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THE COST OF INACCURATE CONSUMER INFORMATION; THE CASE OF THE EPA MILEAGE FIGURES

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ABSTRACT

In this study a utility maximizing model is developed which accommodates changing states of information. Rational consumer choices in one state of information can lead to realizing different levels of utility than anticipated. Differences between these levels of utility suggest a measure for the value of information. This framework is applied to estimating the potential cost of possible inaccuracies in the EPA fuel-economy ratings. Survey data collected from new car buyers then are used to infer the magnitude of the actual costs that may be caused by the present EPA information.

THE COST OF INACCURATE CONSUMER INFORMATION: THE CASE OF THE EPA MILEAGE FIGURES

Although assumed by traditional economic theory, consumers frequently possess less than perfect information when they make their purchase decisions. A consumer's post-purchase experience with product performance may significantly diverge from his or her pre-purchase expectations concerning the product. A learning process can close the gap between pre-purchase expectations and post-purchase realization fairly rapidly for more frequently purchased non-durables and services. However, for durables which are infrequently purchased and involve a large share of the budget, the problem can be serious.

Consumer choices based on inaccurate information can lead to realizing a different level of utility than previously anticipated. Subsequently, consumer demand for the product can be visualized as shifting when the true nature of the good becomes apparent after purchase. If the demand function shifts, changes in consumer surplus occur which can be used to measure economic losses due to imperfect information. Consumer surplus may increase or decrease as a movement in the demand curve results in a positive or negative transfer of wealth, but misallocated resources always result in some economic loss because the true utility function was not maximized.

This paper presents a theoretical model of consumer behavior which accommodates changing states of information. The model builds on earlier work by Peltzman (1973), who analyzed the welfare effects of imperfect information. The concept of differences in perceived and realized characteristics of products was used by Kotowitz and Mathewson (1979). In addition, others such as Auld (1972) and Colantoni, Davis and Swaminuthan (1976) have analyzed the effects misinformation about product characteristics can have on consumer demand and subsequent welfare. Previous work has not, however, conceptualized the effect of different states of information as changing the parameters of the utility function.

The empirical analysis in this study addresses the cost incurred due to inaccurate automobile gasoline mileage information. Gasoline price increases have made accurate information concerning mileage increasingly important. Purchases based on imperfect gas mileage information will result in a discrepancy between the perceived pre-purchase mileage and the realized post-purchase miles per gallon (mpg). In this analysis the Environmental Protection Agency (EPA) mpg estimates for specific automobiles are assumed to be the perceived level on which consumers base their purchase decisions. The EPA estimates are widely publicized as the official government mileage figures. The mpg levels determined by the Consumers Union in actual on-the-road driving tests are treated as the realized figures. The issue of how widely used by consumers the EPA estimates are was addressed in a survey of new car buyers conducted by the authors. The final result of this research is an estimate of the possible cost to society, to consumers, and to producers of inaccuracies in the EPA mileage estimates.

THEORETICAL FRAMEWORK

The Utility Functions

Consumers are assumed to maximize utility

(1) Max: $U = u(X; \beta)$

subject to

(2) $Y = P'X = 0$

where X is a vector of goods and services, $X = (x_1, \ldots, x_n) \varepsilon \bar{X}$ in R^n_+, β is a vector of parameters on the utility function and (2) is the usual budget constraint. β reflects consumers' preferences for elements of X which have been formed, in part, by the information they possess about the characteristics of each x_i. Hence, β can be viewed as embodying a consumer's state of knowledge of the utility obtainable from $X \varepsilon \bar{X}$. Preferences on the set of $\bar{X}$ in each state of knowledge are assumed complete, reflexive, transitive, continuous, strictly convex and strongly monotonic.

With perfect information the consumer chooses vector X^* to maximize utility. Let

(3) $U^* = u(X^*; \beta)$

denote the result.

With incomplete or inaccurate information the consumer chooses vector X^o to maximize utility. The consumer perceives the result will be

(4) $U^o = u(X^o; \beta^o)$

where β^o represents the vector of preferences accompanying the state of information at the time X^o was chosen. However, upon consuming X^o, the consumer realizes utility based on the "true" function with parameter vector β.[1/] The realized utility is given by:

(5) $U^\theta = u(X^o; \beta)$

Thus (1) and (2) yield three states of utility, optimum (U^*), perceived (U^o) and realized (U^θ). If $\beta \neq \beta^o$ for any element, say β_i, then $x_i^o \gtreqless x_i^*$. The vector X^o is a feasible solution to the constrained maximization but, by construction, X^* is the optimal solution. Hence,

$$U^\theta = u(X^o; \beta) \leq u(X^*; \beta) = U^*$$

The difference between realized and optimal utility, resulting from inaccurate information, suggests a measure for the value of information. The loss in welfare, $U^* - U^\theta$, can be viewed as the value of perfect information, in terms of utility.

Perceived utility (U^o) may be greater or less than realized utility (U^θ) depending on the values of β^o relative to β.

$$U^o = u(X^o;\ \beta^o) \gtreqless u(X^o;\ \beta) = U^\theta$$

Since β and β^o reflect mutually exclusive states of knowledge which cannot exist simultaneously for the consumer, no a priori comparison between (U^o) and (U^θ) can be made.

Measuring changes in consumer welfare which occur when the consumer chooses X^o and then discovers that X^* is preferred involves some measure of changes in consumer surplus. The problems of using consumer surplus as an exact measure of consumer welfare are well known. Chipman and Moore (1980) and others have shown that constant marginal utility of income is both a necessary and sufficient condition for compensating and equivalent variation and consumer surplus to be equivalent and precise measures of changes in consumer welfare.[2/] Assuming constant marginal utility of income simplifies the following exposition by allowing the use of Marshallian demand functions. Changes in consumer welfare will be referred to as changes in consumer surplus. The goal is to arrive at the net welfare loss due to allocative errors resulting from misinformation.

