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Working Women and the Aging: Impact on Travel Patterns and Transportation Systems

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Contents

Foreword

Greene uses demographic projections by age cohort and sex to produce 2020 vehicle travel forecasts that vary according to assumptions about license-holding rates and average miles per licensed driver by age and sex. He concludes that there appears to be the greatest potential for increased vehicle travel if rates of travel per female licensed driver begin to approach those of men.

Wachs examines the differences between travel patterns of men and women and notes that women make shorter work trips, make greater use of public transit, make more trips for the purpose of serving another person's travel needs, and drive far fewer miles per year than men. The historical basis for these differences in travel is examined and is attributed to evolution of separate spheres that delineate the social responsibilities of men and women. Man's sphere has traditionally been the work place and woman's, the home, and transportation systems were built with the conscious purpose of separating those functional spheres in geographical space.

Rosenbloom discusses the extent to which noneconomic or social variables explain travel behavior now and are likely to do so in the future. In particular, she focuses on how growing children and their needs affect their parents differentially. The analysis presented shows that working women have markedly different travel patterns than comparably situated men because they accept significant responsibility for most of the travel needs of their children.

Fagnani focuses on daily commuting in France and finds that the length of daily commuting between the home and the place of business accentuates the difficulties encountered by salaried mothers (in France) in reconciling their professional and familial roles. Among mothers who have little formal education and who occupy positions requiring few skills, much more is at stake than the distance to their place of business because they less often have a car at their disposal for commuting than do other salaried women. Among another group of mothers, there is a greater investment in professional life that involves full-time work and the acceptance of long commuting times in order to occupy a more skilled position. These salaried mothers are managers, office workers, and skilled workers.

Kostyniuk and Kitamura hypothesize that the age of a person during intense motorization on his environment influences his perception, habits, and expectations about transportation throughout his life. A paradigm of cohort, age, and time effects is proposed to sort out the effects of motorization and aging on travel behavior. An analytical framework for analyzing these effects by using transportation survey data from several time periods is developed. The implications of cohort-aging effects on forecasting travel behavior of future elderly populations are discussed.

Stahl reports on a study of travel habits and patterns of the elderly in Sweden. The purposes of the study were to determine (a) older people's access to various means of transportation, (b) travel habits of the elderly and their difficulties in using various means of transportation, and (c) the extent to which these factors influence the social situation of the elderly compared with various background variables such as age and physical incapacity.

Long-Run Vehicle Travel Prediction from Demographic Trends

DAVID L. GREENE

A simple method is presented for long-run forecasting of highway vehicle miles of travel (VMT) based on the assumption that travel is fundamentally time-constrained. Demographic projections by age cohort and sex are used to produce vehicle travel forecasts that vary according to assumptions about license-holding rates and average miles per licensed driver by age and sex. With constant vehicle miles per driver, 2020 forecasts range from 1.93 to 2.30 trillion vehicle-mi. The greatest potential for increased vehicle travel appears to depend on whether rates of travel per female licensed driver will begin to approach those of men. Equal rates would boost 2020 VMT to 2.84 trillion vehicle-mi.

Forecasting relies on consistency, whether of certain facts, patterns, relationships, or rules. During the past decade, travel demand forecasters have explored the possibility that key parameters of personal travel may be approximately constant, on average, or may obey very simple rules or patterns that remain constant over time. The significant debate over constant travel time, or travel cost, or generalized cost budgets is of this nature *(1)*. The virtue of the constant-travel-time-budget approach is that it recognizes the highly constrained nature of travel, and especially that travel is constrained not only by command over monetary resources but, more importantly, by the availability of time for travel. Traditional econometric forecasting approaches do not take advantage of this constraint by formally incorporating a time constraint *(2)*.

A demographic approach to forecasting travel demand is explored that is similar to methods Maring *(3)* has called "micro" approaches but that is methodologically akin to constant-travel-time-budget methods. The philosophy that guides these approaches is to reduce the description of the future state of the world required to make a forecast to the fewest and most readily predictable variables possible. Such models are clearly intended for long-range rather than short-range forecasting, and are designed for prediction per se rather than for policy analysis.

Maring *(3)*, for example, relied on the constancy of patterns of household income and vehicle mileage or numbers of licensed drivers and miles traveled to predict vehicle travel as a function of demographic forecasts. Demographic forecasts are likely to be robust, and if the travel patterns selected vary little over time, the forecasts themselves will be approximately correct under a wide range of conditions. Maring's 1974 forecasts for 1984 are exceptionally close to the mark (only 7 percent low), despite wide fluctuations in fuel prices and economic growth, and even the failure of certain key assumptions.

Transportation Research, Oak Ridge National Laboratory, P.O. Box X, Building 4500N, Oak Ridge, Tenn. 37831-6206.

First the methodology of "micro"-forecasting approaches is examined, showing that these approaches are of the same genre as projection methods based on constant travel budgets and vehicle stocks. Next, a simple model of vehicle travel based on demographic predictions of population by age and sex is described. Given a demographic projection, the key parameters of this model are license-holding rates and annual miles per licensed driver. These parameters are examined to determine their constancy or predictability over time. Finally, the model is implemented as a spreadsheet, and the implications of several demographic and vehicle use trends are explored.

Although the intent is to project total highway vehicle travel, the micro procedures explicitly address only passenger travel (by far the largest component). The premise is not only that total highway vehicle travel is dominated by personal travel (especially by households using automobiles), but that freight traffic is strongly correlated with passenger traffic. Thus, if one is concerned with forecasting total, undifferentiated vehicle miles, explicit forecasting of freight vehicle traffic might not be essential. For many purposes, however, explicit consideration of highway freight activity is essential and other methods would have to be employed.

DEMOGRAPHIC AND VEHICLE-STOCK-BASED APPROACHES

Interest in travel forecasting by means of constant travel budgets has been chiefly motivated by a desire to reduce the number and complexity of independent or exogenous variables required by forecasting models, so that predictions can be made without having to rely on forecasts of exogenous variables that may be more difficult to predict than travel itself. The best example of this might be the cost of motor fuel, which has proven to be essentially impossible to predict, and with respect to which the amount of travel is widely acknowledged to be inelastic. There may be other reasons for including fuel costs in a model as a determinant of travel, such as to evaluate tax policies or estimate revenues, but there is little justification for including it to increase forecast accuracy.

The desire to increase forecast accuracy while at the same time simplify forecasting models prompted Zahavi *(4)* and Tanner *(5)* to look for stable relationships between travel and other factors. These researchers found that the average amount of time spent traveling was relatively constant across wide variations in geography, culture, and technology. This led them

to believe that predictive models of travel behavior could be developed that depended on the average speed of travel and a minimum of other, readily predicted variables. Similarly, energy demand modelers found that vehicle stock utilization rates varied relatively little and in reasonably predictable ways over large fluctuations in income and per-mile travel costs *(6)*. This led them to develop fuel-use forecasting models based on projections of the size and composition of the vehicle stock, assuming constant rates of utilization by vehicle age group *(7, 8)*.

If one accepts the premise that the distribution of driving-age population by age groups is readily predictable 10 to 20 years ahead, the accuracy of forecasts will depend on the constancy or predictability of ratios of drivers per capita in each age group and of miles per driver by age group. An important property of this approach is that both unknown quantities are constrained by definite upper and lower bounds. The rate of licensed drivers per age group is clearly bounded by zero and 1. Indeed, data presented in the following show that licensing rates for most age groups for both men and women appear to be converging on 1. The constraint on vehicle miles per licensed driver is less obvious, but no less real. It arises from the fact that time spent in travel is constrained, and is thus related to the concept of travel time budgets. The total time an individual may spend traveling clearly cannot exceed 24 hr a day. Thus, a trivial upper bound on vehicle travel would be 24 divided by the maximum feasible average speed in miles per hour. But the average individual obviously cannot spend 24 hr a day traveling over an extended period of time. The typical individual (or social average) must sleep, work, eat, and perform numerous other essential functions if society is to continue. From an empirical point of view, this implies that socially average travel times will have much lower upper bounds, perhaps 1 to 2 hr a day *(9–11)*.

From the perspective of economic theory, the upper bound is still 24 hr divided by average speed, but the cost of travel includes two components: monetary costs and the cost of time spent traveling. As the time spent traveling increases, it interferes with other important activities, with the result that the cost of time spent traveling increases at an increasing rate as the amount of time spent traveling increases *(2)*. Thus, it may appear that there is an upper bound of 1 to 2 hr on time spent traveling when in theory it is the time cost of travel that is the binding constraint. For practical purposes, as long as average travel times are approximately constant [there is considerable debate on this point *(12)*], the mechanism by which they remain approximately constant need not be explicitly included in the model.

Travel-time-budget modelers claim only that the quantity of time spent traveling by all modes of mechanized transport is approximately constant, on average. In the United States, however, 88 percent of passenger miles are traveled on the highway and most of the rest is by air. Thus, at an aggregated national level it may be a reasonable approximation to assume that highway vehicles are the only mode of transport. Finally, if the number of passengers per vehicle (load factor) is approximately constant, constant passenger miles implies constant vehicle miles. Given all of this, the assumption of constant vehicle miles per driver can be seen as equivalent to the constant-travel-time-budget postulate. From this perspective, the first method is tantamount to projecting the age distribution of the population, predicting rates of driver licensing by age group (a strongly constrained variable), assuming that highway–nonhighway modal shares do not change significantly, assuming that load factors are also approximately constant, assuming that average highway speeds do not change much, and finally, invoking the axiom of approximately constant-travel-time budgets across age groups.

Note that if one accepts the empirical validity of the constant-travel-time hypothesis, it is not necessary to assume that the value of time remains constant or that there are no significant changes in the organization of society. If the constant-travel-time hypothesis is accurate, these vary widely across cultures throughout the world without significant effect on the quantity of time spent traveling.

THE MODEL

The constant-travel-time-budget assumption leads to an extremely simple forecasting model when the following four factors can be assumed to vary negligibly:

1. Modal shares of passenger travel,
2. Vehicle load factors,
3. Travel velocity, and
4. Fixed and variable costs of travel.

If the previous four conditions can be assumed to be approximately correct, there should be approximately constant vehicle miles per driver. If there are constant vehicle miles per licensed driver, one need only predict the number of licensed drivers, which depends solely on the number of persons of driving age and the rate of license holding. As Maring *(3)* points out, the age structure of the driving-age population is particularly predictable 10 to 20 years ahead because nearly all the population of driving age will have already been born.

The basic idea, then, is to begin with a robust forecast of the driving-age population and on the basis of historical patterns and trends, assume rates of license holding and miles per licensed driver. The license-holding and mile-per-driver rates are actually parameters that can be varied to produce alternative forecasts. Both demographic forecasts and the necessary parameters are available by sex and age group. Because there are variations in parameters across age groups and the data are available, it makes sense to operate at the level of age and sex cohorts and add up to obtain the total forecast vehicle miles of travel (VMT). The method is captured by the following simple equation:

$$VMT = \sum_i \sum_j (P_{ij} \cdot \delta_{ij} \cdot \mu_{ij}) \quad (1)$$

where

P = population,
δ = rate of drivers' licenses per capita, and
μ = annual miles per licensed driver for sex i (men, women) and age cohort j.

TRENDS IN PARAMETERS: 1969 TO 1983

It is essential to the usefulness of this forecasting method that the parameters δ_{ij} and μ_{ij} remain relatively constant over time. The Nationwide Personal Transportation Study (NPTS) *(13–15)* provides an opportunity to examine the validity of the postulate that (a) rates of drivers' licenses per capita by age group and sex and (b) vehicle miles per licensed driver by age group and sex are relatively constant over time. Rates of license holding by age are shown in Figure 1 for men and women drivers in 1969 and 1983. These data were taken from the FHWA publication *Highway Statistics*, not from the NPTS *(16)*. The distributions of license-holding rates for men are nearly identical in the two years: only the oldest and youngest age groups are very different from 1.0. The fact that license-holding rates are occasionally greater than 1 is indicative of slight inconsistencies between the population and drivers'-license data. Rates for women drivers, in contrast, increased across the board over the 14-year period.

In brief, license-holding rates show a convergence of men's and women's rates. Rates for men have remained nearly constant (at 1) and the pattern for women has become more similar to that of men and is well on the way to equivalence (Table 1).

Miles per licensed driver, on the other hand, increased consistently for both men and women drivers from 1969 to 1983 in nearly all age groups (Figures 2 and 3). Rates of increase were in the vicinity of 2 percent annually for both men and women (Figures 4 and 5). A strict interpretation of travel-time-budget theory would indicate that such increases must be accompanied by either an increase in average speeds or a movement to higher income levels, resulting in a modal shift toward motor vehicle travel or a decrease in load factors. Although speed data are scarce, average speeds on rural Interstate highways suggest that speeds may have been lower in 1977 and 1983 than in 1969. On the other hand, most households did move to higher income levels.

The most significant aspect of the statistics on miles per licensed driver is the major difference in miles of travel that still exists between men and women drivers. Vehicle travel by men is nearly twice that of women (Figure 6). That gap did not narrow between 1969 and 1983. Travel by both men and women increased at nearly equal rates so that, unlike rates of license holding, women's driving patterns do not appear to be converging toward those of males. It appears surprising that the social changes that have produced convergence in license-holding rates do not appear to be producing convergence in miles of vehicle travel. This anomalous situation may suggest fruitful directions for future research in travel behavior. It also raises the possibility that significant changes in the roles of women, such as continued increasing participation in the labor force and especially relief from other duties that demand a part of the daily time budget, could result in major increases in travel by women in the future. It will be shown later that if such a trend were to develop, it would be the single most important force for increased highway travel in the coming decades. However, such a trend has yet to emerge.

PARAMETRIC FORECASTS TO 2020

The simple model described by Equation 1 can be straightforwardly implemented as a spreadsheet model. Alternative

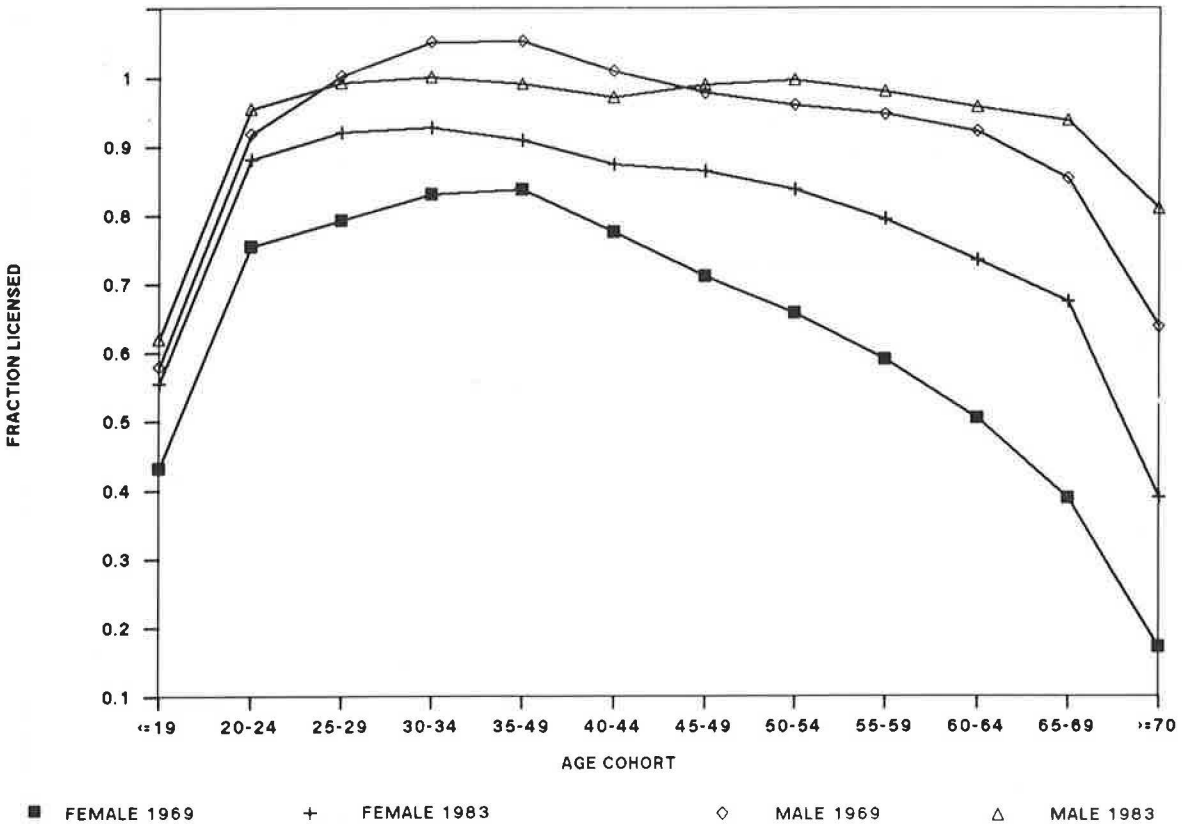

FIGURE 1 Licensed drivers per capita by age cohort and sex, 1969 and 1983 *(16)*.

TABLE 1 VEHICLE TRAVEL PROJECTIONS

	1983	2020 Projections						
	Estimate	Series 14 Population 1983 Age Distribution	Census Series 14	Census Series 19	Census Series 9	Equal License Holding	Equal Vehicle Miles	Equal License and Vehicle Miles
				Vehicle Miles				
Male	1.16E+09	1.54E+09	1.52E+09	1.40E+09	1.67E+09	1.52E+09	1.52E+09	1.52E+09
Female	4.65E+08	6.12E+08	5.71E+08	5.24E+08	6.30E+08	6.75E+08	1.33E+09	1.57E+09
TOTAL	1.63E+09	2.16E+09	2.09E+09	1.92E+09	2.30E+09	2.19E+09	2.84E+09	3.08E+09
				Drivers				
Male	80765	107488	108063	98978	119247	108063	108063	108063
Female	73430	96664	93225	85464	102864	115617	93225	115617
TOTAL	154195	204152	201289	184442	222111	223680	201289	223680
				Miles Per Driver				
Male	14367	14367	14041	14115	13977	14041	14041	14041
Female	6334	6334	6126	6129	6125	5836	14224	13539
TOTAL	10541	10563	10375	10414	10340	9800	14216	13781
				Drivers Per Driving Age Population				
Male	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Female	0.77	0.77	0.74	0.75	0.74	0.92	0.74	0.92
TOTAL	0.85	0.85	0.83	0.84	0.83	0.93	0.83	0.93

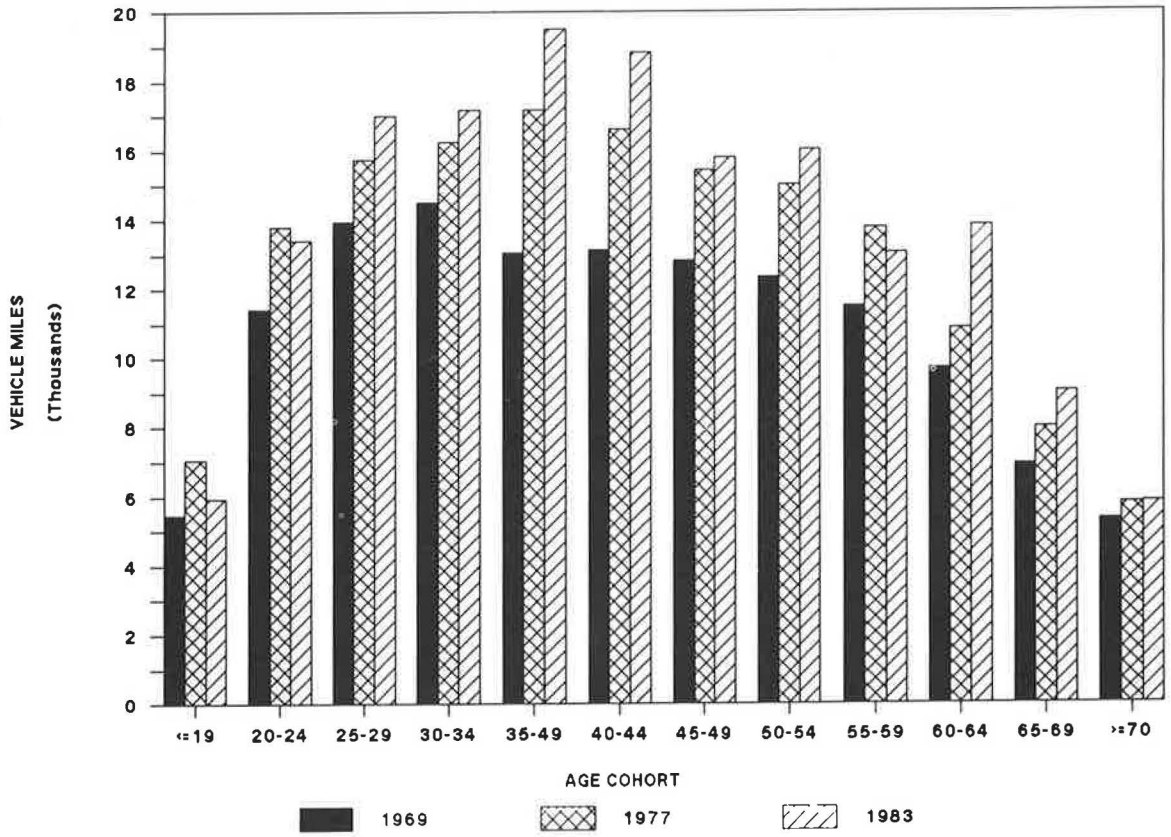

FIGURE 2 Average annual miles per male driver (NPTS data by age).

