AUTOMOBILE USE PATTERNS IN NEW YORK CITY AND ITS ENVIRONS

J. David Jordan, Tri-State Transportation Commission

The transit revolution notwithstanding, the automobile will probably be the dominant means of personal transportation in the coming decades. Rates of daily automobile use in the Tri-State region surrounding New York City were related to several projectable variables in an effort to determine whether use would change significantly in the future. Rates of daily automobile trips, mileage, and time per automobile, which were obtained from home-interview survey data, were cross classified according to income, automobiles per household, persons of 16 years or older per household, and density. It was found that automobile use increased with automobiles per household in the low- and middle-income groups but decreased with automobile ownership within the high-income group. It was also apparent that automobile use increased with income and household size and decreased with increasing density. It was concluded, however, that because of the magnitude of these variations in use it is not necessary to incorporate them into the existing trip-forecasting model. A comparison of rates showed that, where use increased with automobiles per household in New York City, the opposite trend held in the surrounding suburbs. Daily automobile utilization in the suburbs was generally twice that in the city; it is recommended that trip forecasts for the 2 subregions be made separately.

THE TRI-STATE region includes the 5 boroughs of New York City and 23 surrounding counties or planning areas. There are more trips made by automobile in this region than by any other mode of travel. This report first describes the characteristics of automobile trips made by the residents of the 3,600 square miles of the intensely developed portion of the region (Fig. 1) and then attempts to explain the variations in automobile trips, mileage, and time per automobile through relationships to income, population density, number of automobiles owned, and persons of driving age per household.

Data for this study were drawn from a 1963 home-interview survey, which consisted of a 1 percent sample of households in the intensely developed or cordon area. The results of the survey were validated at the county level with secondary source material.

The following numbers provide an overview of automobile ownership and use in the surveyed area.

VEHICLES IN TRI-STATE REGION

In 1963, there were more than 4 million private automobiles in the Tri-State study area where 16.2 million persons resided. Of the 5.3 million households in the area, 39 percent had no automobile, whereas 16.2 percent had 2 automobiles or more available:

Sponsored by Committee on Transportation Forecasting.

Figure 1. Tri-State cordon area.

Automobiles per Household	Households		Automobiles Owned	
	Number	Percent	Number	Percent
0	2,060,000	39.0	0	0
1	2,366,000	44.8	2,366,000	56.5
2	760,000	14.4	1,520,000	36.3
3+	96,000	1.8	301,000	7.2
Total	5,282,000	100.0	4,187,000	100.0

There was an average of about 4 persons per automobile inside the cordon, but this ratio ranged from more than 11 persons per automobile in Manhattan to between 2.5 and 3 persons per automobile in the suburbs.

TRIPS IN TRI-STATE REGION

Of the 29.6 million daily trips made within the intensely developed area of the region each day, more than 64 percent were made by automobile:

Mode	Unlinked Trips	
	Number	Percent
Automobile driver	13,374,000	45.3
Automobile passenger	5,641,000	19.0
Subtotal	19,015,000	64.3
Other modes	10,565,000	35.7
Total	29,580,000	100.0

There were, on the average, 3.19 automobile driver trips for every available automobile per day, and each trip averaged 4.4 airline-miles in length. In addition, for every automobile available, automobile driver-miles averaged 14.05, and automobile driver-minutes averaged 59.02.

These averages are characteristic when all the households in the cordon area are considered. However, in the subsequent sections on cross-classification analysis, only households with automobiles are considered and their corresponding averages are slightly lower. This was because about 120,000 automobile driver trips (0.9 percent of total) originated in households that did not have a private automobile available and could not be included because all the rates under study involved automobiles in the denominator. These trips were probably made with borrowed or rented vehicles.

OUTLINE OF ANALYTIC APPROACH

Three rates expressing characteristics of automobile use were examined in some detail.

1. Automobile driver trips per automobile—For any given area or grouping, the weighted average was derived as follows:

$$U = \frac{\Sigma \text{ automobile driver trips per day}}{\Sigma \text{ automobiles owned}}$$

2. Automobile driver-miles per automobile—Automobile driver-miles for a given trip was the straight-line distance between the origin and destination. For a given area or class, the following formula was used:

$$L = \frac{\Sigma \text{ automobile driver airline-miles per day}}{\Sigma \text{ automobiles owned}}$$

3. Automobile driver-minutes per automobile—Automobile driver-minutes for a given trip were minutes spent in the vehicle (exclusive of time spent walking) as reported by the driver. For a given area or class, the following formula was used:

$$T = \frac{\Sigma \text{ net automobile driver minutes per day}}{\Sigma \text{ automobiles owned}}$$

Variations in each of these rates were studied in the light of variations in the following discrete variables:

1. Median household income, I;
2. Automobiles available per household, A/HH;
3. Persons aged 16 years or older per household, P16+/HH (this was the best approximation available for those in the household eligible to drive); and
4. Density in terms of persons for each residential square mile, RD.

The effect of density on the rates was examined only perfunctorily for cross-classified data because the correct density for each group was not available and county density was used as an approximation. The effects of high density and an extensive transit system on automobile use were derived, however, through the comparison of the relationships in New York City data with those outside the city.

Two methods of analysis were applied to the data: (a) regression and correlation, and (b) cross classification. The first was applied cursorily to gain some perspective

of the strength of the association among the variables. The second method was pursued in greater detail and was reported in the following sequence:

1. The effects of income, automobile ownership, and potential drivers per household on automobile driver trips per automobile;
2. The effects of the same 3 independent variables on automobile driver-miles per automobile;
3. The effects of the same variables on automobile driver-minutes per automobile; and
4. Automobile use in New York City, in which the same approach was generally followed as in the first 3 steps, with New York City data contrasted with data from the area remaining within the cordon.