Let the indirect perceived utility function corresponding to (4) be:

$$(4')\quad U^o = \psi(P,Y;\ \beta^o)$$

and let the indirect true utility function corresponding to (5) be:

$$(5')\quad U^* = \psi(P,Y;\ \beta).$$

The perceived Marshallian demand functions corresponding to (4') are:

$$(6)\quad x_i^o = g_i^o\ (P,Y;\ \beta^o) = \frac{-\partial\psi(P,Y;\ \beta^o)/\partial p_i}{\partial\psi(P,Y;\ \beta^o)/\partial Y}$$

The true Marshallian demand functions corresponding to (5') are:

$$(7)\ x_i^* = g_i^*\ (P,Y;\ \beta) = \frac{-\partial\psi(P,Y;\beta)/\partial p_i}{\partial\psi(P,Y;\beta)/\partial Y}$$

Consumer surplus with perfect knowledge of β is:

$$(8)\ CS_i^* = \int_0^{x_i^*} g_i^{*-1}\ (P,Y;\beta)\ dx_i - p_i^o x_i^* \simeq \int_{p_i^o}^{\bar{p}_i} g_i^*\ (P,Y;\beta)\ dp_i$$

where $\bar{p}_i$ is some price of x_i for which $g_i^*\ (P,Y;\beta) \simeq 0$, and g_i^{*-1} is the price inverse of the Marshallian demand function. If information is not perfect and $\beta \neq \beta^o$, x_i may be over or under consumed relative to the optimal choice. Figure 1 illustrates the case where a consumer underestimated the miles per gallon for automobile x_i and consequently underconsumed x_i or, alternatively, would have been willing to pay more for x_i^o.3/ The consumer realized more utility than s/he perceived. Consumer surplus realized is:

$$(9)\ CS_i^\theta = \int_0^{x_i^o} g_i^{*-1}\ (P,Y;\beta)dx_i - p_i^o x_i^o \simeq \int_{p_i^1}^{\bar{p}_i} g_i^*\ (P,Y;\beta)dp_i + (p_i^1 - p_i^o)x_i^o$$

Since $U^\theta \leq U^*$, $CS_i^* - CS_i^\theta \geq 0$. The welfare gain from perfect information about x_i is:

$$(10)\ W_i = CS_i^* - CS_i^\theta.$$

In terms of Figure 1, equation (10) is area abc = $\bar{p}_i p_i^o c - \bar{p}_i p_i^o ba$. Note that the consumer gained area $p_i^1 p_i^o ba$ which can be referred to as a transfer from producers to consumers. In terms of this study it is the unexpected savings in expenditures on gasoline over the time the consumer owned automobile x_i.

When gas mileage is overestimated too much automobile is purchased. Figure 2 illustrates this case where $x_j^o > x_j^*$. Following equations (8) and (9) for the true and realized consumer surplus,

$$(8') \quad CS_j^* = \int_{p_j^1}^{\bar{p}_j} g_j^*(P,Y;\beta)dp_j$$

and

$$(9') \quad CS_j^\theta = \int_{p_j^1}^{\bar{p}_j} g_i^*(P,Y;\beta)dp_j - (p_j^o - p_j^1)x_j^o$$

Welfare gain from perfect information in this case is

$$(10') \quad W_j = CS_j^* - CS_j^\theta .$$

In Figure 2 (10') is area $\bar{p}_j p_j^1 d - \bar{p}_j p_j^1 dba$ = abd. In this case consumers transferred to producers area $p_j^o p_j^1 db$ which can be interpreted as the unexpected additional expenditure on gasoline over the time the consumer owned automobile x_j. Area abd can further be interpreted as expenditure made for which no utility was received. Consumers should, theoretically, be willing to pay an amount equivalent to area abd for information which would have allowed them to make decisions along demand curve $g_i^*(P,Y;\beta)$.

The implications of an allocative error in the consumer's choice of X^o are far reaching. If data on market purchases are contained in X^o, which were selected on the basis of preferences represented by β^o, it is perceived demand functions which are observed. If information and experience cause consumer beliefs and subsequently β^o to change, the parameters we frequently attempt to estimate will also change. Consequently, demand functions based on less than perfect information are not structural in an econometric sense. Furthermore, assuming a budget constraint, an allocative error on one good means nonoptimal choices of other goods and services as well. It follows that the total value of consumer welfare gain from exact knowledge of β is the summation of the gains $\sum_i^n W_i$ over all goods and services in $\bar{X}$. The larger the budget share of the good for which the consumer's knowledge of β is incomplete, or the smaller the elasticity of demand, the greater can be the error induced in the choice of other goods. The estimation of a single W_i is, therefore, a lower bound to the gain from exact knowledge of β.

EMPIRICAL APPLICATION

Gasoline Mileage Estimates

The EPA mileage estimates are extensively referred to in the advertising of new automobiles. By law each new automobile must bear a label giving the EPA mileage information. The EPA currently provides an estimated city, combined, and highway mileage figure for each car model, engine, and transmission configuration. The city figure actually corresponds to mixed suburban driving and is the figure emphasized by the EPA as most appropriate for making mileage comparisons. In many cases only the city and highway estimates are advertised, with the former highlighted.

The EPA mileage estimates are typically presented with the cautionary note that they are best used for comparisons, that "actual mileage may vary due to driving speed, weather, and trip length," and that "actual highway mileage will probably be less." However, both the automotive manufacturers and the EPA use the estimates in a manner that would seem to indicate that they represent the mileage the average motorist should expect to obtain. For example, vehicle ranges on a tank full of gasoline are calculated based on the EPA estimated mileage and the government's own mileage bulletin contains a table that calculates annual fuel costs using the EPA mileage estimates (Dept. of Energy, 1980, p. 7).