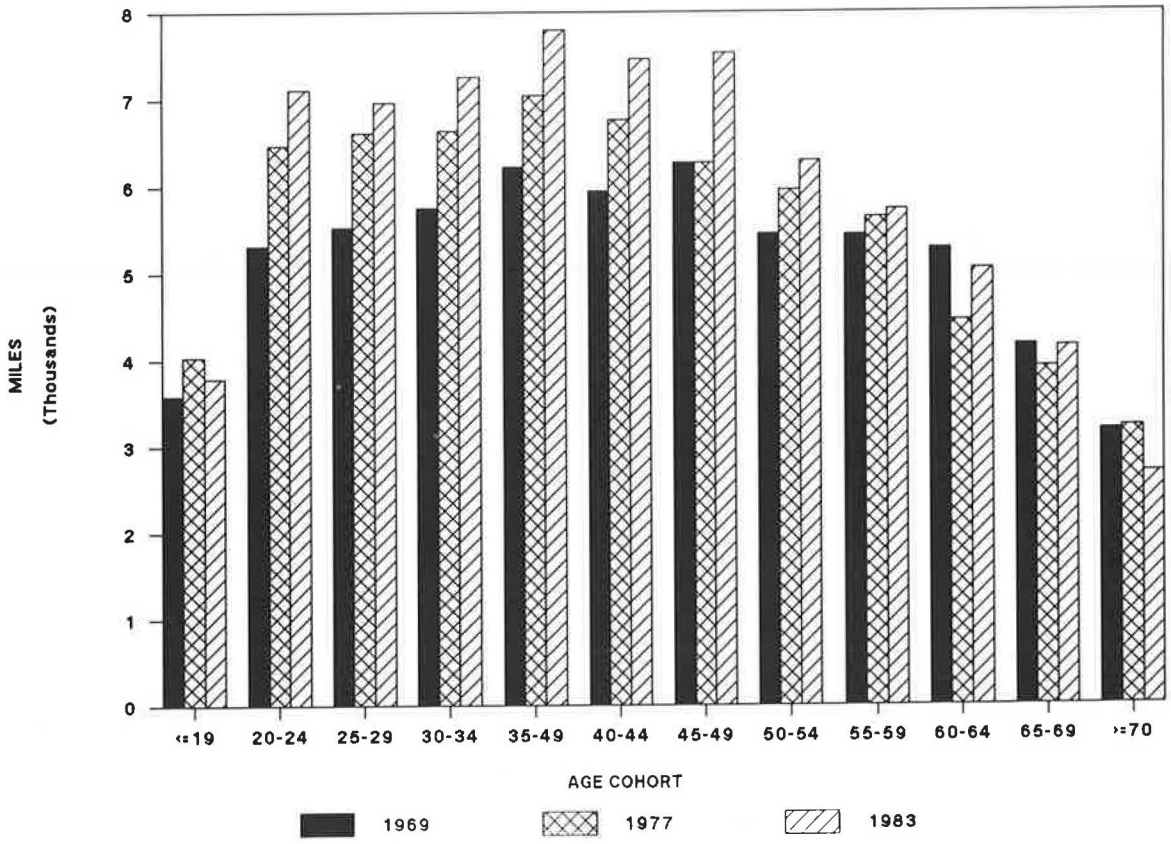

FIGURE 3 Average annual miles per female driver (NPTS data by age).

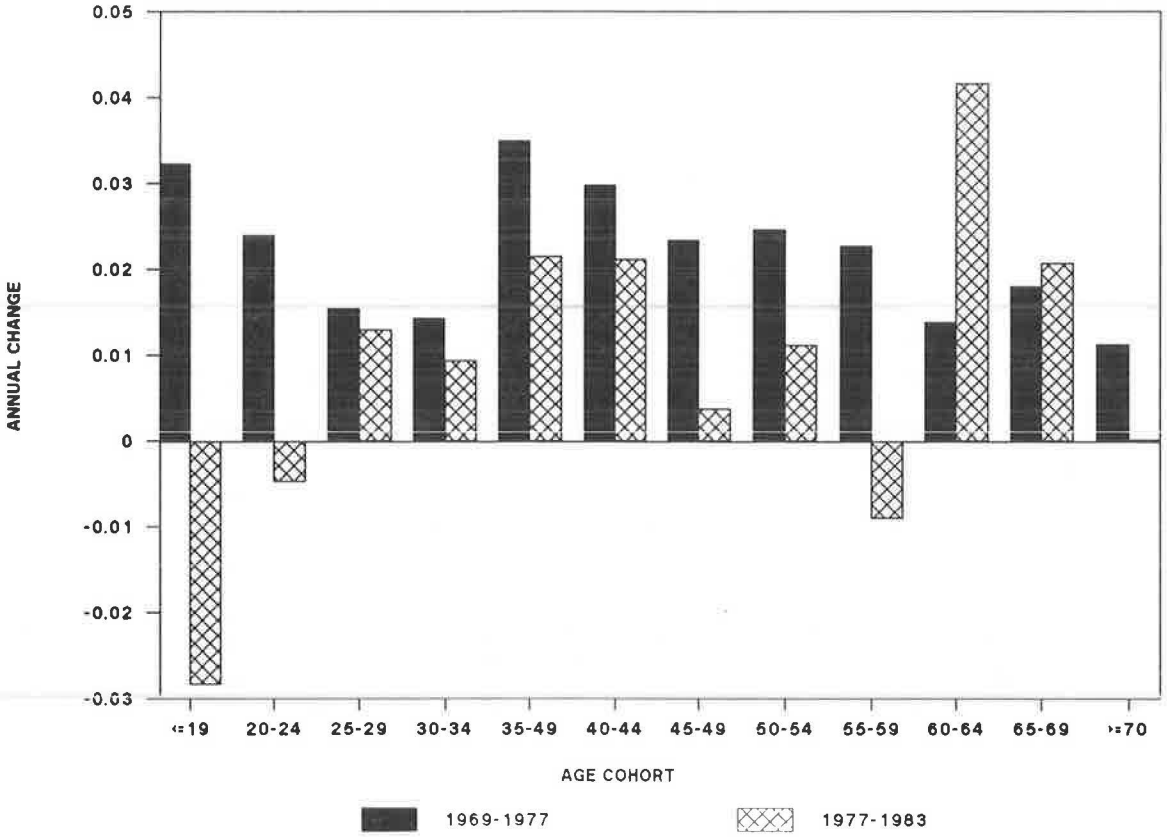

FIGURE 4 Growth rates of miles per driver by age: annual percent change for men.

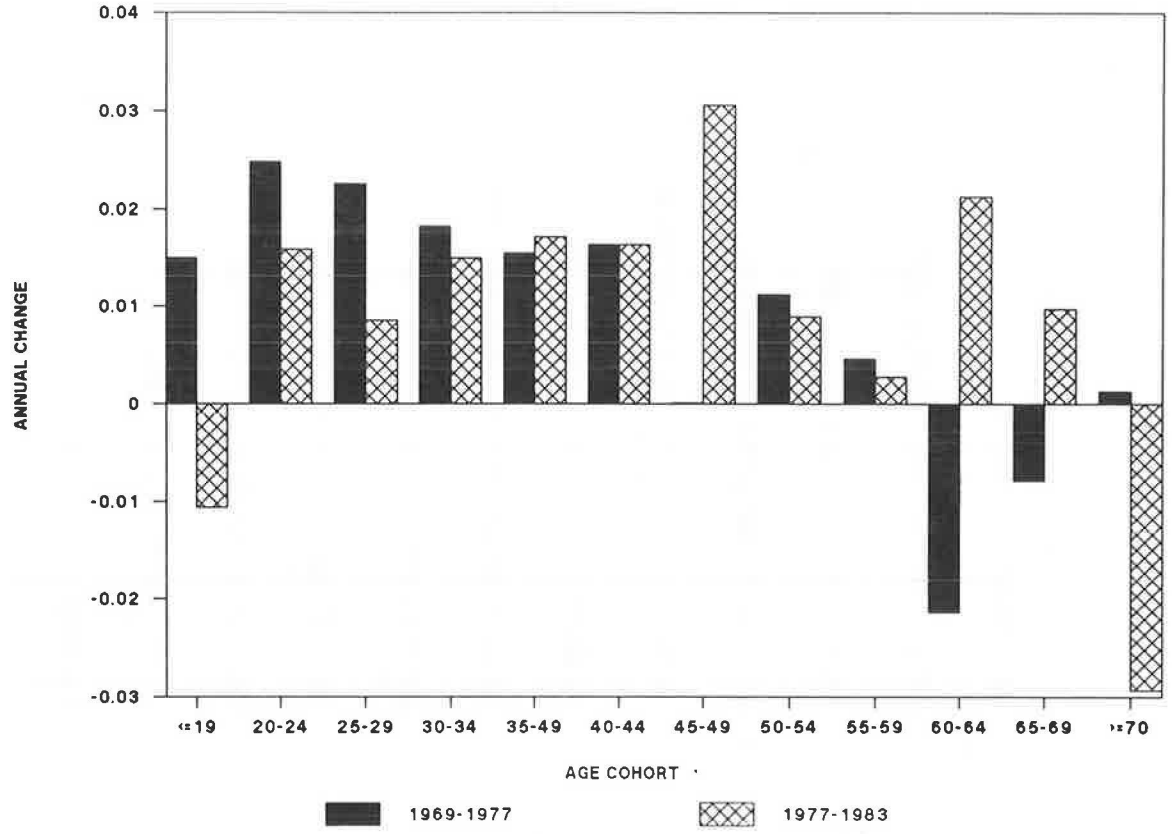

FIGURE 5 Growth rates of miles per driver by age: annual percent change for women.

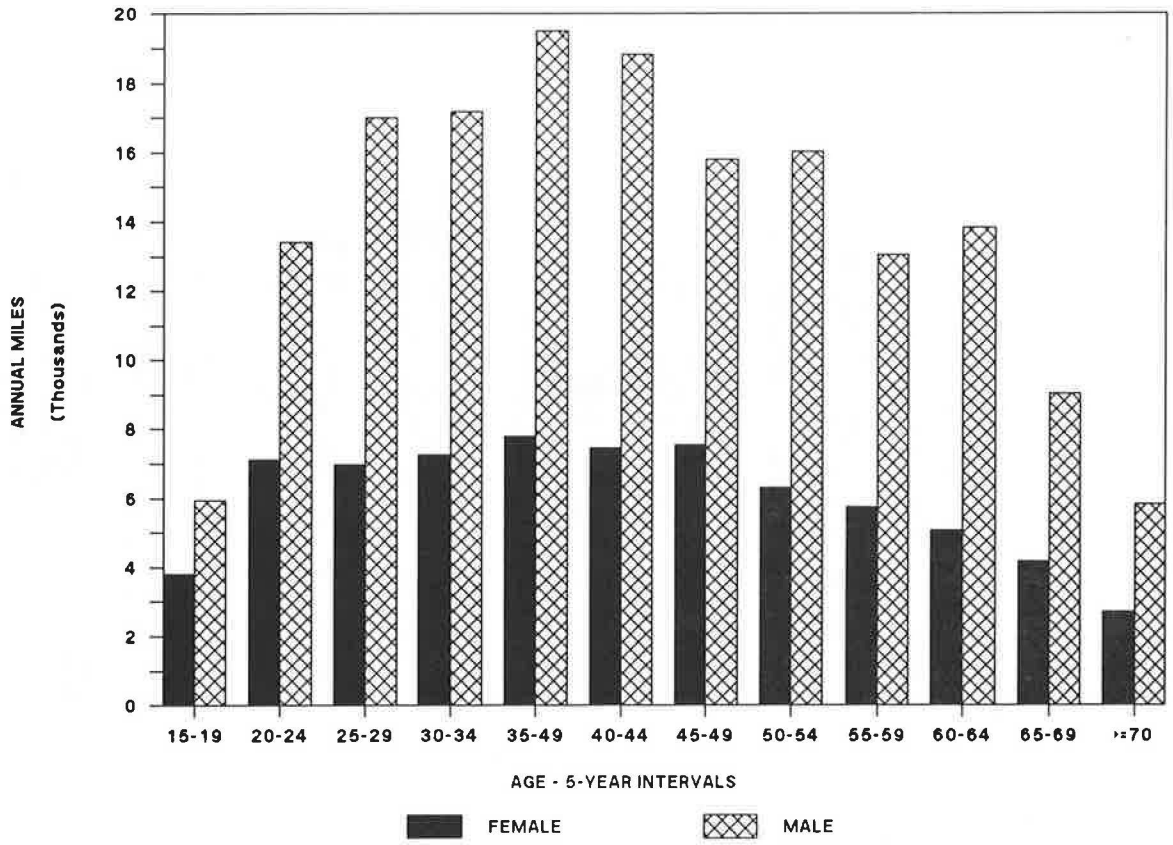

FIGURE 6 Difference between men and women drivers in annual mileage.

forecasts can be produced by using different population projections and by varying assumptions about trends in license-holding rate (δ) and annual miles per driver (μ).

For illustrative purposes, seven such forecasts were made based on three census projections. The Bureau of the Census Series 19, Series 14, and Series 9 projections provided low, medium, and high population projections, respectively, and are believed to bound the range of possible U.S. population totals in 2020 *(17)*. In each of these three projections it was assumed that 1983 values for δ and μ would hold in 2020. Alternative forecasts could have been produced by allowing μ to increase over time. Indeed, as has been seen, μ increased at rates from 2 to 3 percent per year from 1969 to 1983. Whether this indicates increased time spent in travel, increased travel speeds, a modal shift toward highway travel, or decreased load factors for vehicles, it is an important trend and worthy of further investigation. However, its implications will not be explored here.

Four variations on the Series 14 projection were created to explore the effect of differing trends on total travel (Figure 7). In the first, Scenario L, it is assumed that license-holding rates for women and men in 2020 would be exactly the same as those for men in 1983. Because, except for the youngest and oldest age groups, the rates are essentially 1.0, Scenario L represents saturation of license-holding rates. In the second, Scenario M, it is assumed that in 2020 rates of annual miles per licensed driver for men and women will equal those of men in 1983. In the third scenario, M+L, the assumptions of Scenarios M and L are combined so that, from the viewpoint of the model, men and women are equivalent in all respects. The final scenario, D, is intended to measure the effect of the aging of the U.S. population on vehicle travel. It uses the total population predicted by the Series 14 projection for 2020, but redistributes it so that the age distribution is the same as that in 1983. The difference between the Scenarios D and 14 is therefore entirely due to a change in the age distribution of the population.

Although there are nontrivial differences among the three demographic projections, future VMT is clearly most affected by the assumption of equal miles per driver for men and women (Figure 7). VMT is 1.92 trillion in the low-population forecast, 2.09 trillion by the Series 14 projection, and 2.30 trillion for the highest population projection. That is, the total reasonable range of future population projections for 2020 creates a range of VMT forecasts of 2.09 trillion, +10 percent to −8 percent. This is a remarkably small range for a 37-year forecast. Compare, for example, an econometric model with a VMT income elasticity of 1.0 and average annual income growth rates of 1.5 percent versus 2.5 percent versus 3.5 percent. The range of VMT predictions generated by these assumptions would be +43 percent to −30 percent. More important, perhaps, VMT would be predicted to increase 357 percent given high-income growth, and 73 percent under the low-growth assumption. Despite 2 to 3 percent increases in VMT per driver from 1969 to 1983, most are probably not willing to believe that such a rate of growth could continue unabated for the next four decades.

The effect of the license-holding rate trend is even less important. Equating men's and women's license-holding rates at saturation in 2020 results in 2.19 trillion VMT, an increase of only 4.8 percent. Less important still is the aging of the population. Imposing the 1983 age distribution on 2020 population

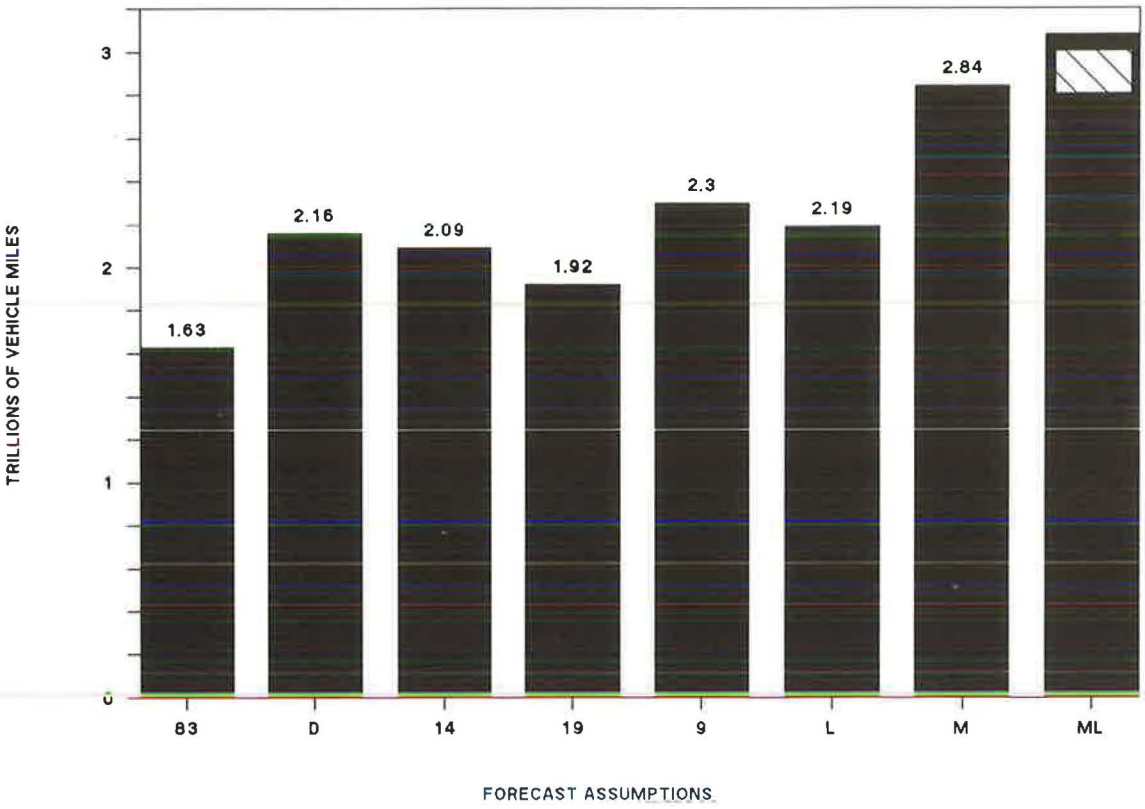

FIGURE 7 Vehicle mile forecasts for 2020.

increases VMT by only 3.4 percent to 2.16 trillion. Thus, the fact that the U.S. population is getting older will be of little consequence for total vehicle travel.

The one factor that has a dramatic effect on total travel is annual miles per female licensed driver. Assigning the same 1983 annual miles to men and women in 2020 results in a forecast of 2.84 trillion VMT, up 36 percent over the unmodified Series 14 forecast. If equal rates of license holding are added to that, the result is 3.08 trillion mi, a 47 percent increase. This potential for increased vehicle travel is particularly intriguing in light of the fact that although women's and men's license-holding rates have been converging, women's and men's driving rates have not. Although one might speculate about possible explanations for this anomaly, a better understanding of men's and women's vehicle travel behavior is clearly important to understanding the potential for greatly increased vehicle travel into the next century.

CONCLUSIONS

The simple travel forecasting method presented provides a means of developing long-run vehicle travel forecasts based on relatively predictable population patterns and making use of relatively stable parameters such as the average miles per driver and the number of drivers' licenses per capita. The stability of vehicle travel per licensed driver over time depends on the relative constancy of vehicle speeds, vehicle load factors, the modal distribution of passenger travel, and the fixed and variable costs of travel. If, in addition to these, travel time per driver is relatively constant, this simple approach should produce accurate vehicle travel forecasts.

A spreadsheet implementation of this model suggests that future levels of vehicle travel may be most sensitive to the annual miles per female licensed driver. Although license-holding rates for women in all age groups have been rapidly approaching the saturated levels for men, there has been no corresponding convergence of rate of miles per licensed driver. Annual miles per woman driver are approximately half those of men of equal age. Increases in these rates appear to be the largest potential source of vehicle travel growth in the future.

