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Do Demographics Drive Transportation?

It is arguable that for nearly half a century, the shape of America’s transportation systems has been dictated by a demographic exigency. The baby boom generation, born over the 20-year period from 1945 to 1964, has by the sheer weight of its numbers been an enormous and undeniable force in shaping American policy in all areas, from economic growth to the convoluted structure of the health care system to large-lot exclusionary zoning. Transportation is no exception. It is not coincidental that America’s present transportation system – dominated by the private automobile – grew up with the baby boom: parents of small children place a premium on a flexible transportation system that maximizes personal utility, and US public policy has made such a system its transportation priority since the 1950s, when the baby boomers were in their childhood. Since that time, the influence of the generation’s demographic bulge has to a large degree shaped transportation policy to its own immediate needs; that system has emphasized mobility, safety, travel speed and comfort for a the beneficiaries of a growing economy, to some degree at the expense of equity, access, conservation and sustainability.

Transportation systems are only as good as the people they serve. The needs, preferences and desires of the population at least partly drive the priorities of those systems. Any discussion of the future of transportation systems or the shapes those systems may take half a century hence must necessarily begin with a discussion of the population that will use them; absent this beginning point, any dialogue about future energy needs, technological innovations or land use planning is moot. Whether Americans fly from one location to another in personal hovercraft or are stuck in a traffic jam that stretches from one coast to another, the first questions to be asked regarding transportation systems are: who is going to be using them? What is their age distribution? What is their economic disposition? In other words, what is the demographic composition of the United States in 2050, and what are the transportation implications of that composition?
This paper explores the range of futures possible given demographic projection methods and the complex relationship between demographics and transportation behavior. An examination of demographic and related economic trends in the United States allows the discernment of demographic factors that may be specifically related to the future state of the country’s transportation systems, enabling the manufacture of several future scenarios based on the country’s forecasted demographic profile in 2050.

**Populations and Transportation**

The relationship between demographics and transportation is a complex one. Some demographic variables are obviously related to transportation systems. The overall size of the population, the age distribution of that population, and certain variables related to household structure and household life cycle all have direct impacts on transportation behavior. For example, person miles traveled increases with the size of the population.\(^1\) This simple relationship is easy to understand: people travel, and more of people means more travel in the aggregate.

However, this is perhaps the only simple correlation between demographics and transportation, and many other demographic factors affect its applicability to any particular population as the structure of that population interacts with the raw numbers. Aggregate person miles traveled in the US have indeed grown over the last half a century, but they have increased at a rate significantly greater than the increase in population. The simple relationship becomes complex once the age distribution is taken into account. Persons between the ages of 55 and 44 years are, statistically, the most employable population and the most mobile population, followed closely by those people between 25 and 34 years of age.\(^2\) These age cohorts travel more miles than others, generally speaking. In the last several decades, the baby boom generation has been passing through these age cohorts; as the members of this demographic bubble has entered their most mobile years, person miles traveled increased at a greater rate than previously, simply because this population travels more and because they dominated the nation’s demographics.

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\(^1\) Leung, Kam S. *How Demographic Changes Affect Wisconsin’s Transportation System*. Wisconsin Department of Transportation. Division of Planning and Budget. Madison. December 1983.

\(^2\) Leung, Kam S. *How Demographic Changes Affect Wisconsin’s Transportation System*. Wisconsin Department of Transportation. Division of Planning and Budget. Madison. December 1983.
Once other demographic variables are considered – household life-cycle stage, labor force participation rate, family structure and many more – it is clear that the relationship between demographics and transportation is extremely intricate, with complex interactions between the variables. There exists, consequently, no small debate over the nature of that relationship. And though the answers to questions about demographics and transportation behavior are by no means clear, it is important that those questions be considered because transportation planners necessarily must work with relatively long time horizons when planning for enhancements that will affect several generations to come, both in terms of creating infrastructure that will meet the needs of future generations and fairly allocating the costs of building it, which are also borne by future generations.

The demographic authority of the baby boom on public policy will wane in the coming decades as the generation ages and eventually dies. As the demographic pyramids in figures 1 through 4 below demonstrate, this process – called “squaring the pyramid” – will leave America with a dramatically different face than the current one. The bars on the pyramid represent the proportion of male and female population broken into five-year age groups. The movement of the baby boom through the population is clear, as is the projected age distribution in 2050. They leave in their wake not a vacuum, but a forecasted demographic profile in which no age cohort will have a dominant affect on transportation systems. There will be no age group whose needs trump all others due solely to demographic weight. It is at this point that this research begins. The question is this: what predictions may reasonably made about the nature of US transportation systems in 2050?
Figure 1: US Population Cohorts 1990.
Source: US Census Bureau

Figure 2: US Population Cohorts 2000.
Source: US Census Bureau.