There are, however, several reasons to be concerned about the usefulness of the EPA ratings as they are presented. The EPA numbers are calculated in a laboratory on a chassis dynamometer, not on the road. The EPA tests are conducted on prototypes, which are submitted by the auto companies for testing. In addition, the EPA may rely on manufacturer reported fuel-economy figures in some cases, not having the resources for complete testing. Most consumers are probably unaware of these factors.

The Consumers Union (CU) has serious concerns about the EPA ratings. The CU states in the April 1980 automotive issues of Consumer Reports:

> Aside from the differences in mileage caused by driving technique, other factors make the mileage estimates by the EPA less than reliable guides to a car's actual mileage (p. 236).

A recent Congressional study concurs with Consumers Union that the EPA tests provide an inadequate measure of the normal on the road performance an average driver can expect. The Chairman of the House Subcommittee producing the report concluded that "individual consumers are being misled by inflated fuel economy claims derived from their government's own test program" (House of Representatives 1980).

Consumers Union conducts its own on-the-road fuel-economy tests for a limited number of models. These results are reported in the April automotive issue of Consumers Reports. They provide mileage figures for driving in heavy downtown traffic, on an expressway at 55 mph, and for a 195 mile trip on a mixture of roads. They also report the gallons of fuel the vehicle would use in 15,000 miles, based on an unweighted average of the mileage under each of the three driving situations. Their experts believe the 15,000 mile figure is "the best number to use for comparing car mileage and should be an important consideration when buying a new car" (Consumer Reports, 1980, p. 229).

The analysis in this study assumes that the EPA ratings form the mileage perception of the consumer prior to purchase and that the CU figures correspond to the actual mileage realized for the average driver. Since there is uncertainty as to precisely how individuals use the EPA information, two comparisons were made. The first compares the unweighted mileage figure stressed by each organization: the EPA estimated city (mixed suburban) figure and the CU mileage figure for the 15,000 mile trip. The second comparison weights both EPA and CU mileage figures by the types of miles driven by the average motorist. Based on government data on vehicle miles by road class, the following weighting factors were used for EPA and CU mpg estimates: (a) EPA: city (suburban) .63, highway .37; (b) CU: city (downtown) .12, expressway .37, 195 mile mixed trip .51 (Dept. of Transportation 1979, p. 48).

These two approaches will be referred to as the unweighted and weighted mpg comparisons. The former simply assumes individuals use the EPA city estimate as their mileage expectation and realize CU's mpg for 15,000 miles in actual use. The latter assumes they use some combination of the city and highway figures, weighted by driving type, to form their mileage expectations. A similar weighting scheme is applied to CU's mpg levels to obtain a realized mileage.

As shown in Table 1, mileage comparisons were made for 44 automobile models, including engine and transmission configuration.[4/] For example, for Car (1), an Audi 4000 with a 1.6 liter engine and 4 speed manual transmission, the EPA city figure was 22 mpg, the CU 15,000 mile mpg 27.5, the weighted EPA figure 26.4 mpg and the weighted CU mpg 29.5. As illustrated by this example, the EPA estimates did not always overstate realized mileage according to Consumers Union tests.

For the 44 vehicles in Table 1 the EPA estimate understates the realized CU mileage in 20 cases, overstates it in 23 cases, and the two figures are equal in one case,for the unweighted figures. The difference between the EPA and CU mileage is greater than 2 mpg for 18 vehicles; the difference is less than 1 mpg for 16 vehicles. The largest difference is 5 mpg. With the weighted figures, the EPA estimate understates the CU mileage in nine cases and overstates it in the remaining 35 cases. With the mileage figures weighted by types of miles driven, the difference is greater than 2 mpg for 26 vehicles; the largest discrepancy is 7.9 mpg.

Calculation of Private Costs

Unexpected savings on gasoline purchases will be incurred if the EPA estimate understates actual mileage and unexpected additional costs will be incurred if the EPA overstates actual mileage, assuming miles driven remain constant. To translate the mileage difference into a monetary value requires making assumptions about the length of operation of the vehicle, the miles driven per year, and the price of fuel. By assuming a discount rate, the present discounted value of the future stream of reduced or increased gasoline expenditures can be derived. Since assumptions about the future must be made, including something so uncertain as the future price of gasoline, the approach of this study was to specify a set of alternative assumptions.

With regard to the time period over which the vehicle is operated, the average length of time a new car is operated before replacement was used. The best estimate available for this period is 3-1/2 years, based on a 1968 study.[5/]

The average miles traveled per private passenger car per year in the U.S. was 10,046 miles in 1978, the latest year for which the data are published (Dept. of Transportation, 1979). In addition, data on yearly travel of all passenger cars as a function of age are available. The average new passenger car, as reported in a 1977 study, is driven 18,000 miles in the first year, 15,100 in the second, 13,400 in the third, and 12,200 in the fourth year (Dept. of Energy, 1977, p. 97). A large part of the reason that mileage is so high in the initial years is that a sizable portion (57 percent) of new vehicles are purchased for business use. The average business vehicle is driven more miles per year and held fewer years than the average household vehicle. Alternative calculations were made based on these two assumptions about annual mileage: a constant 10,046 miles and a declining figure based on age.

With the recent wide fluctuations in interest rates, the choice of a reasonable long-term discount rate was unclear. Therefore, two alternatives were specified: 10 and 12.6 percent. The latter figure was the effective annual yield on a 2-1/2 year plus savings certificate at a commercial bank in mid-April, 1980.