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Men, Women, and Wheels: The Historical Basis of Sex Differences in Travel Patterns

MARTIN WACHS

There are substantial differences between the travel patterns of men and women, despite the fact that a majority of women are now in the paid labor force. Women make shorter work trips, make greater use of public transit, make more trips for the purpose of serving another person's travel needs, and drive far fewer miles per year than men. The historical basis for these differences in travel are examined and they are attributed ultimately to the evolution of separate spheres that delineate the social responsibilities of men and women. Man's sphere has traditionally been the workplace and woman's, the home, and transportation systems were built with the conscious purpose of separating those functional spheres in geographic space. This was the case when new transit systems were built at the end of the last century and the suburbanization of middle- and upper-class residences ensued. As the automobile became the dominant mode of transportation in the 1920s, the idea of separate spheres was extended to that vehicle, and social conventions developed regarding appropriate uses of the automobile by men and women. These uses differed for the two sexes, and sex-based stereotypes were used to reinforce the division between man's and woman's worlds. Many of the sex-role definitions that were established decades ago have remained, and women's work is still defined within limits associated with their special domain. It is important that transportation planners consider the special travel needs of women because they are indeed the product of conscious policies that have been pursued in the past.

Travel patterns of men and women differ substantially. This might not have been a surprising statement decades ago when most men were employed outside the home and most married women were engaged in full-time homemaking. It is certainly more surprising today when the majority of adult women are in the workforce, even those having small children at home, and there are actually more employed women than employed men in the United States.

Despite the fact that a larger proportion of American women are licensed to drive than at any time in U.S. history, the 1983 Nationwide Personal Transportation Study (NPTS) showed that the average number of annual miles driven per licensed male driver was 13,962, whereas the figure per licensed female driver was only 6,381 (*1*, p. E-11). Women make trips to satisfy a wider diversity of travel purposes than do men, yet women's trips are on average of shorter distance than men's *(2)*. A number of studies have shown that women work closer to home than do men and that women make a much larger proportion of their trips as passengers. Reviewing a variety of disparate sources of information, Giuliano concluded that women also make the majority of trips taken on public transit in the United States *(3)*.

Most complex social phenomena have deep historical roots, and that is certainly true for travel and the residential location and labor-force participation patterns that influence travel. Research on historical change has shown that these patterns are best understood as part of a continuous evolution of social relationships that has been under way for more than a century.

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EARLY EVOLUTION OF SEX DIFFERENCES IN TRAVEL

For most of recorded history, the majority of people worked at home. Most households produced food, shelter, and clothing under their own roofs, and merchants, blacksmiths, craftsmen, and others who offered services for sale did so at their homes. This was true in the United States until well into the 19th century. It began to change slowly as capitalism matured and the industrial revolution gained momentum. Factors reached sufficiently large scale that they required more workers than could be provided within a household and needed separate buildings and special locations, for example, access to waterways and railroad lines.

By 1850 a substantial proportion of the population—but still a minority—worked outside of the home. Virtually all those workers were men and most walked to work. The first metropolitan transit services, horse-drawn omnibuses, operated in the 1830s through 1850s, reflecting increases in travel to and from work and for economic transactions during the workday *(4)*.

This was happening in most industrialized countries throughout the 19th century, but another factor came into play that was especially important in America. Throughout recorded history, most societies had been patriarchal. Men dominated all household decisions. Women and children were important parts of household production; they provided the labor that produced food, clothing, and shelter, but men were in command. In the United States during the last century, a different doctrine evolved, derived perhaps from a combination of the Judeo-Christian ethic and the frontier experience. Men and women here had what historians have called "separate spheres," but women were respected and even dominant within their sphere. Man's arena was work, economic production, and public life (politics, scholarship), and woman's sphere was the care of children, the nurturing of husband, the comfort and tranquility of home, and the moral guardianship of the family. By 1850 or so, home had become more than an economic unit of production. It slowly became a symbol of the ideal of goodness and

morality, and it provided material comfort and status. Although this was true to some extent in many western capitalist countries, it was particularly characteristic of American society, and occurred here to a greater degree than elsewhere *(5)*.

The growing separation in space between home and workplace and the established role separation between men and women, along with the related evolution of the home as the primary symbol of the American self-image, are important sources of today's sex differences in activity and travel patterns. Another source is the revolution in transportation and communications technology, which changed more rapidly from 1850 on than it had in all of prior recorded history.

Between 1850 and 1900 transportation technology advanced from horse-drawn carriages to horse-drawn streetcars on rails to cable cars, to steam-driven and electric railways, and finally to individual horseless carriages. Each advance encouraged greater spatial separation between home and work, as did the advent of the telephone. Glorification of home and family caused people to strive for single-family, low-density living, and the streetcars made it possible. As Charles Horton Cooley wrote in 1884 *(6)*:

> Humanity demands that men have sunlight, fresh air, grass, and trees. It demands these things for the man himself and still more earnestly for his wife and children. On the other hand, industrial conditions require concentration. It is the office of urban transportation to reconcile these conflicting requirements; in so far as it is efficient it enables men to work in aggregates and yet to live in decent isolation. The greater its efficiency in speed, cheapness, and convenience, the greater the area over which a given industrial population may be spread.

As this quotation illustrates, Americans aspired 100 years ago to lower densities and larger individual homes, which were designed largely to be the woman's domain. Streetcar suburbs of low-density single-family homes were built in most urban areas before the arrival of the automobile, but they were available to only the small proportion of the population who could afford them, and they remained almost exclusively residential in character. Although shops and service establishments were located near their suburban residential customers, factories and commercial institutions were still clustered downtown at the ports, railheads, and markets of the metropolitan area.

Those who used public transit had to pay roughly 20 percent of their average daily wage in fares. Thus, only the rich could live in the suburbs and commute by transit, whereas most people remained in the inner city and walked to work *(7*, pp. 128–173). This remained the case as urban densities increased precipitously around the turn of the century with the flood of migration from Europe. By 1910 population density on Manhattan's East Side reached 900 people per acre and was growing by 40 percent per decade *(8)*. In Pittsburgh steel workers lived in crowded tenements in the shadow of the mills because they could afford neither elegant single-family suburban housing nor the cost of commuting.

Social reformers saw high-density urban living as the source of disease and maladjustment, and progressives called for suburbanization and the lowering of transit fares to permit it. Feminists and settlement workers joined with real estate developers in calling for lower density and greater separation of home and workplace, and that meant more transit lines and lower flat fares. V. G. Simkovitch, for example, a New York settlement house worker who was the only woman to address the first National Conference on City Planning in Washington, D.C., in 1909, joined with men speakers in advocating a lowering of transit fares, universal free transfers, and the construction of low-density residential suburbs as the solution to the urban crisis *(9)*. The new subway in New York City was designed to operate with the flat fare and free transfers that still exist in order to promote suburbanization and lower densities by separating man's sphere from woman's sphere in space as well as in function.

WOMEN AND THE EARLY AUTOMOBILE

The automobile appeared before the new transit systems were fully built, bringing with it an enormous variety of social changes. As is well known, the automobile was for a time the plaything of the rich, and although at first one's class determined one's access to it, sex did so to a far lesser extent. Automobiles fit most naturally in low-density, spacious surroundings, and that meant the suburbs, which were the woman's domain during most of the work week. The unconventional Mrs. August Belmont, who had already shocked society by marrying a Vanderbilt before that family was considered socially eligible and by then divorcing him when divorce was unheard of, also blazed a trail by appearing in public at the wheel of her new car in 1897. Later she financially supported the National Women's Party, one of several groups that used automobiles extensively in their campaigns for women's rights and suffrage. Suffragists held automobile parties in town squares, at which speakers would arrive in automobiles draped with banners, carrying mobile podiums and literature to distribute to the assembled audiences. In 1912 the pugnacious and portly Mrs. Belmont made national headlines by leading a "monster parade" down Fifth Avenue in support of the feminist cause, and she did so at the front of an impressive "automobile contingent" (*10*, pp. 27–28).

Before the turn of the century and until World War I, there were women's automobile races and automobile gymkhanas. Many books were published recounting cross-country automobile adventure trips by women, including one by Emily Post, who was accompanied by her son *(11)*. On January 2, 1900, Florence E. Woods, at the age of 17, merited front-page headlines as she became the first woman to drive her automobile through New York's Central Park (*12*, pp. 72–73).

There is ample evidence that women could crank-start a car, replace flat tires, and disassemble carburetors as effectively as men. In her 1908 book about motoring, for example, Hilda Ward describes in detail how she patched tires, fixed fuel leaks, and corrected the functioning of cylinders that were misfiring *(13)*. Similarly, the daughter of Laura Ingalls Wilder, while herself motoring across Europe with a woman companion, wrote to her father, Almanzo, giving him detailed instructions on what he should do to clear clogged fuel lines, including blowing into them and using the tire pump should exhaling fail (*14*, p. 102). She joked about how mechanically inept her father seemed to be, whereas the technical details of automobile maintenance came so easily to her.

Society women before 1910 drove for recreation quite as freely as wealthy men did, and were called *chauffeuses*, but effects of the doctrine of separate spheres were evident in their

travel patterns. Women drove downtown more rarely than men. Typically they stayed within their suburban communities, driving to social events, shops, and school functions.

Electric automobiles were easier to start, because they did not require cranking, and they were cleaner than gasoline-powered vehicles. But they had less power than gasoline cars and were much less adept at hill climbing because of their lesser power and the weight of their batteries. Research by Virginia Scharff (unpublished data, 1986) has shown that electric automobiles were vigorously marketed as women's cars, whereas gasoline cars were pitched toward men drivers, a reflection of their different travel patterns and the social consensus that men and women lived in separate spheres. Women were taken to benefit more than men from the electric's absence of a hand crank for starting, and were expected to drive primarily to perform errands and make social calls within their communities, where the limited range of electrics would suffice. Men, on the other hand, were presumed to put great emphasis on speed and range for longer recreational trips and more adventurous driving, and would not be inhibited by the need to crank-start a car. Scharff points out that at exactly the same time that Henry Ford was introducing the Model T, he bought his wife an electric car for her birthday.

NATIONAL ADOPTION OF THE AUTOMOBILE

In the first three decades of this century, enormous political, economic, and social change occurred, and the automobile was emerging in the midst of that change at an almost unbelievable pace. Although the automobile was still a phenomenon that turned heads in 1900, by 1910 there was one for every 265 people in the United States. Mass production lowered the price of the automobile in relation to income, and by 1917 the ratio stood at one car for every 22 people, and in 1919 it was reported to be one per 16 people. The proportion of the population engaged in manufacturing, servicing, selling, and insuring automobiles had grown so large that the general prosperity encouraging automobile ownership was in large part explained on the basis of the growth of the automobile industry itself. By 1929, with new-car financing on a credit basis quite universal, there was one car for every six men, women, and children in the country; ownership extended to middle- and even lower-class families, and it was almost literally possible to accommodate the entire population had it wished to take to the roads at once (*15*, p. 59). By now, as one author put it, "A new car means more to the clerk in the chain grocery store, who never owned one before, than it means to the president of the company whose garages have housed a dozen for years" *(16)*.

As automobile ownership grew by leaps and bounds, inner-city population densities declined, and suburbs grew in every metropolitan area. In response, transit use increased for work trips but declined dramatically for recreational and social trips, which were increasingly the domain of the automobile.

Many of the features of the electric automobile, especially the electric starter, had by the early 1920s been incorporated into gasoline-powered vehicles, and electric vehicle purchases declined until they represented an insignificant portion of the new-car market. In addition, enclosed all-weather "family" vehicles, rather than open cars, rapidly came to dominate the new-car market. For example, in 1919 only 10.3 percent of cars produced in the United States were classified as closed, but by 1929 some 89.4 percent were closed (*17*, p. 39). The closed car was clearly utilitarian, and in combination with paved roads and streets it completed the transformation of the automobile from recreational vehicle to family necessity.

The enormous growth of the automobile industry in the first part of the 20th century was the most important factor in the prosperity of the 1920s, yet economists and businessmen began to worry about the future. With the number of automobiles approaching the number of families in the United States, industry spokesmen and social commentators wondered aloud whether "saturation" was approaching and whether that meant that the future demand for replacement automobiles would be much lower than the annual demand for "first cars" that had fueled the early growth of the industry. If so, would manufacturers be left with idle capacity in the coming years, and would the economic growth of the country be impaired *(18)*? The answer came as a conscious and vigorous effort by the industry to promote the ownership of more than one car per family, and the advertising of the 1920s clearly indicates that the second car was marketed to households whose first car was largely the man's domain, but whose second car would be used mostly by the woman.

SEX STEREOTYPING AND THE AUTOMOBILE IN THE 1920s

Given that the automobile industry had decided to market cars to a growth market consisting primarily of women, it is interesting to examine both how the industry viewed women and how it attempted to appeal to them. After all, during World War I women had entered the workforce in unprecedented numbers, and in 1920 they had attained the vote. The image of the flapper was dominating the media; women bobbed their hair, wore short skirts, and were seen drinking and smoking in public. The 1920s are often described as a time of increasing female independence and assertiveness, and the automobile might have been presented as a technology that could liberate women from their traditional roles and help break down the barriers between men's and women's separate spheres.

But the established values were very strong, and the flapper was more a counterculture image than she was the typical housewife of the period. Indeed, leaders of public opinion appeared to have a greater need than ever to reinforce the traditional roles of women against the threats of change. They spoke out against the declining importance of family and home, and transformed the meaning of the liberation of women from a change in their roles to a release from drudgery by applying technology to the reinforcement of traditional roles. Barbara Peterson, for example, describes the emergence of the modern woman in the 1920s in these terms (*19*, pp. 81–99):

> The decade of the 1920s wanted its women soft and pliant and condoned aggressiveness only in sex and sports . . . . In the era which glorified that "the business of America is business," every woman was told through the media and advertising that she was entitled to an automobile, radio, washing machine, vacuum cleaner and a "total electric kitchen." This was to be her true liberation; with her new leisure she could be a better mother and more beautiful wife.

Thus, it is not surprising that in a world of jazz, rouge, and short skirts, women were deliberately portrayed in extremely traditional roles by those writing the advertising copy for the automobile industry. In what appeared to many an unstable world, it was safer and more lucrative to appeal to mainstream values than to the minority culture that was trying to break with tradition.

A General Motors advertisement of the 1920s, typical of hundreds of ads placed in magazines and newspapers, shows a middle-class woman picking flowers with her children; their car is visible in the background. The text reads as follows *(20)*:

> "When I was a child it was easy for mothers to keep in touch with their children," says a woman in Illinois. "Today the members of the family must make a real effort to keep united. I thought a great deal about this as my children began to grow up. I decided that the most important thing I could possibly do would be to plan ways in which they and I could have good times together. My husband agreed, and for that reason we bought a second automobile, since he had to use his car in getting back and forth to business. I can't begin to tell you of the happiness it has given us—picnics together, expeditions for wild flowers in the spring, and exploration parties to spots of historic interest. It's our very best investment. It has helped the children and me to keep on being pals." . . . Every year thousands of families decide that a second car is a saver of time, a great contribution to family happiness and health.

The text suggests that traditional roles may be harder to achieve than in the past, but it glorifies them and recommends an automobile as the path to their attainment.

In a society faced with threats of new economic, social, and political freedom for women during the 1920s, the automobile increasingly became a means by which the woman's sphere of home and family was reinforced. Women's opportunities to use the automobile became more and more limited through symbolism and social convention as their actual physical access to the automobile increased.

The popular literature of the 1920s began to present exaggerated descriptions of the women's world as compared with that of men, and the automobile constituted a central part of the imagery. In a widely quoted treatise, *The Suburban Trend (21)*, Harlan Paul Douglass advocated that decentralization and suburbanization continue as the solution to urban ills, though he was well aware of the extent to which suburban life affected men and women differently. He noted, for example, that in several suburbs where commuters were surveyed, women constituted only between 8 and 15 percent of the commuters to the central city. He described women's role as driving their husbands to and from the train stations, driving children to school, and driving to shopping locations. The isolation of suburban housewives was noted, yet his solution was less than satisfying by present-day standards. Observing that suburban women are increasingly well educated, energetic, and possessed of managerial skills, he comments that their energies are and will be put increasingly into organizing (*21*, pp. 194–195)

> women's clubs of spectacular proportions, with palatial buildings, and sometimes representing federation or other forms of complex organization. Their interests are all-sided with a strong tendency to stress civil responsibility, and in their seriousness and competence of administration they often go far beyond the traditional dilettante character of the average women's club in places of like size.

Although women who drove in the first decades of the century were assumed to have at least some interest in the mechanical properties of automobiles, during the 1920s the mechanical traits of cars came to be more associated with men's domain. Women were increasingly important as a market for automobiles, but it was asserted that they had little interest in the engines, brakes, or tires, and instead were devoted to the properties of cars that were more associated with feminine roles: color, styling, upholstery, and comfort. An article in *Automobile Topics*, a trade journal read by automobile dealers, for example, stated that "one of the first things a woman thinks of when the purchase of a new car is considered, is whether the color of the upholstering will harmonize with her personality, coloring, and clothes." The article goes on to state that if she thinks the car will not complement her looks, the salesman "might as well try to sell his cars to an Eskimo" *(22)*.

In a popular book on consumers, Walter Pitkin reported on a study that showed that in 1929 men were the principal buyers of 59 percent of the automobiles sold, whereas women had become the principal buyers of 41 percent of all new cars. Despite women's increasing influence on car purchases, in a section entitled "Woman, The Economic Imbecile" he quotes Alice Hamilton's column from the *New York World Telegram* to describe how women go about selecting automobiles (*23*, p. 282):

> When a woman views a motor car and looks as if she were pondering weighty matters the automobile dealer grows elated. "Ah," he thinks, "she is considering our wonderful new floating power. She is enchanted by our full pressure engine lubrication."
>
> That puzzled look is deceptive. She is not thinking of freewheeling, of automatic clutches. She is wondering if the car is sufficiently impressive to serve as a frame for her as she sits, viewed through the glass by passing admiring multitudes. She considers how her foot, ankle, and calf will look as she steps smartly down upon the running board . . . . Does this fawn gray upholstery go with most of her clothes?

As the lines between men's and women's roles regarding the automobile were drawn increasingly sharply in the 1920s to limit woman's place, the stereotype of the woman driver as indecisive, erratic, and unsafe became ever more common. Michael Burger, for example, quotes one writer who stated in the *New Statesman* in 1927 that women *(24)*

> do not very commonly possess the nervous imperturbability which is essential to good driving. They seem always to be a little self-conscious on the road, a little doubtful about their own powers. They are too easily worried, too uncertain of their own right of way, too apt to let their emotions affect their manipulation of the steering wheel.

Women's roles in the home and as mothers are frequently described in the literature of the 1920s as more suited to their temperament and motor abilities than such mechanical tasks as driving a car. Walter Pitkin, for example, states that women differ from men in motor ability, primarily because "boys and men on the average greatly exceed women and girls in the ability to manipulate mechanical contrivances," and as a consequence, "women shink from acting when facing a crisis," "work by fits and starts" when under high pressure, and work consistently only when there is no pressure. Consequently, Pitkin concludes that women are overcautious, that they make

poorer drivers than men, and even that "they cause accidents on the part of their fellow drivers." He goes so far as to state that "owing to their inferior motor outlets, women succeed best in outer behavior in relatively simple motor activities, such as sweeping, washing, and ironing" rather than in more complex motor tasks like driving *(23)*.

A central part of the traditional image of women as moral guardians of household and children is the ideal of chastity, and an important part of the imagery of the new womanhood of the 1920s was the expression of her sexuality as revealed in clothing, hair styles, dance, and many other forms of social behavior. It is not surprising, then, that part of the imagery that developed about the automobile at that time was attached to sexuality and involved the limitation of young women's access to automobiles for the purpose of protecting their chastity. It was assumed, with good reason, that automobiles were widely used for romantic liaisons and for access to dimly lit roadhouses, where young women would smoke and drink, far from parental supervision, and that such behavior could only lead to sexual excesses.

In their famous sociological study, *Middletown*, for example, the Lynds observed that the automobile and the movie theater had already replaced the parlor as the locus of most courtship, and they quoted the community's judge as saying that automobiles had become "houses of prostitution on wheels." It was observed that children spent more time away from home since the advent of the automobile, and that a boy almost never took a girl to a dance except by car. The automobile became identified with petting parties, and some 31 percent of girls and 40 percent of boys reported having "disagreements" with their families over the use of automobiles. Increasingly, parents attempted to protect their daughters by limiting their opportunities to travel with young men in automobiles, and this in turn further identified the automobile with the different roles of men and women *(25)*.