REGRESSION ANALYSIS

The study area was divided into 158 districts and an analysis of correlation was performed on household data aggregated to the district level. The dependent variable, automobile driver trips per automobile, showed significant linear correlation with each of two of the 4 independent variables, automobiles per household and the logarithm of density. The 2 variables were highway intercorrelated (R = 0.96) however; and automobiles per household emerged as by far the more significant explainer of variance in automobile use. The additional explained variance on adding density as the second independent variable was only 0.1 percent. In fact, automobile ownership emerged as the dominant explanatory variable when all 4 independent variables were regressed against automobile use, as shown in the following where automobile driver trips per automobile, U, is the dependent variable:

Independent Variables	Simple Correlation Coefficient	Multiple Correlation Coefficient	Beta Coefficient
A/HH	(+)0.85	0.86	0.739
log RD	(-)0.82		0.141
	(+)0.57		0.098
P16+/HH	(+)0.56		0.078

In the multiple regression analysis, income in any combination with automobile ownership showed an implied decreasing rate of automobile use with increasing income. This rather illogical trend cast doubt on the usefulness of the equation and led to the consideration of methods of analysis more suited to the discrete nature of the income variable. The results of the regression analysis also led to the belief that some of the relationships were nonlinear and would, therefore, be better analyzed by a method without linearity restrictions.

The relationship between automobile use and automobile ownership was further explored through a stratification of districts into those with net population densities of 25,000 or more and those that were less dense.

Least square lines and their associated correlations were derived within each of the density groups. The high-density group showed a slightly stronger relationship between use and ownership than had the unstratified data, but the low-density group displayed an insignificant correlation. The results of this analysis of automobile driver trips per automobile available versus automobiles per household are as follows:

Group	Density	N	R	Mean U	Mean A/HH
Unstratified	All	158	0.85	3.17	1.03
Group I	RD $\geq$ 25,000	60	0.88	2.20	0.59
Group II	RD < 25,000	98	0.19	3.76	1.30

According to these results, automobile use increased up to a district ownership level of about 1 automobile per household and then leveled off to a use rate of between 3.5 and 4.0 trips per automobile per day (Fig. 2.)

Stratification according to density had much the same effect on the relationship of each of the independent variables to the dependent variable. The high-density group showed correlation comparable to those for the unstratified data, whereas the low-density group revealed insignificant relationships. This indicated that automobile use in suburban areas varied within a small range regardless of variations in automobile ownership, density, income, or potential drivers per household. It was recognized, however, that aggregation of data to the district level tended to obliterate much of the variation in the quantities under consideration. For example, it was impossible to describe characteristics of households owning 2 and 3 automobiles, because no district had that high an average automobile ownership. The aggregation effect and linearity restrictions involved in the regression approach led to further exploration of the data through cross-classification analysis.

CROSS-CLASSIFICATION ANALYSIS

The household is where most trips originate. This method of analysis assumed that automobile-owning households with similar social and economic characteristics would use their vehicles in a similar manner. The method was used in a descriptive role only; no measures of statistical significance were derived. An analysis of variance approach would have added more processing and computation than was warranted for a study of this scale.

Household data were cross classified within county, in 3 dimensions, as follows:

Median Income ($)	Automobile Owned Per Household	Potential Drivers Aged 16 or Over Per Household
Low, 0 to 3,999	1	1
Medium, 4,000 to 9,999	2	2
High, 10,000 and more	3+	3+

Thus, for each of the 22 counties within the cordon area, there were 3 matrices of automobile use rates: one each for trips per automobile, miles per automobile, and

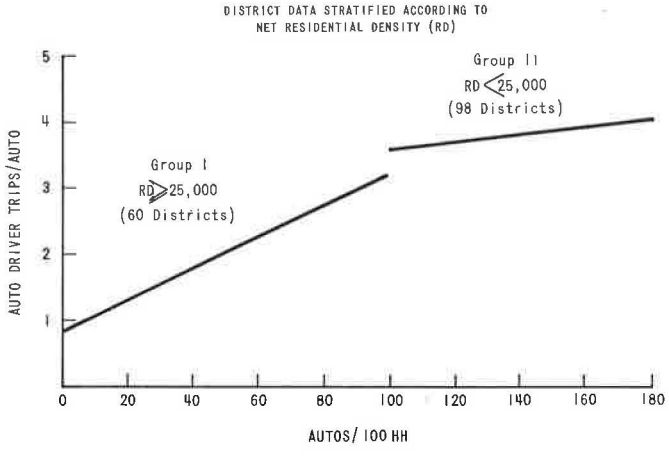

Figure 2. Automobile use related to automobile ownership.

minutes per automobile. Each matrix had 27 elements; for example, the first element would contain the weighted average automobile use rate for low income. households having 1 automobile, 1 resident aged 16 years old or older. The disadvantage at the county level was the insufficient sample sizes in many classes. For this reason, most of the analyses were conducted for the entire cordon area. The criteria for sufficiency were a minimum of 10 interviews. Samples were then inadequate in unusual classes, for example, where automobiles exceeded potential drivers in a household or where there were 3 or more automobiles per household in the low-income group.

AUTOMOBILE DRIVER TRIPS PER AUTOMOBILE

Automobile usage was defined by the number of automobile driver trips made by the residents of an area for each private automobile at the household:

$$U = \frac{\Sigma \text{ automobile driver trips per day}}{\Sigma \text{ private automobiles available}}$$

where U was 3.2 trips per automobile for the cordon area.