Finally, and perhaps the most difficult to predict was the price of gasoline over the following four years. An average price of $1.27 per gallon for unleaded regular was used as the base gasoline price (National Consumer Finance Association, 1980). The price of unleaded gasoline was used since most new cars require this fuel. Three of the 44 vehicles analyzed used diesel fuel, in which case an average price of $1.14 per gallon was assumed for 1980. Alternative calculations were made assuming price increases of 10, 15, and 20 percent per year. The annual increase in the price of gasoline averaged 16 percent over the five-year period from December 1975 to December 1980 and 35 percent between December 1978 and December 1980 based on the Consumer Price Index.

With these assumptions, alternative estimates of the present value of unexpected gasoline savings or additional expenditures due to the gap between expected and realized miles per gallon can be calculated. This unexpected savings or increase in the operating cost of the vehicle would result in the "true" demand function, based on perfect information, falling to the right or left of that perceived.

For the case in which the EPA underestimated actual mileage, the distance ab in Figure 1 measures the shift in demand from $g_i^o(P,Y;\beta^o)$ to $g_i^*(P,Y;\beta)$ and is equal to the present value of the unexpected reduction in gasoline expenditures. If consumers had perfect mileage information, instead of an underestimate, the retail price of the vehicle could have been raised by $p_i^o p_i^1$ and $0x_i^o$ units would still have been purchased. Alternatively, the present value of unanticipated savings on gasoline can be conceived of as a rebate reducing the purchase price of the vehicle by an equivalent amount.

If the EPA overestimated actual mileage, the distance bd in Figure 2 measures the demand shift from $g_j^o(P,Y;\beta^o)$ to $g_j^*(P,Y;\beta)$ and is equal to the present value of the unexpected increase in gasoline expenditure. In Figure 2, with perfect information instead of an overestimate, the retail price would have to have been reduced by $p_j^o p_j^1$ to sell $0x_j^o$ units. Unanticipated additional gas expenditures can be viewed as a surcharge increasing the purchase price.

As an example, Vehicle (1) in Table 1, the Audi 4000, with an EPA estimate of 22 mpg and CU figure of 27.5, has a present value of unexpected gasoline savings of $639.57 using the declining annual mileage levels, assuming a discount rate of 10 percent and gasoline price increases of 15 percent. A purchaser of this vehicle, who had underestimated mileage by 5.5 mpg, received an unexpected gain of \$640 on the operating costs of this car. Therefore, he or she should have been willing to pay a retail price \$640 higher based on the higher mileage estimate. This study assumes that consumers possess perfect information about all other vehicle characteristics, so that the cost of mpg misinformation can be isolated.

Calculation of Allocative Loss

Whether consumers have positive or negative costs (transfers) associated with misinformation about mpg, they will have misallocated resources by purchasing a non-optimum amount of car. The allocation error as defined by equation (10) is the difference between consumer surplus under the true demand curve and that realized with the initial purchase (x_i^o or x_j^o). In the aggregate it represents the net social welfare loss due to misallocated resources resulting from imperfect information.

Based on the assumption that the EPA mileage ratings represent the information upon which consumer's form preferences for new automobiles and CU mileage estimates represent the mileage realized while using the automobile, welfare losses from misallocated resources due to imperfect mileage information were estimated. In Figures 1 and 2 the net welfare loss triangles abc and adb, respectively, can be computed using geometry and the elasticity formula. Solving the elasticity formula ($\Delta X/\Delta P.P/X$) for ΔX and substituting into the formula for the area of a triangle ($1/2\ \Delta P\ \Delta X$) yields:

$$\text{abc or adb} = \frac{e_p x \Delta p^2}{2p}$$

where e_p is the price elasticity of demand, x is original demand and p is original price. Original demand is Ox_i^o in Figure 1 and Ox_j^o in Figure 2. The original price is Op_i^o and Op_j^o, respectively.

To estimate aggregate allocative losses, data on prices, quantity, and the elasticity of demand were required. Automobile prices were reported in the April 1980 automotive issue of Consumer Reports. The prices utilized in this study were derived by averaging the dealer cost and list price for each automobile with the options CU suggests buying. This averaging was done to reflect the discounting from list price that typically occurs on new automobile sales.

The quantity figures for each of the 44 vehicle types are based on an annualized version of sales reported for the six month period October 1979 through March 1980 (Automotive News, 1979 and 1980). Monthly auto sales are given by major model type for domestic producers and by manufacturer only for foreign producers. Data on sales of foreign cars by model type and both foreign and domestic cars by engine and transmission type were available for 1978 (Ward's Yearbook, 1979). This information was used to weight the 1979-80 sales figures to obtain estimated sales figures for the 44 specific model, engine, and transmission type vehicles studied. For example, Datsun 210's represented 40 percent of all Datsun sales in 1978. Therefore, a weight of .40 was used to obtain Datsun 210 sales as a function of all Datsun sales in 1979-80. In 1978, 41.2 percent of Chevette's were sold with 4 speed manual transmissions and all are equipped with four cylinder engines. Again, this proportion was applied to 1979-80 to get a sales estimate for the specific vehicle for which mileage comparisons were available. General Motors' X-Car (Chevrolet Citation) Series was not produced in 1978. The proportions to apply to various engine and transmission types were, therefore, determined by looking at similar vehicles. The cost estimates developed in this study are for the 1980 model year, assuming a rate of passenger car sales of 9.8 million vehicles.[6/]

Model specific price elasticity estimates would be desirable. However, the overall elasticity of demand for automobiles was the best approximation available. Because of the possibility of substitution between models the specific elasticities would probably be greater than the aggregate estimate. Previous aggregate estimates of e_p have ranged from -.601 to -1.0 by Chow (1960, p. 160), to -1.35 by Weiserbs (Phlips, 1974, p. 195), with Houthakker & Taylor (1966) estimating approximately -.92, and Sexauer (1977) finding -1.05. Based on all these studies, the most reasonable estimate of a price elasticity for automobiles was deemed to be -1.00.