In a treatise by sociologist Emory Bogardus (*26*, pp. 74–75), the automobile is directly linked with illicit sexual liaisons in the minds of parents and social workers, who are quoted at length. According to one social worker, "a couple gets off in the country in some secluded spot, and there are very few people who would not be tempted." A parent stated that "the couple out for a ride reach some secluded spot and things go from bad to worse . . . . perpetual spooning in all places leads to promiscuous relationships." A social worker observed that high-speed driving "tends to break down all of the barriers that before existed. Other things being equal, the couple in the sports car are more liable to step over the bounds than otherwise, simply because the car they are in is different or a little off color, so to speak." Parents were urged to protect their daughters by restricting their company and their hours of travel in automobiles, and young men were assumed to be doing what was natural to their sex when they acquired cars and used them in the pursuit of female affections.

The 1920s was the decade in which the automobile fully assumed the functions that it has in today's society, with most households having at least one automobile that is central to their economic and social lives. Yet, despite the increasing universality of automobile transportation and the prospect that women and men might have equal access to automobiles by each having one, this period was also characterized by a solidification of sex roles with respect to cars. Women were clearly defined to be more restricted in their access to automobiles, as their roles as homemaker and nurturer of children were reinterpreted and applied to their status as automobile operators. Their mechanical competence and driving skill were portrayed as limited in order to maintain social limits on women's access to transportation for fear that women might use this access to step beyond their traditional sphere of activities.

SEX ROLES AND THE AUTOMOBILE SINCE WORLD WAR II

The process of suburbanization and expanding motorization of the population and their reinforcement of the doctrine of separate spheres were severely interrupted for fully 15 years by the Depression and World War II. First economic distress and then shortages, rationing, and military service brought great discontinuities in families' patterns of residential location and travel. But after the war the previous pattern of suburbanization was resumed with renewed commitment, as if to make up for lost time. Suburbs grew more rapidly than ever, and automobiles became the nation's primary mode of commuting as highway building and single-family housing subsidy programs reinforced the shared commitment to this pattern. Home remained the separate sphere of women, and in keeping with that image the design of suburban residential tracts stressed built-in cabinets, versatile kitchen appliances, and provision of play areas for children *(27)*. Suburbs were still designed as dormitories for downtown workplaces, and freeways were built to replace commuter railroads and trolley lines as the connections to the traditional downtowns.

But the nature and location of work was changing, as services, information processing, finance, and retailing eclipsed manufacturing and heavy industry as the sources of most employment. Because work in these types of jobs did not require downtown locations and the labor force was now increasingly concentrated in the suburbs, a growing proportion of all jobs came to be concentrated in the suburbs, and by 1970 the census showed that more people traveled to work from suburb to suburb than from suburb to downtown or entirely within the central city. Service and retailing establishments located in the suburbs to take advantage of lower-cost land, proximity to their markets, and proximity to a low-priced labor force consisting increasingly of suburban women. In the 1980s the suburbs are home to a variety of families, many of which do and many of which do not match the traditional stereotypes. Most suburban women are in the labor force, and many single-parent households headed by women are found in the suburbs alongside two-parent households. Suburban households often have as many automobiles as they have licensed drivers, and yet differences in roles and travel patterns persist as an echo of the past.

CONCLUSION

For 100 years the city has been associated with male characteristics. Cities epitomize assertiveness through their economic activity, intellectual creativity, and centrality in world affairs. Simultaneously, the suburbs have been associated with women's sphere. Suburbs are thought of as places of domesticity,

passivity, repose, closeness to nature, and spiritual values *(28)*. Scholars have frequently noted this dichotomy when describing the place of the home and house in American society. They have less often noted the central role that transportation has played in both creating and maintaining this dichotomy, and the utility of travel data for measuring the extent of the dichotomy.

By permitting the spatial separation of home and workplace within the bounds of reasonable expenditures of time and cost, public transit and the automobile encouraged cities to develop spatially in response to the image of separate spheres that was so central to American culture. And current studies of transportation patterns provide measures of the extent to which that image still dominates family and economic life.

Women have entered the work force in very large numbers but still make work trips that are on average substantially shorter than men's. Women, whether they are working or not, make many more trips for the purpose of "serving passengers," that is, delivering someone else to a destination of importance to that person. Although women today have nearly universal access to automobiles and the labor market, the persistence of these differences can be interpreted literally as the echo of the historical patterns that have been reviewed in this paper.

Lower-paid workers have always made shorter work trips than higher-paid ones. Poorer workers a century ago lived near their places of employment because the cost of transport would deplete their earnings if they moved farther away. Today women live closer to their jobs than do employed men in the same households. There are three factors that, taken together, may explain this phenomenon. First, women are paid substantially less than men. Although more women are in the labor force than ever before, they tend to hold the same types of jobs as they did in the 1950s. Women are overrepresented in what is called the "secondary" workforce, consisting of part-time or seasonal workers, and are concentrated in job classifications in which the majority of employees are women, especially clerical and sales work. These positions pay lower wages than the positions traditionally held by men, and it is argued by some that women select jobs closer to home because searching farther away yields no wage advantage among the jobs for which women qualify. Second, women may work closer to home because the recent suburbanization of service and retail activity has resulted in the more even distribution across the urban landscape of "women's" jobs than the professional and technical jobs that are more typically held by men. In other words, women are filling the jobs that moved to the suburbs in the first place in order to take advantage of a proximate low-paid workforce, and those jobs involve shorter commuting distances for just that reason. Third, women work closer to home and drive shorter distances in part because even as they enter the workforce they retain their family obligations as nurturers, shoppers, and homemakers. Because of the time commitments involved in these activities, and the need to be nearer to children in case of a school emergency call, women choose work locations in order to minimize travel and maximize productive uses of their time *(29)*.

Susan Saegert has written that men who enter the workforce rely on their wives for support, but female workers have no wives to rely upon *(28)*. Even as women enter the economic world of work in record numbers, they retain the traditional role for which the suburbs were designed in the first place. The structure of suburban life, the low densities, and the distances that must be traversed continue to limit women's full entry into what has traditionally been men's sphere, and that is not surprising because the suburbs were built with distinct sex roles in mind. Surveys have shown that men continue to prefer suburban living, but working women who value both their family roles and their work have reported that they find it easier to juggle their dual responsibilities in urban rather than suburban environments, where child care, shopping, and services are available at shorter distances from the home *(28)*. It is not surprising that this is the case, because women are now exerting extra effort and energy to blend roles that were consciously planned to take place in spatially separated locations. Transportation policies and investments made those separations possible, and it is therefore appropriate that the special travel patterns and needs of women be explicitly addressed as part of current transportation policymaking.

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The Impact of Growing Children on Their Parents' Travel Behavior: A Comparative Analysis

SANDRA ROSENBLOOM

The extent to which noneconomic variables, such as household and child-care responsibilities, explain travel behavior and are likely to do so in the future is examined. The focus is on how growing children and their travel needs affect their parents differentially. On the basis of data from 100 intact households in the United States and 200 households in the Netherlands, it is shown that working women have markedly different travel patterns than comparably situated men because they accept significant responsibility for most of the travel needs of their children. These responsibilities change as children grow older, being heaviest for the youngest (under 6) and the oldest (teenagers). It is concluded that if women continue to bear a disproportionate share of the direct or emergency responsibility for their children, travel differences between the sexes will not disappear, regardless of other economic and occupational changes.

Data from the U.S. census, the Nationwide Personal Transportation Study (NPTS), and a number of local studies show that salaried men and women often have empirically different travel patterns; women use transit more for their work trips, spend less time commuting, and work closer to home than men. Moreover, women are often not as well served as comparably situated men by the mass transit on which they seem to depend: they often have suburban-to-suburban commutes rather than the radial transportation patterns best served by traditional transit, and they have security and safety concerns about transit use that men do not.

These data raise both policy and methodological questions. Some analysts and advocates argue *(1, 2)*, against strong opposition, that these data indicate that there is a "women's transportation" problem, that is, a set of undesirable situations faced by women alone. Not surprisingly, most of these making this argument call for government redress of part or all of these problems.

Methodologically, some analysts question how well transportation models, which rarely incorporate sex or individual characteristics, as opposed to household characteristics, can predict or analyze travel behavior. Most commonly used transportation models are based on the assumption that travel behavior is correlated with only a few household economic variables and that sex is not a predictive variable.

Researchers have asked whether such methods recognize or take into account the different transportation patterns of women *(3)* or their differential response to transport system characteristics *(4; 5*, pp. 381–416). Several analysts have suggested that dramatic increases in female labor force participation, particularly by mothers of young children, call into question the underlying assumptions of many travel demand models *(6–9; 10*, pp. 151–158).

The important questions for both policy analysts and methodologists are, What causes sex differences in travel and will they continue? If they do continue, will they continue long enough to warrant policy concern or alterations in planning methodology?

The focus of this paper is the extent to which noneconomic or social variables explain travel behavior now and are likely to do so in the future. In particular, this paper focuses on how growing children, and their travel needs, affect their parents differentially. The analyses presented show that working women have markedly different travel patterns than comparably situated men because they accept significant responsibility for most of the travel needs of their children and for sick children. These responsibilities change as children grow older, being heaviest for the youngest (under 6) and the oldest (teenagers).

CAUSAL ANALYSIS OF TRAVEL DIFFERENCES

Are observed travel differences between men and women the result of social and cultural norms or economic factors? The dominant economic school of thought is that travel characteristics are linked to economic variables; women, who work in lower-skilled occupations and who are traditionally paid poorly, travel less and use transit more frequently because such behavior is economically rational.

If this is so, rising real wages (and concomitant increases in occupational status) will cause working women to behave more and more like comparably situated men. Therefore, a case can be made that there are only short-term differences in travel; as historical economic and occupational disadvantages disappear, travel differences will disappear.

Other researchers argue that women's travel characteristics are closely linked to the household and domestic roles or responsibilities that they accept. There is a growing body of empirical work that suggests that women of all socioeconomic groups have different travel patterns because they have accepted a variety of household and child-care responsibilities that comparably situated men do not.

Hanson and Hanson *(11)* found that Swedish working women had significantly different travel patterns than their

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spouses, women making more shopping and other domestic-type trips and fewer social and recreational trips, and more often using public transit (although presumably both spouses had equal access to the car).

Rosenbloom *(10, 12)* found that women in three separate cultures—France, the United States, and the Netherlands—had very different travel patterns than comparably situated men; in all situations women were more likely to be motivated in their travel and employment choices by their household responsibilities.

Pickup *(13)* found that British women in Reading with the most child-care obligations made the shortest work trips, passing up better jobs with longer commute times. Pickup found little indication that traditional economic variables explained work travel distances; he concluded from both national British statistics and in-depth Reading studies that women are constrained from traveling farther from home by "gender role activities" and not by travel costs (*13*, p. 101). Although Pickup found a general tendency for longer work trips to be associated with higher pay for both men and women, a significant number of women were willing to commute a long distance for fairly low pay if they had no family restrictions.

Although it is beyond the scope of this paper, it is hard to ignore the disturbing body of information suggesting that even if travel differences were all explained by economic variables, the disparity in income between men and women is not narrowing appreciably. For policy analysts this economic reality may make debates over the causal explanations of travel differences meaningless, although it is possible that the same noneconomic variables that motivate women's travel behavior explain some of their economic plight.

In order to address the causes of travel differences between the sexes, an analysis will be made of the travel patterns of comparably situated, salaried male and female parents in Austin, Texas, with children of different ages. The analyses will concentrate on four variables related to children's needs or household activity: trips linked to work trips, trips made solely for children, children's travel patterns, and parents' response to sick children.

The analyses show that acceptance of these household roles and chauffeuring duties leads to both short-term and long-term differences in women's travel behavior: in the short term these needs become incorporated directly into women's travel behavior, making it different than that of comparably situated men. In the long run, women accepting these obligations may perpetuate their economic dilemma by accepting marginal employment and jobs closer to home in order to efficiently carry out domestic duties and to be available to children in need.

It is hard not to be struck by how some of women's short-term and long-term transportation problems are in reality a result of their children's transportation problems—of children's inability to find safe, convenient, available transportation for their needs.

An examination of the travel patterns of Dutch children in similar households reveals that although Dutch working women carry an even more disproportionate share of household responsibilities than American women, they are far less likely to chauffeur their children or address the majority of their children's travel needs. The availability of transportation alternatives for their children frees these women of some of their transportation burden.

In the following sections the study from which these data are drawn and the comparative analysis of the four major travel variables are described. In conclusion, the comparative Dutch travel data are examined.

SURVEY DATA AND METHODOLOGY

The analyses and data presented in this paper are part of a larger comparative study of the transportation implications of the increasing involvement of mothers in the paid labor force in the Netherlands, the United States, and France. Small-scale attitudinal surveys were undertaken between 1982 and 1985 in all three countries; respondents were married and single workers with children of various ages. One hundred intact families and 50 families headed by currently unmarried mothers were interviewed in Austin, Texas; 150 intact families and 50 single-parent families were interviewed in Rotterdam. The two communities are not alike and were chosen largely for convenience and internal policy considerations. A complete description of the overall study and the survey methodology has been given elsewhere *(8, 9)*.

Because of the small sample size, many of the following observations are not statistically significant at high confidence levels. However, the small sample allowed the collection of detailed and complete responses to a variety of factual, attitudinal, and hypothetical questions.

Trip information is based on responses to particular questions and does not represent trip-diary data; this approach has both strengths and weaknesses. Memory is uncertain without written reinforcement; moreover, it is hard to tell how often a trip called "frequent" or "usual" is really made if the respondent is not required to keep daily records. But this approach may have significant advantages over travel diaries for one or two "average" days; there is growing evidence of the variability of travel behavior over a week. Those chauffeuring children and accepting household duties may well have the most varied weekly schedule.

TRAVEL BEHAVIOR

In the following analysis, the travel behavior of men and women working more than 35 hr a week is explored in terms of four variables: trips linked to and from work, trips made solely for children, children's travel modes, and responsibilities for sick children.

The four variables are directly related to either travel behavior or household responsibilities, although not necessarily to both at the same time. From the overlap of these responses, a preliminary portrait of the travel patterns of working parents with children of different ages can be drawn.

Linking Work Trips

Figure 1 shows the significant differences between working men and women whose youngest child was either very young or a teenager; 65 percent of all salaried women with children under 6 linked trips to work, although only 42 percent of comparably situated men did so. Working men were less and less likely to link trips to work as their children got older.

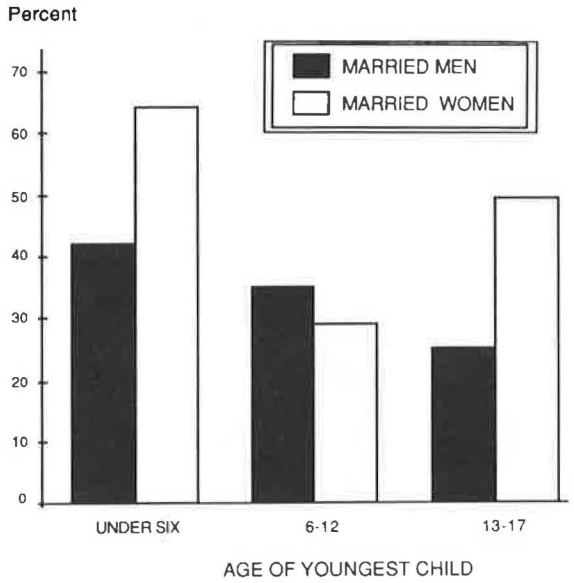

FIGURE 1 Percentage of parents who link trips to work.

Although the majority of working women linked trips when they had small children, less than a third did so when their youngest child was 6 to 12, and half did so when they had teenagers.

Figure 2 shows how parents linked trips from work; as is common nationally, far more adults of both sexes reported linking trips on their way home. Yet the linking behavior of men appeared unaffected by the age of their children; roughly three-fourths of all men linked trips regardless of their children's age.

The data for working mothers were similar to those for trips to work: more than 80 percent of mothers of young children linked trips from work, only half of all mothers with children 6 to 12 linked work trips, but almost 90 percent of the mothers of teenagers did so.

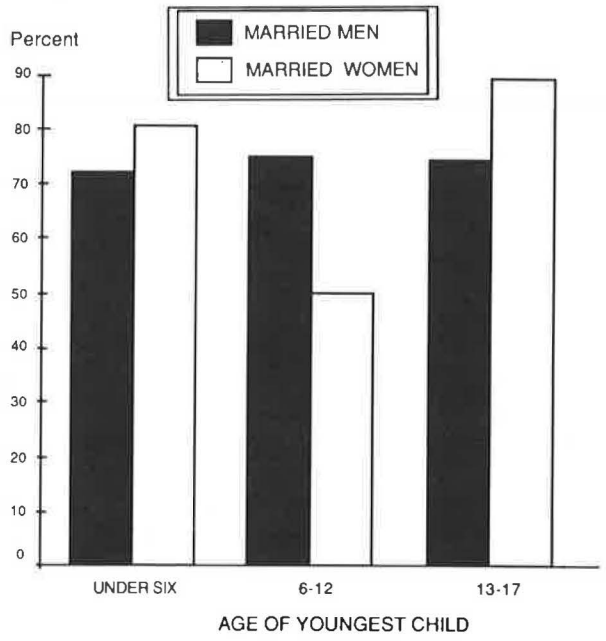

FIGURE 2 Percentage of parents who link trips from work.

It is not possible to say exactly what caused these differences, but a look at the trip purpose data in Tables 1 and 2 is revealing. In general, working mothers with very young children made a greater variety of trips and more of their trips were directly related to their household responsibilities (shopping) or their children (school).

TABLE 1 TRIP PURPOSE BY PERCENTAGE OF PARENTS WHO LINK TRIPS WITH WORK TRIPS: CHILDREN UNDER 6

	To Work		From Work	
	Men	Married Women	Men	Married Women
Recreation	7.7	4.5	14.3	10.3
Shopping	31.0	27.2	47.6	44.8
Personal Business	34.0	31.8	33.3	38.1
School	-	9.1	-	-
Volunteer Activities	7.3	13.6	4.8	3.4
Medical	-	13.8	-	-
Other	-	-	-	3.4

TABLE 2 TRIP PURPOSE BY PERCENTAGE OF PARENTS WHO LINK TRIPS WITH WORK TRIPS: CHILDREN 6 TO 12

	To Work		From Work	
	Men	Married Women	Men	Married Women
Recreation	-	-	5.3	7.4
Shopping	40.0	14.2	52.6	44.0
Personal Business	60.0	57.1	31.6	30.0
School	-	28.6	-	11.0
Volunteer Activities	-	-	5.3	-
Medical	-	-	5.2	7.4
Other	-	-	-	-

The parents of older children of both sexes appeared to link similar trips with their trips to and from work: shopping and personal business were the two major trip links. But fewer men made linked trips, and women were making far greater numbers of trip links reflecting domestic responsibilities whatever the age of their children.

Trips Solely for Children

All full-time working parents in all households were asked whether they ever made trips solely for their children and not because they themselves needed to be somewhere. Both men and women said yes, although Figure 3 shows that the percentages dropped sharply as children grew older.

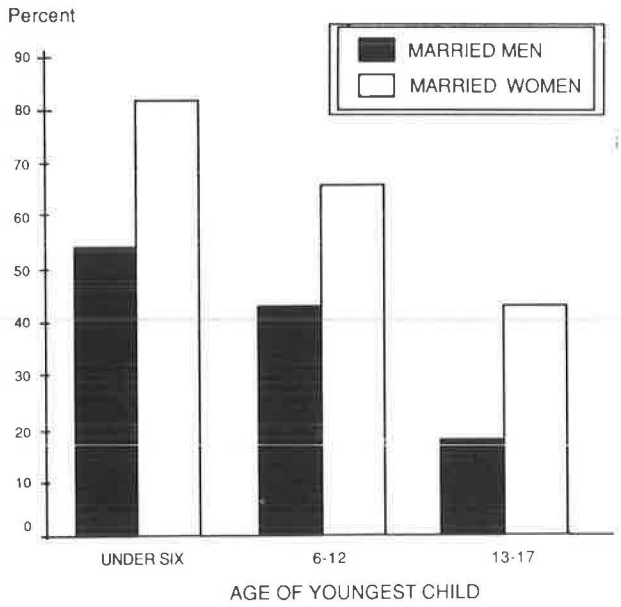

FIGURE 3 Percentage of parents who make trips solely for their children by age of youngest child.

Women were far more likely to make trips for their children; almost 82 percent of all married women with young children did so. Although the percentage of trips dropped sharply as their children aged, almost half of all married women continued to make trips to chauffeur their teenagers. Slightly more than half of all men made trips solely for their children when their youngest were under 6, but only 18 percent of men did so for their teenagers.

Figures 4–6 give data on the types of trips made for children by their parents as the children grew up. When children were young, mothers and fathers differed only slightly in the kinds of trips for which they chauffeured their children; recreation trips were the most common for both parents, but fathers were more likely to take children to organized school or church activities as their second most frequent trip purpose.