Effect of Automobile Ownership

Automobile ownership was expressed in 3 categories: households owning 1, 2, or 3 cars or more. When separated according to these categories, automobile use revealed a nonlinear relationship with automobile ownership (Fig. 3a). The average number of automobile trips per automobile was 3.17. Thus, the addition of 1 automobile to a household owning one automobile produced an increase in utilization of about 9 percent. The acquisition of a third automobile produced a decrease in use of about the same magnitude. The decrease in U after the second automobile is contrary to the results of the regression analysis described earlier, in which each additional automobile increased use by 2 trips a day. The difference in results can probably be attributed

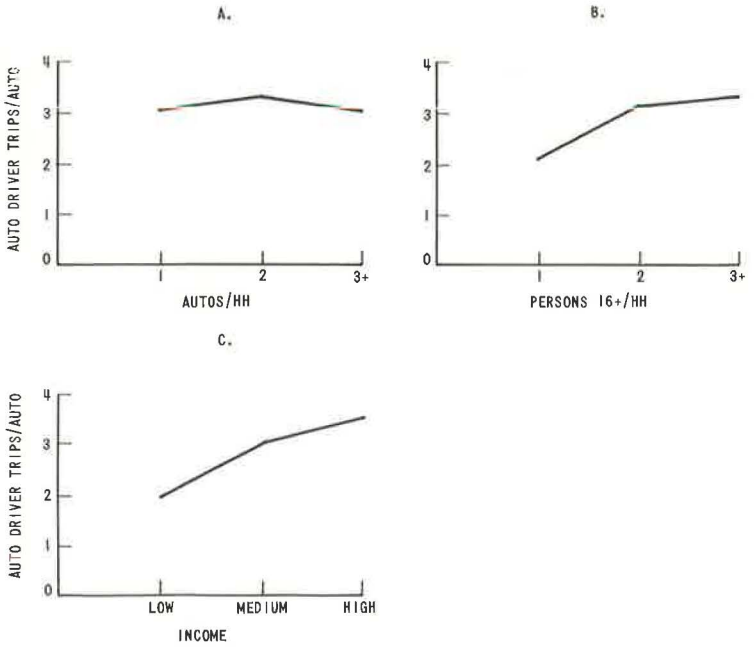

Figure 3. Automobile trips per automobile related to ownership, household size, and income.

to the bias introduced through the use of data compiled to the district level for input to the regression analysis. The highest average automobile ownership within the district was less than 1.75 per household.

Effect of Household Size

Household size was expressed as the number of people aged 16 years old or older in every household. This number should nearly equal the eligible drivers. The addition of 1 potential driver to the household with one driver increased automobile utilization by more than 1 trip. The addition of a third driving member to the household added about a fifth of a trip per automobile (Fig. 3b).

Effect of Income

When automobile use was derived within each of the 3 income classifications, it was found to increase with income. From low to medium income, there was an increase of more than 1 trip per automobile per day; from medium to high income there was a further increase of about half a trip a day per automobile (Fig. 3c). The relationship of automobile use with each of the 3 variables considered was nonlinear; use increased at a faster rate with the first increment than with the second for each of the variables. Although study of the separate effects of each of the variables on use had some value, all variables were found to be acting on use simultaneously, and it was this combined effect that was examined in detail.

Effect of Automobile Ownership, Household Size, and Income

A 3-way classification according to income, automobile ownership, and potential drivers per household produced a 27-element matrix of U-values. Five were eliminated because they contained fewer than 10 interviews, and all represented households where automobiles outnumbered potential drivers. The partial effect on automobile use of each of the 3 stratified variables was examined by changing 1 variable for all possible combinations of the remaining two.

Partial Effect of Household Size

If the income classification is disregarded, the effect of changes in the number of potential drivers on U was quite similar for households with 1 or 2 automobiles (Fig. 4d). Both ownership groups showed an increase of about 1 trip per automobile with the addition of a second driver and an increase of 0.15 to 0.20 trips with the addition of a third driver.

The pattern of variation in U with growing household size was distinct for the low-income group. Where the high- and middle-income use rates leveled off after the second potential driver, that of the low-income group continued to increase (Fig. 4a). This might indicate that people in these more wealthy households became passengers instead of drivers after the second adult; having already approached such a "saturation" level of trips as drivers (3 to 4 trips per day), they simply had little time left for driving. In the case of the low-income households, where U was low (under 2 trips per day), there was still time for the third driver to make a trip. The expense of owning an automobile would probably not be undertaken by a low-income family were the desire for an automobile not acute, and it would probably be used to the limit of the resources available for travel.

Partial Effect of Automobile Ownership

The effect on U of varying automobile ownership was quite small overall, but increased significantly within income class. The trend in automobile use was distinct for each of the groups; use increased with increase in number of automobiles in the low-income group and decreased with increasing number of automobiles in the high-income group (Fig. 5d). Automobile use rates were most dissimilar by income group for households owning only 1 automobile, and automobile use by the high-income group

