What Will Happen to Travel in the Next 20 Years?

DAVID T. HARTGEN

This paper develops a baseline projection of travel and energy use for New York State for the period 1975-1995. The projection is developed from an equilibrium forecast of gasoline price, supply, improvements in average car efficiency, and population. This projection is then adjusted by using straightforward elasticity approaches to account for major trends in household and population characteristics, the economy and inflation, urbanization, and automobile ownership. Results show that upward pressure on travel will be caused by increased car efficiency, growth in population, suburbanization, and automobile ownership, in that order. Downward pressure will be exerted by energy price, supply embargoes, inflation, and employment, in that order. The projection of travel into the 1990s suggests that, in spite of higher-than-historical inflation, rapid increases in energy price, and a slowly growing economy, travel will continue to grow slowly and rise 40-50 percent over 1975 rates by 1995. In the same period, gasoline use will fall 10-20 percent, spurred downward by price rises and the rapid increases in car efficiency. Periodic supply shortfalls are likely and will slow the growth in travel but will not reverse it.

Forecasts of traffic are a basic element in decisions concerning transportation investments. Based on such forecasts, analyses can be made of benefits to users and nonusers; impacts on the economy, safety, and accidents; operating costs; energy; air quality; noise; and congestion.

Traffic forecasts are generally prepared by two basic approaches. In major urban areas, forecasts are generally based on the four-step travel-simulation process, in which travel on street links is an output of the assignment process. In nonurban areas, where assignment-based modeling does not exist or may not be appropriate, estimates are generally made by growing present traffic into the future by using projections of population, households, cars, employment, county or town vehicle miles of travel (VMT), or other parameters. Whenever such forecasts are made, whether in rural or urban contexts, they are likely to contain errors. These errors result from misspecification (wrong variables), misestimation (wrong assumptions about input level), or wrong coefficients.

These problems have always been with us, but have recently been highlighted by national and international events, the effects of which have not explicitly been accounted for in prior forecasts. Among these are rapid increases in energy price and periodic shortfalls in gasoline; high inflation, possibly coupled with recession in the economy; changes in employment and unemployment rates; slow economic growth; changes in life-style, family structure, and population age; automobile ownership; and automobile efficiency. Some of these factors may have been accounted for in the particulars of a traffic forecast for a given project, but the need to incorporate such factors, in general, is real. Indeed, forecasts prepared without consideration of such factors are, at best, likely to be received with disbelief; at worst, dismissed as unreasonable.

Ideally, we need to develop new tools for traffic forecasting that can handle various assumptions concerning these and other factors. Some of the research necessary to do this is now under way. But we need not wait for the results; much of the knowledge is available now, in disparate studies and reports. The purpose of this paper is to pull together this information and focus on the findings of the studies, not the methods used. A number of studies have attempted such forecasts at the national level. The Federal Highway Administration (FHWA) (1) prepared joint forecasts of travel, population, employment, and fuel use after the 1973-1974 energy crisis. This effort has recently been updated by the U.S. Department of Transportation (DOT) (see Spielberg and others in this Record). Both documents, however, do not lend themselves to use in making direct traffic forecasts or in adjusting previously developed forecasts because they are primarily overviews of travel and economic growth. The approach taken in this paper is to develop adjustment factors based on empirical evidence and travel elasticities that are applied to baseline forecasts to obtain adjusted estimates.

BASELINE PROJECTION FOR TRAVEL

It is often suggested that, now that energy prices are rising rapidly and supplies are tightening, travel growth will slow, perhaps, even reverse, thus the need for new projects will be short circuited. Prices will probably rise and curtailments may occur, but it does not follow that VMT will decline (more likely, its growth may slow). To see this, consider jointly the relationships among travel, gasoline price, gasoline consumption, and, most importantly, average passenger car efficiency.

The following analysis is based on extensive modeling of energy futures of the New York State Department of Transportation, documented elsewhere (2,3). The analysis assumes an equilibrium model of travel, gasoline supply, and price, expressed as follows:

$$VMT_F = VMT_{75}(POP_F/POP_{75})[1 + e_1(\Delta X_1/X_1) + e_2(\Delta X_2/X_2) + \ldots] \quad (1)$$

$$GD_F = (VMT_F)(1/EFF_F) \quad (2)$$

where

VMT = vehicle miles of travel in 1975 and future (F) year;
POP = population;
GD = gasoline demand;
X = independent variable, including gasoline supply, price, unemployment, and labor force; and
EFF_F = automobile efficiency, over the road, miles/gal (actual vehicle in-use efficiency).