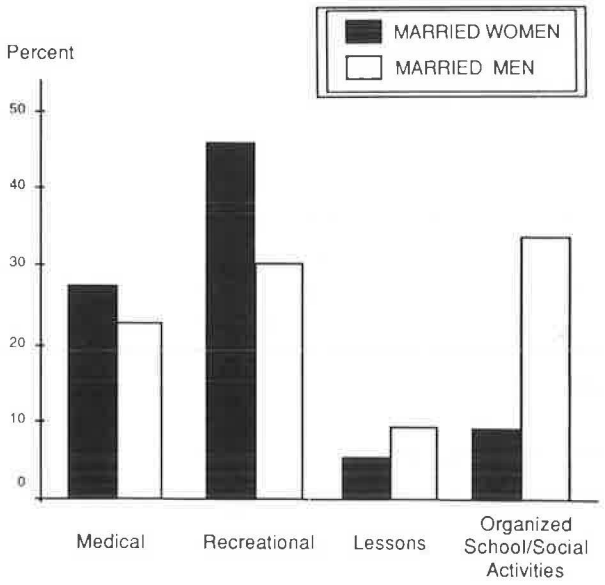

FIGURE 4 Percentage of all trips made by parents solely for children under 6 by type of trip.

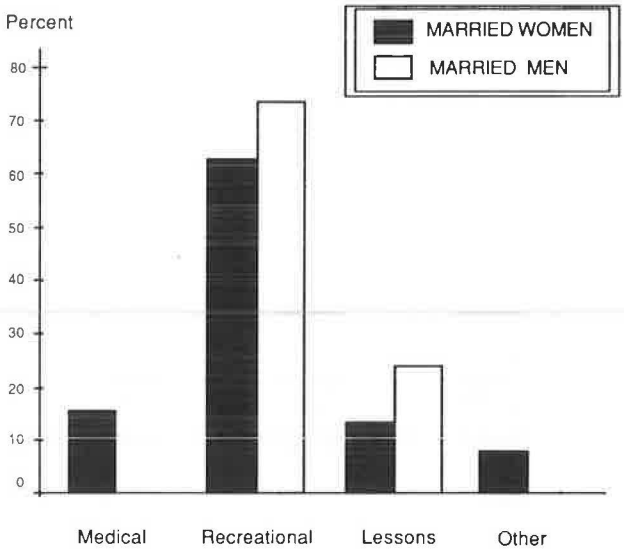

FIGURE 5 Percentage of all trips made by parents solely for children 6 to 12 by type of trip.

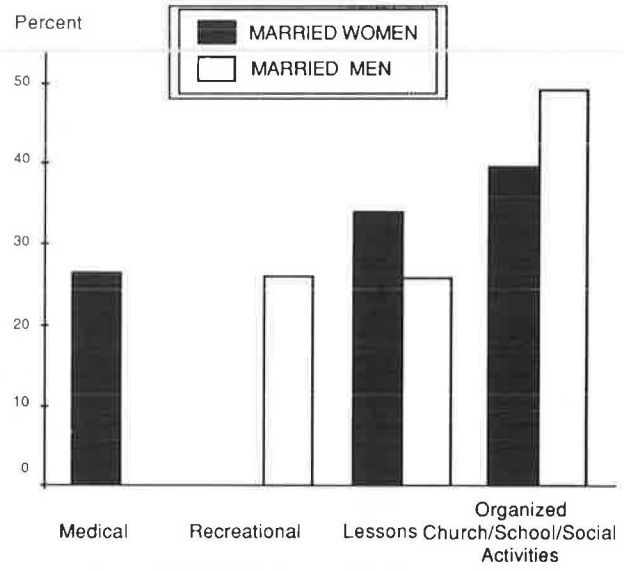

FIGURE 6 Percentage of all trips made by parents solely for children 13 to 17 by type of trip.

As children grew up, fathers, who were making far fewer trips solely for their children, largely made recreational trips; three-fourths of all their trips for children 6 to 12 were for recreation. The small number of fathers (18 percent) who made trips for teenagers also made recreational and organized social trips.

As children grew up, mothers continued to provide a variety of trips, including medical and organized church or school activities. By the time their youngest children were teenagers, the 88 percent of all women chauffeuring their children were making no recreational trips but continued to make trips to doctors, organized activities, and lessons for their children.

Figures 7 and 8 show the reported frequency of trips made solely for children. The frequency data are very illuminating;

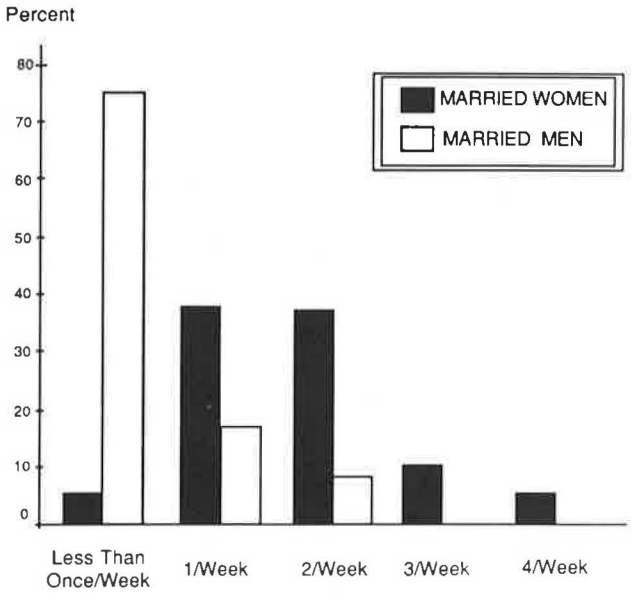

FIGURE 7 Percentage of trips made solely for children under 6 by frequency of trips.

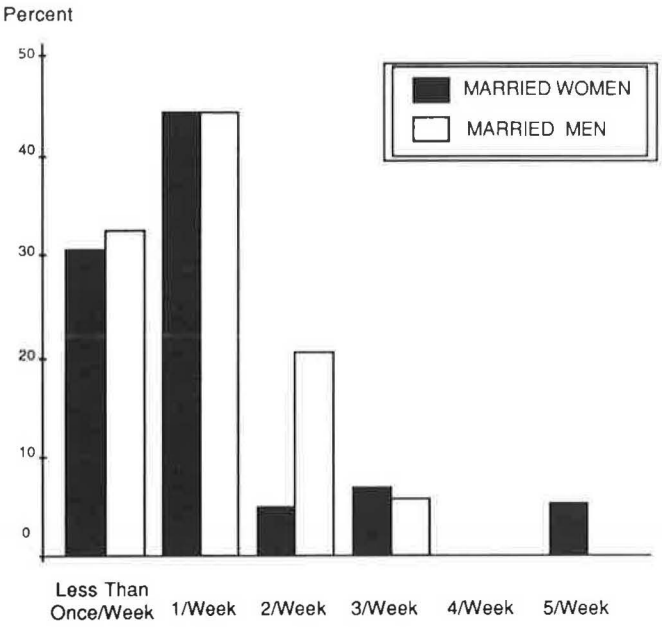

FIGURE 8 Percentage of trips made solely for children 6 to 12 by frequency of trips.

of the 54 percent of men who reported making such trips for their children under 6, the overwhelming number, 75 percent, did so less than once a week. Of the more than 90 percent of all women with young children who reported such chauffeuring duties, most did so once a week or more, 16 percent doing so more than three times per week.

Both parents were less likely to chauffeur slightly older children, although the drop was far larger for men; only 40 percent of fathers but 64 percent of married mothers answered in the affirmative. Of the smaller number of fathers who did so, the trips in question were made more frequently than those made by fathers of younger children. The majority of fathers reported making trips once or twice a week for these children; it should be recalled that 75 percent of all these trips were for recreation.

Mothers' frequency patterns were similar to men's for children 6 to 12 although, as described earlier, trip purposes were different. Most mothers made one trip a week for their children, although approximately 15 percent were made more than once a week.

The patterns for mothers and fathers are very different for teenagers. The overwhelming number of trips by the 18 percent of fathers who made trips for teenagers were made less than once a week. Of the 46 percent of mothers who continued to make trips solely for their children, over a third were made once a week or more, with 15 percent being made three times a week.

Although it is difficult to see clearly from these data what is happening, some observations seem reasonable. Mothers of very small children are overwhelmingly the chauffeur for these children; the majority of trips being made by men are made very infrequently and appear to serve a back-up or emergency function.

Children from 6 to 12 probably make fewer trips not covered by their school or caretakers. So both mothers and fathers make fewer trips, although far more mothers still provide the trips needed. The frequency of the trips, however, declines so that the majority of both parents are making trips once or less than once a week.

Children from 13 to 17 are probably far more active than younger children but probably have more alternative travel modes than younger children. However, almost half of all mothers feel obliged to continue to chauffeur them to activities that appear to occur more frequently than those of children 6 to 12. However, few fathers appear to be willing or able to involve themselves in these teenage patterns; when they do so, it is very infrequently.

Children's Travel Modes

Working parents were individually asked to describe their children's most frequent travel mode; there was a very high degree of agreement among fathers and mothers. Figures 9 and 10 show the percentage of responses for children of different ages. Both parents agreed that the mother was the most frequent travel "mode" for children of all ages; roughly 60 percent of all respondents reported that the mother provided transportation most frequently.

Interestingly, more parents of both sexes reported that "other adults" were the primary travel provider than reported that the father was the primary provider. Roughly 5 percent of all women and 2 percent of all men reported that the father was the primary travel mode for children under 6; 7 percent of all men but no women reported that fathers were the primary provider of travel for children 6 to 12.

Equally shared chauffeuring was more likely to be reported for younger children; approximately 12 percent of both parents reported that the younger child's most frequent travel mode was "both parents equally." However no father or mother reported equally shared transportation provision for older children.

Other travel modes that did not require the presence of an adult, or more likely a car, were not frequently reported. Roughly 11 percent of all mothers reported that their slightly

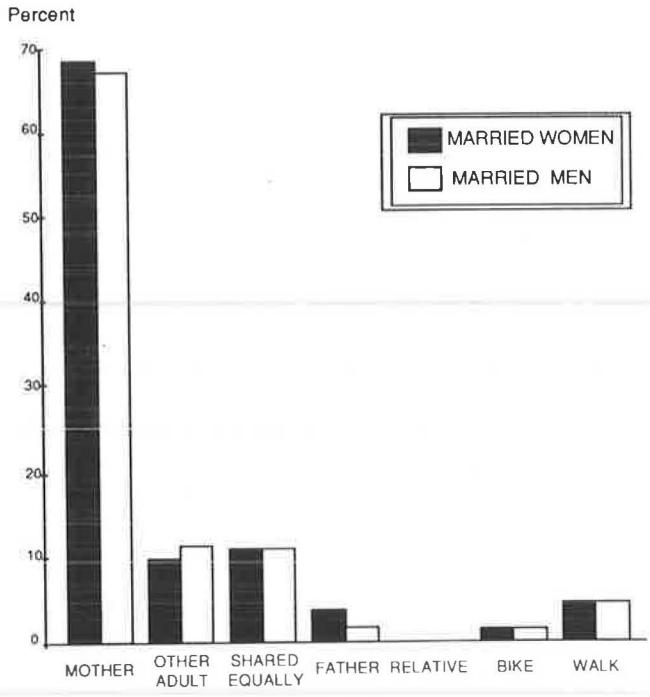

FIGURE 9 Children's most frequent travel mode as reported individually by parents for children under 6.

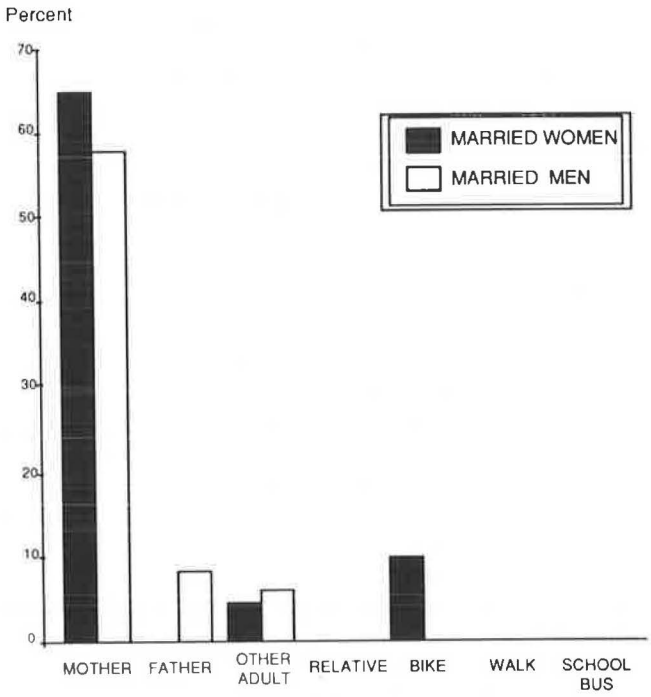

FIGURE 10 Children's most frequent travel mode as reported individually by parents for children 6 to 12.

older children relied more on bikes than on people. Although single mothers, not reported on in this paper, reported bus use by their children *(12)*, no married respondent reported that this was the most frequent travel mode for their children of any age.

Responsibility for Sick Children

Working parents were asked who had responsibility for sick children of various ages if they could not remain in school or childcare. This is, of course, not directly a transportation question; rather it addresses the larger issue of how the continued assumption of household or domestic roles may affect long-term employment decisions, which in turn create short-term transportation patterns.

Specifically, workers were asked what happened if a child became ill; Tables 3 and 4 give the data on answers reported by mothers. The mother was overwhelmingly the adult who changed activities to fit the needs of all children; 56 percent of mothers with sick children under 6 and 64 percent of mothers with children 6 to 12 stayed home or missed some work. Other adults, related and unrelated, were all more likely to care for sick children than the father. In fact, fathers were only slightly more likely (13 percent) to alter their schedules than the family was to use a paid sitter (7 percent).

TABLE 3 CARE OF SICK CHILDREN: MOST COMMON OPTION

OPTION	Child Under Six	Child Six to Twelve
Mother misses work	56	64
Father misses work	13	14
Care by:		
Relative	12	15
Unrelated Adult	6	0
Paid Sitter	7	0
Child Left Alone	6	7

TABLE 4 CARE OF SICK CHILDREN: SECOND OR BACK-UP OPTION

OPTION	Child Under Six	Child Six to Twelve
Have None	44	36
Mother misses work	25	14
Father misses work	0	0
Care by:		
Relative	0	8
Unrelated Adult	25	21
Paid Sitter	6	8
Child Left Alone	0	13

Table 4 also gives back-up or second alternatives for sick children. Not one mother reported that the father would be the back-up; that is, if the father was not available as the primary option, he was totally unavailable as a back-up. Other unrelated adults were reported as the most likely back-up option for sick children of all ages. The 25 to 35 percent of respondents in Table 3 who specified an adult other than the mother as the primary sick-child caretaker simply reported the mother as the secondary caretaker.

There are some sobering data in Tables 3 and 4. First, a small number of parents report leaving sick children home alone, even children under 6. But it is not particularly fanciful to assume that some number of the roughly 40 percent of respondents who simply could not think of any back-up option would in fact leave those children home alone.

COMPARATIVE ANALYSES

These findings show that the transportation patterns of working women are influenced heavily by their children's travel needs. It seems likely that such influences have long-term implications as well. It might be interesting, therefore, to briefly examine some comparable data about Dutch working women and see how differences in the resources available to Dutch children affect the travel needs of their parents.

Dutch working parents were asked if they ever made trips solely for their children; the data in Figure 11 show that there are many similarities to U.S. data, although there are important differences as well. Roughly 75 percent of fathers of very small children reported that they made trips solely for their children—comparable to similar U.S. fathers—but no fathers of older children reported that they did so.

Dutch women were as likely as U.S. women to make trips solely for very young children, but even more likely to make trips for children 6 to 12. Overall, more than 70 percent of Dutch working mothers of children of all ages reported that they made trips to take their children somewhere. However, because Dutch women may have absorbed those trips not made by Dutch fathers that are made by American fathers, Dutch parents as a couple probably are as likely as Americans with small children to ever make parent-chauffeured trips.

As with U.S. data, frequencies are illuminating. Figures 12 and 13 show the frequency of trips made for Dutch children of various ages. Dutch women make far less frequent chauffeuring trips than comparably situated U.S. women; over 60 percent of all trips for children under 6 are made once a week or less and the number rises to close to 80 percent for children 6 to 12.

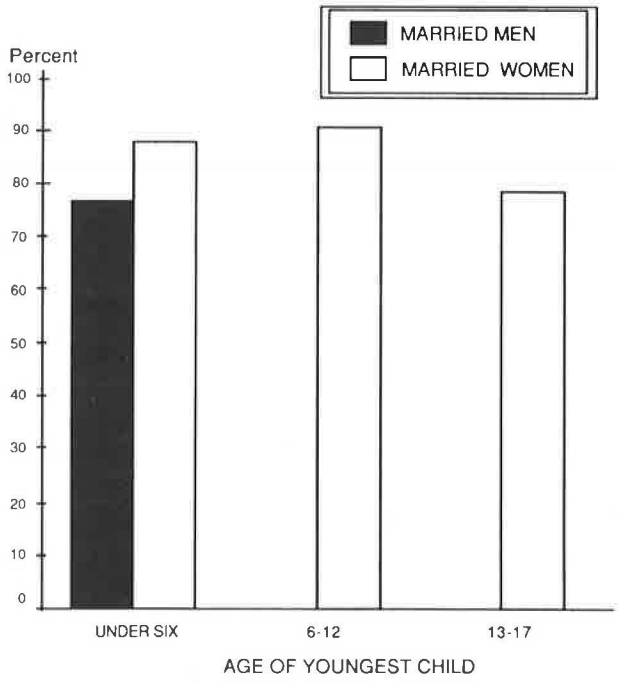

FIGURE 11 Percentage of trips made by Dutch parents solely for their children by age of youngest child.

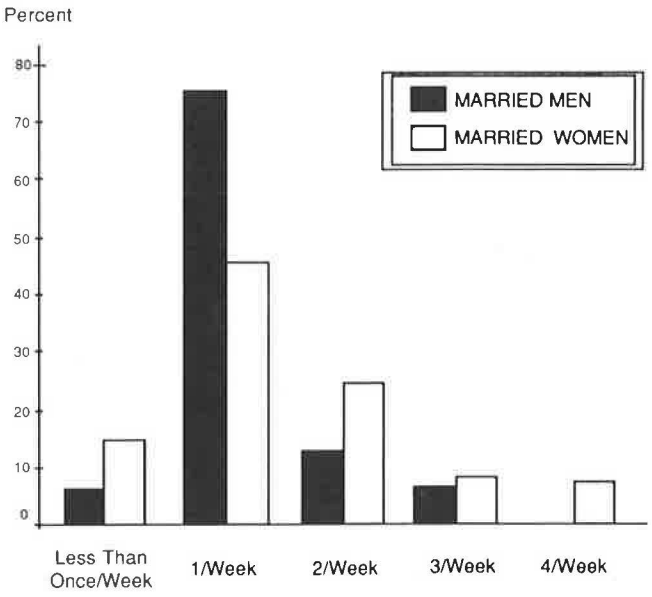

FIGURE 12 Percentage of trips made by Dutch parents solely for their children under 6 by frequency of trips.

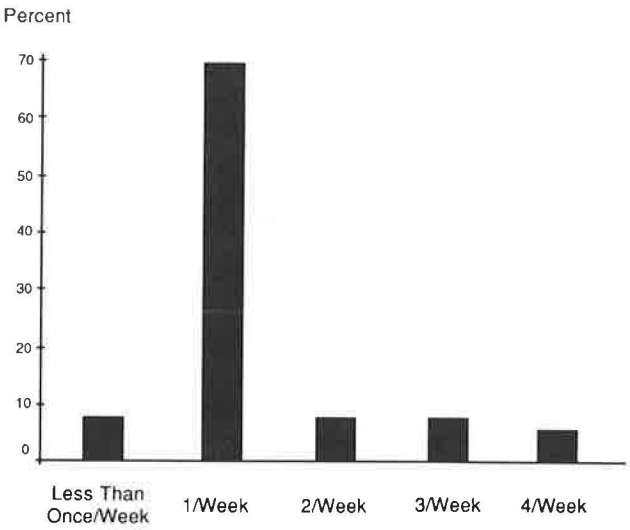

FIGURE 13 Frequency of trips made solely for Dutch children by their mothers; children 6 to 12.

In other words, although Dutch working women are more likely to make serve-passenger trips than American mothers, the trips they make are made far less frequently. Because Dutch men are making more frequent trips for their young children than comparable U.S. men, it is possible that children under 6 receive roughly comparable numbers of parent-chauffeured trips. But another explanation is necessary for older children.

Rotterdam and Austin are very different cities in very different cultural contexts, and it is dangerous to ascribe too much to simple answers. But certainly one possibility is that the greater transportation alternatives offered to children free patents from the need to see to all their children's trips. Table 5 provides data on one aspect of this situation.