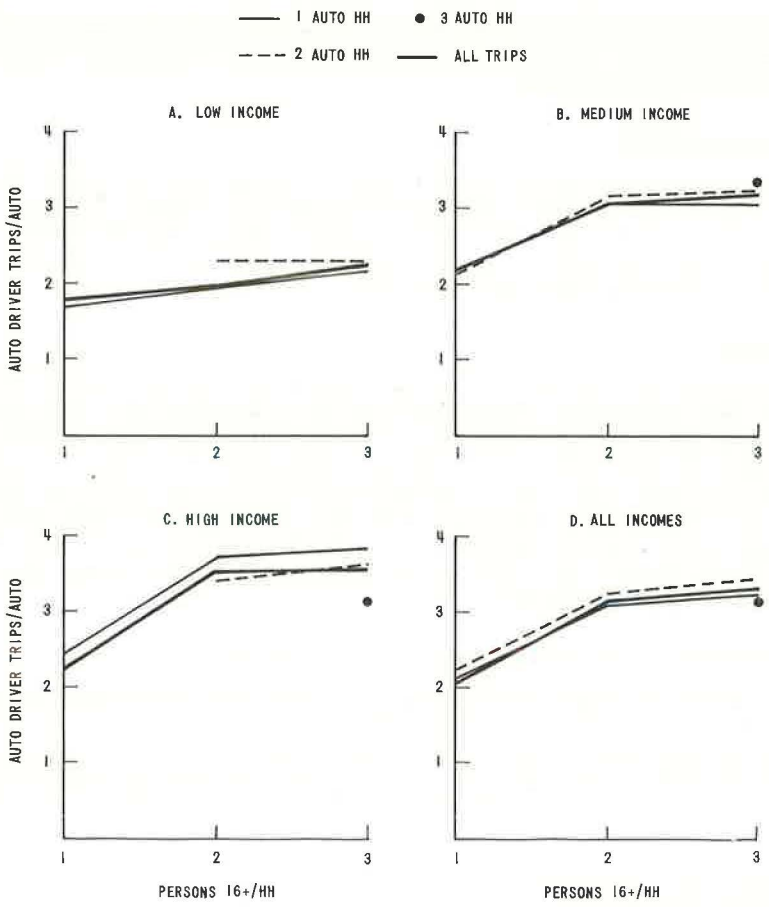

Figure 4. Automobile trips per automobile and potential drivers per household.

was almost twice that of automobile use by the low-income group. For households that owned 3 automobiles or more, the use rates were within 5 percent of one another for all income groups.

Once again, the results seemed to imply that as long as U was less than about 3 to 4 trips per day, the second and third automobiles would be used as much or more than the first. When that rate was reached, the additional automobile was used at the same or lesser rate than the first. The only exceptions to this were the supersaturated groups that had more automobiles than potential drivers.

Effect of Density

With stratified household data, it was not possible to obtain population densities because there was no way to assemble land area for each socioeconomic level. A rough approximation of the effect of density was attempted by assuming that the average county net population density would prevail regardless of the economic level of the segment under consideration.

Trip rates per automobile were related to net density according to income level, controlling automobile ownership, and household size. Taking the most populous sector—2-person households with 1 automobile—a fair correlation was obtained between U and the logarithm of density with each income stratum (Fig. 6). The higher the income level was, the faster U decreased with increasing density, although the percentage rate

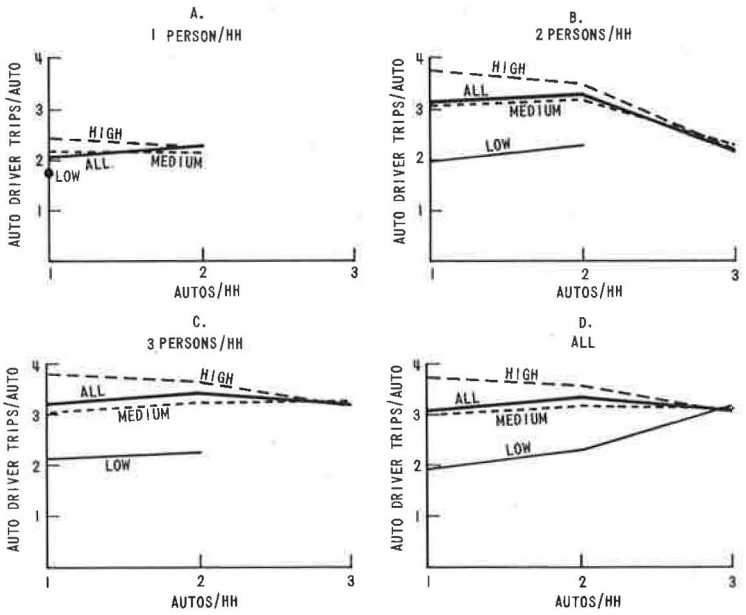

Figure 5. Automobile trips per automobile and automobile ownership.

of decrease in U was about the same in each income group. U varied with income most in the outlying counties and progressively less toward the central area. For automobile trips per automobile by households having 1 automobile and 2 persons aged 16 and over, the results were as follows:

Income	Density		
	Low	Medium	High
Low	2.90	2.28	1.21
Medium	4.59	3.54	1.72
High	5.83	4.56	2.37

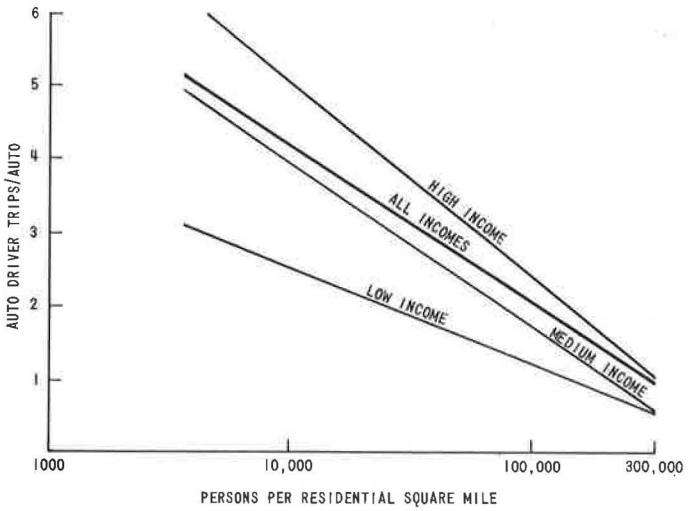

Figure 6. Automobile trips per automobile and density.

TRIP LENGTH—DISTANCE

The average airline-miles driven per automobile owned was computed for each group in the matrix:

$$L = \frac{\Sigma \text{ automobile driver-miles}}{\Sigma \text{ automobiles}}$$

where L is the mileage per automobile per weekday.

