1982

The Cost of Automobile Safety and Emissions Regulation to the Consumer: Some Preliminary Results

Robert W. Crandall
The Brookings Institution

Theodore E. Keeler
University of California - Berkeley

Lester B. Lave
Carnegie Mellon University

Follow this and additional works at: http://repository.cmu.edu/tepper

Part of the Economic Policy Commons, and the Industrial Organization Commons

Published In
The American Economic Review, 72, 2, 324-327.

This Article is brought to you for free and open access by Research Showcase @ CMU. It has been accepted for inclusion in Tepper School of Business by an authorized administrator of Research Showcase @ CMU. For more information, please contact research-showcase@andrew.cmu.edu.
The Cost of Automobile Safety and Emissions Regulation to the Consumer: Some Preliminary Results

By Robert W. Crandall, Theodore E. Keeler, and Lester B. Lave*

The cost of government regulation of the automobile has been the subject of heated controversy since its inception in the mid-1960's. Much of this controversy has centered on the costs and benefits of individual regulations, but there has been little attention paid to the overall effect of emissions and safety regulation. In this paper, we attempt to measure the effect of these regulatory policies upon the consumer cost of owning and operating an automobile.

I. Automotive Services and the "Cost" of Regulation

Automotive services require capital, gasoline, repair services, and highway services as well as insurance. Many of these inputs are partial substitutes—for example, greater expenditures on engineering an automobile can reduce fuel consumption or repair frequency. This substitution casts doubt on the validity of measuring regulatory costs by simply totting up the reported increases in production costs due to individual regulations.

Consumers may choose various combinations of size and such performance attributes as ride, handling, acceleration, braking, and fit and finish. Ceteris paribus, increasing size, performance, safety, or fuel efficiency, or decreasing emissions of pollutants entails greater production and engineering costs. The extent to which the consumer pays for this depends upon the ability of the manufacturer to pass on these costs in higher prices.

Safety and emissions regulations have three effects: (i) alteration of the ratios of fuel, capital inputs, repair services, and other inputs for each vehicle; (ii) a change in the mix of vehicles actually purchased; and (iii) a change in the amount of auto services demanded. Even without regulation, the sharp rise in gasoline costs during the 1970's should have led to smaller, more expensive cars. Indeed, regulation, the customers' budget constraint, foreign competition, and technological change have interacted to complicate the measurement of regulatory compliance costs.

To obtain useful estimates of the cost of regulation, we must attempt to measure the change in the full costs of owning and operating a car that are not due to changes in fuel prices, repair prices, and the rental price of capital, or to technological change. To begin, we assume that a representative consumer or firm produces auto services (assumed to be vehicle-miles, $VM$) according to the following production relationship:

\[
VM = F(X_1, \ldots, X_k, Q_1, \ldots, Q_m, R_1, \ldots, R_n),
\]

where $X$ represents factor inputs, such as fuel, capital, mechanics' labor, etc., $Q$ represents size and quality attributes, and $R$ represents government regulatory constraints, such as physical measures of allowed emissions.

We then assume that the consumer or firm minimizes the total costs of auto ownership and operation for a given set of factor prices, physical vehicle attributes, and government regulatory constraints. This cost-minimization process yields a cost function, in which total costs are a function of vehicle-miles,
factor prices, qualitative attributes, and regulatory policies. This can be expressed in average cost form as

\[ AC = \frac{TC}{VM} = C(w_1, \ldots, w_k, \quad Q_1, \ldots, Q_m, R_1, \ldots, R_n, VM). \]

We exclude VM from the equation, concentrating instead on the impact of factor prices, qualitative attributes, and regulations on the average cost per vehicle mile.

II. Econometric Specification

The most general specification of the cost function is the translog specification. However, collinearity among the translog terms in the cost function has made it impossible to invert the moment matrices. For the present estimation, a Cobb-Douglas specification has been used.