EMPIRICAL RESULTS

Cost Estimates

The present value of the allocative loss and private (transfer) costs for individual vehicle types are presented on Table 2. The estimates assume a 15 percent gasoline price increase, a 10 percent discount rate, and declining annual mileage figures. The mpg comparison is between the unweighted EPA estimated city figure and the unweighted CU 15,000 mile trip mileage estimate. The allocative loss and transfer on Car Model (43), the Chevrolet Impala, are zero since the EPA and CU mpg estimates are equal. For 23 car model types the transfer is from consumers to producers, since the EPA estimate exceeds the CU figure. For 20 others the transfer is from producers to consumers.

The largest transfers from consumers occur on some of the larger less fuel-efficient domestic vehicles. The largest allocative loss was $4.9 million with a transfer to producers of $86.5 million occurring on the Buick Regal, Car Model (26). The discrepancy between the EPA and CU mileage estimate was only three miles per gallon, (18 vs. 15); however, weighting this figure by a large sales figure of 110,664 produced considerable aggregate losses in consumer surplus. The aggregate allocative loss for the 44 model types analyzed was $26.9 million. The transfer to consumers was $408.9 million and to producers $376.0 million, for a net transfer to consumers of $32.9 million.

Positive and negative transfers occur on different vehicles and to different consumers. Since transfers to and from consumers do not cancel each other out, a distributional inequity occurs. Aggregating the transfers by country of origin revealed that for the vehicles listed on Table 2, consumers transferred a net $34,513,118 to manufacturers of American cars. Foreign car manufacturers transferred a net $67,376,436 to American consumers. Two-thirds of this transfer came from Japanese automobile producers. The allocative error of $26.9 million represents a significant social welfare loss due to misinformation, which is not recouped by any market segment.

The car model, engine, and transmission types covered by this analysis accounted for 33.8 percent of the total sales of passenger automobiles during the period covered. If the car models analyzed are assumed to be a representative sample, these results can be extended to the entire market. Based on an extrapolation of these results, the estimated allocative loss and net transfer are three times greater for the entire market; $80.7 million and $98.7 million, respectively.

Table 3 presents estimates for the allocative loss and transfers for the entire automobile market based on various alternatives concerning the price of gasoline, the discount rate, and annual mileage. The costs reported represent the potential impact of the EPA mileage estimates assuming all new car purchasers expected to obtain the EPA figures, but realized the Consumers Union mpg levels. The estimated allocative loss ranges from \$123.9 million to \$30.9 million. The magnitude of the allocative loss is most affected by the assumption regarding annual miles driven: 10,046 miles vs. the age related declining figures, with constant miles giving the smaller losses. Constant miles are probably the most realistic for privately owned cars. Another dramatic result is the sensitivity of the magnitude and direction of the transfer to weighting the mpg estimates by types of miles driven. Alternatives (1) and (2) in Table 3, with the other assumptions held constant, show a net transfer of \$98.7 million to consumers with the unweighted mpg figures and \$2,554.9 million to producers with the weighted mpg figures. This result implies that consumers, on average, would make smaller allocative errors and be more likely to gain consumer surplus if they used the EPA city estimate as their expectation of mpg and did not try to interpolate city and highway EPA figures or otherwise adjust them for personal driving habits.

Survey Results

A survey of individual new automobile buyers was conducted to obtain data on the utilization of the EPA ratings by new car buyers. The results of the survey provide insights into both the importance of the EPA ratings as an information source and how the EPA estimates are used to form expectations. Mail questionnaires were sent to 800 individuals and 440 responses were received. The survey was conducted in Hennepin County, Minnesota in September 1980. Hennepin County contains the city of Minneapolis, its suburbs and some rural outlying areas. Based on the types and quantities of automobiles purchased, the Hennepin County sample was assumed to be reasonably representative of new cars purchased for the following analysis.

In one question the car purchaser was asked to list the most important source of information about gasoline mileage prior to buying the car. The question was open-ended; categories were not listed. Only 7 percent of the respondents listed the EPA ratings as most important. In addition, 6 percent listed advertisements, 13 percent automobile dealers, and 26 percent automobile evaluation reports. Other sources listed were friends and relatives, auto magazines, previous experience, and other owners. The number who directly named the EPA ratings was quite low. However, ads were required to use the EPA figures if they reported fuel-economy. The mileage estimates normally supplied by auto dealers would probably be the EPA figures, which are displayed on the window stickers and in the promotional literature. Therefore, the proportion who used the EPA ratings as their primary source of mileage information was at least 26 percent, and could be as high as 52 percent, if automobile evaluation reports are considered a source of EPA ratings.

The new car buyers in the survey were also asked whether the mileage they were getting in normal driving was better, worse, or the same as they expected when the car was purchased. In the overall sample, 27.5 percent responded worse, 23.4 percent better, and 44.7 the same. Of those who indicated the EPA ratings were their most important information source, 48.5 percent answered worse, 15.2 percent better, and 33.3 percent the same. For those who relied on the EPA ratings, ads, or auto dealers as their major information source, 37.7 percent said worse, 23.7 percent better, and 35.1 percent the same.

The EPA ratings were less reliable than other information sources and led to overestimates of actual mileage far more frequently. Actual use of the EPA figures would appear to produce a substantial net transfer from consumers to producers. These survey results indicate the cost calculations based on the weighted mpg comparison are more realistic in terms of consumer behavior (see Alternative 2, Table 3). The indication is that a substantial proportion of the car buyers did not simply base their mileage expectations on the EPA city estimate, but rather on some weighted combination of the EPA mileage estimates.