The average L for the cordon area was about 14 miles. Among the subcategories, L ranged from about 6.9 miles (1 person, 1 automobile, low income) to 16.8 miles per automobile (3 persons, 2 automobiles, high income). In general, changes in the independent variables caused automobile mileage to vary in much the same manner as the trip rate per automobile (compare Fig. 7 with Fig. 3); there was little variation in average trip length.

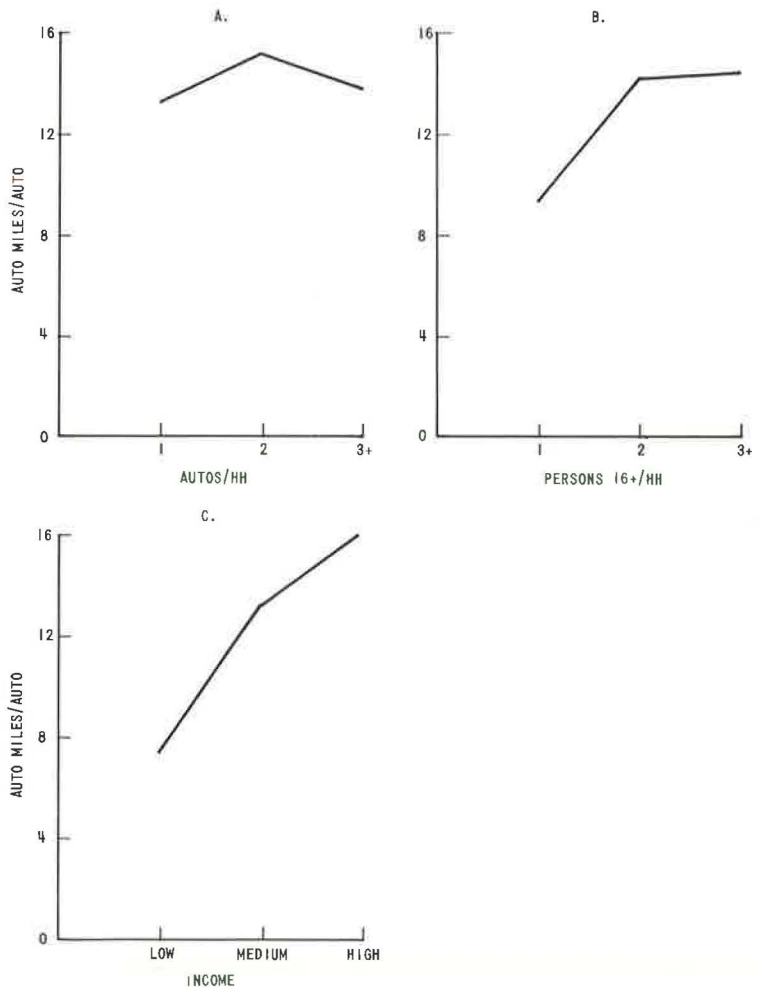

Figure 7. Automobile miles per automobile related to ownership, household size, and income.

Automobile Ownership

The second automobile acquired caused an increase in mileage for each automobile of about 14 percent (Fig. 7a). The third automobile brought the mileage down by about 9 percent. This meant an increase in trip length (airline-miles per trip) from 4.3 miles for households with 1 automobile to 4.5 miles for households with 2 and 3 automobiles, which was a difference of less than 5 percent.

The slightly unexpected phenomenon of increasing mileage per automobile with increasing automobile ownership was also found in Chicago, where households with 2 or more automobiles averaged 12.4 miles per automobile compared to 11.6 miles for households with 1 automobile (2). The increased use was most evident in the 3 densely populated central rings.

Another study conducted by the state of Illinois found that households with 1 automobile averaged 9,900 miles per automobile per year compared with 10,000 miles for households with more than 1 automobile (3). A national study of vehicle use showed that households with more than 1 automobile averaged 9,300 miles per automobile per year compared to 8,900 miles for households with 1 automobile (3).

Of the studies mentioned, only the Tri-State data displayed an increase in mileage per car of more than 10 percent in the transition by households from 1 to more than 1 automobile. The greatest increase was observed within Tri-State's low-income group and Chicago's inner rings, both of which had mileages well below their respective area-wide averages for households with 1 automobile and moved closer to the area-wide averages for households with 2 automobiles.

Work-Trip Length

There was some evidence to support the contention that the second (probably the newer) automobile was driven farther to work than the first. Seventeen of 22 counties in the cordon area had a longer automobile driver work-trip length for households with 2 automobiles than for households with 1 automobile. The cordon area average for households with 2 automobiles was 6.0 compared to 5.6 airline-miles for households with 1 automobile. Whether the 7 percent difference in trip length was statistically significant was not determined. Average trip lengths for trips bound for other destinations showed no such trend.

The transition from 2 to 3 automobiles per household brought a decrease in work-trip length in 15 of the 22 counties; however, the sample of households with 3 automobiles was small. The average work-trip length for households with 3 automobiles was 5.7 airline-miles. It would appear possible, then, that the purchase of the second automobile was often tied to the job location being farther away or the new home being farther from the job. Considering the increase in use per automobile discovered earlier, the latter was more likely because the move was probably to a more automobile-oriented community.

Household Size and Income

Similarly, the effects of household size and income on mileage closely paralleled their effects on trips per automobile (Fig. 7). The household with 2 persons 16 years old or older, more likely to be a family unit than a household with 1 person over 16 years old, had more needs and therefore traveled more to satisfy them. The addition of the third adult had little effect on the mileage per car. Household size had no significant effect on trip length (miles per trip).

The low-income group accumulated 7.5 miles per automobile, compared with 13.4 miles per automobile for middle-income residents and 16.1 miles per automobile for the high-income group (Fig. 7c). The latter could afford to take advantage of opportunities that were distant from home and thus accumulated more than twice the mileage per automobile of the low-income group. However, the difference in mileage per automobile driver trip between the 2 extreme income groups was less than 20 percent.

