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This paper represents an abridgement of a report prepared for the U.S. Department of Transportation. The background report contains detailed analysis that was necessarily omitted in this shortened version.

REFERENCES

1. A Study of the Quarterly Demand for Gasoline and Impacts of Alternative Taxes. Data Resources, Inc., Lexington, MA, Dec. 1973.
2. R. G. McGillivray. Gasoline Use by Automobiles. The Urban Institute, Washington, DC, Aug. 1974.
3. B. Burright and J. Enns. Econometric Models of the Demand for Motor Fuel. Rand Corporation, Santa Monica, CA, 1975.
4. The Effect of Automotive Fuel Conservation Measures on Automotive Air Pollution. Charles River Associates, Cambridge, MA, 1975.
5. The Effect of Tax and Regulatory Alternatives on Car Sales and Gasoline Consumption. Chase Econometrics, New York, 1974.
6. J. R. Pucher and J. Rothenberg. Pricing in Urban Transportation: A Survey of Empirical Evidence on the Elasticity of Travel Demand. Center for Transportation Studies, Massachusetts Institute of Technology, Cambridge, 1976.
7. T. Domencich, G. Kraft, and J. P. Valette. Estimation of Urban Passenger Travel Behavior: An Economic Demand Model. HRB, Highway Research Record 238, 1968, pp. 64-78.
8. A. Talvitie. A Direct Demand Model for Downtown Worktrips. Transportation, Vol. 2, No. 2, July 1973, pp. 121-152.
9. L. Moses and H. Williamson. Value of Time, Choice of Mode, and the Subsidy Issue in Urban Transportation. Journal of Political Economy, Vol. 71, June 1963, pp. 247-264.
10. H. Fulkerson. A Direct Demand Model of Work Trips in Louisville, Kentucky. Transportation Systems Division, Massachusetts Institute of Technology, Cambridge, 1975.
11. T. A. Domencich and D. McFadden. Urban Travel Demand: A Behavioral Analysis. American Elsevier-North Holland, New York, 1975.
12. M. E. Ben-Akiva and T. Adler. A Joint Frequency, Destination, and Modal Choice Model for Shopping Trips. Department of Civil Engineering, Massachusetts Institute of Technology, Cambridge, 1975.
13. T. Atherton, J. H. Suhrbier, and W. A. Jessiman; Cambridge Systematics. The Use of Disaggregate Travel Demand Models to Analyze Carpooling Policy Incentives. Federal Energy Administration, Draft Rept., Oct. 1975.
14. D. McFadden. The Measurement of Urban Travel Demand. Journal of Public Economics, Vol. 3, 1974, pp. 303-328.
15. Economic Analysis of Policies for Controlling Automotive Air Pollution in the Los Angeles Region. Charles River Associates, Cambridge, MA, 1975.
16. S. L. Warner. Stochastic Choice of Mode in Urban Travel: A Study in Binary Choice. Northwestern Univ. Press, Chicago, 1962.
17. T. E. Lisco. The Value of Commuters' Travel Time. Univ. of Chicago, Ph.D. thesis, 1967.
18. C. A. Lave. Modal Choice in Urban Transportation. Stanford Univ., Stanford, CA, Ph.D. thesis, 1968.
19. R. G. McGillivray. Binary Choice of Transport Mode in the San Francisco Bay Area. Univ. of California, Ph.D. thesis, 1969.
20. Regional Plan Association. Financing Public Transportation. Regional Plan News, March 1976.
21. R. Kirby. Road User Charges: Some Practical Considerations. The Urban Institute, Washington, DC, Paper 1212-5, 1974.
22. D. Kulash. Parking Taxes for Congestion Relief: A Survey of Related Experience. The Urban Institute, Washington, DC, Paper 1212-1, 1974.

