-term, large-scale AVR programs is the effect such programs have on the purchase price that owners of old cars are willing to accept.

Many factors determine the amount of emissions that a scrapped car would have emitted if it had remained on the road. The car’s emissions rate, average annual mileage, and expected remaining life all contribute to what we term the *avoided emissions*. Because these variables are impossible to measure, emissions reductions are usually calculated by imputing to the scrapped cars the emissions rates, annual mileage, and remaining life of “average” cars of the same years as the scrapped cars. However, the resulting estimates of avoided emissions are unlikely to be correct because the cars that enter an AVR program are not representative of cars of a certain age. On the one hand, the scrapped cars are at the lower end of the used-car market and are therefore likely to have a relatively shorter remaining life span than the average vehicle of their age. They also may be driven less. On the other hand, they may have greater per-mile emissions.

Emissions from cars and other modes of transportation that replace scrapped cars are also difficult to predict. Even if we know what cars have been purchased to replace scrapped cars and thus can measure their emissions, it is unlikely that we will also know what cars have been purchased by the people who sold the replacement cars. Nor is it likely we will know what cars the people who sold those cars bought to replace the cars they sold and so on. Because these chains of transactions are impossible to track, the emissions rates of replacement cars are often assumed to be equal to the average emissions rate of a region’s car fleet.

Predicting how vehicle owners will respond to different purchase-price offers presents still more difficulties. Presumably, the higher the offer, the greater the number of cars AVR programs will enlist. But without information about how many cars each different offer will attract, a firm or agency cannot predict what level of emissions reductions can be achieved. This uncertainty makes AVR programs a gamble, because the firms or agencies that run them often will be required to reduce emissions by a specific amount.

When AVR programs are designed to be a large or steady source of emissions-reduction
credits for a region, another set of problems arises. Long-term, large-scale AVR programs may create so much demand for old cars that used-car prices will rise. The retirement of a large number of old cars in the region served by the program is likely to increase the value of the remaining old cars in that region. If so, large-scale programs will have to offer increasingly higher prices to obtain a given number of cars; this means that they will reduce emissions at a higher per-ton cost than small-scale programs, which do not affect the market for old cars.

In addition, ongoing AVR programs may create the wrong incentives for car owners. For instance, people might be encouraged to keep their cars longer than they would normally, so as to have an old car to sell. Also, people living in one region might offer their cars to a program operating in a different region. If so, emissions would not be reduced in the geographic area where they were intended to be reduced.

**Study of the Delaware Vehicle-Retirement Program**

Given these uncertainties, the role AVR programs should play in reducing air pollution is still unclear. However, our analysis of data collected from USGen’s AVR program in Delaware in the fall of 1992 provides some insight about the role these programs could play.

As noted above, it is difficult for firms and agencies to determine whether AVR programs are worth starting without knowing how many cars they will attract. Before starting its program, USGen estimated that it would have to buy and scrap 125 cars if it wanted to offset an increase in air pollution caused by transporting coal to one of its power plants.

The company predicted that it would recruit this number of cars if it targeted a select group of car owners to participate in its program. Initially, USGen tried to enlist cars from among the 1,034 cars that had received waivers from Delaware’s vehicle inspection and maintenance (I&SM) program. These waivers allow cars to be driven after they undergo repairs to reduce tailpipe emissions and fail to pass the I&SM program’s emissions test a second time. Because cars with waivers are likely to be the most polluting cars on the road, they are the ones AVR programs want to enlist so as to obtain the greatest emissions reductions.

Since USGen enlisted only sixty cars from owners of waivered cars, it made offers to about 3,000 owners of cars randomly chosen from the pre-1980 car fleet. From these, it recruited sixty-five additional cars.

The combination of both waivered and non-waivered cars gave us the opportunity to test the feasibility and quantify the benefits of an AVR program that targets highly polluting pre-1980 cars, as well as a program that accepts any pre-1980 car.

Half of the 125 cars USGen purchased were given emissions tests. Using the results of the emissions tests, we estimated the average emissions rate of the scrapped cars. We found that, on average, the waivered vehicles emitted about 60 percent more hydrocarbons from their tailpipes than the nonwaivered vehicles. Using a model developed by the U.S. Environmental Protection Agency, we then predicted the average emissions rate of replacement cars.

We surveyed car owners participating in the program to obtain information on which to base estimates of the annual mileage and the expected remaining life of the 125 cars scrapped. We also surveyed a sample of car owners who were solicited to participate in the AVR program but who declined to do so. By surveying both those who accepted USGen’s $500 purchase-price offer and those who refused it, we were able to determine how the scrapped cars differed from the fleet of pre-1980 cars as a whole.