The Potential for Estimation Bias. All factor prices and attributes must be exogenous to the model if ordinary least squares estimates of the coefficient of (2) are to be unbiased. For some variables, such as fuel prices and interest rates, this is plausible. In other cases, the assumption of exogeneity is less plausible. For example, it is difficult to believe that domestic auto manufacturers set the prices of different new car models in a way totally exogenous to the cost equation we are estimating. As a result, our measure of the user cost of capital services employs an estimate of what new car prices would have been in the absence of regulation along with variables to measure the tightness of exogenous regulatory constraints, as discussed below.

For the attribute variables (mainly size), our estimates are possibly subject to bias. The process by which the size (and other qualitative) attributes of an auto are selected is unlikely to be independent of other disturbances in the system (such as, for example, emissions and safety regulation). A better understanding of these effects awaits the development of a more complete, simultaneous-equations model of the U.S. automobile market.

The Data Sample. The data sample (described in more detail in a data appendix, available from the authors) comes from two studies. Since the 1950's, the Runzheimer Corporation has estimated for the American Automobile Association the ownership and operating costs for subcompact, compact, intermediate, and full-sized models. The Baltimore study (based on typical operating costs in that area) was begun in 1960 by the U.S. Department of Transportation. Retail list prices for the relevant cars are employed in the calculation of capital costs. This may impart some upward bias to our cost estimates, but the effect is unlikely to be important unless discounts vary enormously among cars. To obtain consistent estimates of interest and depreciation from year to year, we calculated costs assuming that the consumer buys a car new, keeps it for four years or 49,000 miles, then sells it at the used car price for the relevant car size-class.

Factor Prices. Factor-price estimates are derived from three series: fuel prices, mechanics' wages (or the price of repair services), and a durable capital equipment series. The fuel price \( (P_F) \) is most straightforward, representing the cost per gallon of all gasoline sold, with average fuel taxes included. Use of it will, however, lead to an understatement of the cost of regulation because the fuel cost increase due to the use of unleaded gasoline is treated as an exogenous cost increase, rather than a cost of regulation. Repair costs were accounted for through the inclusion of a mechanic's wage rate series \( (W) \).

The durable price index is chosen to capture the increase in auto prices which would have occurred in the absence of regulation. For this purpose, the price of household appliances such as refrigerators, washers, and ranges was used. These are mass-produced consumer goods, generally with moving parts, motors, and enamelled stampings. Unlike autos, these household durables have been subject to relatively little direct regulation. The BLS price index for these appliances is multiplied by a measure of the user cost of holding a dollar of consumer durable (inter-
est and depreciation), and in one variant, it has been adjusted to reflect the higher wages paid in the auto industry.

For automotive attributes, measures of size are most important. We have selected two measures of size (and interior volume): wheelbase (B); a measure of length of passenger compartment; and rear shoulder room as a measure of usable width. Some studies have managed to find significant relationships between costs and other attributes, such as acceleration and interior noise. However, preliminary explorations suggest that such structural relationships have not persisted or at least are rather weak.

Regulatory Constraints. These are the most difficult variables to measure in our equations. Ideally, we would like to measure the constraints in physical terms. For emissions regulation, Cₐ, we used the reciprocal of the geometric mean of the hydrocarbon, carbon monoxide, and oxides of nitrogen standards for the given model year, measured in grams per mile.

For safety, there was no physical variable that seemed suitable. Instead, we used independent estimates of the cumulative costs of safety regulation (Cₐ), made from engineering evidence and converted to constant dollars for each vintage of cars.

Technological Change. The consumer durables price index provides a direct measure of inflation-adjusted productivity increase in producing consumer durables. Inclusion of a time trend simply reduced the level and significance of the durables index coefficient, and it appears that they are both capturing the same effect. We conclude that the time trend adds nothing to the explanatory power of the model.