The model is operated by balancing gasoline supply and demand scenarios against price and efficiency. The forecast reflects a baseline set of assumptions as follows:

1. Real prices increase by 2 percent/year,
2. Average new-car efficiency follows federal efficiency standards to 1985 and is constant thereafter,
3. Population growth is moderate, and
4. Fuel supplies are adequate (at higher prices).

The analysis (Figure 1) shows that the most significant effect on travel is the effect of improved efficiency of new model year vehicles and over-the-road New York State fleet efficiency. Federal law mandates that new cars increase in corporate average fuel economy (CAFE) from 1978 to 1985. New York's CAFE has exceeded the standard for the 1978, 1979, and 1980 model years, as can be seen in the following table, which gives New York State CAFE values through November 1980.

Model Year	Standard	New York State Domestic New Car CAFE
1978	18	19.2
1979	19	19.7
1980	20	21.4
1981	22	23.8
1982	24	
1983	26	
1984	27	
1985	27.5	

As a result of such trends, the average over-the-road efficiency of cars in New York will increase from 13.26 miles/gal in 1976 to 23.78 miles/gal in 1995, about 79 percent (4.0 percent/year). This means that, all things being equal, gasoline demand could fall 4 percent/year, or travel could grow 4 percent/year, solely because of fleet turnover and increases in car efficiency. But, not all of this potential gasoline savings is actually saved; a portion of it is reinvested in additional travel that otherwise would have been curtailed in the face of rising gasoline prices. To say it another way, improvement of vehicle efficiencies means that more miles can be driven on the same amount of gasoline. This encourages continued growth in travel, without a subsequent increase in gasoline fuel use. Table 1 and Figure 1 show that travel is projected to grow 46 percent (2.3 percent/year) during the 1976-1995 period, but gasoline consumption will actually decline 7.6 percent (0.4 percent/year) during the same period. These projections essentially parallel those of DOT (4), a recent National Cooperative Highway Research Program (NCHRP) analysis of energy scenarios (5), and a national assessment of energy use (Spielberg and others in this Record).

Federal decontrol of domestic crude oil, continued world pressure on supplies, and political factors are likely to result in continued increases in the real price of gasoline. Prices are expected to rise to about $2.00/gal (1978 dollars) by 1995. The projections incorporate estimates of the elasticity of gasoline sales with respect to price, estimated to be about -0.15 in current years and rising uniformly to -0.50 by 1995. This implies an increased public sensitivity to gasoline price increases. (An assumption about a lower absolute elasticity would lead to even higher prices.)

Figure 1. New York State baseline forecasts of travel, energy, gasoline price, and fleet efficiency.

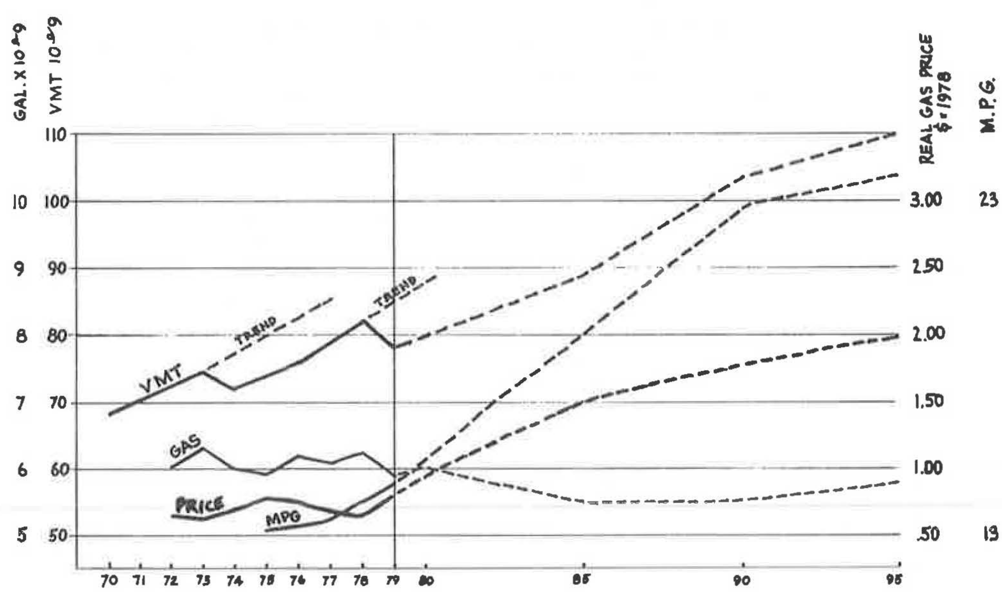

Table 1. New York State baseline forecasts of travel, energy use, gasoline price, and fleet efficiency.