In the surveys, we asked car owners how often and how many miles they drove their cars, what condition their cars were in, how much longer they planned to keep their cars, whether they expected the cars to need major repairs in the near future, and how much effort it took for them to maintain their cars.
To gauge how the purchase price affected participation in the program, we asked respondents to give us their reservation price—that is, the minimum offer they would have accepted for their cars.

To get better estimates of avoided and replacement emissions, we conducted follow-up surveys of both participants and nonparticipants one year later. These surveys examined how participants had replaced their cars—by purchasing new cars or relying on public transportation, for example—and how their driving habits had changed.

Study Results

Using data from the surveys and emissions tests, we were able to estimate the potential for emissions reductions from USGen’s AVR program, as well as the program’s cost-effectiveness compared with other mechanisms for reducing emissions. We also were able to draw some general conclusions about AVR programs.

Our data analysis focused on the relationship between the value of old cars and the cars’ expected remaining life. We found that old cars with low values typically have a short remaining life. This finding, which is based on the first empirical evidence ever collected about the remaining life of cars sold at different purchase-price offers, confirms what economic theory suggests. AVR programs that offer $500 will attract cars that would have remained on the road no more than two years on average. This information is essential for evaluating the cost-effectiveness and emissions-reduction potential of AVR programs.

In estimating the cost-effectiveness of the Delaware AVR program and in deriving what economists would call an emissions-supply function (the function that predicts the number of tons of emissions reduced at varying purchase-price offers), we had to make some assumptions about replacement cars’ emissions and usage. We based these assumptions on data gathered from the original and follow-up surveys.

Both surveys indicated that the scrapped cars were driven just as many miles (if not more) than the cars not sold and scrapped and that annual mileage was not meaningfully correlated with the age of individual pre-1980 cars. The follow-up surveys showed that, on average, replacement cars were driven no more than scrapped cars had been. We assumed, therefore, that a scrapped car would be replaced by another car with equal annual mileage. The follow-up surveys also showed that the average replacement car was a 1986 model-year car. Because such a car is very similar to the “average” car in the U.S. car fleet, we assumed that the emissions rate of replacement cars was the same as the average emissions rate of the nation’s car fleet.

Using these assumptions and the emissions-test and survey data, we estimated a statistical model that correlates the remaining life of a car with the likelihood that its owner will sell it to an AVR program. Based on estimates generated by the model, we determined in two different ways the Delaware AVR program’s cost-effectiveness in reducing hydrocarbon emissions. First, we estimated the cost-effectiveness of the entire program, which included both waived and nonwaived cars. We found that the program reduced hydrocarbon emissions by about fifteen tons at a per-ton cost of about $5,000.

Second, we restricted our analysis to only the waived cars and found that the per-ton cost of emissions reductions was a little more than $4,000.

Next we estimated the cost of reducing hydrocarbon emissions for a hypothetical AVR program that pays $500 for any pre-1980 car. We found that the comparatively lower emissions of nonwaived cars in such a program would increase the per-ton cost of reducing hydrocarbon emissions to about $6,000 (see Table 1).

According to these estimates, a program that targets waived cars appears to be more cost-effective than a program that accepts any older car. If we had taken the value of carbon monoxide and nitrogen oxide reductions into account, the cost-effectiveness of each program would have increased.

Emissions reductions depend, of course, on the number of cars recruited, and participation in AVR programs appears to be very sensitive to the purchase price offered. USGen’s offer of $500
Table 1. Predicted Cost-Effectiveness, Participation Rates, and Expected Remaining Vehicle Life in a Small-Scale Accelerated Vehicle-Retirement Program at Various Purchase-Price Offers

<table>
<thead>
<tr>
<th>Purchase price offer</th>
<th>Average cost per ton of HC reductions</th>
<th>Predicted participation of the pre-1980 fleet</th>
<th>Expected remaining life of a participating vehicle (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$400</td>
<td>$3,370</td>
<td>1.8 %</td>
<td>1.5</td>
</tr>
<tr>
<td>$500</td>
<td>$3,946</td>
<td>4.3 %</td>
<td>1.7</td>
</tr>
<tr>
<td>$600</td>
<td>$6,219</td>
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</tr>
<tr>
<td>$700</td>
<td>$6,572</td>
<td>12.8 %</td>
<td>2.1</td>
</tr>
<tr>
<td>$800</td>
<td>$6,904</td>
<td>18.2 %</td>
<td>2.3</td>
</tr>
<tr>
<td>$900</td>
<td>$7,194</td>
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<td>2.4</td>
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<td>$8,800</td>
<td>52.3 %</td>
<td>3.0</td>
</tr>
<tr>
<td>$1,500</td>
<td>$9,123</td>
<td>57.0 %</td>
<td>3.1</td>
</tr>
</tbody>
</table>

Note: The program does not target the most highly polluting cars, but rather accepts any pre-1980 car. The shading reflects uncertainty about estimates of cost-effectiveness, participation rates, and expected remaining life at high purchase prices.

attracted only 4.3 percent of the total population of Delaware's pre-1980 cars, and only 5.9 percent of its subpopulation of waived cars. If the offer price had been increased to $700, we estimate that the company's program would have attracted approximately 13 percent of the total population and 18 percent of the waived fleet.

