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Household Characteristics and the Determinants of Travel Behavior

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Due to the existing energy situation, there is a distinct possibility that motor fuel may be rationed. DOE is currently in the process of developing a standby fuel-rationing plan. Under the proposed plan, motor fuel will be allocated primarily on the basis of vehicle registrations. Fuel will first be allocated to individual states on the basis of current or recent fuel consumption, and the states will then allocate their supplies to consumers in accordance with the number of vehicles registered. How much discretion a particular state will have in developing a final allocation procedure is uncertain at this time.

The purpose of this paper is to present an analysis of household travel characteristics that may aid in the understanding of the reasons for and extent of such travel. Currently, although considerable discussion on how rationing should be accomplished has taken place, much of this discussion has occurred with limited factual data to support the various positions. If some of the data that we already possess becomes more widely known, a more rational discussion and allocation can take place.

The following analysis is based on the 1977-1978 National Personal Transportation Survey, which was conducted for the U.S. Department of Transportation by the U.S. Bureau of the Census. (Some of the figures used may differ from those of the Federal Highway Administration—a result of classifying data by slightly different categories or definitions.) This was the second survey of household travel; the first took place in 1969-1970. The 1977-1978 survey interviewed approximately 18 000 households throughout a 12-month period. Information was collected on household characteristics, each person within the household, all trips taken on the travel day, as well as all trips over 75 miles in length taken during the preceding two-week period, and on each vehicle available for use in the particular household. Although none of the summary findings from this survey has yet been published, a series of reports will be available in the near future.

VEHICLE TRAVEL BY PLACE

People have argued that rural areas should receive more fuel than urban areas, or that suburbanites are more dependent on automobiles than are residents of the central city. Table 1 shows the annual vehicle miles of travel (VMT) per household by area population and the number of vehicles the household owns. Among households owning only one vehicle, there is little variation in the amount of travel, regardless of whether they live in rural areas, small towns, or large cities. In fact, the range in values is less than 1800 miles. It is interesting that the households in the largest cities (with more than 1 million population) travel more than residents of small towns and rural areas.

Although the range in values is slightly higher for two-

and three-vehicle households, the distribution of average annual VMT is also very compact. Regardless of the number of vehicles owned, residents of small towns and rural areas travel less than the average. Since this refutes some commonly held ideas on the subject, a further explanation of the reasons is appropriate.

Vehicle ownership rates are lowest (1.24) in the central cities and the average number of vehicles a household owns is higher (1.71) in rural areas. This factor is the most significant reason for higher fuel consumption outside central city areas. In small towns, the ownership rate is 1.54 and in the suburbs, 1.68. Although the data for 1977-1978 could not be segregated by state or region, previous analysis of the 1969 survey revealed little differences between states and regions after automobile ownership was considered.

Another surprising result is that travel seems to be linearly related to the number of vehicles a household possesses. Two-car households travel a little more than two times, and three-car households three times, as much as one-car households. One might have expected that travel would increase with the number of vehicles owned, but at a decreasing rate. This is true, but the breakpoint exists at a level above three vehicles.

If a rationing scheme seeks to replicate existing travel patterns, a vehicle registration plan would probably be the least disruptive. However, a plan that allocates fuel on the basis of registered vehicles may encourage households to obtain additional vehicles. Evidence suggests that, once a household obtains an added vehicle, it is used. Thus, such a plan might encourage travel behavior that is contrary to the national goal of fuel conservation. Also, it might have disruptive effects on central-city neighborhoods by fostering additional car ownership.