III. Specification, Estimation, and Results

In a long-run cost function (average or total), the elasticities of cost with respect to factor prices should sum to one (i.e., ceteris paribus, a 1 percent increase in all factor prices must generate a 1 percent increase in average costs). We have constrained our equation to satisfy this result by treating fuel price as a "numeraire" and subtracting the logarithm of Pₔ from both sides of the equation, to generate the following specification:

\[ \ln AC - \ln Pₔ = a_0 + a_1 (\ln P_D - \ln Pₔ) + a_2 (\ln W - \ln Pₔ) + a_3 \ln B + a_4 \ln Cᵢ + a_5 \ln Cₚ + a_6 D, \]

where \( Pₔ \) is the CPI index for gasoline, \( P_D \) is the rental price of consumer durables, corrected for the higher (and more rapidly increasing) wage rate which prevailed in the auto industry during the period, \( W \) is the prevailing wage rate for motor vehicle repairs, \( B \) is the wheelbase (inches), \( Cᵢ \) is the emissions constraint variable, \( Cₚ \) is the estimated cost of safety equipment to manufacturers, (and \( D \) is a dummy variable equal to 0 for the Runzheimer study and 1 for Baltimore). To capture the effect of interior volume on costs, separate measures of width and rear-seat depth were included but their coefficients were never statistically significant. The estimated coefficients are shown below (t-statistics are below the coefficients in parentheses).

\[
\begin{align*}
\ln AC - \ln Pₔ &= -10.909 (13.6) \\
&+ .5445 (\ln P_D - \ln Pₔ) (4.65) \\
&+ .1642 (\ln W - \ln Pₔ) + 1.984 \ln B (1.96) \\
&+ .1692 \ln Cᵢ - .000352 \ln Cₚ (1.83) \\
&+ .08843 D; (4.99)
\end{align*}
\]

\[ R^2 = .957 \text{ with 48 degrees of freedom.} \]

These results show almost all the coefficients to be of the right sign, of plausible value, and significant. The only exception is safety regulation whose size and significance suggest that it has had a much smaller effect on auto costs than emissions regulation.
TABLE 1—ESTIMATES OF THE COST OF FEDERAL SAFETY AND EMISSIONS REGULATION

<table>
<thead>
<tr>
<th>1980 Model/Size Class</th>
<th>Estimated Operating Costs ($/m)</th>
<th>Cost of 1980 Standards vs. 1967 Benchmark (%)</th>
<th>Simple Difference in 4 years, 49,000 miles Operating Costs due to Regulation ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chevette Subcompact</td>
<td>14.23</td>
<td>12.0</td>
<td>750</td>
</tr>
<tr>
<td>Citation</td>
<td>19.37</td>
<td>12.0</td>
<td>1024</td>
</tr>
<tr>
<td>Compact</td>
<td>19.84</td>
<td>12.0</td>
<td>1044</td>
</tr>
<tr>
<td>Malibu Intermediate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impala</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full Size</td>
<td>23.31</td>
<td>12.0</td>
<td>1235</td>
</tr>
</tbody>
</table>

*Note: Column (1) is with 1980 standards; Column (2) is with 1967 standards.*

These results are extended in Table 1, which shows simulations of what the ownership and operating costs would have been for each car type, had 1967 levels of emissions and safety equipment prevailed for 1980 autos. They indicate that regulations have raised ownership and operating costs by about 18 percent over the period, and that practically all this increase is due to emissions regulation. It may be that the results for safety regulation stem from relatively poor measurement of the safety regulatory constraint, but conversations with auto manufacturers have suggested that our coefficients are accurate in their relative orders of magnitude.

Over time, manufacturers have managed to incorporate safety improvements into cars relatively inexpensively (with the exception of high-impact bumpers), whereas emissions constraints have required costly changes in auto manufacture.

Another surprising aspect of our results is the magnitude of our estimate of auto regulation costs. Based on prior expectations, these estimates seem high. Whether these new results are in fact valid is still open to some question. More research is needed, based on additional data and more general specifications of the model.