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Abridgment

Gasoline Rationing Based on Licensed Drivers or Vehicles: Potential for Coupon Sales Between Income Groups in Michigan

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In a proposed standby gasoline rationing plan released for public comment in June 1978, the U.S. Department of Energy (DOE) proposed that the unit of allocation for gasoline be registered vehicles rather than licensed drivers. It was asserted that this would make rationing quicker to implement and be a more realistic response to existing use than driver-based allocation (1). The plan also emphasized the value of a "white market" for the unrestricted exchange of rationing rights at uncontrolled prices. The vehicle-based allocation and white-market proposals raise controversial questions about the impact of rationing on different income groups. These questions can only be addressed by using detailed data on the trip-making characteristics of drivers and vehicles. This paper summarizes analyses of a micro-data base on vehicle ownership and use to compare the impact of rationing on Michigan drivers grouped by location, income, and vehicle size.

ORIGIN OF THE DATA

The data base, known as the Michigan driving experience survey (MDES), was created to investigate public policy issues in driver and vehicle licensing, traffic safety, driver behavior, and energy conservation. It is based on 7581 interviews of applicants for renewal of driver's licenses, which were conducted throughout the state during 1976. It used a controlled selection procedure to randomly select 30 sites and, because of the paucity of rural trip-making data, rural areas were deliberately oversampled. Within the sites, a random number system was used to select seven or eight interviewees per office per week. Overall, this provided an excellent random sample of the Michigan driver population and a very high response rate. Note, however, that drivers under the age of 19 are not included because they are not old enough to have reached first renewal.

The interviews were conducted by the managers of the local license offices. The emphasis of the survey was on the careful reconstruction of a recent trip day (usually the previous day) and on the complete set of vehicles to which the respondent had access, together with basic socioeconomic information on the respondent and his or her household.

THE STANDBY RATIONING PROPOSAL

The 1978 standby rationing plan provided for a fixed allocation of gasoline to all registered vehicles. All privately owned vehicles under 4535 kg (10 000 lb) would receive an allocation based on the national average consumption for an automobile [estimated to be 2830 L/year (748 gal/year) (1)], less a percentage necessary to respond to the predicted shortfall in supply. The allocations would be made for periods of about 90 days. Ration rights would be distributed directly to the public, with a small amount of additional rights (perhaps 3 percent of the total) distributed through state government agencies to provide relief for hardship cases. Ration rights could be traded legally at uncontrolled prices, and much is claimed for the value of this white market in the redistribution of income to offset general inflationary effects and benefit poorer households.

Methods

For our purposes, analyses are confined to the 98.7 percent of the respondents who stated that the vehicle they drive most often is a private automobile, van, pickup, or utility.

In order to compare driver- and vehicle-based allocation methods, the detailed respondent trip-making information available in MDES was analyzed together with a surrogate for per-vehicle trip-making, obtained as follows:

$$TV = (TP \times DH/VH) \qquad (1)$$

where

DH = number of drivers in household,
VH = number of vehicles in household,
TP = respondent trip making (km, min), and
TV = vehicle trip making (km, min).

Analyses of trip making were performed by using three subgroupings of the respondents:

1. Income group—self-reported household income;
2. Vehicle size—size of vehicle most often driven, classified from make and model; and
3. Location of residence—five strata of counties ranked by population density.

In the analysis of costs, white-market cash exchanges are, of course, subject to widely differing assumptions. However, because the value of the MDES data is in providing trip-making data, some simplistic scenarios are postulated to examine the distributional effects of a hypothetical 25 percent shortfall in gasoline supply. Costs are estimated here on the artificial basis that, if all drivers reduced their travel by the same percentage as the shortfall (25 percent in this instance), a fixed allocation of gasoline based on a similar reduction in supply would be oversufficient for some and insufficient for others. The average cost in dollars per month is calculated by the formula

$$\text{Dollars per month} = [(KMD \times 0.75) - KMR] \times (365/12) \times [WM/(KM/L)] \qquad (2)$$

where

KMD = kilometers per day (per driver or vehicle),
KM/L = kilometers per liter of vehicle used,
KMR = kilometers allowed by ration, and
WM = white market cost per liter.

For analyses by vehicle size, KMR is adjusted to the average fuel economy of the vehicle class analyzed, and KM/L is set to that figure. The fuel economy constants are mostly based on U.S. Department of Transportation (DOT) standards for 1972 vehicles (2), and range from 9.35 km/L (22 miles/gal) for subcompacts to 4.68 km/L (11 miles/gal) for vans and pickups. (The median year of vehicles in the survey is 1972.)