VEHICLE OWNERSHIP

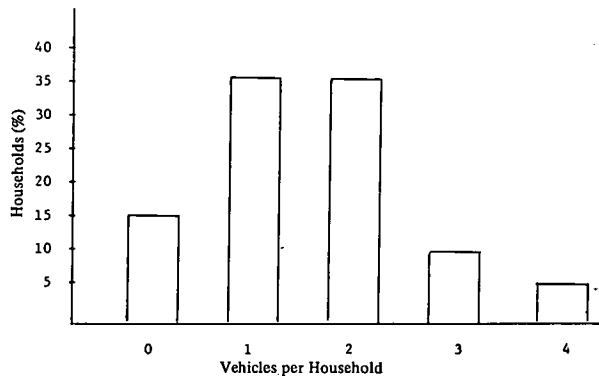
On average, there are 1.5 vehicles per household. The distribution of households by number of vehicles owned is shown in Figure 1. There are almost as many two-vehicle households as there are one-vehicle households. Approximately 85 percent of the households owns at least one vehicle. The number of households owning three or more vehicles exceeds 15 percent of the total households.

The extraordinary number of multivehicle households will have some important implications concerning allocating fuel on the basis of registered vehicles. Almost 16 percent of households has more vehicles than drivers. This relation, as well as the percentage of households with matching drivers and vehicles, is indicated by these data: households without licensed drivers, 13 percent; more licensed drivers than vehicles, 19 percent; equal number of licensed drivers and vehicles, 52 percent; and more vehicles than licensed

Table 1. Annual VMT per household based on area population and number of vehicles owned.

Area	Population (000s)	Number of Vehicles			
		1	2	3	>4
Rural	<5	8 260	17 618	25 071	35 157
Small town	5-50	8 119	17 083	25 787	31 629
City	50-100	17 723	36 277	51 762	65 944
	100-250	16 900	35 120	52 110	74 560
	250-500	15 556	35 722	50 529	69 970
	500-1000	16 594	36 826	53 825	70 381
	1000-3000	18 312	36 612	52 169	74 609
	>3000	17 527	36 665	53 453	88 312

Figure 1. Distribution of households according to number of vehicles owned.



drivers, 16 percent. A possible improvement in the existing vehicle registration plan would be a requirement that each vehicle have a matching driver. To do otherwise would reward profligate fuel consumers at a time when energy must be conserved. Such requirements might also discourage households from acquiring excess vehicles simply to obtain additional allotments.

VEHICLE CHARACTERISTICS

The average annual miles a household vehicle was driven is 8677. The following table analyzes this figure according to different vehicle types:

Vehicle Type	Average Annual Miles Driven	Percentage of Total Vehicles
Car	8 678	72.1
Station wagon	9 713	8.4
Van bus	10 412	2.0
Other van	11 152	0.8
Pickup truck	8 708	11.7
Camper	9 270	0.8
Other truck	10 131	1.1
Motorized camper	7 146	0.4
Motorcycle	2 372	2.4
Other	-	0.3

The average miles per vehicle does not vary significantly by vehicle type unless motorcycles are included. It must be remembered that these characteristics are for vehicles that are household based. A significant number of vehicles (15 percent) are public vehicles or are based at businesses and rental agencies. Furthermore, distribution of vehicles by the mileage driven appears to be highest in those categories related to low numbers of miles driven.

DAILY TRIP CHARACTERISTICS

The National Personal Transportation Survey collected data for all trips the household had taken on the travel day. The following table shows the percentage of daily travel for various trip purposes and average car occupancy:

Trip Purpose	Percentage of Total VMT	Average Car Occupancy
Work	34.6	1.47
Shop	9.7	2.17
Family business	16.9	2.14
Recreation	27.7	2.67
Other	11.1	2.47

More than one-third of daily VMT is for work or work-related purposes. The next most prevalent trip purpose is for recreation. It is interesting to note the corresponding car occupancy for the various purposes. The lowest occupancy rate, by far, occurs for the work trip, while the highest occupancy rate is for recreation. These figures were weighted by trip distance. Average occupancy proved to be higher for long trips than for short ones. Although some people view the recreation trip as the target for conserving fuel because most of this travel is discretionary, likewise the work trip can also be considered discretionary. The work trip may be necessary; however, the occupancy rate is so low that many of these trips could be potential candidates for ridesharing.