Year	Vehicle Miles of Travel[a] (000 000 000s)	Index[b]	Total Gasoline Use (000 000 000s)	Index[b]	Real Gasoline Price (1978 dollars)	Index[b]	Car Efficiency	Index[b]
1968	62.326	0.831						
1969	64.641	0.862						
1970	67.042	0.894						
1971	69.532	0.927						
1972	72.115	0.961	6.063	0.978	0.625	0.839		
1973	74.794	0.997	6.321	1.020	0.624	0.838		
1974	72.222	0.963	5.998	0.967	0.746	1.001		
1975	73.621	0.981	5.985	0.965	0.757	1.016	13.110	0.989
1976	75.020	1.000	6.200	1.000	0.745	1.000	13.262	1.000
1977	78.260	1.043	6.122	0.987	0.744	0.999	13.529	1.020
1978	81.50	1.086	6.202	1.000	0.693	0.930	13.955	1.052
1979	79.50	1.059	5.871	0.947	0.798	1.071	14.418	1.087
1980			6.017	0.970	0.998	1.340	14.853	1.120
1985	89.073	1.187	5.485	0.885	1.495	2.007	19.156	1.444
1990	103.049	1.374	5.486	0.885	1.775	2.383	23.063	1.739
1995	109.786	1.463	5.730	0.924	1.970	2.644	23.776	1.793

Notes: Figures for 1980-1995 are forecasts.
Annual growth from 1976 to 1995 is projected to be +2.3 percent for vehicle miles of travel, -0.4 percent for gasoline, +8.2 percent for the real price of gasoline, and +4.0 percent for car efficiency.

[a]Vehicle miles of travel for 1968-1975 are adjusted estimates. [b]Index in 1976= 1.0.

Table 2. Changes in efficiency and travel.

Year	Vehicle Miles of Travel	Car Efficiency (miles/gal)	Vehicle Miles of Travel (%Δ)	Efficiency (%Δ)	Ratio
1976	75.020	13.262			
1979	77.810	14.418	3.7	8.7	0.425
1985	89.073	19.156	18.7	44.4	0.421
1990	103.049	23.063	37.4	73.9	0.506
1995	109.786	23.776	46.3	79.3	0.584

Table 3. Vehicle miles of travel adjustment factors for average car efficiency.

Difference in Over-the-Road Efficiency (%)	1980, Ratio = 0.42	1985, Ratio = 0.42	1990, Ratio = 0.50	1995, Ratio = 0.58
-10	0.958	0.958	0.950	0.942
-5	0.979	0.979	0.975	0.971
0	1.000	1.000	1.000	1.000
5	1.021	1.021	1.025	1.029
10	1.042	1.042	1.050	1.058
20	1.084	1.084	1.100	1.116
30	1.126	1.126	1.150	1.170
40	1.168	1.168	1.200	1.232
50	1.210	1.210	1.250	1.290
60	1.252	1.252	1.300	1.348

Notes: Ratio values are taken from Table 2.
Formula: Factor = 1 + (ratio) (percentage difference)

Table 4. Example adjustment for revised fuel efficiency.

Year	Base Data Traffic Forecast	Miles/Gal Old	Revised	Change (%)	Vehicle Miles of Travel Adjustment Factor[a]	New Traffic Forecasts
1975	1000	14.0	14.0	0	1.000	1000
1980	1150	14.0	14.8	+6	1.024	1178
1985	1294	14.0	19.1	+36	1.151	1489
1990	1423	14.0	23.0	+64	1.320	1878

[a]Interpolated from Table 3.

Table 5. Adjustment factor for price increases with no shortfalls.

Time Frame	Elasticity	Percentage Above Baseline Real Prices 10	25	50	75	100
1980-1982	-0.15	0.9850	0.9625	0.9250	0.8875	0.8500
1983-1987	-0.35	0.9650	0.9125	0.8250	0.7375	0.6500
1988-1992	-0.50	0.9500	0.8750	0.7500	0.6250	0.5000

Notes: To use, multiply future year vehicle miles of travel by factor in table that corresponds to elasticity and price change.
Formula: F = 1 + (elasticity) (percentage increase).

VARYING THE ASSUMPTION

The above (or some other) forecast can be adjusted to account for new projections or additional assumptions.