The formula used for KMR is

$$KMR = [\overline{KMD} \times 0.75 \times (KM/L)]/(\overline{KM/L}) \qquad (3)$$

where

$\overline{KMD}$ = grand sample mean of kilometers per day (per driver or vehicle),
$\underline{KM/L}$ = kilometers per liter of vehicle used, and
$\overline{KM/L}$ = average kilometers per liter.

For analyses in which vehicle size is not differentiated, the KM/L constant used is the same as that quoted in the DOE plan, namely 5.74 km/L (13.5 miles/gal).

Results

Two fundamental findings of the MDES data are the similarity between income groups in the number of vehicles per driver and the major increase in daily kilometers driven with increasing household income (Table 1). Therefore, the potential for a white market to operate between high- and low-income groups is considerable; it is slightly greater for a per-driver than for a per-vehicle allocation basis. Other analyses showed that about 54 percent of drivers in the top two income groups would have enough gasoline for all of the driving they now do if a 25 percent shortfall occurred, compared to about 78 percent of drivers in the bottom two income groups.

There are also significant differences in the amount of daily travel as a function of the vehicle size most often used. The table below shows that use of smaller automobiles is associated with increased driving, and other MDES analyses have revealed that this effect generally holds true, regardless of the age of the driver. The higher averages for those driving vans and pickups reflect some degree of rural bias in the location of these vehicles, with associated longer trip lengths. The full-sized vehicle class includes luxury automobiles; full-sized vehicles alone have lower average travel (1 km = 0.62 mile).

Vehicle	Average Daily Kilometers per Driver	Number of Respondents Using Size
Automobile		
Subcompact	45.1	644
Compact	43.9	1042
Intermediate	41.6	1327
Full-sized	41.2	2700
Van, recreational vehicle, and pickup	55.2	892
Motorcycle	39.1	16
Truck and bus	182.8	77
Total		6698

The effect of vehicle size on rationing is also influenced by the distribution of vehicle classes within each income group. In general, higher-income groups opt for more large vehicles than do lower-income groups; vans and pickups are a middle-income phenomenon. The popularity of the smallest automobiles, once a higher-income speciality item, is now growing in the lower-income groups.

The cost analyses were performed by using mean daily travel for the various population subgroups. Summaries of the costs to each income group of a 25 percent shortfall and postulation of a 25 percent reduction in travel by all are shown in Figures 1 and 2. Figure 1 examines differences by geographical location; Figure 2 gives results by the vehicle size most often used. Both figures compare the costs on a per-driver basis (upper graph) and a per-household-vehicle basis (lower graph). The hypothetical average coupon price of $0.24 [predicted by the DOT plan (3) for a 20 percent shortfall] is used as the basis for the tentative costs shown. The results for Figure 1 assume that all household vehicles have similar fuel economy.

Table 1. Driver-vehicle ratio and mean daily travel by income group.

Household Income ($000s)	Ratio in Household (Drivers:Vehicles)	Mean Daily Travel: Kilometers per Driver	Mean Daily Travel: Kilometers per Vehicle in Household
Under 5	1.07:1	24.8	27.8
5-10	1.01:1	31.7	32.5
10-15	0.99:1	39.4	41.2
15-25	0.94:1	50.5	50.7
Over 25	0.95:1	63.1	58.6

Note: 1 km = 0.62 mile; respondents who normally drive trucks, buses, or motorcycles are excluded (N = 6605).

Figure 1. Distribution of potential ration coupon exchange costs by income group and residence location for a 25 percent shortfall (truck, bus, and motorcycle users excluded).