Besides varying with trip purpose, travel varies on a daily and a monthly basis. This is shown by the following index figures (average = 100): Sunday, 0.94; Monday, 0.87; Tuesday, 0.94; Wednesday, 0.98; Thursday, 0.98; Friday, 1.15; and Saturday, 1.15. On a monthly basis, the index figures are January, 0.87; February, 0.83; March, 1.00; April, 1.05; May, 1.01; June, 1.06; July, 1.07; August, 1.14; September, 1.05; October, 1.04; November, 0.93; and December, 1.00. These figures become more relevant as the possibility nears of restricting travel on one or more days of the week. It should be noted that a ban on travel or a restriction on gasoline sales probably would not reduce travel by the same amounts noted here because some portion of the travel on any given day could be shifted to another day.

Table 2 shows a breakdown of travel by purpose and day. Although almost one-half of the travel occurring on weekends is recreation related, 15 percent of Saturday's and 8 percent of Sunday's travel is also work related.

Person miles of travel for various modes and trip purposes are noted in Table 3. The amount of travel by transit is less than 3 percent of the total. It seems unlikely that improvements in transit will make a significant reduction in energy use. The biggest payoff from an energy standpoint will come from more efficient use of personal vehicles.

HOUSEHOLD CHARACTERISTICS

Analyzing the amount of household travel by mileage increments reveals that an extraordinary amount of travel is accounted for by relatively few households. Table 4 shows the percentage of households and the percentage of travel by varying annual mileage ranges. Less than 16 percent of all households travels more than 25 000 miles/year, yet these households account for more than 45 percent of total vehicle travel. This same phenomenon also exists when one analyzes licensed drivers. The table below shows that only 13 percent of the drivers traveled more than 20 000 miles/year, yet they account for more than 40 percent of the total travel:

Annual VMT	Percentage of Drivers	Percentage of Total Travel
0-4999	33.7	6.3
5000-9999	23.2	15.3
10 000-14 999	20.9	23.2
15 000-19 999	9.1	14.5

Annual VMT	Percentage of Drivers	Percentage of Total Travel
20 000-24 999	5.8	11.9
25 000-29 999	2.4	6.0
>30 000	5.0	22.8

Therefore, households that travel more than 25 000 miles/year and drivers who travel more than 20 000 miles/year are traveling more than three times the average and accounting for 40-45 percent of total travel.

The immediate question that one might ask is, "Who are these high-mileage travelers?" It is difficult to find any one reason why they should travel so much, but some generalized characteristics do emerge. As a group, they report needing their vehicle for work on one or more days each week, much more frequently than the lower-mileage group. More than 40 percent of these drivers report needing their car for work versus 10 percent of lower-mileage drivers. However, only 4.5 percent of this group's travel is for work-related purposes.

The higher-mileage group, on average, travels much more for each trip purpose. The disparity is greatest for work-related and work trips and least for recreation. Thus, it would be misleading to claim that high-mileage households result from work needs or recreation preferences. All that can be said is that work-trip needs are more significant.

Some of the other factors that tend to cause higher levels of travel are longer distances to work, income, age, sex, higher vehicle ownership rates, and greater number of drivers per household. (Sex was found to be an extremely

important variable. Men travel almost twice as much as women even when they are disaggregated by work status. However, because it is unlikely that either sex or age would ever be used as a factor for rationing fuel, further analysis has been omitted.) The income factor is very important because income is closely related to vehicle ownership; once vehicle ownership is considered, the income effect tends to diminish.

Previously, this paper showed how the number of vehicles owned by a household explains travel variations between places. Because the number of vehicles owned is the most important determinant of vehicle travel, average VMT can be classified by vehicles, income, and the number of drivers to see how much additional variation these factors explain. Although annual VMT increases almost linearly with the number of vehicles owned, the average VMT for all drivers within a vehicle class is at most 7 percent more than for the single-driver household in that class. The effect of income is more pronounced. The average VMT for a vehicle class ranges from 16 to 44 percent higher than the lowest income group. A vehicle-based allocation scheme will not discriminate against the poor because for each class of vehicles owned, they drive less than the average. Therefore, they will not have to reduce their travel as much.