Figure 3: US Population Cohorts 2025
Source: US Census Bureau

Figure 4: US Population Cohorts 2050
Source: US Census Bureau
Methodology

In general, the method used to answer the question of possible states of the US transportation system in 2050 is this:

- Conduct a literature review to identify demographic variables correlated to transportation behavior.
- Establish range of demographic forecasts for the period between 2000 and 2050.
- Combine the forecasts with the information about correlated demographic variables and use this information to compose alternative scenarios for the state of US transportation systems 50 years hence.

In this paper, the term “transportation behavior” will be used to encompass the entire range of ways in which people interact with transportation systems, from mode choice to trip frequency and distance, from chaining activities to the ways in which citizens affect transportation policy. It must be noted that freight movement is beyond the scope of this paper, as the relationships between demographics and freight systems are even less predictable than those between demographics and individual behavior.

The Variables

The literature exhibits a wide range of interpretations on the ways in which demographics are related to transportation behavior. In the most general sense, there exists a consensus that several demographic variables are correlated to transportation, although the strength of those correlations is the subject of considerable debate (see the next section, “Critique of the Methodology”). Those variables are:

- Overall population
- Age distribution
- Race and ethnicity
- Household composition, number of people in household, and family distribution
- Household life cycle stage
- Household income
- Education level
- Residence location vis-à-vis urban, suburban and rural locations.
The Demographic Projections

The US Census Bureau calculates demographic forecasts at several geographic levels of analysis and over several time horizons. These forecasts include overall population growth, state population growth along with forecasts of future household and family structures. Economic forecasts for the United States are available from the Bureau of Economic Analysis and the Federal Reserve.

The Census forecasts encompass a wide range of possible population scenarios due to the difficulties of projecting birth, death, and immigration rates. Four series of forecasts are available: the high series assumes high growth rates, the low series assumes very low growth rates, and the middle series assumes rates of growth that seem reasonably related to current trends. Finally, the census forecasts a “zero immigration” scenario projecting the birth and death rates only of the country’s current residents and their progeny, with no allowances for either in- or out-migration on a national scale.

Figure 5 shows the range of these forecasts for population growth over the next 50 years. The low series has US population peaking in 2041 at 314.7 million, with a slight decline thereafter. The high series forecasts the country’s 2050 population at 553 million. The middle series forecast, not shown in this chart, puts US population in 2050 at 404 million people. In this paper, the zero migration series is disregarded because, although the series is enlightening as an academic exercise, it is not particularly realistic given current
Demographics and Transportation in the United States 2050

immigration levels, the exigencies of the US economy and its need for workers. The projections computed by the Census Bureau are theoretically and statistically sophisticated constructions, accounting for a large number of variables that affect population growth and distribution. The vast range in forecasts for the country’s total population is a clear indication of the difficulties in undertaking a project such as the one at hand.

Other projections also provide several difficulties. Census Bureau forecasts of household and family structures are limited in their time horizons to a ten-year period. Economic forecasts used in this paper, products of the Federal Reserve Bank and its branches, as well as the Bureau of Economic Analysis, are likewise conservative in their time horizons, ranging from 18 months to ten years. This means that the scenario writing in this paper is forced to project from forecasts that do not include the time period under consideration.

Scenario Writing

The correlations between demographics and transportation behavior are combined with the various forecasts to form the basis for an exercise in scenario writing. This paper focuses on the high and low series forecasts to speculate on a broad range of potential transportation scenarios for the future. It seeks to highlight the differences between the high and low ends of the spectrum, rather than attempt to envision a “real” future.

Critique of the Method

Any research that seeks to look into the future is, of course, fraught with difficulty, and in order to preserve the credibility of the exercise, it is necessary to make explicit the methods limitations. It is instructive to contemplate why this undertaking is difficult to complete with any degree of certainty. This critique of the method also hints at the larger debates that currently inform the discussion of the relationship between demographics and transportation behavior, and in that way hint at some of the deeper currents of thought affecting transportation research.