Effect of 3 Independent Variables

Having again cross classified according to automobile ownership, persons 16 years of age and more per household, and income level, we found the combined effect of these variables on mileage per automobile to be similar to their effect on the trip rate per automobile; that is, mileage per trip (trip length) did not vary significantly.

TRIP LENGTH—TIME

The average time each automobile was driven per day was computed for each social or economic group:

$$T = \frac{\Sigma \text{ net automobile driver-minutes}}{\Sigma \text{ automobiles}}$$

where T is the net minutes per automobile per weekday.

The average for the cordon area was 58.4 min, ranging from 35.2 min (2 persons, 2 cars, low income) to 71 min per car (3 persons, 1 car, high income). Trip time per

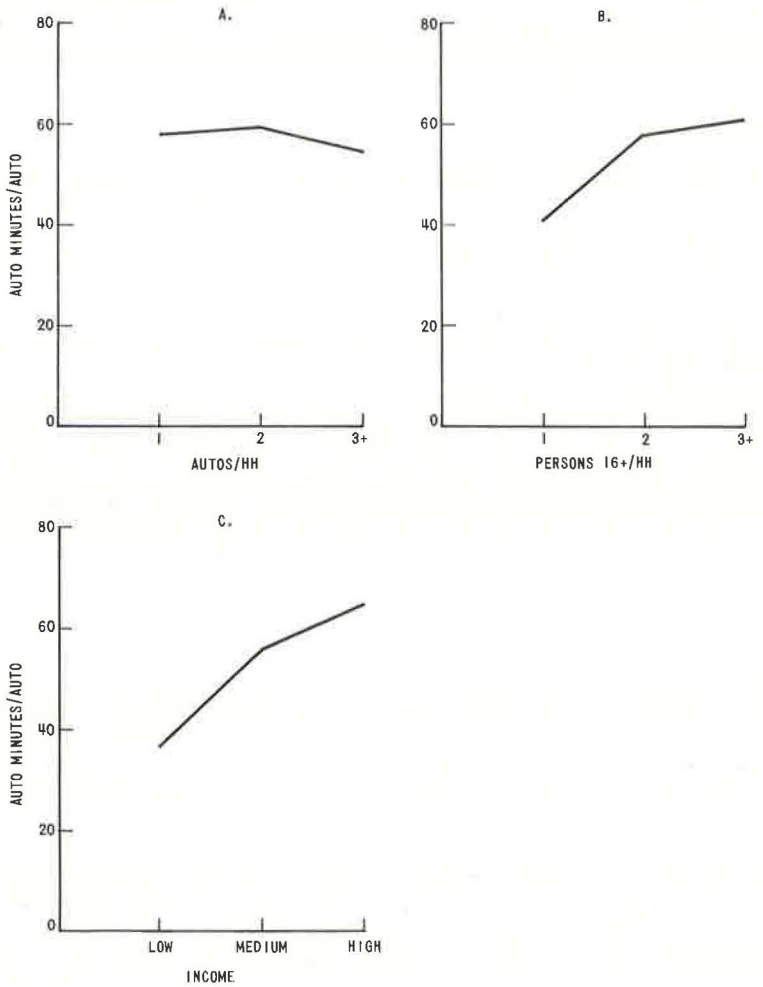

Figure 8. Automobile minutes per automobile related to ownership, household size, and income.

trip (18.4 min for the cordon area) did not vary much, and, in general, the magnitude and direction of changes in T with increments in the independent variables were similar to those for U and L (compare Fig. 8 with Fig. 3).

AUTO USE IN NEW YORK CITY

The average automobile use rate was 1.97 trips per automobile for New York City residents, 3.66 trips for residents of the remainder of the intensely developed area, and 3.17 trips for residents of the study area. This reflected, in part, the lower income level and smaller household size, in general, in the city. In addition, the extensive transit system and the close convenience of shopping and other facilities, along with the high cost of highway congestion and parking, appear in many cases to have kept the rate of automobile use low on weekdays. Thus, about a quarter of the trips by residents of automobile-owning households in the city were by subway and, altogether, 47 percent by modes other than the automobile, compared to only 16 percent in the suburbs.

First, when the independent variables are considered separately, the incremental effects of potential drivers per household and income on automobile use were similar for both New York City residents and nonresidents. Although the initial U was lower in New York City by at least 1 trip, comparable increases in potential drivers or income brought comparable increases in U for city and noncity (Figs. 9b and 9c).

This was not the case where automobile ownership was concerned. Households with 1 automobile in the suburbs generated more than 2 trips per automobile more than those in New York City. The addition of a second automobile caused the automobile use rate to fall to 3.5 trips per day in the suburbs and to rise to 2.3 in the city (Fig. 9a). The third car caused a further decrease to 3.1 trips in the suburbs and a slight decrease to