Finally, there are important conceptual reasons for arguing the values of the allocative loss and transfer may underestimate the impact on individual consumers. First, the shifts in demand captured in this study are a result only of the monetary gain or loss due to the unanticipated gasoline savings or additional cost. The pleasant surprise of receiving better mileage than expected might have a direct positive psychological impact on consumer satisfaction. The disappointing shock of getting worse mileage could have a direct negative effect.

Second, the loss is understated since the best that could be done empirically was to calculate the loss on each vehicle in isolation. However, a nonoptimal choice on one good produces misallocations on other goods and services through the budget constraint. To the extent that mileage misinformation causes consumers to purchase the wrong vehicle given their preferences, rather than to not purchase one at all, much of the ensuing additional misallocation is within the automotive group. This is a partial rather than a general equilibrium analysis.

In terms of the aggregate allocative losses and transfers reported in Table 3, a caveat is in order. Quantity of automobiles was based on total sales including those purchased by major fleets and other businesses. If business purchasers have better information about mpg than individual consumers, the aggregate numbers in Table 3 can be reduced by 57 percent, the proportion of new cars sold for business purposes (Flanagan 1980). If only 26 percent of individual automobile consumers use the EPA as a most important source of information and they use it in some weighted fashion as the survey indicated, the allocative loss can be reduced to $13.8 million and the net transfer to producers to $284.5 million (Alternative 2, Table 3).[7/] The aggregate losses and transfers calculated assumed every new car buyer used the EPA mpg estimates and obtained the same mpg as CU found in its tests. It appears this may be a reasonable assumption for somewhere between 11 and 22 percent of all new car buyers.

CONCLUSIONS

In this study a theoretical framework was developed whereby the parameters of the utility function were allowed to change as preferences changed with new information. Consequently, a shift in the demand curve lead to changes in consumer surplus which could be positive or negative in terms of private transfer costs, but always resulted in some economic loss due to misallocated resources.

The application of this model to the case of consumer information about gas mileage on new automobiles produced estimates of a net transfer to all American car buyers which ranged from -$2,544.9 million to +$103.8 million depending on the underlying assumptions which were made. The cost to society from misallocated resources ranged from $123.9 million to $30.9 million depending on the same assumptions.

It was found that differences between perceived and realized utility were smaller when consumers used the EPA city mileage rating to form expectations than if the estimates were adjusted according to driving habits. Survey results indicated, however, that consumers tended to weight the EPA number with other information, exacerbating the errors.

Government policy has mandated EPA mileage ratings as important information for automobile consumers. Considerable public resources have been spent testing automobiles to discover their mileage characteristics and to publicize the results. To the extent that the information is unreliable, economic losses are magnified by public funds spent to generate misleading information. On the other hand, the discipline and competition imposed on the industry by standardized, mandatory information should not be underestimated. Even though the numbers may not be completely reliable for an individual consumer's decisionmaking purpose, there is reason to believe their ubiquitous existence has aided the general cause of energy consciousness and conservation.

FOOTNOTES

1/ The move assumes consumers acquire perfect information in one time period through experience with products comprising X^o. In most cases, a whole series of β vectors exist as the consumer's states of knowledge and preferences adjust choices from X^o in a gradual convergence towards X^*.

2/ This is a strong assumption. Three conditions under which it holds are outlined by Samuelson (1942). One of the three that is useful to assume is homoethetic preferences resulting in unitary income elasticities. The practical implication of these assumptions is that the Marshallian and the Hicksian demand curves converge and measures of changes in consumer surplus are identical to measures of compensating variation or equivalent variation.

3/ If x_i is a particular type of automobile $(x_i^* - x_i^o)$ can be thought of as adding more options to x_i, i.e. adding an air conditioner or soundsystem.

4/ Twin or equivalent models are included. Therefore, in Table 1, number 9 includes Mercury Capri, 12 includes Dodge Omni, 15 - Dodge Challenger, 16 - Chevrolet Monza, 28 - Chrysler LeBaron, 29 - Cadillac Seville, 30 - 33 - Buick Skylark, Oldsmobile Omega, Pontiac Phoenix, 34 - 36 - Plymouth Volaire, 37 - Mercury Zephyr, 38 - Ford Granada, Lincoln Versailles, 43 - Chevrolet Caprice, Buick Electra, Buick LeSabre, Oldsmobile Delta 88, Pontiac Catalina and Bonneville.

5/ Conversation with Mr. R. Grehher, Motor Vehicle Manufacturers Association, Detroit, Michigan, April 1980.

6/ The best data on vehicle sales for this type of study would be that which the auto manufacturers must submit to the Department of Transportation under the Corporate Average Fuel Economy regulations. However, this information is not available for public use, since it is considered confidential.

7/ Forty-three percent of consumers buy cars for private use (Flanagan 1980). Therefore, .43 x .26 x \$123.9 million = \$13.8 million and .43 x .26 x-2544.9 million = -284.5 million.