Dutch working women were asked if their children routinely or frequently traveled alone; only 21 percent of

TABLE 5 PERCENTAGE OF DUTCH CHILDREN TRAVELING ALONE AND MOST FREQUENT TRAVEL MODE

Under 6	6-12	13-17
21	92	100

Mode of Travel for Those Travelling Alone
(PERCENTAGES)

	Under 6	6-12	13-17
Mass Transit and Train	58	58	43
Bike	8	42	43
Walk	34	-	9
Motorcycle	-	-	5

mothers reported that their children under 6 travel alone, but the number rose to 92 percent for children 6 and over, and was 100 percent for teenagers. Table 3 also gives data on the mode that these children use; it is clear that they rely heavily on bikes and mass transit. Bicycles are, of course, a major feature of Dutch culture; they are heavily used by adults and account for 25 percent of the Rotterdam home-to-work commute.

It is not reasonable to assume that Americans will ever heavily depend on this mode of travel, although it is interesting that a mode that was once synonymous with children's travel no longer plays a major role in U.S. children's life. Still the existence of workable transportation options that are considered safe and secure enough for fairly young children probably explains why Dutch women make fewer chauffeured trips than their American counterparts.

Mass transit and bikes are hardly a panacea for Dutch women; in spite of extremely good transit facilities and strong support for cycling, mothers still make many chauffeuring trips, and their travel patterns are still strongly affected by their children's needs *(8, 9)*. In fact, the availability of alternatives—whether used or not—seems to have given their spouses less reason to meet their children's needs.

IMPLICATIONS

The data and analyses presented show that U.S. women have significantly different travel patterns than comparably situated men because they accept primary and sometimes almost exclusive responsibility for their children. Some of these analyses directly addressed current travel behavior, for example, making trips solely for children; others only indirectly addressed travel by suggesting that women with primary child-care responsibilities will always make interconnected travel–employment–child-care decisions differently than comparably situated men.

Although these analyses do not address longer-term questions of employment and travel choices, they suggest that women are indeed under strong pressure to make major economic as well as transportation decisions based on the explicit or implicit acceptance of either certain domestic roles or certain family responsibilities. The larger economic trade-offs may not be clear to any working parent, but it is unlikely that women with primary child-care or other obligations could accept longer work commutes or more demanding—if higher-paid—jobs.

The discussion also suggests that there is a women's transportation problem that can be differentiated from the problems that men and those who are not parents face, and that embedded in the women's transportation problem are the transportation problems (including safety and security issues) facing their children.

What the foregoing analysis did not directly address is whether this problem will continue. It seems reasonable to assume that if women continue to bear a disproportionate share of direct or emergency responsibility for their children, the travel differences generated by these responsibilities cannot disappear without remarkable changes in other societal systems. Even if women did not make longer-term decisions based on these responsibilities, and society changed so that women were able to increase their occupational and income levels, it is still clear that they would have different travel patterns than comparably situated men.

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Daily Commuting Time: The Stakes for Working Mothers in France

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The length of daily commuting time between the home and the place of business accentuates the difficulties encountered by salaried mothers in reconciling their professional and familial roles. The majority refuse jobs at too great a distance from their homes. Nevertheless, a study conducted among mothers of children under 16 years of age brings to light two radically different forms of behavior corresponding to two different strategies. In the first case, proximity of employment is an absolute priority and long commuting time an insurmountable obstacle. Among the mothers who adopt this behavioral attitude, many have little formal education and occupy positions requiring few skills; thus much more is at stake in the distance to their place of business because they less often have a car at their disposal for commuting than do other salaried women. In the second case, there is a strategy of greater investment in professional life: full-time work and the acceptance of long commuting time in order to occupy a more skilled position. These salaried mothers are, of course, managers, but also, in not inconsiderable proportions, office workers and skilled workers. For working mothers, maneuverability in time management is also determined by the urban context. Salaried mothers put more time into commuting in the metropolitan Paris area than in the provinces. In return, they have access to a larger range of jobs served by an elaborate network of public transportation. Primary and secondary teachers seem to benefit from the best working conditions: they often work close to home and declare much more frequently than do other working mothers that they have some free time.

There has been a dramatic increase in the female labor force in France since World War II and especially since 1962. This growth was essentially due to the increasing percentage of married women working outside the home: for example, the rate of economically active women aged 30 to 34, living conjugally with a man, and having two children rose from 27 percent in 1962 to 65 percent in 1982 and from 13 to 32 percent for those having three children. In addition, 8 of every 10 working women are salaried employees. It may be implied that the place of residence is spatially dissociated from the work place and that working mothers consequently face strong pressures on their time. As many studies conducted in different places at different times and the author's prior research have shown *(1–6)*, married women tend to be much more preoccupied than men with working close to their home and having shorter journeys to work. As a matter of fact, analyses of the activity patterns and time-scheduling studies of women and men have demonstrated that the tenacity of traditional sex roles and the need to reconcile the demands of work with those of family life require working mothers to devise coping strategies that may include reducing their travel time. Even if the husband contributes some time to household chores, as is often the case in the "new middle classes," and even if the wife is relieved of some of the physical burden of housework, the responsibility of the home remains essentially hers *(7)*. Therefore, it is proposed here to focus on the commuting time of working mothers in France in relation to some other aspects of their daily life and to analyze the effect of the journey to work on their strategies for reconciling their professional and family commitments.

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METHODOLOGY AND HYPOTHESES

The data used were from a survey conducted in 1981 by the Institut National des Etudes Démographiques and by the Centre d'Etudes et des Coûts among a representative national sample of all mothers having at least one child under 16 years of age at the time of the survey (n = 3,935). Of these, those who held salaried employment (n = 1,827; 46 percent) outside their home were selected. Because the question, as posed, asked women to estimate their (one-way) commute times, some of the answers may of course contain an element of subjectivity, tending to overestimate when this trip was "stressful." On the contrary, others may underevaluate this time in order to rationalize their choices a posteriori.

In addition, there is a lack of information about women's job opportunities near the place of residence. The questionnaire was not elaborated in order to specifically study travel to work. The relationships between the residential choice of household and the place of the mother's job are not known. In fact, as recent data on the metropolitan Paris area (MPA) suggest, families may try to live close to the woman's work place in order to facilitate her reconciliation of household responsibilities with a job. In the MPA, the residential patterns of households in which both parents work are different from those in which only the husband works. The former are much more frequently located in or near the urban center (where half of the metropolitan women's jobs are concentrated). In the suburbs, where there is a lack of women's jobs, noneconomically active married women are overrepresented. In this study, the focus is on some factors affecting mothers' work-trip times and their impact on some aspects of their daily life.

The background of this study takes into account that spatial organizational characteristics, particularly in metropolitan areas, are not especially adapted to working mothers, torn—in time and space—between their place of residence and their job location. The spatial division of work and the "functional

specialization" of the different parts of suburbs magnify the difficulties encountered by women in combining family life with a job.

But it is hypothesized that if time is a critical factor in job choices for mothers who are unskilled or poorly educated, it constitutes a less important stake for mothers who are highly educated and privileged.

Reluctance of Working Mothers to Work Far Away from Home

Half the mothers working outside the home commute for less than a quarter of an hour (one way), whereas only about one-third of the total working population spends this amount of commute time *(8)*. The last census also showed that female employees having at least one child under 14 spend 3 hr 15 min in commuting each week compared with 4 hr 5 min for women employees without any children under 14, and 4 hr 45 min for men employees *(9)*.

These data reflect the reluctance of many mothers to work far away from their residence. As Maurice and Delomenie *(10)* observed in their study on women married to blue-collar workers in Marseilles, mothers preferred to take any kind of job near their residence rather than commute farther away to get a better-paid and higher-status job.

However, travel time among working mothers varies according to miscellaneous variables, as will be seen.

Influence of Urban Size on Travel Time

Working mothers living in small and middle-sized towns have the shortest trip times: 64 percent spend less than 15 min commuting compared with 50 percent for the whole sample. At the opposite end of the scale, those living in the MPA have the longest trip times: almost half (48 percent) of the journeys to work take 25 min or more and one-third, 40 min or more. This phenomenon is explained by the greater reliance on public transportation; the scarcity of parking opportunities in the central areas where 75 percent of the women's jobs in the MPA are located; the long journey-to-work distances, which in part reflect the spatial distribution of women's employment opportunities vis-à-vis their spatial distribution of residences; and the overrepresentation of women in management and as skilled office workers (27.5 percent of working mothers in the MPA are in high- or middle-level management compared with 15.9 percent of those living in the rest of France).

As a matter of fact, middle- and high-level management, other professionals, and office workers have the longest trip times almost everywhere, partly as a result of their concentration in the centers of the service- and office-related occupations. However, the urban patterns of the MPA accentuate the differences between the occupational categories. The time and spatial constraints here are so strong that this could explain in part why the rate of employment among married women decreases with the distance into the suburbs *(11)*.

Teachers (primary, secondary, and college) are especially favored. They tend to work close to home, even in the MPA (51 percent are less than 15 min from their home compared with 38 percent for management and other professionals), thanks to the equal spatial distribution of educational institutions.

Travel Time to Work Reduced as Number of Children Increases

The average travel time regularly decreases when the number of children increases in the MPA as well as in the provinces (asterisk indicates data not significantly different at 5 percent):

	Travel Time (min) by Residence	
No. of Children	*MPA*	*Provinces*
1	31.2	16.1*
2	26.3	15.1*
3 or more	24.4	12.6

These data corroborate those of the 1982 census *(12)*. The proportion of married women who work in their own residential neighborhood regularly increases with the number of children. But the categories "unskilled manual workers" and "service workers" are much more susceptible to travel time: 63 percent spend less than 15 min commuting when they have three children or more compared with 51 percent for those who have only one child. On the other hand, the number of children does not have any significant effect on the travel times of management, other professionals, and office workers.

When level of education is taken into account, a distinction can be observed between uneducated or poorly educated mothers and highly educated mothers (i.e., with or without a high-school diploma). (In order to have sufficient numbers in each sample, a distinction was feasible only between low and high educational levels.) For the poorly educated, the percentage of long travel times (more than 25 min) decreases as soon as there are two children in the family, whereas for highly educated mothers, this percentage decreases only when there are two to three children. For the mothers living outside of the MPA, the same phenomenon can be observed (Table 1).

TABLE 1 AVERAGE TRAVEL TIME ACCORDING TO NUMBER OF CHILDREN AND LEVEL OF EDUCATION

No. of Children	Poorly Educated[a]	Highly Educated[b]
Whole Sample		
1	18.1	19.5
2	16.7	19.3
3	13.7[c]	15.4[c]
Mothers Living in Provinces		
1	16.1[c]	16.4
2	14.3[c]	17.2
3	11.9[c]	14.5

[a]No high school diploma.
[b]High school diploma or more.
[c]Significantly different at 5 percent.

Therefore, the benefits obtained by a profitable and socially valued job seem to compensate for the disadvantages of long travel times. Within the MPA, for example, management and other professionals who assume responsibility for others (33 percent) have significantly longer travel times than those who de not have this responsibility (65 percent compared with 47 percent). The same distinction is found between office workers who have many promotion opportunities and those who do not (60 percent compared with 46 percent).

On the other hand, mothers who are poorly educated or unskilled seem all the more reluctant to work far away from their home because the additional incentives are insufficient *(13)*. In addition, they devote much more time to their household responsibilities than do the more privileged mothers and do not benefit from paid household help *(14)*. Moreover, their access to the labor market is all the more spatially restricted because they also less frequently have access to a car than do the mothers with more education and skills, as will now be seen.

Travel to Work and Means of Transportation

Almost 6 of every 10 working mothers (58 percent) use a car (as a driver or as a passenger) to commute. Only 15 percent use public transportation. Service and unskilled manual workers rely greatly on foot travel, bicycles, mopeds, or a bus service offered by their employer. The data in Table 2 reveal that, concerning two-car households and access to a car (as a driver or as a passenger), these occupational categories are the most penalized, because the use of a car allows the reduction of travel time and the enlarging of job opportunities.

TABLE 2 DISTRIBUTION OF MOTHERS COMMUTING BY CAR ACCORDING TO OCCUPATIONAL STATUS

Occupation	Living in Two-Car Household (%)	Commuting by Car (%)
Teacher	55	70
Management	47	69
Office worker	42	64
Sales worker	37	62
Blue collar		
Skilled	30	63
Unskilled	24	44
Service worker	25	31
Total	38	58

Of course, in the MPA, as a result of their greater reliance on public transportation (44 percent compared with only 10 percent in the rest of France), all working mothers have much longer travel times (75 percent of the work trips made by public transportation last more than 20 min). The diverse professional advantages that Parisians may have are often offset by long commute times and their consequences on the worker's remaining time.

Daily Life and Travel Times

In coping with the problems of time and spatial constraints, working mothers elaborate different compromises, depending on many factors. One-fourth of the mothers in high- and middle-level management and office workers work full time (39 hr or more a week) and spend at least 1 hr every day commuting, whereas only 12 percent of the service workers and the unskilled manual workers do so. A part-time job is a more and more frequent solution for working mothers, especially those for whom family responsibilities still take precedence. For example, part-time jobs are much more frequent among unskilled manual workers than among management or other professionals (20 percent compared with only 14 percent) and are more often associated with short travel times. This phenomenon reflects the priority given by most of the poorly educated women to their family responsibilities over their work obligations, more especially because they often have no career prospects and earn low wages.

The number of meals (mid-day and evening) eaten at home during the working day according to occupational status confirms the heterogeneity of attitudes toward family life and brings to light different forms of behavior concerning different obligations. Of course, eating at home both at mid-day and in the evening is strongly correlated with short work trips; 69 percent of mothers working 15 min or less from their residence eat all their meals at home compared with 48 percent for the whole sample; conversely, when they have long commuting times, 78 percent of the working mothers eat at home only in the morning and evening. However, for mothers working less than a quarter of an hour from their residence (half the sample), significant differences can be observed according to occupational status. Only 48 percent of management and other professional personnel take advantage of the proximity to work to have lunch at home compared with 81 percent for sales workers and 73 percent for service and unskilled manual workers. Skilled blue-collar workers and office workers occupy an intermediate position.

Free Time and Working Conditions

It was possible to see the influence of some working conditions on the perception of free time. Mothers were asked, "Do you think that you have enough free time during the week to rest or to entertain?"

The perception of free time and the requirement for it vary naturally according to different sociocultural factors. Women attached to traditional values, who give priority to their roles of mother and spouse and are often poorly educated, may put in the same category free time and the time spent to take care of their children or simply the time spent at home. For example, among mothers who are service workers, 78 percent of those who claim to have free time have both mid-day and evening meals at home during the week compared with only 40 percent of management personnel.

For highly educated and career-oriented women, free time is more frequently associated with autonomous activities: "modernist" values govern their attitudes and it seems as if the more privileged they are, the harder it is for them to be satisfied with their free time. Even if, objectively, they enjoy more time for their personal activities, thanks to their material conditions, they are more likely to give a negative answer to the question of whether they have free time. Consequently, even when they assume the same professional constraints as those of other working mothers, they claim less often to have free time than do mothers in other occupational categories, as Table 3 shows. For example, only 10 percent of mothers in management and other professions who work full time and have long commute times claim to have free time compared with 22 percent for unskilled blue-collar workers and 16 percent for office workers under the same conditions.

However, whatever occupational category is considered, the longer the work day, the more often these workers claim to have no free time at their disposal. Travel time also has a

TABLE 3 PERCEPTION OF FREE TIME BY OCCUPATION, NUMBER OF HOURS WORKED, AND LENGTH OF COMMUTE

Work and Commute Time	Percentage of Responses by Occupation[a]													
	Teacher		Management		Office Worker		Sales Worker		Blue-Collar				Service Worker	
									Skilled		Unskilled			
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Whole group	45	55	27	73	24	76	38	62	19	81	33	67	45	55
Work part time (30 hr or less)	45	55	65	35	68	32	82	18	n.s.	n.s.	59	41	73	27
Work full time with short travel time (<15 min)	–[b]	–	25	75	17	83	19	81	23	77	29	71	37	63
Work full time with long travel time (>25 min)	–	–	10	90	16	84	n.s.	n.s.	n.s.	n.s.	22	78	n.s.	n.s.

NOTE: n.s. = not significant because the numbers are too small.
[a]Mothers were asked, "Do you think that you have enough free time to rest or to entertain during the week?"
[b]Teachers are all considered part-time workers.

statistically significant influence on the perception of free time: among mothers who have a full-time job, those spending more than 25 min traveling to work claim less frequently to have free time than those having short travel times (14 percent compared with 25 percent).

Surprisingly, the number of children is not a discriminating factor for the answers on free time: 23 percent of mothers who have one child claim to have some free time compared with 16 percent of those who have three children.

Teachers, who benefit from the most convenient working conditions, also claim much more frequently than any other category to have free time (45 percent compared with 32 percent for the whole sample). In addition, a substantial proportion participate in a number of associations (26 percent compared with 10 percent for management and other professionals and only 6 percent for other working mothers).

These miscellaneous advantages and the consequent relative facility in reconciling their professional and familial roles may partly explain the attractiveness of teaching jobs for educated women and the increasing number of women teachers (especially in elementary and secondary schools).

CONCLUSION

Therefore, beyond the different strategies developed by working mothers to cope with the difficulties of daily life and to overcome the time and spatial constraints, one can say that their choices are determined not only by economic and social factors but also by urban characteristics. These characteristics appear not to be adapted to the specific needs of working mothers and especially not to those of the less-privileged group: the spatial distribution of work and the scarcity of mixed land use exacerbate the conflicts between family and professional life and tend to penalize women, especially if they have no car. Moreover, as a result of the demographic segregation in French urban areas, mothers are more likely to live in the outlying suburbs than women living alone or without children *(11)*.

Consequently, it may be seen that they often face difficult choices concerning their job; they are often obliged to accept long commute times in order to hold a job corresponding to their qualifications and requirements, which is frequently the case with career-oriented women. The higher women are in the socioоccupational hierarchy, the more readily they accept the time commitment to commuting and the freer they seem from the constraint of working as close as possible to home. At the lower end of the hierarchy, women accept whatever jobs are available near their residence because long commuting time is an insurmountable obstacle, and consequently their job choices are restricted, all the more so if they have no car at their disposal. Among these latter, many have little formal education and occupy positions requiring few skills. The lower they are in the socioоccupational hierarchy, the more difficulties they have in facing the time and spatial constraints, especially if they have two or more children. But the more privileged mothers face a strong time squeeze and often complain about the "double day burden." However, strong support was found for the hypothesis that trip time is a much more important consideration for poorly educated mothers than for highly educated mothers.

In conclusion, if it is assumed that the participatory revolution has essentially been a change in labor-force participation of wives and mothers and that young mothers are more and more willing or obliged to work outside the home, or both, one could hypothesize that the difficulties linked to spatial characteristics could, in part and indirectly, explain the declining fertility rate in France since 1965 and especially the increasing number of women refusing to have a third child.

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Effects of Aging and Motorization on Travel Behavior: An Exploration

LIDIA P. KOSTYNIUK AND RYUICHI KITAMURA

It is hypothesized that the age of a person during intense motorization of his environment influences his perceptions, habits, and expectations about transportation throughout his lifetime. Thus successive age groups of individuals form cohorts, and the travel behavior of each cohort as it ages may be very different from that of other cohorts as they age. A paradigm of cohort, age, and time effects is proposed to sort out the effects of motorization and aging on travel behavior. An analytical framework for analyzing these effects using transportation survey data from several points in time is developed. Data from origin-destination studies from Rochester, New York, for 1963 and 1974 are analyzed by log-linear models of multidimensional contingency tables. Results of the analysis indicate that the effects of age on an individual's mobility vary across cohorts. The implications of cohort-aging effects on forecasting travel behavior of future elderly populations are discussed.

Those over the age of 65 are the fastest-growing portion of the population of the United States. Census projections estimate that by the year 2000 this group will make up 13 percent of the population, and by 2030 the percentage will increase to 21 percent *(1)*. It is inevitable that the well-being of elderly populations will have increasing implications for the well-being of American society as a whole. Because transportation is essential for the pursuit of daily activities and for well-being, it is critical that planners and policy makers be able to assess the transportation needs of future elderly populations.

Results are reported of some thinking about the effects of age on travel needs and the effects of motorization on travel habits and expectations. It is proposed that motorization has formed cohorts of individuals with respect to automobile use and it is this distinction that is the key to predicting future travel behavior. A paradigm of cohort, age, and time effects, proposed to sort out the influences of aging and motorization on travel behavior, is used to explore the effects of age and aging on travel observations. The ultimate goal of this effort is to contribute toward the development of practical and improved procedures to determine the mobility trends of future elderly populations.

The argument for and the importance of considering motorization as a source of a cohort phenomenon in travel behavior are presented in the following section. Hypotheses and conjectures about the effects of motorization and aging on travel behavior are developed next. Then an analytical framework for analysis of cohort, age, and time effects is proposed. As an initial application and test of the framework, the ability of individuals to use automobiles is studied by using data from origin-destination surveys from the same urban area from two different time periods. The results are summarized and the implications and research directions are discussed.