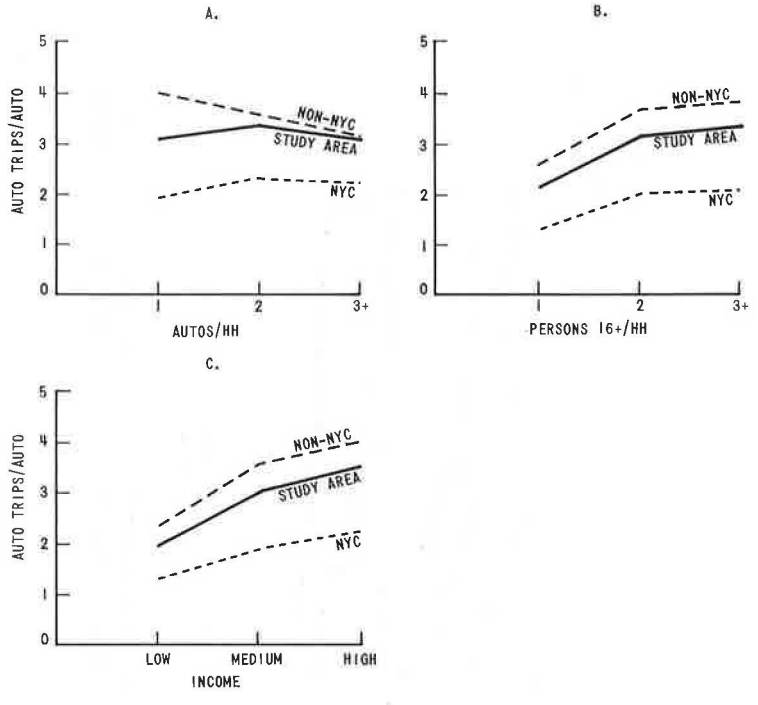

Figure 9. Automobile trips per automobile related to ownership, household size, and income—New York City comparison.

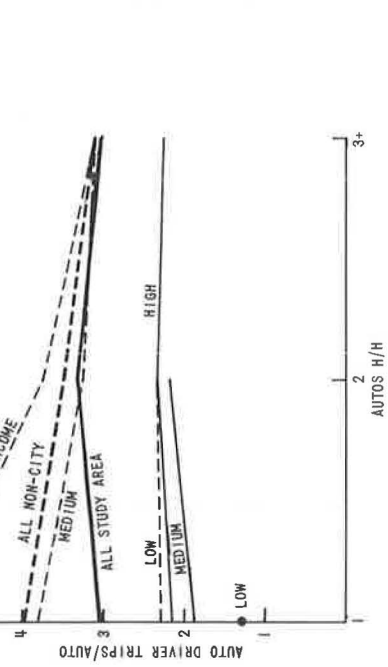

Figure 11. Automobile trips per automobile and persons 16 years old and more per household stratified by income level—New York City comparison.

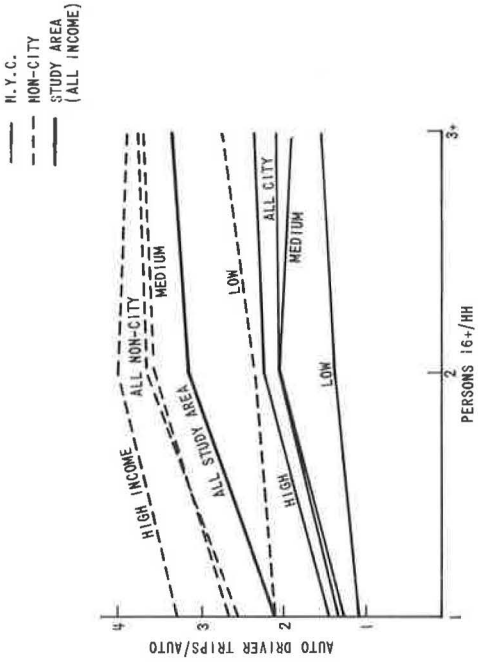

Figure 10. Automobile trips per automobile and automobiles per household stratified by income level—New York City comparison.

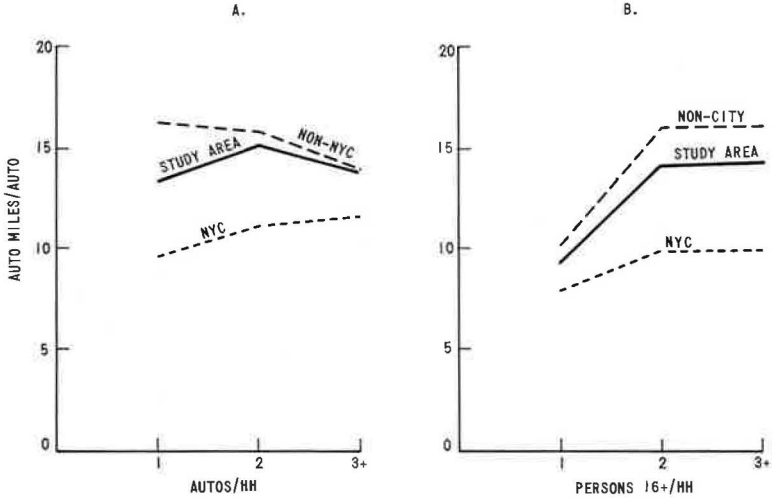

Figure 12. Automobile miles per automobile related to ownership, household size, and income—New York City comparison.

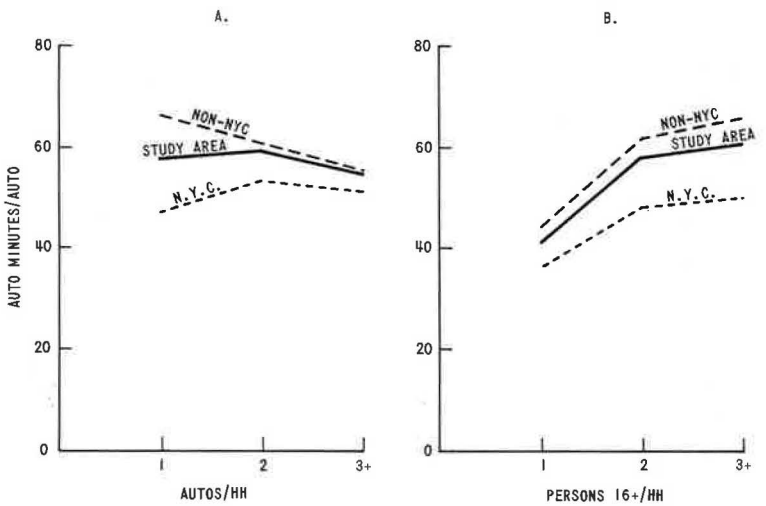

Figure 13. Automobile minutes per automobile related to ownership, household size, and income—New York City comparison.