Car Efficiency

If the analyst has a forecast of traffic that assumes a constant efficiency (compared with a base year), it should be adjusted to account for the greater mobility provided by the increased efficiency. Figure 1 provides a clue to the magnitude of this adjustment. Table 2 summarizes the percentage growth in travel and car efficiency over 1976, from Figure 1.

These data suggest that the proportion of the gain in average car efficiency, which shows up as VMT, is about 42 percent at present and rises to 60 percent by 1995. This information can be expressed as adjustment factors, such as in Table 3. As an example, if an analyst has estimates of traffic volume for a facility (based on an assumed over-the-road efficiency of 14.0 miles/gal), this can be adjusted as shown in Table 4.

This example shows that traffic forecasts prepared in the early 1970s (hence increased car efficiencies are not assumed) are likely to substantially underestimate VMT, particularly if they included rapid price increases. Ironically, forecasts that include both increasing efficiency and price rises are likely to require little net adjustment because, as will be shown, these two tend to cancel each other out.

Gasoline Price Increases

The baseline projection assumes an equilibrium price profile that rises more rapidly than inflation. This projection is our best assessment of the price trends at this time. Note that it shows real prices of gasoline doubling during the 1980-1990 period. In the event that the actual or implied price increases in a traffic forecast do not follow this track, some adjustments must be made in the values of estimated vehicle miles of travel.

Table 5 shows adjustment factors to apply to forecasts to account for price increases above or below estimated values. Previous estimates do not necessarily need to be those contained in Table 1; any prior estimate can be adjusted. To use these factors, the analyst selects the appropriate elasticities of travel and gasoline price, then estimates the percentage difference between the price forecast and the actual price (both are real prices in 1978 dollars).

The table further assumes that elasticities are likely to increase over time; this is consistent with our observations of increased public sensitivity to higher real prices and generally higher estimates of long-term elasticity in the literature, compared with short-term elasticity (5).

As an example, consider the above traffic forecast made with assumptions of gasoline price as shown in Table 6. Suppose new trends show a revised steeper price profile (1978 dollars), and the analyst wishes to adjust the above forecasts. Table 6 shows that substantial underestimates of real price can lead to overprojections of travel, particularly in later years. The price error here is typical of many projections made in the early 1970s and leads to an overforecast of about 30 percent by 1990. This is about the same error as is made by failing to account for increased efficiency of cars; hence, the two tend to cancel out in many cases.

Table 6. Example adjustment for revised prices.

Year	Base Forecast Volume	Price ($)	New Price ($)	Change (%)	Elasticity	Adjustment Factor	New Volume
1980	1150	1.00	1.20	20	-0.15	0.970	1115
1985	1294	1.10	1.50	44	-0.35	0.846	1095
1990	1423	1.25	2.00	60	-0.50	0.700	996

Energy Supply Cutoffs and Embargoes

As shown in Figure 1, historical growth rates of New York State travel before 1974 and in the interim period 1975-1978 were 3-4 percent/year. These rates were temporarily curtailed by the 1973-1974 and 1979 energy shortages, during which time VMT fell 3.4 and 4.5 percent, respectively. However, in the same periods, gasoline use fell 5.1 and 5.3 percent, respectively, and prices rose 30 percent (6). These trends are summarized as follows:

	Change (%)	
Trend	1973-1974	1979
Maximum quarterly shortfall	-13	-11
Annual gasoline use	-5.1	-5.3
Annual travel	-3.4	-4.5
Annual nominal price	30	35

A number of separate effects result from such shortfalls:

1. Travel declines caused by the shortfall, and
2. If price rises are permitted, energy prices rise consistent with the shortfall.

When a short-term interruption in gasoline supply occurs, travel must fall, to the extent that the drop in supply cannot be taken up by increases in driving efficiency, or price rises do not reduce demand. During the 1973-1974 and 1979 shortages, supplies were down by 11-13 percent at the height of the shortfalls and averaged just over -5 percent for the year. However, the corresponding declines in VMT do not quite account for the entire reduction of the fuel supply. Some of the savings was achieved from increased purchases of fuel-efficient cars (especially in 1979), slower driving, and tune-ups. Approximately 70-80 percent of the reduction in supply showed up as reduced travel. Behavioral data from a panel of 1520 households interviewed in 1979 (7) also showed that 72 percent of the energy saved came from actions that entail a drop in travel. Based on this, we conclude that, in a crisis, the annual drop in travel will be approximately 75 percent of the reduction in supply. This will introduce a downward shift in the VMT growth curve, as in Figure 1. However, VMT will continue upward growth following the easing of the problem, thus leading to a saw-tooth picture of travel over time (8). The 75 percent factor would be applied to all future forecasts to account for the interim shortage (Table 7).