Before the discussion, the definition of several key terms used in this study is appropriate. A *cohort* is a group of individuals defined by a common characteristic. In this research the most frequently used variable for demarcating cohorts, date of birth, is used. *Mobility* in this research is defined as the ability of individuals to use the automobile-oriented transportation system and is selected as the criterion measure of travel behavior. *Cohort effects* on travel behavior are defined to be enduring intercohort distinctions that are attributable to the common "imprinting" of cohort members. *Time effects* are fluctuations in the data that are due to idiosyncratic events or circumstances occurring at particular time points. *Age effects* refer to long-term patterns associated with the progression through life cycles, though not necessarily with aging per se. To distinguish between age and aging effects, the term "age effect" will be used when an effect can be well defined given the age alone and the term "aging effect" will be used when the effect is associated with the process of aging and therefore can be defined only when a cohort of individuals is observed at different points in time.

MOTORIZATION AND COHORTS

Motorization is the spread across a population of the ownership and use of the automobile as a consumer technology. The process has been ongoing in the United States since the early part of this century. In particular, the rapid pace of motorization after World War II is evident from statistics. For example, in 1950, 41 percent of households were without a car; by 1980, 87 percent of U.S. households had at least one car available. The percentage of households with two or more cars increased from a mere 7 percent to 52 percent during the same time period *(2)*. Today about 85 percent of the adult population is licensed to drive *(3)*, and the percentage of license holders among those between 25 and 35 years of age reaches 96 percent.

The increases in automobile ownership and driver licensing have leveled off, and today motorization in the United States is considered to be at a mature stage *(4)*. Nonetheless it is indisputable that the expansion of the highway network and growth of the suburb, which took place as part of motorization, have irreversibly converted urban land use and infrastructure to an automobile-based system. By the same token, it is conceivable

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that motorization has irreversibly affected the travel behavior and attitudes of Americans.

Another aspect of motorization is that the acquisition of licenses to drive automobiles was not uniform across the population. Younger and more affluent adults were the first to drive. For example, in 1940 only 25 percent of all drivers in the United States were 40 years old or older and only 1.7 percent were over 65 *(5)*. In 1983 about 45 percent of the drivers were over 40, about 24 percent were over 55, and 11 percent were over 65. Thus, many of today's elderly, and even more of the elderly of the past, may never have acquired a license to drive. A large portion of the future elderly, on the contrary, has had a lifestyle in which automobiles were the central device for pursuing daily activities *(6)*.

It is suggested that the process of motorization "imprinted" travel habits and expectations on successive groups and in effect formed cohorts with respect to travel behavior. Those individuals who were in their twenties and thirties during the intense motorization process of the 1950s and 1960s are now reaching their fifties and sixties and will soon reach the elderly category.

An increase in car ownership and use among older Americans is becoming evident, and this trend is expected to continue as new cohorts of the population enter the elderly category. FHWA estimates that by 2000, 28 percent of drivers will be over 55 and by 2050 this percentage will be 39 percent *(7)*. It is certain that the well-recognized problem of the aging driver will intensify in coming years.

Solutions to this problem seem to call for extensive modification of the vehicle-highway-driver system and improved public transit services for the elderly. A critical element in such an effort is the understanding of the context in which older people make trips, that is, understanding of their needs and desire for travel, and rigorous quantification of the spatial and temporal characteristics of their travel patterns.

Studies of the elderly as transportation disadvantaged (*8*, pp. 23–41; *9*), in particular, have examined the elderly with low incomes, low automobile availability, or with physical impairments. There appear to be consistent empirical indications from these and other studies that older individuals make fewer and shorter trips and that their mobility levels are far below those of the rest of the population *(10)*. This may be a result of age itself, or of physical impairment due to age, or of the inability to use the key component of the transportation system—the automobile.

Nonetheless, the current understanding of travel behavior and needs of the elderly is unfortunately limited. With the exception of the work by Wachs *(6)* and by Goodwin and Layzell (*11*, pp. 185–200), in which the idea of cohorts is connected with automobile and transit use, knowledge in the transportation planning field has been based on cross-sectional examination of travel patterns obtained from standard transportation planning surveys. This is also the case in studies of the elderly as transportation disadvantaged.

It is anticipated that the large future elderly population will be much more diversified with respect to income. Low car availability may have been in part a manifestation of the motorization-cohort effect and not an inherent characteristic of the elderly. Physical impairment may be an inevitable effect of age, but it may affect the future elderly later in life, if the numerous forecasts of the health and longevity of the new cohorts of elderly are to be believed.

From this viewpoint, it appears most appropriate for this study to adopt the cohort analysis, a set of methods for studying longitudinal change. First used in demography to examine generation effects on mortality *(12, 13)*, the cohort concept is used in epidemiology (*14; 15; 16*, pp. 151–227) and in the social sciences (*17*, pp. 215–239). The goal of cohort analysis is to assess the extent to which the variation in a criterion measure observed on cohorts over time is attributable to period, age, and cohort effects or possibly to their interactions. The analytical methods include a wide array of approaches, from simple examination of tabular displays to fairly rigorous multiple regressions and log-linear estimation procedures *(18–20)*.

In summary, most of what is known about the travel behavior of the elderly is based on observations made at one point in time. This is in line with the fact that the numerous planning studies conducted in the past took a static viewpoint toward motorization and travel behavior; the possibility that travel behavior was a dynamic process the characteristics of which may have been changing as motorization progressed was not considered. The characteristics of activity and travel of the elderly derived from a cross-sectional transportation survey, therefore, cannot be extrapolated to another time point unless travel behavior of population segments remains stable over time. This extrapolation is not reasonable because most large-scale transportation surveys were made during the time when urban areas in the United States were undergoing rapid motorization. Therefore, the findings of these studies cannot be simply applied to the forecasting of future transportation needs and behavior of the elderly without a sorting out of the effects of mobility habits, expectations, and capabilities.

CONJECTURES

It is reasonable to expect that those individuals who were young and just forming habits during the time of intense motorization acquired travel habits that are fundamentally different from those of individuals who were older during that period. Motorization may have had permanent impacts on urban residents' attitudes toward trip making, expectations for mobility, and formation of habitual trip patterns. It is hypothesized that the possible differences in perception, motivation, and habits that influence travel behavior are associated with the age of the person during the period when motorization progressed in his or her environment. Note that this in effect is a cohort effect on travel behavior.

Coupled to this cohort effect are the changes in travel behavior due to aging. It is expected that age has its own independent effect on travel behavior apart from the effects of retirement, changes in life cycle, and other events. Gelwicks *(21)* argues that the "lifespace," or the predominant locus of activities and settings of an individual in his normal activities, contracts as the person ages. This constriction, however, has not been rigorously quantified.

Furthermore, observed travel patterns also carry with them effects of the particular time at which the observations were made. This would include such phenomena as economic recessions, gasoline shortages, or the extent of motorization at that particular time. Note that the time effect (or period effect) uniformly influences all individuals in a cross section.

The following conjecture is proposed: time, age, and cohort effects are among the factors that influence travel behavior and needs of urban residents. The cohort effects arise because, it is hypothesized, motorization leaves a permanent imprint on an individual's travel behavior and attitudes, and therefore his or her travel behavior at any point in time is influenced by his age during the period of intense motorization.

This leads to the second conjecture: the effect of aging on travel behavior differs across cohorts. A given cohort may exhibit unique characteristics, not only in a static comparison with other cohorts within each cross section, but also in a dynamic comparison of behavior across cross sections. In other words, each cohort is unique in the way it ages. This is postulated because the permanent imprints of motorization on a cohort of individuals may combine with the effect of aging in a manner unique to the cohort. The counterhypothesis is that the effect of aging is uniform across cohorts. Proper identification of these effects is critical for predicting the travel behavior of future elderly populations as well as for understanding their travel needs.

Some clarification is due at this point about the hypothesis postulated earlier that the major component of cohort effects is caused by motorization. The cohort effects identified from transportation survey results will reflect not only the effects of motorization on habit formation but also those of any significant factors influencing cohorts of individuals. Although the authors strongly believe that the degree of motorization at the societal level at some past point in time is the central component of cohort effects on travel behavior, this will remain an assumption. In order to reduce the risk of being confounded by ecological fallacies, the concept of motorization at the individual level, which is assumed to condition the individual's short-term travel behavior, will be adopted.

The second point to be noted here is that the factor more directly contributing to the formation of an individual's travel habits may be the initial acquisition of an automobile and driver's license and the history of car ownership at the individual or household level, not the extent of motorization at the societal level. This hypothesis, although very plausible, cannot be tested by using repeated cross-sectional observations with independent sampling, which is the case for the data set available in this study. In the discussion of this study, therefore, the effects of history are treated as random effects. The development of an automobile-oriented infrastructure and relocation of opportunities took place at the societal level, and these societal changes are believed to have influenced a cohort in a certain manner despite the obvious variations within the cohort with respect to car and license acquisition.

ANALYTICAL FRAMEWORK

It is appropriate to view observed daily travel behavior as a result of short-term travel choices that are conditioned on long-term mobility choices *(22)*. The latter are the decisions concerning residential location, car ownership, and driver's license holding. These decisions collectively set an individual's capability to use the automobile-based transportation system, which is defined as the individual's mobility level. The mobility level thus sets the conditions for the individual's decisions associated with daily activity and travel behavior. Therefore, age, cohort, and time may have measurable effects on the individual's mobility level as well as on his or her daily travel patterns, given the mobility level.

Motorization and suburbanization at the societal level are an aggregate of individuals' decisions as to license holding, car ownership and use, and residential location. In this sense an individual's mobility level can be viewed as an indicator of motorization at the individual level, or as "microlevel motorization." Similarly, the distribution of mobility levels within a cohort can serve as an indicator of the degree of motorization of that cohort. Unlike the degree of motorization at the societal level (or background motorization), the degree of motorization defined at the individual level is observable from available transportation survey data.

Detailed information on travel behavior is available from origin-destination surveys of large-scale transportation studies carried out in most metropolitan areas of the United States since the 1950s. During the last three decades most metropolitan areas updated their data bases, and records of travel patterns are often available for two or more points in time in the same metropolitan area. These sets of records contain a wealth of information about changes in travel behavior that has been virtually untapped.

Methods of cohort analysis *(6, 18–20, 23, 24)* and other multivariate statistical techniques, in particular the log-linear model of multidimensional classification table analysis *(25)*, can be used to separate out the effects of age, cohort, and time on travel behavior. Various formulations of log-linear models can be applied in order to represent behavioral hypotheses to be tested. Examples of such formulations are found in the next section.

In an empirical analysis any other classifiers that are (or are suspected of being) important should be included in the analyses. This would account for the internal sample distribution and any "fact-of-life" interdependencies among the classifiers, and would help avoid pitfalls such as Simpson's paradox *(26)*.

EMPIRICAL ANALYSIS

The model development effort in this pilot study is directed by both theoretical and empirical explorations. Models are theoretically developed to represent specific hypotheses, and the hypotheses are then tested by estimating the corresponding models. In this paper models that represent the hypotheses of uniform aging effect across cohorts and of stable age effects are discussed. The statistical package used is the PDP-11 version of BMDP Statistical Software.

Observations from 1963 and 1974 origin-destination survey data from Rochester, New York, form the data base. The original trip records are examined for consistency and aggregated into person records *(4, 27)*. Only records of those over 21 years of age are used in this exercise.

The observation is organized into two sets of tables—one formulated by using age categories and the other by using cohort categories. Log-linear models developed on the first set of tables assume the presence of age effects on mobility, whereas those developed on the second assume the presence of aging effects.

Individuals in the sample are classified by age into five categories for each time period. Each age category from 1963

TABLE 1 ROCHESTER, NEW YORK, SAMPLE CLASSIFIED BY YEAR, AGE, AND COHORT

	No. in Sample by Age						
Year	21–31	32–42	43–53	54–64	64–74	75–85	Total
1963	2,551	4,959	3,107	2,105	1,668		14,390
	$^aC_1$	C_2	C_3	C_4	C_5		
1974		647	657	584	376	182	2,446

^aC_n refers to the nth cohort category.

together with the next higher age category from 1974 form a cohort, resulting in five cohort groups for analysis. Table 1 shows the sample size classified by age and cohort group. (There are six age categories altogether, but the individuals in the youngest category in 1974 and those in the oldest category in 1963 are not used in the analysis so that the identical set of individuals will be included in both age and cohort tabulations.)

The following three categories are used to represent the level of mobility of each individual:

Level 1: no car available, not licensed to drive;
Level 2: no car available, licensed to drive; or car available, not licensed to drive; and
Level 3: car available, licensed to drive.

In order to adequately account for the heterogeneity across individuals in the sample, employment and sex are included in this analysis as additional classifiers of individuals. No additional classifiers are examined in this exploratory analysis of the effect of aging.

Variables common to both sets of tabulations are

- M = mobility level (the response variable, defined in previous section),
- T = time (year, i.e., 1963, 1974),
- E = employment (employed, not employed), and
- S = sex (male, female).

Age, used in the first set of models, is denoted by A, and cohort, used in the second set, by C. Their categories are as defined in Table 1. Individuals older than 75 in 1963 and those younger than 31 in 1974 are eliminated from the tabulation in order to have an identical set of individuals in both age and cohort tabulations.

Test of Uniform-Aging-Effect Hypothesis

In a table formulated by using cohort categories, the differences in cohort behavior between two time points can be interpreted as representing the effect of aging. In other words, the interaction between time (T) and cohort mobility (MC) can be used as a measure of the aging effect of that cohort. Then the assumption of uniform aging can be obtained by dropping the time–cohort–mobility interaction effect. Starting from a saturated model (the model that contains all possible effects and interactions, *MCEST*), all terms that involve *MCT* are eliminated and (*MEST, CEST, MCES*) is obtained as the model representing the hypothesis of the uniform aging effect. First the term *MCEST* is eliminated, which results in a model with 5 four-way interaction terms (*MCES, MCET, MCST, MEST, CEST*). *MCET* and *MCST*, which contain *MCT*, are removed next to yield the previous model, which will be called a saturated-uniform-aging-effect model because it comprises all interaction effects that do not involve *MCT*.

This saturated-uniform-aging-effect model, however, does not fit the observation. As indicated in Table 2, the model yields a χ^2-statistic of 76.35 with 32 degrees of freedom (df). The discrepancy between the observation and the expected frequency (or prediction) by the model is significant at $\alpha < 0.00005$. Clearly the hypothesis of uniform aging must be rejected and the term *MCT* must be introduced into the model.

TABLE 2 GOODNESS OF FIT OF ALTERNATIVE LOG-LINEAR MODELS: COHORT FORMULATION

Model	Description	χ^2	Degrees of Freedom	α
(MEST, CEST, CMES)	Saturated-uniform-aging model	76.35	32	<0.00005
(CEST, MST, MCT, CMES)	Best cohort-aging model	41.63	28	0.0470

Table 2 also shows the best cohort-aging model selected. The model includes *MST* and *MCT* in place of *MEST* (note that the degrees of freedom in the best model decrease because *MCT* alone consumes larger degrees of freedom than *MEST*). The inclusion of *EST* (subordinated in *CEST*) and exclusion of *MEST* in the best model imply that the association of mobility, employment, and sex did not vary over time. On the other hand, the association between mobility and cohort did vary over time, as indicated by the inclusion of *MCT*. The five cohorts of this analysis did not age uniformly with respect to mobility between the two points.

The association between cohort and mobility as revealed by the best model is presented in Table 3 (effects of interaction terms are shown in the table in terms of the distribution of mobility levels as revealed by the interaction terms). The cohort–mobility interaction clearly shows that individuals in younger cohorts tend to have higher car accessibility. Note that these interaction terms isolate the effects of the factors involved and present their pure effects.

The distribution obtained by superimposing the time–cohort–mobility effect onto the cohort–mobility effect demonstrates different patterns of aging effects on mobility across the cohorts. The two youngest cohorts (those 21 to 31 years old

TABLE 3 AGING EFFECTS AS REVEALED BY PERIOD–AGE–CAR ACCESSIBILITY INTERACTION EFFECTS

Period	Car Accessibility	Age 21–31	32–42	43–53	54–64	≥65
Age–Car Accessibility Interaction						
NA	Level 1 (low)	10.9	22.5	34.5	51.2	57.2
NA	Level 2	30.4	32.4	31.5	26.1	30.7
NA	Level 3 (high)	58.7	45.1	34.0	22.7	12.1
Period–Age–Car Accessibility Interaction[a]						
1963	Level 1 (low)	23.6	29.5	31.6	37.1	45.3
	Level 2	33.6	29.0	31.8	33.9	35.1
	Level 3 (high)	42.8	41.5	36.6	29.0	19.6
1974	Level 1 (low)	4.4	16.7	37.5	65.3	67.8
	Level 2	24.3	35.4	31.0	18.4	25.1
	Level 3 (high)	71.2	47.9	31.5	16.3	7.0

NOTE: NA = not applicable.
[a]Obtained by superimposing the period–age–car accessibility interaction effect on the age–car accessibility effect.

and 32 to 42 years old in 1963 age) show increased degrees of mobility in 1974, whereas the last two cohorts (54 to 64 and 75 to 85 years old) exhibit substantial decline in their microlevel motorization. The overall increase in car accessibility observed between the two time points *(4, 27)* is not evenly distributed across all cohorts, but is due to the increased car accessibility among individuals in younger cohorts.

Test of Fixed-Age-Effect Hypothesis

The saturated model of fixed age effect can be obtained by eliminating the interaction term *MAT* from the saturated model (*MAEST*) formulated for the five-way table based on the age categories. This yields (*MEST, AEST, MAES*) as a saturated model of fixed age effect. Fitting this model to the data leads to a good fit (χ^2 = 29.51, df = 24, α = 0.20) that supports the hypothesis of fixed age effect (Table 4). As the best age-based

TABLE 4 GOODNESS OF FIT OF ALTERNATIVE LOG-LINEAR MODELS: AGE FORMULATION

Model	Description	χ^2	Degrees of Freedom	α
(MEST, AEST, AMES)	Saturated age-period model	29.51	24	0.2016
(EST, AST, AET, MET, AMES)	Best age-period model	48.14	31	0.0255

model, a more parsimonious specification including a four-way interaction term (*MAES*) and 4 three-way interaction terms involving time (*EST, AST, AET,* and *MET*) is selected. The age–mobility relationship shown by this model is presented in Table 5, in which the same relationship—that the level of mobility is higher among younger individuals and lower among older individuals—is shown.

The stability of the age effect suggests that the aging effect on microlevel motorization can be represented as a shift to the next higher age category in the age–mobility table (Table 5). Table 6 shows this aging effect implied by the fixed-age-effect model. Comparison of Tables 3 and 6, however, clearly shows the difference between the aging effects derived from the two models. For example, the drastic increase in car accessibility observed for the youngest cohort between 1963 and 1974 cannot be represented as a shift from the 21–31-year age group to the 32–42-year age group as in Table 6.

TABLE 5 AGE EFFECTS AS REVEALED BY AGE–CAR ACCESSIBILITY INTERACTION EFFECTS

Car Accessibility	Age 21–31	32–42	43–53	54–64	≥65
Level 1 (low)	23.6	29.1	30.1	37.1	47.2
Level 2	33.1	28.1	34.5	33.1	34.3
Level 3 (high)	43.3	42.8	35.5	29.8	18.5

TABLE 6 AGING EFFECT DERIVED FROM THE UNIFORM-AGE MODEL

Period	Car Accessibility	Age 21–31	32–42	43–53	54–64	≥65
1963	Level 1 (low)	23.6	29.1	30.1	37.1	47.2
	Level 2	33.1	28.1	34.5	33.1	34.3
	Level 3 (high)	43.3	42.8	35.5	29.8	18.5
1974	Level 1 (low)	29.1	30.1	37.1	47.2	
	Level 2	28.1	34.5	33.1	34.3	
	Level 3 (high)	42.8	35.5	29.8	18.5	

It is difficult to determine which formulation is better on the basis of the available statistics because the two tables are prepared differently. No convenient procedure appears to exist for testing across models when they are developed for differently organized classification tables. However, inspection of the observed frequencies favors the cohort model. In the youngest cohort, the percentage of individuals in mobility Level 3 was 74.8 percent in 1963, which increased to 95.8 percent in 1974. This drastic increase in the observed frequency, which is evident in both cohort and age tabulations, is not captured by the age model in which the interaction term *MAT* is not significant.

The findings of this analysis indicate that motorization did not progress equally across the population. The younger generation has a much higher level of mobility than the older generation and can be considered to be much more motorized. Examining the results by sex showed definite differences in mobility levels between men and women for the older cohorts. Although there was an increase in mobility between the two time periods for all cohorts, the increases were much larger for men than for women. In particular, older nonworking women showed the smallest gains in mobility between the two time periods. The cohort of persons 21 to 31 years old did not exhibit much effect of sex on mobility. This particular cohort is now 43 to 53 years old, indicating that much different patterns of travel behavior can be expected from the future elderly than those observed for today's elderly.