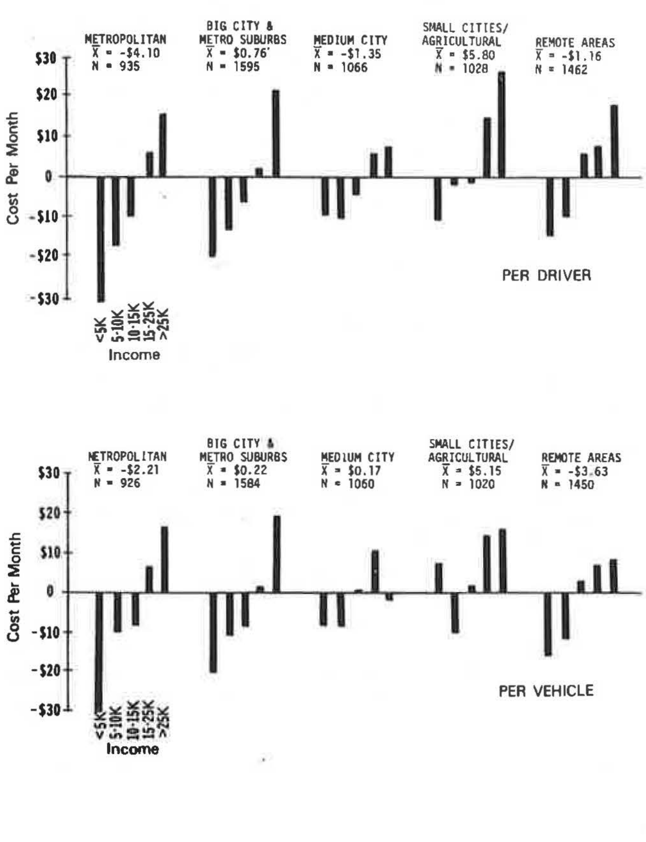


Figure 2. Distribution of potential ration coupon exchange costs by income group and vehicle size most used for a 25 percent shortfall (truck, bus, and motorcycle users excluded).

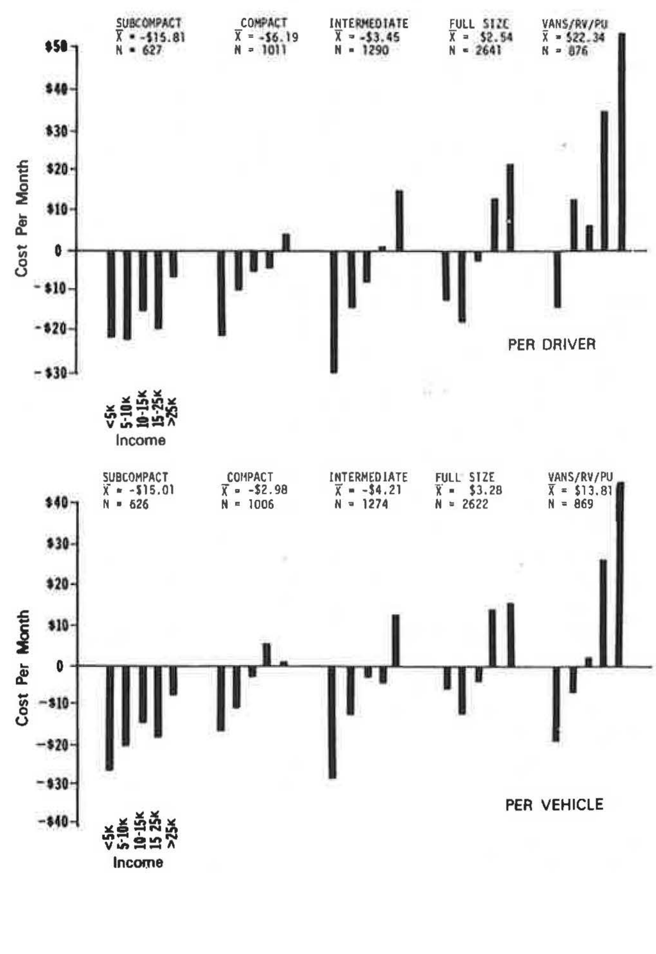
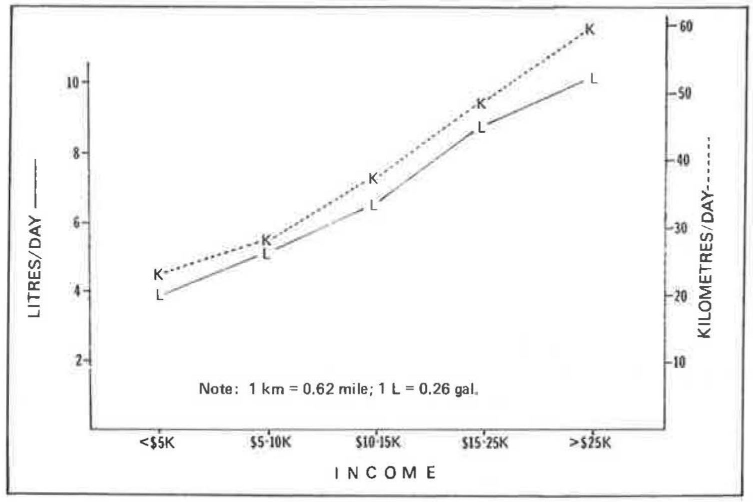


Figure 3. Average gasoline consumption and kilometers driven per day by household income of respondent.