During a period of short-term shortage, the effects of price rises have been on the order of 2.5 to 3 times the immediate maximum shortfall and 5-7 times the annual shortfall. Although further evidence is scanty, we believe this past experience to be reasonably indicative of the immediate price impact of a future shortage, moderating somewhat at the high end. Considerable evidence exists to suggest that the price elasticity of gasoline use is about -0.15. This figure is higher in large cities such as New York City (-0.23) and lower in small cities and rural areas (-0.10). By using this and the ratios above, Table 8 shows factors to adjust prices upward in response to a shortfall.

We have purposely not shown adjustments for shortfalls above 20 percent because we do not believe that prices would remain decontrolled at that level of shortage. Several analysts, however, have calculated the equilibrium price at $2.15/gal for a 20 percent shortfall (5).

Inflation

Data are displayed in Table 9 (2) for the national consumer price index (CPI) and for total VMT in New York State. The data indicate that, in years of moderate growth in the CPI (3-6 percent annually), the associated annual growth in VMT is the highest. High growth in the CPI (6-9 percent annually) is associated with lower growth in VMT. Very high rates of inflation (above 9 percent annually) were associated with a decline in travel in 1974 and 1979 and stability in travel during 1975; both of these events were fueled by energy crises that triggered a rise in energy price and the subsequent inflation.

For the moderate inflation group, a change of +1 percent in the CPI was associated with a change of about +0.75 percent in VMT. A +1 percent change in the high inflation group was associated with a change of +0.6 percent in VMT. For very high inflation, a +1 percent change in CPI was associated with a decline in VMT of 0.25 percent. From the above information, VMT adjustment factors may be developed, as shown in the table below:

Table 7. Adjustment factors for travel reductions following energy-supply cutoffs.

Annual Supply Shortfall (%)	Annual Drop in Travel (%)	Adjustment Factor
2	1.50	0.9850
3	2.25	0.9775
4	3.00	0.9700
5[a]	3.75	0.9625
6	4.50	0.9550
7	5.25	0.9475
8	6.00	0.9400
9	6.75	0.9325
10	7.50	0.9250
15	11.25	0.8875
20	15.00	0.8500

[a]This figure is close to the experience of 1979.

Table 8. Adjustment factors for price effects of shortfalls.

Maximum Quarterly Shortfall (%)	Annual Shortfall	Annual Resulting Real Price Rise (%)
-5	-2	+13
-10	-4	+25
-12[a]	-5	+30
-15	-7	+42
-20	-8	+48

[a]-12% is close to the experience of 1979.

Table 9. Vehicle miles of travel for New York State and U.S. consumer price index.

			Annual Change (%)	
Year	CPI[a]	Vehicle Miles of Travel (000 000 000s)	CPI[a]	Vehicle Miles of Travel
1968	83.2	62.3		
1969	87.6	64.6	5.2	3.7
1970	92.8	67.0	5.9	3.7
1971	96.8	69.5	4.3	3.7
1972	100.0	72.1	3.3	3.7
1973	106.2	74.7	6.2	3.6
1974	117.9	72.2	11.0	-3.4
1975	128.7	72.2	9.1	0.0
1976	136.1	75.0	5.7	3.8
1977	144.9	78.2	6.4	4.3
1978	155.9	81.5	7.6	4.1
1979	173.5	77.8	11.3	-4.5

[a]1972 base.

Annual Infla- tion Rate	Adjustment Factor
2	1.015
4	1.030
6	1.036
8	1.048
9	1.000
10	0.975
12	0.970
14	0.965

Employment

To determine the impact of employment levels, the labor force and resulting expected employment were projected for New York State for 1970-1995. By using the available population projections and the 1970 participation rates by cohort, projections of the labor force for 1980, 1990, and 1995 were made. The projected increase in population of 1.5 million is concentrated in the principal age groups of workers and, by using the 1970 rates, this yields an additional 1.23 million in the labor force: 947 400 men and 287 100 women. The overall participation of those age 16 or more rises from 57.1 percent in 1970 to 58.3 percent by 1995. The rate of unemployment in 1970 was 4.8 percent. This rose to 7.0 percent at the beginning of 1980. A long-run rate of 5 percent was estimated for 1990 and 1995. Under these conditions, New York State must provide jobs for an additional 1 134 500 workers (at constant cohort rates of labor force participation) if the population projections are to be realized.