Our cost-effectiveness estimates indicate that the expected remaining life of cars purchased by AVR programs is also very sensitive to purchase-price offers. According to our estimates, a car sold to an AVR program for $500 would otherwise have remained on the road for about 1.7 years, and a car sold for $700 would have been driven another 2.1 years. In contrast, the average remaining life for the typical pre-1980 car is about 4.2 years. The significant difference between this figure and our estimates shows the danger of relying on average fleetwide estimates of variables, such as expected remaining life, when projecting the benefits of AVR programs.

Another important conjecture is that high purchase-price offers may adversely affect the cost-effectiveness of AVR programs that attract a large percentage of a region's old-car fleet. Removing a large number of cars from the fleet could increase average vehicle prices and thus influence the willingness of potential participants to accept a given offer price. Participation rates would therefore be lower at all offer prices. If this is the case, our estimates of the per-ton cost of removing hydrocarbon emissions would be too low, and our estimates of participation rates would be too high.

Once we established estimates of remaining vehicle life and participation rates, we were able to derive an emissions-supply function that predicts the number of tons of emissions reduced at varying purchase-price offers (see Figure 1). The emissions-supply curve is an increasing function of these offers: the higher the offer, the higher the number of cars AVR programs will attract and the more emissions savings the programs will realize. The slope of the curve depends on car owners' responsiveness to the offer price, which in turn depends on the number of cars in the targeted fleet that are valued at less than the offer price. Large or
ongoing AVR programs would likely make the curve flatter—especially at high offer prices—because high used-car prices would make most owners less willing to participate in an AVR program.

The Future of AVR Programs

Whether AVR programs are cost-effective relative to other means of reducing hydrocarbon emissions will depend on the severity of the air quality problems and the extent of existing pollution controls in the regions they serve. As noted above, the Delaware AVR program, which offered car owners $500 to scrap their cars, reduced hydrocarbon emissions from waivered cars at a per-ton cost of $4,000. By comparison, the U.S. Environmental Protection Agency estimates that the substitution of reformulated gasoline for regular gasoline would reduce hydrocarbon emissions at a per-ton cost of $3,900.

A small-scale AVR program that does not target waivered cars is less cost-effective. It will reduce hydrocarbon emissions at a per-ton cost ranging from about $5,000 (at a $400 purchase-price offer) to about $7,000 (at a $900 purchase-price offer). However, a small-scale AVR program is more cost-effective than a program to replace cars that run on gasoline with cars that run on natural gas or on methanol, which would reduce hydrocarbon emissions at a per-ton cost of $12,000 and $30,000, respectively.

We conclude that small-scale, short-term AVR programs can be cost-effective for some regions. Programs that target the most highly polluting old cars may be the most promising. However, only a very large-scale program will generate appreciable emissions reductions. Since such a program is also likely to increase used-car prices, its cost-effectiveness is likely to decrease over time. The cost-effectiveness of ongoing AVR programs may also decrease in the long run because these programs are likely to create adverse incentives and unexpected consequences, especially when combined with efforts to target highly polluting vehicles.

Another area of uncertainty concerns the interaction of AVR programs and states’ vehicle inspection and maintenance (I&EM) programs. If the
Update

Since we wrote this article, there continues to be interest in old-car scrap programs as a way to reduce emissions of hydrocarbons and nitrogen oxides in polluted urban areas. Illinois and Colorado both ran old-car scrap pilot programs in recent years. In the Los Angeles region, the South Coast Air Quality Management District has allowed old-car scrap programs to be part of the private sector emissions-trading program in the region. Industrial or stationary sources of pollution can purchase and scrap old cars in lieu of other ways of reducing equivalent emissions. Since 1993, twenty-two thousand vehicles have been scrapped as part of this program, with the current market-determined price at about $500 to $600 per vehicle. The current rules assume the remaining useful life of these vehicles is three years, which is different from the 1.7 years estimated here for the Delaware program. While there are likely some differences in the fleet distribution and the used-car pricing structure between the two states, it is unlikely to account for all of this difference. This is perhaps the most important component of the RFF study of old car scrappage—that it is important to consider the “selection” problem (old cars recruited for such programs are likely to be those in poor condition with only a short remaining life) in designing and granting emission reductions for these programs. California is considering a major old-car scrap effort in the future, and it will be interesting to see how they deal with this issue.

Suggested Reading


South Coast Air Quality Management District, Rule 1610, Old Vehicle Scrapping.