2.2 trips per automobile in the city. (The number of households with 3 automobiles or more in the city was relatively small.) These opposite trends were similar to those found for cordon area high- and low-income groups described earlier; the use rates for households with both 1 automobile and 2 automobiles were almost identical in the city and in the low-income stratum of the cordon area.

Household Size and Income

The effect of increasing household size was similar in the city and remaining area. The suburbs generated 1 to 2 trips more per automobile than the city at each level, but the common trend was an increase in automobile utilization of about a trip with the addition of the second potential driver, and then a much smaller increase in use with the addition of the third person over 16 (Fig. 10). The exception to this trend in both city and suburbs was the low-income group, which exhibited no leveling off of use with the addition of the third driver.

Automobile Ownership and Income

In the suburbs, U decreased with increasing automobiles owned within the high- and middle-income groups to about 3 trips for each automobile per day. The noncity, low-income group, however, showed use rates similar to the city's high-income group and an increased rate of use with increasing automobile ownership, also coalescing to about 3 trips per automobile (Fig. 11). This low-income stratum could hardly be classified suburban as it was probably composed largely of households in cities such as Newark and Jersey City and was subject to much the same influence as households in New York City.

High- and medium-income households in the city were very close in use rates. The low-income group had a low rate of use but the sample was small.

Trip Length (Miles) in New York City

The automobile belonging to an average household outside of New York City was driven 15.9 miles a day; this was 61 percent more than was driven by a similar vehicle that was garaged within the city and driven for an average of 9.9 miles. The average automobile trip, however, was slightly longer within the city; 5.0 miles to 4.3 miles. This held within all the subclass variations and probably meant that city drivers used their cars mainly for getting to special objectives that could not be reached easily by walking or by using public transit. While automobile ownership for each household increased, mileage per automobile increased in the city and fell in the remainder of the cordon area, generally following the trip-rate trend for the 2 subregions (compare Fig. 12 with Fig. 9).

Trip Length (Time) in New York City

The average city automobile was driven 48 min a day compared to 63 min for the noncity car. Congestion contributed to a slower trip in the city; airline speeds were 12.3 mph there, and 15.2 mph outside. Thus, the time elapsed on each trip was 24.4 min in the city and 17.7 min beyond its boundaries. Because trip time did not vary appreciably, minutes per automobile behaved in much the same manner as trips when the independent variables were varied (compare Fig. 13 with Fig. 9).

RESULTS AND DISCUSSION

Because miles traveled and time elapsed for each trip varied so little, automobile use generally refers to automobile driver trips for each car, mileage per car, and net minutes for each car.

For the cordon area as a whole and the effect of each independent variable on automobile use taken in turn, the following observations can be made:

1. Automobile use was about 9 percent higher for households with 2 automobiles than for households with 1 and 3 automobiles, for which the rate was about 3.1 trips

per automobile per day. The increase in use with the second car was limited to the medium- and low-income groups for whom, it was conjectured, the decision to purchase the additional vehicle would be made only if there was a significant desire, and its intensive use was therefore ensured. High-income households were more likely to purchase pleasure cars whose use would not exceed that of the existing car.

2. Automobile use increased with the number of potential drivers in the household but tended to level off at about 3.3 trips per automobile after the second person 16 years of age or over. Greatest use of the vehicle was made by the first 2 adults, presumably the parents.
3. Automobile use increased with income, leveling off as income increased beyond the $10,000 per year group. The high-income group, at almost 3.6 trips a day, used the automobile 80 percent more than the low-income group.
4. Automobile use decreased with increasing density within each income group.

Automobile utilization in New York City compared to that in the less dense areas revealed the following:

1. Households with 2 automobiles in New York City generated more trips per automobile than households with 1 automobile. The opposite was true outside the city. The use rate outside the city, at almost 4 trips per automobile, was about twice that inside the city for households with 1 automobile.
2. Income and household size affected usage in much the same way both inside and outside New York City. Use rates per automobile outside the city were generally 1 to 1.5 trips higher for any class or group.

IMPLICATIONS FOR TRIP FORECASTING

Although there were differences in automobile use patterns for different segments of the population, their application to the derivation of automobile trip estimates for future years is of questionable value. The magnitude of the differences in usage rates is probably smaller than the range of error involved in the projection of population and income. Even if it were assumed that the use rate would remain steady over time in each socioeconomic class, the degree of accuracy is doubtful in projections of households grouped according to automobile ownership, income, and household size.

ACKNOWLEDGMENTS

Invaluable aid was received in the preparation of this paper from several persons: general guidance and direction from Lawrence V. Hammel and Edward F. Sullivan; technical assistance from William H. Coelln, Thea Edelstein, and Elizabeth Phifer; editorial and clerical assistance from Lyman Coddington, Jerry Kendall, and Diane Sydnor; and data processing by Jocelyn Bishop, George Fasciana and Widge Connolly.

The preparation of this report was financed in part through federal funds made available by the Federal Highway Administration and an urban planning grant from the U.S. Department of Housing and Urban Development, under the provisions of Section 701 of the Housing Act of 1954, as amended, and in cooperation with the states of Connecticut, New Jersey, and New York.

REFERENCES

1. Oi, W. Y., and Shuldiner, P. W. An Analysis of Urban Travel Demands. Northwestern University Press, 1962, 281 pp.
2. Chicago Area Transportation Study Final Report, Vol. 2, p. 76, 1960.
3. Bostick, T. A., and Greenhalgh, H. J. Relationship of Passenger-Car Age and Other Factors to Miles Driven. Highway Research Record 197, 1967, pp. 25-35.
4. Mills, F. C. Statistical Methods. Henry Holt and Company, New York, 1955.