The sensitivity of changes in the overall labor force participation rates and unemployment was also examined for the impact on travel. These results are shown in Table 10. Note that a 1 percent change in the unemployment rate results in a change of 147-171 million VMT during the 1970-1995 period; this is about 0.20 percent of the travel estimated in New York State (assuming changes in work trips only).

Trip Length and Trip Rates

A comparison of changes in Buffalo and Rochester travel from the early 1960s to 1970s (9) indicates that, overall, both average trip length and average trip rates per household were relatively stable, and the gain in person miles of travel (PMT) generally resulted from increases in the number of households not changes in trip rates. This conclusion masks a number of individual factors that did change. Among these changes were the following.

1. Increased length of work trips, but on nearly the same travel-time budget, as new highway construction eased the move to suburbs and rural areas and permitted longer work trips with little change in travel time. A smaller share of trips for all purposes, including work, were made to central business district (CBD) destinations and destinations within the city; this indicates that trip origins and destinations are becoming more oriented to the suburbs.

2. A substantial decline in shopping trips to the CBD confirmed a trip reorientation to nearby suburban shopping centers. Shopping trips were slightly longer but constituted a smaller share of trips. Trips for personal business were similarly affected with respect to the CBD, but to a smaller degree.

3. The share of automobile driver trips rose and the share of automobile passenger trips and bus trips declined, which reflects greater affluence and increased automobile ownership. PMT per car declined substantially, and PMT per household rose slightly in Rochester and declined about 10 percent in Buffalo.

4. The share of social and recreational trips declined sharply and these trips were much shorter in length. Trips for the purpose of catching another mode of transportation (e.g., to bus stop or train station) declined by nearly 50 percent in length but the share was stable. Although these trip purposes and trip lengths showed a mixed pattern, the overall trip length and number of trips per household remained relatively stable.

5. Household size declined in nearly all automobile ownership classes; this was especially noticed in the zero-automobile households in Buffalo, where household size declined from 2.6 to 1.8 persons during the 1962-1973 period. This characteristic is also reflected in the growth of single-person households, which rose from 10 percent to 21.5 percent in Buffalo from 1962 to 1973. Nevertheless, trip rates and trip lengths for both oneand two-person households were either stable or rose slightly and overall stability in both trip rates and trip length was noted during the period.

Table 10. Effect of a 1 percent change in labor force participation and unemployment rate in New York State.

Year	Unemployment Rate (%)	Labor Force (000s)	Employment (000s)	Change in Vehicle Miles of Travel: Millions	Percentage
1970	4.8	74.59	71.00	147.35	0.220
1980	7.0	81.34	75.65	156.97	0.247
1990	5.0	84.59	80.35	166.75	0.209
1995	5.0	86.93	82.58	171.36	0.207

Note: The addition (or change) in vehicle miles of travel for an additional worker is limited to the work trip and is calculated by 250 days of work x 10 miles round trip distance for work x 83 percent automobile mode split, or 2075 miles/ worker per year.

Stability in household trip rates and trip length, as reflected in the Buffalo and Rochester comparisons in the early 1960s to early 1970s, although not updated for post-1974 events, suggests that constant travel per household is a reasonable expectation. Given the declining household size and the moderating gain in the number of automobiles (registrations), then a reasonable expectation for future travel trends is one where travel will increase by about the same magnitude as the growth in households. Under this expectation, the impact in New York State is as follows:

Year	Household Growth Index	VMT Adjustment: Rate	Annual Percentage
1980	1.0	1.0	
1985	1.068	1.068	+1.31
1990	1.132	1.132	+1.25
1995	1.184	1.184	+1.00

Population growth in New York State is projected to be modest--about 8 percent from 1970 to 2000. However, the population declined slightly during the 1970-1980 portion of the period; population growth is projected to be evenly distributed after 1980 (Table 11).

Age Distribution

A gain of about 369 000 is expected in the elderly population category (65 and older) from 1970 to 2000. Estimates of baseline VMT have been projected by using a set of general trip rates for the general

Table 11. Households and population in New York State.

Year	Households (000 000s)	Population (000 000s)	Size of Average Household
1970	5.91	18.24	3.1
1975	6.13	18.08	2.9
1980	6.45	18.08	2.8
1985	6.89	18.34	2.7
1990	7.33	18.76	2.6
1995	7.77	19.23	2.5
2000	8.09	19.71	2.4

Table 12. Adjustment factors for elderly population.