Of major importance are the relative effects of this scenario on different income groups. It is clear from this perspective that the per-vehicle and per-driver schemes are similar in impact. Although this might be expected, given the almost one-to-one ratio of drivers to vehicles in Michigan regardless of income, it is not necessarily true that the amount of driving done is independent of varying driver-per-vehicle configurations found in households.

The differences between geographical locations are of particular interest in that the most remote locations do not seem to carry the penalty of increased driving, which is conventionally assumed. One possible explanation is the concentration of retirees in the more remote parts of Michigan. By far the heaviest average use of gasoline is in the agricultural centers. Metropolitan drivers (Detroit area) would have the highest income potential on a per-person basis and the second highest on a per-vehicle basis. This provides an estimate of the penalty associated with the lower levels of vehicle ownership in metropolitan areas under a per-vehicle rationing plan. However, this study does not reveal anything about those people in central cities and elsewhere who would not appear in the system at all because they have no access to private automobiles.

The data on vehicle size in Figure 2 reveal that those who have the smallest automobiles could be in a positive cash-flow situation in this scenario, regardless of income group. The three lowest-income groups could sell some ration rights; however, those who use larger vehicles do not appear to reduce their driving enough to compensate for the poorer fuel economy. The higher average travel of those who drive vans and pickups shows up clearly, and those in the higher-income groups could spend over $600/year more to maintain 75 percent of their previous driving activity.

A more accurate calculation of gasoline consumption is supported in MDES by the data on vehicles actually driven during the trip days. Figure 3 shows consumption by income group based on the average kilometer-per-liter estimates for the vehicles actually driven. For comparison, the average kilometers driven within each income group is plotted against the right-hand scale. A comparison of the shape of the curves suggests that there is a slight trend for the higher travel of the $25 000+ group to be associated with more fuel-efficient vehicles. Considerably more adaptation to fuel-efficient vehicles by high-kilometer drivers than these analyses reveal will be necessary if this method of gasoline rationing is to encourage conservation. It should be noted that average fuel economy has improved since 1972, the year for which estimates were used and the median year of vehicles in this sample.

CONCLUSION

This is a manipulation of personal travel data to examine who might be able to benefit from a white market in ration rights. It poses the highly improbable, zero-sum, scenario that, under rationing, all drivers would reduce their travel by the same proportion. Taken at face value, it does appear that wealthier vehicle users would be likely to buy available ration rights from the spare capacity of lower-income groups. Before assuming that the operation of such a market contributes to the general welfare, it should be asked whether it is right in a shortage situation to assent to a system that reinforces existing demand patterns. Wealthier people would, in all probability, pay the white-market price; and, at an extra $0.24/L ($0.90/gal), the inhibition of their driving would probably be minimal, given the inelasticity of demand for gasoline. A shortfall situation would seem to be an opportunity to reward conservation more specifically than through a white market. The travel needs of lower-income groups should be examined in more detail to establish the price of inhibited travel in terms of quality of life, not just in terms of (uncertain) cash flow or procrustean ideas of existing nonessential travel demand.

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REFERENCES

1. Proposed Standby Gasoline Rationing Plan. U.S. Department of Energy; Federal Register, Vol. 43, No. 125, June 28, 1978.
2. G. Maring. Highway Travel Forecasts. Office of Highway Planning, Federal Highway Administration, Nov. 1974. NTIS: PB 239 169/6SL.
3. Proposed Standby Gasoline Rationing Plan: Economic and Regulatory Analysis Draft. Office of Regulations and Emergency Planning, U.S. Department of Energy, DOE/ERA 0009, June 1978.

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