IMPLICATIONS AND RESEARCH DIRECTIONS

The foregoing empirical analysis is a limited exercise, and more extensive analyses of the effects of age, cohort, and time are needed. Nonetheless, the results of this empirical analysis offer support for the concept of a cohort effect on individual mobility because the effects of aging on this measure were found to vary across cohorts, and further because a model based on age alone was unable to replicate the aging effects observed in origin-destination survey results.

An immediate and important extension of this research is the examination of the effects of age, cohort, and time on daily travel behavior indicators given the microlevel of motorization (e.g., number of trips made by individuals, time spent for travel, travel modes used, type of activities pursued outside the home, temporal and spatial distribution of activities and their locations, and structuring of a set of trips into trip chains). Microlevel motorization can be used as a control, and cohort effects that are identified could be an extraction of the travel habits unique to each cohort.

Such an analysis should indicate into which of the following four cases each effect falls. Identifying which case best represents the effect of age, cohort, or time is a crucial step for the prediction of travel behavior of future elderly populations because extrapolation of observation into the future is appropriate if and only if Case 4 proves to hold for cohort and age effects.

	Significance of Age, Cohort, or Time Effects			
	Case 1	*Case 2*	*Case 3*	*Case 4*
Microlevel motorization	Yes	Yes	No	No
Daily travel pattern	Yes	No	Yes	No

If cohort or time effects on travel patterns, given microlevel motorization, are significant, it would imply that the widely practiced approach in transportation planning will be inadequate and the future elderly will behave differently. Furthermore, significant effects on microlevel motorization would point to changes in car ownership and residential locations among future elderly populations. Answers to these questions can help to determine the travel characteristics and needs of future elderly populations and to infer their implications for transportation planning and policy development.

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Changing Mobility Patterns and the Aging Population in Sweden

AGNETA STAHL

A number of investigations of travel habits and patterns of activity of the elderly have been carried out in Sweden during the 1980s. The results from a study made by the Department of Traffic Planning and Engineering at the Lund Institute of Technology are presented. The purpose of this study was to determine (a) older people's access to various means of transportation, (b) travel habits of older people and their difficulties in using various means of transportation, and (c) the extent to which these factors influence the social situation of older people compared with various background variables such as age and physical incapacity.

There has been much interest in studying the living conditions of the elderly in Sweden during the 1970s and 1980s. One major reason for this interest is the large and steadily growing number of elderly in the general population. Currently the elderly—that is, those 65 years of age and older—constitute a good 17 percent of the population in Sweden. Available prognoses indicate that this share will go on increasing into the 21st century until it encompasses 20 to 23 percent of the population. The prognoses also indicate that it is the oldest part of the population that will increase the most, that is, those more than 80 years old. At present, one of five people of retirement age in Sweden is more than 80. According to the prognoses that have been made, one of four retired persons will be more than 80 at the beginning of the 21st century.

This phenomenon has received a good deal of attention in Sweden. For the past several decades, an overriding goal of social planning has been to make it possible for the country's population to use the services and participate in the activities provided by society. Another goal has been to enable the elderly to go on living in their own homes as long as possible, instead of having to move to social or medical institutions. This kind of planning requires a well-functioning system of traffic and transportation for the elderly to facilitate their active participation in society and to maintain their social contacts with relatives and friends.

Therefore, a number of investigations have been carried out in Sweden during the 1980s in order to study travel habits and patterns of activity of the elderly. The results from such a study that was made at the Department of Traffic Planning and Engineering at the Lund Institute of Technology are presented. The purpose of this study was to determine

- Older people's access to various means of transportation,
- Travel habits of older people and their difficulties in using various means of transportation, and
- The extent to which these factors influence the social situation of older people compared with various background variables such as age and physical incapacity.

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METHOD AND AIM OF THE STUDY

The investigation was carried out in two Swedish cities: Malmo in southern Sweden (population of about 215,000) and Skelleftea in the north (population of about 30,000), in both central and more peripheral residential areas. The results are based on postal questionnaires (619 in Malmo, 301 in Skelleftea), interviews in the home (43 in Malmo, 49 in Skelleftea), and practical experiments with boarding and leaving buses (11 people in Malmo). The selection of respondents for the questionnaires was stratified to assure that those of advanced age would be included in the investigation. Age, sex, and marital status (married or single) were used as stratification variables. Interviews were conducted in the homes with a selection of those who had participated in the postal questionnaire.

The investigation is based on the available a priori information about the status of the elderly in traffic. Figure 1 shows the causal principle model that served as the foundation for constructing the investigation. The model's point of departure is that various individually defined circumstances in combination with the design of the traffic system create different opportunities for different people to cope in traffic, and that this in turn influences the degree of fulfillment or satisfaction they experience.

By "individually defined circumstances" is meant sex, age, and physical capacity, as well as socioeconomic status, actual access to means of transportation, and individual habits. When combined with the traffic system's design, these factors produce individual dependent capability problems, or varying abilities to cope in traffic. All this constitutes the basis for the person's travel activity, for example, shopping and doing other errands and maintaining contacts with friends and relatives. Beyond this, different people have different needs and habits that influence both their travel activity and the way in which they experience traffic problems. If travel activity is low, or if the problems are great, dissatisfaction with the travel situation arises.

One major purpose of the study was to show whether, and if so to what extent, various factors affect a person's travel activity and his or her inability to make necessary outings. Three travel objectives were studied: shopping, visiting, and

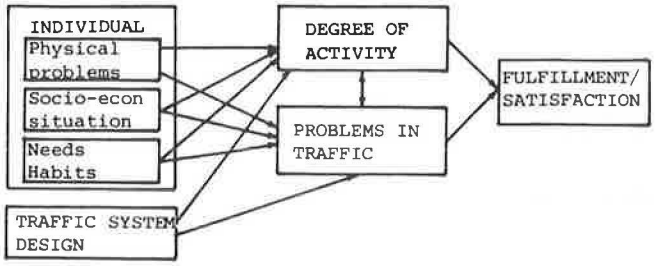

FIGURE 1 Causal principle model for the investigation.

recreation. These were regarded as response variables. All three travel objectives were measured in the following manner:

1. Making the trip daily (= 6 trips/week),
2. Making the trip a few times a week (= 3 trips/week),
3. Making the trip a few times a month (= 0.6 trip/week), and
4. Making the trip seldom (= 0.1 trip/week).

The variables that were considered explanatory variables in the analysis were

1. Sex,
2. Age,
3. Marital status (living alone or with someone),
4. Physical incapacity (vision, hearing, mobility),
5. Physical incapacity that causes problems in traffic,
6. Experienced problems in traffic with different means of transportation, and
7. Access to transportation.

Variables 4, 5, and 6 were all measured in a three-part categorical scale, as follows: severe problems, light problems, and no problems. For the experienced-problems variable, every means of transportation was measured separately. The access-to-transportation variable was created for the analysis. The older population was thus divided into five groups according to the initial hypothesis that individual access to a means of transportation provides greatest flexibility and satisfaction. In order to be placed in a certain transportation group, a person had to use that means of transportation on a regular weekly basis.

Thus, a person with access to an automobile was placed in the first group; this group accounts for 32 percent of older people. The next group, 21 percent, consists of those who have their own bicycle and continue to use it, but who do not have access to a car. Next comes a group who have the possibility of being driven by a relative or friend, but who do not have access to a car of their own or to a bicycle (6 percent). The next group, and the largest one, accounting for 36 percent of older people, have no possibility of getting around outdoors other than walking or using public transportation. And finally, there is the group made up of those who are eligible for Special Transportation Service. They make up 5 percent of the older population and are regarded as occupying the worst situation in terms of transportation possibilities.

It is also important to point out that it is primarily those up to the age of 75 who have access to a car in the household, mainly men and those generally who have not suffered any noteworthy physical disability. Thus it is those who are in some way dependent on society for their transportation, either those who are users of public transportation or those who qualify for Special Transportation Service, who are clearly overrepresented in the older age groups, in other words, those over the age of 75, women, and those who have begun to suffer noticeably from some kind of physical disability.

The overall purpose of the study was to investigate those factors that may be considered to have major significance when the patterns of movement and degree of activity among older people are studied. Is it being old per se, or are there other important factors to be taken into account? This age group is by no means homogeneous. Therefore, merely being older in and of itself cannot always be assumed to be a significant factor. Rather, other factors influence one's capacities, especially in traffic situations. Other such factors are, for example, sex, marital status, physical incapacity, access to transportation, and experienced problems in traffic with different means of transportation.

These last two factors are of particular interest. They represent external factors that can influence what measures are to be taken if the goal is to remedy the decrease in activity that is assumed to be typical for the elderly. Although individual factors such as the ability to function physically, sex, marital status, and even age may influence the degree of activity, these factors are more difficult to deal with than, for example, shortcomings in the traffic environment or inadequate access to means of transportation. Although such external factors may also be hard to deal with simply and directly, there is nevertheless a practical possibility of doing something about them. This should be a basic premise in the business of planning traffic and transportation for the elderly.

The analyses thus include two kinds of explanatory variables:

- those in which the interest is to really measure the effects on the degree of activity (the external factors) and
- those in which the effect on the degree of activity is more to be controlled for than actually measured (the individual factors).

RESULTS

To study the influence of different explanatory variables on the degree of activity, to begin with, analyses of two-dimensional contingency tables were conducted. In these analyses one factor was compared with each one of the three response variables at a time (the degree of shopping, visiting, and recreation).

These two-way analyses demonstrated, for example, a significant decrease in the degree of activity with increasing age (Table 1). With shopping, for example, a decrease in activity level is not really shown until the age of 80, when weekly

TABLE 1 DEGREE OF ACTIVITY IN DIFFERENT AGE GROUPS

	Percentage of Activity by Age Group				
Weekly Activity	65–69	70–74	75–79	80–84	85+
Shopping	95	94	92	90	76
Visiting	44	42	32	28	24
Recreation	30	25	22	14	18

shopping decreases from 90 percent of the population to 76 percent. Visiting also decreases with age. Among older people up to the age of 75, nearly 50 percent visit relatives and friends every week. Thereafter, the percentage successively decreases, and less than one-fourth of those over 85 pay a visit every week. The same is the case with recreational activities. Whereas about 30 percent of those in the younger group participate in recreational activities on a weekly basis, for those in the older group it is only about 15 percent.

Thus it would seem reasonable to assume that patterns of movements change, and especially that the degree of activity decreases with increasing age. Two possible hypotheses arise: (a) only growing older per se results in altered travel habits and diminished activity, or (b) there are other, "hidden" factors that dictate a reduction in the activity of older people. The results of this research come down heavily on the side of the second hypothesis.

Other individual factors that were examined (sex, marital status, and physical incapacity) also showed the same pattern, that is, a decreasing activity level with, for example, increasing physical incapacity. A more important finding, however, was that external factors such as access to transportation and experienced problems in traffic with different means of transportation also showed a significant correlation with the degree of activity. Table 2 shows the degree of activity with various means of transportation.

TABLE 2 ACTIVITY WITH VARIOUS MEANS OF TRANSPORTATION

	Percentage of Activity by Means of Transportation				
Weekly Activity	Car	Bicycle	Ride with Friends	Walk or Ride Bus	Special Transportation Service
Shopping	95	95	95	91	85
Visiting	52	50	50	33	9
Recreation	32	31	27	18	9

When one examines the degree of activity in the various means of transportation, one finds, for example, that of the first group—those who have access to their own car—95 percent make shopping trips every week. That number is somewhat less (91 percent) for the group who have access only to public transportation, and lowest of all (85 percent) for those who are restricted to Special Transportation Service. The same worsening situation is found when one looks at the data for those who make weekly social visits (from 52 percent to 33 percent to 9 percent) as well for those who make weekly trips for recreation (from 32 percent to 18 percent to 9 percent). All the differences are statistically significant.

When the experienced problems with different means of transportation are examined, it appears that the two means of transportation most used by the oldest people and by those with physical disabilities—walking and taking the bus—are also the two modes that cause the most problems. There are significant differences in the degree of activity between the pedestrians and bus passengers that report problems and those that do not.

To summarize, the two-way analyses clearly showed, perhaps not very surprisingly, that it is not merely growing older that correlates with a decrease in activity. It was shown that other variables are also important, such as sex, marital status, an individual's physical condition, an individual's access to means of transportation, and the problems an individual experiences when employing various means of transportation. However, to conclude that an influence exists on the basis of this analysis is not quite satisfactory. The analyses also showed that most of the variables studied are in some way correlated (Figure 2).

Figure 2 implies that the next step in the analyses is to use analytic methods that permit a simultaneous overview of all the

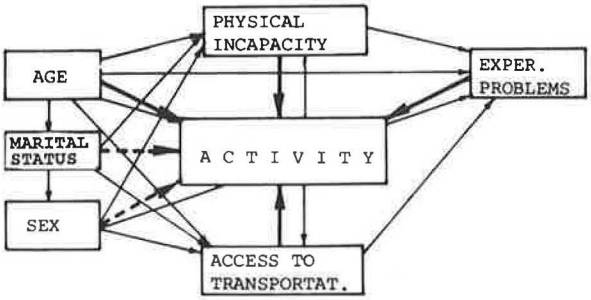

FIGURE 2 Correlation between all studied variables (two-way analyses).

variables studied in order to identify those factors that influence a person's degree of activity. Especially interesting is the attempt to quantify the influence of various factors and thereby compare the effects of different factors on the degree of activity among those who otherwise appear to be equal with regard to other variables examined.

Because this investigation is based mainly on qualitative data and only some quantitative data, the analytical methods that seemed appropriate were analysis of covariance and logistic regression. Two different analysis methods were used because neither is quite satisfactory by itself: analysis of covariance implies certain (doubtful) statistical assumptions, and logistic regression implies renouncing available information in the basic variables. The results from the two different methods turned out to be very similar; only the results from the analysis of covariance are shown in this paper.

The statistical method of analysis of covariance requires that the response variable be quantitative, which is the case in this analysis. Degree of activity is measured in a way that makes it possible to express the activity in number of trips per week. Analysis of covariance can deal with both quantitative and qualitative explanatory variables, but the analysis is statistically more powerful when the number of qualitative variables is low. Therefore a number of the qualitative variables were quantified by means of an estimation method based on normal distribution. The variables that were measured on a three-part categorical scale (physical incapacity, physical incapacity that causes problems in traffic, and experienced problems in traffic with different means of transportation) were thus transferred to three quantified values (see Figure 3, for example).

The assumption behind the estimation in Figure 3 is that there is a hidden variable called "hearing incapacity" that is normally distributed over the population studied. The three-part categorical scale (severe problems, light problems, and no

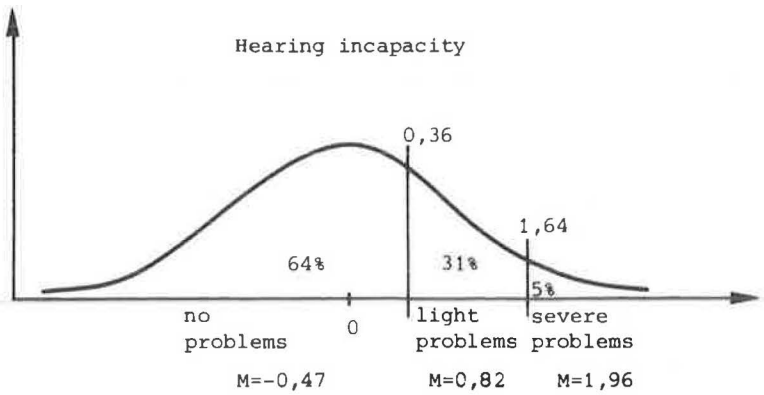

FIGURE 3 Quantified values of the variable "hearing incapacity."

TABLE 3 CREATION OF VARIABLE "PROBLEMS IN TRAFFIC"

	Means of Transportation						
	Car	Bicycle	Ride with Friends	Bus	Walk	Special Transportation Service	Total
Problem (p_i)	1.67	–	1.20	2.33	0.88	–0.29	–
Frequency (f_i)	4	0.6	–	0.1	4	0.6	9.3
Problem × frequency	6.68	–	–	0.23	3.52	–0.17	10.26

NOTE: Mean problem: 10.26/9.3 = 1.10; p_i = quantified value from the variable problems when a certain means of transportation is used; f_i = frequency (e.g., the number of trips/week the person actually makes with a certain means of transportation).

problems) was therefore translated into quantitative values of the hidden variable. Because it is known that 64 percent of the population studied claims to have no hearing incapacity, this implies that the mean value of the border, which of course varies from person to person, between claiming no problems and light problems is 0.36. In each group the median was used as the value representing the persons in the three groups. So those claiming no hearing incapacity are given the value –0.47 on the quantitative variable "hearing incapacity."

On the basis of this estimation method the following qualitative variables were made quantitative:

- The three physical disability variables: mobility, vision, and hearing; and
- The five variables representing the problems with using each means of transportation (car, bicycle, ride with friends, walk or ride the bus, and Special Transportation Service).

To represent a person's problems in traffic as a whole, a new variable was created (Table 3). A "mean problem" representing a person's problems in traffic as a whole was created according to the following formula:

$$\frac{(p_i \times f_i)}{f_i}$$

This value represents the variable "problems in traffic with different means of transportation" in the analysis and was one of the explanatory variables. The explanatory variables in the analysis were hereby the following eight variables:

1. Sex (qualitative variable),
2. Age (quantitative variable),
3. Marital status (qualitative variable),
4. Physical disability:
   a. mobility (qualitative variable),
   b. vision (quantified variable),
   c. hearing (quantified variable),
5. Access to transportation (qualitative variable), and
6. Problems in traffic with different means of transportation (quantified variable).

The results from the analysis of covariance indicated that there is a difference among the three different activities studied (shopping, visiting, and recreation). Starting with shopping, the average for the age group was 3.5 shopping trips a week. The variables that have a significant influence on the degree of shopping activity are age, marital status, mobility impairment, and problems with various means of transportation. The difference between one group aged 73 and another aged 83 (i.e., a 10-year age difference) is 0.2 shopping trip a week, which means a decrease of 5 percent. On the other hand, those with serious impairments of movement make 20 percent fewer shopping trips a week than those who have no such impairment. And those who have light problems with all means of transportation they actually use make 15 percent fewer weekly shopping trips than those with no problems at all (all means of transportation used included).

Similarly, when visiting activity was examined, the average for all those over 65 is 1.5 visits a week. The significant variables regarding degree of activity here are age, marital status, access to a means of transportation, and mobility impairment. The 83-year-old group makes 20 percent fewer such trips a week than the 73-year-old group. Those with major mobility

impairment make about 30 percent fewer social calls per week than those with no such impairment. Inferior access to means of transportation results in 15 percent fewer visits a week for the group who use public transportation compared with those who have a car in the household and 40 percent fewer visits a week for those depending on Special Transportation Service.

Once again, for the whole age group the average number of recreational trips a week is 1.0. The significant variables with regard to the degree of activity are access to transportation and mobility impairment; thus age per se does not influence recreational activity. Those who have severe impairment of movement make 35 percent fewer recreational trips a week than those who have no such disability. Inferior access to transportation is so significant that people dependent on public transportation make 40 percent fewer recreational trips a week than those who have a car in the household. Even worse, those entirely dependent on Special Transportation Services make 60 percent fewer recreational outings than those who have access to a car.

CONCLUSION

The analyses show that even if age per se does have a significant influence on such activities as shopping and visiting, it is by no means the most important factor. Rather, where shopping is concerned, more important factors are the person's physical capacity and problems encountered by older people when out in traffic, especially as pedestrians and bus passengers. Where visiting is concerned—and the same applies to recreational trips—access to transportation plays a major role.

These results described are interesting and important, mainly, of course, because the degree of activity as people grow older is not only a matter of aging and because aging is not the most important factor involved. This is both interesting and important because it indicates that measures can be taken to improve the situation. On the other hand, it is with mixed feelings that one must conclude that older people's difficulties in remaining active are the result of the shortcomings of various means of transportation or the shortcomings of the traffic system itself. The design of the traffic and transportation systems plays a large role in the decrease of activity. It is important to take action now, considering that the prognoses show that it is the oldest segment of the population that will grow the most in the coming decades.

The question of whether a person's degree of activity could be dealt with through measures taken in the transportation and traffic systems can be answered affirmatively on the basis of this study. From the introductory part of this study in which the problems experienced with all means of transportation were examined, it is obvious that such measures often consist of minor changes in the physical surroundings or in public transportation. For example, level walking surfaces, good snow removal, and clearly demarked curbs are important for pedestrians; for bus passengers, easy boarding and exiting of the vehicle and proximity to a bus stop. Furthermore, such measures would also be appreciated by other people as well.

This study indicates that there is good reason to assume that the social situation of certain groups of people would be improved if measures were taken to improve their access to transportation or to improve their possibilities of coping with various means of transportation. The natural question to ask in conclusion, then, is not "Can we plan the traffic environment from the point of view of the needs of older people?" but rather "Can we reasonably refrain from doing so?"