Period	Increase in Elderly Population	Reduction in Travel from General Population (vehicle miles of travel 000 000s)	Reduction in Vehicle Miles of Travel, Final Year Estimate (%)	Vehicle Miles of Travel Adjustment Factor
1980-1985	66 101	271.4	0.391	0.996
1980-1990	164 695	731.6	0.919	0.991
1980-1995	229 765	1020.6	1.235	0.987

Table 13. Factors that will influence travel, 1980-2000.

Factor	Trend Direction	Likely Impact on Travel by 1995 Compared with 1975 (%)
Automobile efficiency	80 percent gain in efficiency, 1975-2000	+40 to +50
Gasoline price	Double real 1978 price by 1995	-40 to -50
Population	Growth in number	+8
Net baseline	Vehicle miles of travel	+45
Projection	Gasoline use	-10 to -20
Energy supply cutoffs	Periodic shortfalls	-10 to -20
Inflation	8-12 percent average over next 15 years	-10 to +10
Employment	Women working	+0.5
	Unemployment rates higher	-3
Households	Growth in number	+18
Urbanization	Increase ruralization	+9
Automobile ownership and use	Increase saturation and use	+5

population. Adjustments can be made to such assumptions if necessary. For instance, data from Albany show that the elderly trip rate there is about half that of the general population. If one wished to transfer the results of the diminished travel for the Capital District's elderly to the increase in the elderly population forecast for New York State, an estimate of travel by the elderly can be made. On the other hand, if the new group of elderly will retain travel patterns that are more consistent with those exhibited by the general population, rather than acquiring travel patterns associated with the existing group of elderly, then no reduction in estimated VMT for the elderly are necessary. The values for possible adjustments for reduced travel by the elderly are shown in Table 12.

Urbanization

The share of population living in the 10 standard metropolitan statistical areas (SMSAs) in New York State is projected to fall slightly from 1970 to 1990. This would suggest that the slightly higher population in the nonurban areas would tend to acquire the higher VMT of those areas and that a proportional gain in travel in these less urban areas would result in an increase of about 9 percent by 1995 (in addition to the change in households). Adjustment factors for urbanization trends are as follows:

Year	Population of SMSA: Urban (%)	Population of SMSA: Rural (%)	Rural Area Adjustment to VMT
1980	88.1	11.9	No adjustment
1985	87.6	12.4	1.04
1990	87.3	12.7	1.07
1995	87.0	13.0	1.09

Automobile Ownership and Use

The level of automobile ownership per household has increased steadily over time. By 1975 it had reached 1.25 cars/household on the national level. Some researchers (10) expect that the level of ownership will increase based on changing lifestyles and household composition. Some (11) expect no further increase, and still others (12) expect an increase well into the latter part of this or the early part of the next century, to be followed by a stable plateau in the level of ownership per household.

The forces behind the changes in automobile ownership lead to changes in the use of automobiles as well. Because VMT per car is projected to level off earlier than the number of cars per household, we find that VMT per household reaches a stable plateau after VMT per car stabilizes but before the number of cars per household does so.

Existing forecasts of VMT can be adjusted in a very straightforward manner to account for changes in the level of automotive ownership or the use of the automobile. The national data described above, however, show too much growth for New York, which is a relatively densely developed urban state in which automobile saturation has already occurred. The table below presents a set of factors based on the growth rates inherent in these projections. These factors can be applied to a baseline forecast that assumes unchanged levels of ownership. Thus, they are most useful for separate studies of isolated links in which effects of automobile saturation have generally not been taken into account.

Year	Level of Ownership	Pattern of Use	Ownership and Use
1980	1.00	1.00	1.00
1985	1.01	1.005	1.02
1990	1.02	1.01	1.04
1995	1.03	1.02	1.05
2000	1.04	1.02	1.06

SUMMARY AND POLICY IMPLICATIONS

The above analysis suggests that broad forces at the national and state level are likely to have significant impact on the magnitude of travel in future years. Table 13 summarizes the likely magnitude of these impacts.

In particular are major changes in the efficiency of cars and the real price of gasoline. The effect of increased car efficiency is to permit more miles to be driven per unit of gasoline, as consumers trade off fuel efficiency and gasoline price. Price rises will reduce gasoline demand in the long run by accelerating fleet turnover further, but in the short run, low price elasticities prohibit major reductions in use through price alone. In the aggregate, these effects are likely to cancel out and result in growth in VMT of 40-50 percent higher than during the 1975-1995 period.