Most of the discussion has revolved around vehicle travel rather than fuel consumption. But do lower-income households have fewer fuel-efficient vehicles? Although it is not possible to determine this precisely, one measure of the efficiency of vehicles is their number of cylinders. In this respect, lower-income households have approximately the same proportion of eight-cylinder vehicles, about 4 percent more six-cylinder vehicles, and 3 percent fewer four-cylinder vehicles than the rest of the population. Thus, lower-income households do not significantly differ from everyone else with respect to the vehicles they drive.

Table 2. Percentage of VMT by purpose and day.

Day	Purpose				
	Work	Shopping	Family Business	Recreation	Other
Sunday	8.1	7.2	18.7	48.6	17.4
Monday	48.6	8.1	17.9	18.3	7.1
Tuesday	45.2	8.7	17.6	17.9	10.6
Wednesday	48.2	8.1	17.6	16.8	9.2
Thursday	44.7	8.3	17.6	19.9	9.3
Friday	38.1	9.6	16.1	24.8	11.3
Saturday	15.1	16.5	13.8	43.6	10.9

Table 3. Person miles of travel by purpose and mode.

Mode	Purpose					Total
	Work	Shopping	Family Business	Recreation	Other	
Personal vehicle	87.6	99.1	90.8	95.9	83.2	91.3
Transit	3.0	0.6	6.6	1.3	2.9	2.8
Air	7.5		1.6	2.1	12.7	4.8
Nonmotorized	0.4	0.3	0.6	0.3	0.6	0.4
Other	1.5		0.3	0.4	0.6	0.7

Table 4. Percentage of VMT and households based on VMT range.

Annual VMT	Percentage of Total VMT	Percentage of Total Households	Percentage of Households with Vehicles
0-4999	2.6	32.7	18.7
5000-9999	7.6	14.4	17.3
10 000-14 999	14.6	16.4	19.8
15 000-19 999	14.4	11.3	13.7
20 000-24 999	15.3	9.3	11.3
25 000-29 999	10.9	5.4	6.5
>30 000	34.6	10.5	12.7

EXCEPTIONAL CASES

Much of the discussion concerning fuel rationing has evolved around who should receive supplementary rations based on some form of necessity. This section will shed some light on the subject, but it should not be considered a comprehensive analysis.

The table below indicates the number of vehicles selected by type of ownership and percentage of travel for work:

Type of Ownership	VMT (%)		
	Work	Related	Nonwork
Household	28	6	66
Company	32	30	38
Leased	24	22	54

Households that have use of company vehicles use these vehicles for a substantial amount (38 percent) of nonwork travel. Considering that company vehicles are only used to travel to work a little more than household vehicles, it is only the work-related travel that stands out. In fact, company vehicles are used for business purposes less than one-third of the time (this refers to company vehicles that are based at the household, not at the business site).

A much higher proportion of the individuals who traveled 20 000 miles or more annually reported needing their car for work at least once a week. On average, drivers who use their vehicles for business-related purposes three or more times a week travel 35 percent more than the rest of the population. When this figure is broken down by trip purpose, about two-thirds of this increase is explained by work-related travel. Thus, on average, such individuals travel only 24 percent more than the rest of the population because of work-related reasons. This may be considered an upper bound on supplementary rations for drivers who need their vehicles for work. On the other hand, since their jobs do not require them to travel that much, they could easily

purchase additional fuel on the white market without undue hardship.

SUMMARY

The findings of this paper generally support the vehicle-allocation plan selected by DOE for rationing fuel. Such a plan would allocate fuel in a manner that best replicates existing travel patterns. In that respect, the transfer of income from one group to another would be minimized. The vehicle registration plan would not be biased against the poor. Almost half of the households earning less than \$6000/year do not own cars and, consequently, do not consume fuel. For the low-income households that do have cars, their average travel is less than the overall average for all households owning the same number of vehicles.

There is also no justification for providing supplementary allocations to households who reside in rural or suburban areas. Any differences in their travel are explained by the higher levels of vehicle ownership.