FIGURE 1

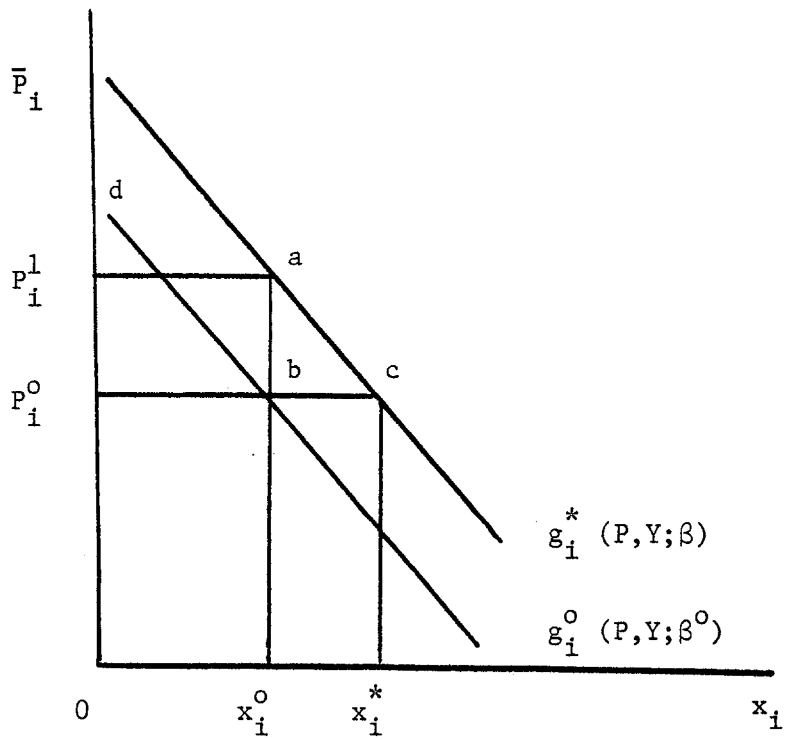

FIGURE 2

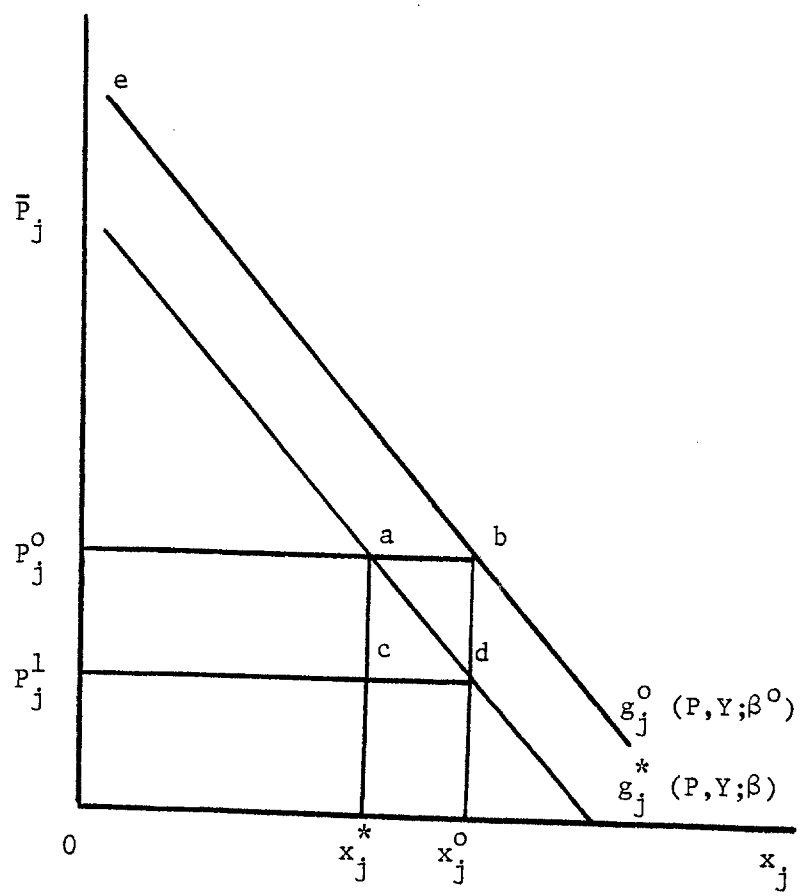

TABLE 1. EPA and Consumer Union Mileage Estimates

	Car Make and Model	Engine and Transmission[a]	Miles Per Gallon (unweighted)		Miles Per Gallon (weighted)	
			EPA	CU	EPA	CU
1.	Audi 4000	1.6L - 4M	22.0	27.5	26.4	29.5
2.	Chevrolet Chevette	1.6L - 4M	26.0	26.3	29.7	28.2
3.	Datsun 200 SX	2L - A	26.0	21.9	29.0	23.9
4.	Datsun 210	1.4L - 5M	31.0	33.7	35.4	36.0
5.	Datsun 310	1.4L - 4M	31.0	30.9	34.7	33.0
6.	Datsun 510	2L - 5M	31.0	31.2	35.4	34.3
7.	Dodge Colt	1.6L - 4M	33.0	31.9	36.7	34.5
8.	Fiat Strada	1.5L - 5M	25.0	30.6	28.7	32.8
9.	Ford Mustang	2.3L - 4M	23.0	22.2	28.6	23.7
10.	Honda Accord	1.8L - 4M	25.0	27.5	27.2	29.3
11.	Honda Civic	1.5L - 5M	36.0	30.9	40.8	32.9
12.	Mazda GLC	1.4L - 5M	30.0	37.5	34.4	40.3
13.	Mazda 626	2L - 5M	24.0	25.4	27.3	27.1
14.	Plymouth Horizon	1.7L - 4M	23.0	29.7	26.7	31.7
15.	Plymouth Sapporo	2.6L - A	22.0	19.6	23.5	20.9
16.	Pontiac Sunbird	2.5L - A	24.0	20.5	27.0	21.6
17.	Suburu	1.6L - 4M	25.0	25.7	28.3	27.3
18.	Toyota Celica	2.2L - A	20.0	19.4	22.2	20.3
19.	Toyota Corrolla	1.6L - A	26.0	22.6	27.8	24.0
20.	Toyota Corr. Tercel	1.5L - 5M	31.0	31.9	35.4	34.2
21.	Toyota Corona	2.2L - 5M	21.0	24.6	25.1	26.3
22.	V.W. Rabbit	D - 5M	42.0	40.5	47.1	43.3
23.	V.W. Scirocco	1.6L - 5M	25.0	30.9	30.6	33.2
24.	AMC Concord	4 - M	22.0	21.4	25.0	22.6
25.	Audi 5000	2.2L - A	17.0	17.5	20.0	18.5
26.	Buick Regal	V6 - A	18.0	15.0	20.6	16.0
27.	Datsun 810	2.4L - 4M	21.0	19.8	23.2	21.6
28.	Dodge Diplomat	V8 - A	15.0	15.6	18.0	16.7
29.	Cadillac Eldorado	D - A	21.0	18.8	24.7	19.9
30.	Chevrolet Citation	4 - A	22.0	22.5	26.8	24.0
31.	" "	6 - M	20.0	22.0	25.2	23.6
32.	" "	4 - M	24.0	26.5	29.2	28.3
33.	" "	6 - A	20.0	21.6	23.7	23.1
34.	Chevrolet Malibu	6 - A	19.0	18.2	21.6	19.2
35.	Chev. Monte Carlo	5L - A	17.0	15.5	19.6	16.6
36.	Dodge Aspen	6 - A	17.0	15.7	20.0	16.6
37.	Ford Fairmont	4 - A	22.0	20.3	25.7	21.8
38.	Mercury Monarch	5L - A	17.0	16.3	20.0	17.5
39.	Mercedes Benz 300	D - A	23.0	22.6	24.5	23.9
40.	Olds. Cutlass Salon	6 - A	20.0	17.6	22.6	18.7
41.	V.W. Dasher	4 - 4M	23.0	26.0	27.4	27.7
42.	Volvo GLE	V6 - A	16.0	14.8	17.8	15.7
43.	Chevrolet Impala	V6 - A	18.0	18.0	21.0	19.2
44.	Mercury Marquis	5L - A	17.0	15.5	19.6	16.5