Other important demographic and economic factors could significantly change these projections. Trends toward greater automobile ownership per household but declining household size could add as much as 23 percent to travel projections over the same period; decreasing urbanization could add another 9 percent. But double-digit inflation, higher unemployment rates, and periodic energy supply shortages could more than cancel out these effects. The net direction of all of these factors is difficult to determine, but on the whole, our assessment is that, in spite of higher prices, the likelihood of a stagnant economy, and possible supply shortages, travel is likely to grow, albeit at a slower rate than in the 1960s and 1970s. Gasoline use (already down since 1979) is likely to continue to fall slowly.

U.S. energy policy, which so far has focused on new car efficiency and price decontrol, is generally correctly placed. Specific actions to reduce transportation demand (and hence energy use) through modal diversion or decreased travel have been historically cost-ineffective and will probably remain so. Such actions may be justifiable for other reasons, however.

In general, more attention needs to be placed on such factors than has been the case previously. Projections of travel made in the 1970s are not likely to include most, if any, of these concerns, particularly car efficiency, price rises, and inflation. Some of this work can be done with existing tools, but most of it cannot. New methods are needed that are sensitive to the joint interaction of these variables. Such methods need not be complicated: In fact, simplicity and ease of use are highly desirable attributes. We hope that this paper contributes to that effort.

ACKNOWLEDGMENT

I wish to express thanks and appreciation to those members of the New York State Department of Transportation who provided input to this document. By its nature this document is preliminary. Errors of interpretation, fact, or omissions remain with me. I also wish to recognize the assistance of Karen Rapp and Diana Davis in preparing this manuscript.

REFERENCES

1. Highway Travel Forecasts. FHWA, Nov. 1974.
2. N.S. Erlbaum, D.T. Hartgen, G.S. Cohen. NYS Gasoline Use: Impact of Supply Restrictions and Embargoes, New York State Department of Transportation, Albany, Prelim. Res. Rept. 142, Aug. 1978.
3. D.T. Hartgen and N.S. Erlbaum. Long-Range Forecasts of Transportation Energy Consumption in New York State (Rev. Ed.). New York State Department of Transportation, Albany, Prelim. Res. Rept. 158, April 1980.
4. Annual Automotive Fuel Economy Progress Report to Congress. U.S. Department of Transportation, April 1980.
5. Charles Rivers Associates, Inc. Methods for Analyzing Fuel Supply Limitations on Passenger Travel. NCHRP, Rept. 229, 1980, 132 pp.
6. D.T. Hartgen, A.J. Neveu, J.M. Brunso, J.S. Banas, and J. Miller. Changes in Travel in Response to the 1979 Energy Crisis. New York State Department of Transportation, Albany, Prelim. Res. Rept. 170, Dec. 1979.
7. D.T. Hartgen and A.J. Neveu. The 1979 Energy Crisis: Who Conserved How Much? In Considerations in Transportation Energy Contingency Planning, TRB, Special Rept. 191, 1980, pp. 157-165.
8. C.E. Meyers. NYS Transportation Energy Data. New York State Department of Transportation, Albany, Rept. No. 4, Nov. 1980.
9. G.S. Cohen and M.A. Kocis. Components of Change in Urban Travel. TRB, Transportation Research Record 775, 1980, pp. 42-47.
10. K.-W.P. Koeppel. Trends in Automobile Ownership Patterns, 1973-1977. TRB, Transportation Research Record 723, 1979, pp. 1-6.
11. G. Shunk and C. Loxley. An Analysis of the Automobile: Modeling the Long Run Determinants of the Demand for Automobiles. Wharton Economic Forecasting Associates, Inc., Philadelphia, Feb. 1977.
12. D.P. Sharp. Projections of Automobile Ownership and Use Based on Household Life-Style Factors. Univ. of Pittsburgh, Ph.D. Dissertation, 1978.

Publication of this paper sponsored by Committee on Passenger Travel Demand Forecasting.

The Shape of the 1980s: Demographic, Economic, and Travel Characteristics

FRANK SPIELBERG, EDWARD WEINER, AND ULRICH ERNST

Forecasts of economic and demographic conditions are the base for all forecasts of travel demand. During the 1970s many changes were observed in the demographics of the nation. This paper reviews the trends in pertinent demographic measures and projects the directions of these measures through the 1980s. The objective is to determine how transportation demand is likely to change.

Transportation analysis is based on the premise that demographic, social, and economic factors are major determinants of travel demand. For the past 25 years, metropolitan planning organizations throughout the world have conducted surveys of travel, performed analyses, and estimated models of travel demand, distribution, and mode choice. The projections of future conditions forecast by these models have been used to guide decisions on investments in new and improved transportation facilities.