The major drawbacks of a vehicle registration plan are that it aids in preserving the status quo (i.e., 15 percent of the households accounts for 45 percent of the VMT) and encourages households to obtain additional vehicles that, once purchased, are used. In respect to the former drawback, it is unlikely that the trend toward multivehicle families would continue if the price of fuel were unconstrained.

Because 16 percent of all households already has more

vehicles than drivers, limiting allotments to each registered vehicle matched with a specific driver would certainly aid the goals of energy conservation. Furthermore, it would place a ceiling on the number of allotments a household could obtain.

The finding that 15 percent of households is responsible for 45 percent of travel is significant. However, since many of these same households possess more than one vehicle, there does not seem to be a way of restricting their travel more than the lower-mileage households. However, government initiatives should encourage more efficient use of personal travel. Such efforts might encourage people to plan their travel and combine trips, if possible, and to improve their driving habits.

Our extraordinary dependence on private vehicles is vividly illustrated in Table 3. With less than 3 percent of personal travel on transit, it is doubtful that even major expansion of transit service will have a substantial impact on fuel conservation.

This paper has focused on household and travel characteristics that could influence the rationing of fuel. There are many additional factors that also influence travel behavior, such as age, sex, and life-style. In fact, the elements that influence how, when, and where a person travels are so numerous that it would be naive for government officials to declare that one is essential and another is not. A rationing plan that enables the individual to decide what portion of his or her travel must be reduced would be the preferable plan.

Driver- Versus Vehicle-Based Rationing and the Potential for Coupon Sales Between Different Income Groups in Michigan

Martin E. H. Lee

In June 1978, DOE released a proposed standby gasoline-rationing plan for public comment, which replaced an earlier plan. Both plans were prepared in response to the Energy Policy and Conservation Act of 1975. The primary difference between the two plans is the use of registered vehicles rather than licensed drivers as the unit of allocation for gasoline. It was asserted that this would make rationing quicker to implement and be a more realistic response to existing use than a driver-based allocation. The recent plan also emphasized the value of a white market for the unrestricted exchange of rationing rights at uncontrolled prices.

In subsequent federal legislation in November 1979, Congress renewed the President's authority to impose rationing and, in 1980, specified congressional review of standby plans. A revised standby plan was released by DOE for comment in December 1979. The main differences between this plan and that released in 1978 are an increased role for the states in resolving priority use and hardship problems and a proposal to allow the federal government to intervene in the coupon market to control the number of coupons in circulation. The vehicle-based allocation and white-market proposals together raise controversial questions about the impact of rationing on different income groups. However, to investigate distribution-related questions, it is necessary to have detailed data on the trip-making characteristics of drivers and vehicles.

SURVEY AND DATA BASE DESCRIPTION

The Michigan Driving Experience Survey (MDES), a micro data base on vehicle ownership and use, was built from 7581 personal interviews of driver's license renewal applicants

conducted throughout Michigan during 1976. It used a controlled selection procedure for random selection of sites within two dimensions—level of urbanization and gasoline sales per capita (the latter was the only indicator available of gross personal travel activity). Because of the scarcity of rural trip-making data, the rural areas were deliberately oversampled. All data are capable of being weighted to compensate both for sampling rates and for variations owing to the day of week of the interview and the level of nonresponse. Overall response was very high—85 percent of those asked to participate. The number (7581) of usable interview forms represents 72 percent of the number of interviews predicted from the workload of the 30 local driver's license bureaus selected for the survey. The difference between the two percentages primarily represents some continuity gaps inevitable in the conduct of a decentralized survey operating over an entire year.

Within the 30 sites, a random number system—beyond the control of the employees—was used to select seven or eight interviewees per office per week from among all driver's license renewal applicants. Because the system used a meaningless sequence number that became a transaction identifier in an audit trail, it was possible to verify later that none of the (unannounced) eligible drivers had been missed. Follow-up procedures, which were more time-consuming than an interview done at the time the driver was in the local bureau, helped keep administrative response very high. Overall, this provided a representative sampling of the Michigan driver population, but it must be noted that drivers under the age of 19 are not represented because they are not old enough to be renewing a driver's license.

The interviews were conducted by the managers of the