[a] Symbols: L = liter; 4, 6 or 8 = cylinder; D = diesel engine; A = automatic transmission; 4M = 4 speed manual; 5M = 5 speed manual.

TABLE 2. Estimated Allocative Loss and Transfer by Car Model (in dollars)

	Car Make and Model	Allocative Loss	Transfer: To Consumers (+) To Producers (-)
1.	Audi 4000	388,029	8,645,621
2.	Chevrolet Chevette	16,065	5,048,862
3.	Datsun 200 SX	231,701	-5,351,447
4.	Datsun 210	535,910	26,526,874
5.	Datsun 310	5	-7,432
6.	Datsun 510	260	200,436
7.	Dodge Colt	5,662	-716,311
8.	Fiat Strada	350,366	6,531,167
9.	Ford Mustang	186,547	-18,277,963
10.	Honda Accord	644,366	30,225,268
11.	Honda Civic	396,027	-9,822,680
12.	Mazda GLC	1,500,163	25,268,564
13.	Mazda 626	71,975	4,722,032
14.	Plymouth Horizon	5,522,281	81,630,366
15.	Plymouth Sapporo	140,462	-4,412,206
16.	Pontiac Sunbird	1,612,122	-29,957,228
17.	Suburu	51,408	6,438,746
18.	Toyota Celica	48,069	-5,478,970
19.	Toyota Corrolla	1,710,194	-38,230,783
20.	Toyota Corr. Tercel	63,782	8,268,256
21.	Toyota Corona	425,923	9,209,004
22.	V.W. Rabbit Diesel	4,326	-955,547
23.	V.W.Scirocco	11,104	295,523
24.	AMC Concord	1,403	-198,862
25.	Audi 5000	13,322	2,298,559
26.	Buick Regal	4,972,049	-86,504,826
27.	Datsun 810	28,745	-2,406,789
28.	Dodge Diplomat	235,569	18,151,899
29.	Cadillac Eldorado	38,700	-3,453,040
30.	Chevrolet Citation	54,525	10,281,625
31.	" "	1,104,137	46,267,316
32.	" "	1,238,584	60,016,566
33.	" "	1,099,594	56,548,942
34.	Chevrolet Malibu	418,094	-33,394,620
35.	Chevrolet Monte Carlo	540,440	-18,622,589
36.	Dodge Aspen	1,287,337	-46,960,346
37.	Ford Fairmont	270,039	-11,898,783
38.	Mercury Monarch	150,464	-11,429,573
39.	Mercedes Benz 300	561	-554,702
40.	Olds Cutlass Salon	810,969	-23,331,283
41.	V.W. Dasher	55,701	2,288,440
42.	Volvo GLE	10,990	-733,704
43.	Chevrolet Impala	0	0
44.	Mercury Marquis	634,812	-23,301,064
TOTAL:			
Allocative Loss		26,882,782	
Transfer to Consumers (+)			408,864,066
Transfer to Producers (-)			-376,000,748
Net Transfer			+32,863,318

TABLE 3. Alternative Estimates of Total Allocative Loss and Transfer (in million dollars)

Alternative Number	Gas Price Increase (%)	Discount Rate (%)	Annual Miles	Mileage	Allocative Loss	Transfer to Consumers	Transfer to Producers	Net Transfer: To Consumers (+) or To Producers (-)
1.	15	10	Declining	Unweighted	80.7	1,226.7	1,128.0	+ 98.7
2.	15	10	Declining	Weighted	123.9	307.2	2,852.1	-2,544.9
3.	15	10	Constant	Unweighted	36.6	825.0	758.7	+ 66.3
4.	15	10	Constant	Weighted	56.1	206.7	1,918.5	-1,711.8
5.	15	12.6	Declining	Unweighted	76.2	1,193.4	1,097.4	+ 96.0
6.	10	12.6	Declining	Weighted	105.9	284.4	2,640.3	-2,355.9
7.	10	12.6	Constant	Unweighted	30.9	756.6	695.7	+ 60.9
8.	20	10	Declining	Unweighted	89.4	1,291.5	1,187.7	+ 103.8

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