First, it is difficult to account for all the factors other than demographics that affect transportation behavior. The most obvious of these is the transportation infrastructure available in a given place to a given group of people. Even the most transit-minded commuter cannot ride the bus if she lives in a place where no service exists. A report prepared for the Wisconsin Department of Transportation on economic and demographic forecasts notes that the demand for “...passenger transportation is determined by many economic and demographic factors. These factors include population size and age structure, income, inflation rates, prices and service attributes of highway transportation, prices and service attributes of other passenger transportation modes, the spatial organization of human activities, and individual preference.”

Second, demographics are necessarily reductive, aggregating the behavior of individuals into a collective dynamic that loses depth of focus for breadth of inclusion. In other words, demographics and the ways they are applied to transportation don’t really apply to individuals, only to the common denominators among individuals with certain common characteristics. This leads to the interesting question of causality. One group of researchers argues that relying on social indicators to predict transportation behavior can never be considered better than a guess, due to the necessarily subjective nature of interpretation of the data, of attaching meaning the correlations between demographics and transportation. These researchers contend that dependence on demographic correlations evidenced by past behavior will lead to erroneous conclusion about future transportation behavior; only when users are engaged with in-depth public participation techniques can accurate predictions be made.

Other researchers point out that demographic indicators correlated to transportation behaviors and attitudes really function as proxies for other variables. The reductionists among this groups argue that the only factors that really matters is per capita income: Americans will choose to drive private automobiles more and more as their incomes rise, and the transportation planners role is to determine how to accommodate the ever-rising tide of vehicle miles traveled. Those that take a more subtle approach contend that demographic correlations are surface representations of deeper and more complex combinations of economic variables and social and political structures. For example, African-Americans commute via public transit in a greater proportion than whites, but rather than focusing on some basic characteristic inherent in black Americans, this phenomenon

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4 Leung, Kam S. How Demographic Changes Affect Wisconsin’s Transportation System. Wisconsin Department of Transportation. Division of Planning and Budget. Madison. December 1983 p S-1
7 Gardenhire, Alissa D. “Economic and sociodemographic influences on autolessness: Are missing variables skewing results?” Transportation Research Record, n 1670, 1999. p 13-16.
can likely be explained by the gap in incomes between the races and the spatial concentration of African-Americans in central cities, areas with generally higher levels of transit access. This example merely serves to point out the issues of internal and external validity that hover over any generalizing correlation of demographic variables to transportation behavior.

Most importantly, uncertainty is unavoidably at home in this exercise. The huge range in demographic predictions mentioned above is one source of this uncertainty: many variables affect who live here – including immigration rates, which are largely political in nature – along with who lives where, where they came from and how they live. For the most part, it is very difficult to make meaningful predictions when dealing with a large number of variables.

Next, long-term projections are only available for the most basic demographic variables: population, age distribution, and race and ethnicity distributions. Inconsistent time horizons for the data also play a role in introducing uncertainty. Credible economic projections, as well as those for household composition, are generally available only through 2010. Meanwhile, the sorts of studies that correlate transportation behavior to demographics are subject to all the vicissitudes of data availability, political side taking and subjective interpretation as with any socio-scientific endeavor.

Finally, the whole exercise rests on one major and generally insupportable assumption – that Americans’ transportation behavior and infrastructure priorities will not markedly change over the next 50 years. That this assumption is untenable is of course proved by the significant changes in these behaviors and attitudes over the last half century. This question is particularly crucial in addressing the ways the transportation infrastructure will be impacted by the aging of the baby boom in the period between the present and 2050. In addition, the very process of scenario writing is, of course, a sort of informed and educated fiction.

Still, despite the uncertainty inherent in this exercise, this is the method that is generally used to apply demographic projections to future transportation scenarios. Demographics at their coarsest levels clearly impact transportation systems, simply because transportation systems exist to provide mobility and access for people. The results of such a study, once its limitations are understood, may be of value as one means of opening up the future and considering the range of possible shapes it may take.

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8 Leung, Kam S. *How Demographic Changes Affect Wisconsin's Transportation System.* Wisconsin Department of Transportation. Division of Planning and Budget. Madison. December 1983
Demographic Variables Correlated to Transportation Behavior

A review of recent literature on the relationship between demographics and transportation systems use reveals a wealth of materials on the subject. Many researchers are pursuing statistical inquiries attempting to correlate population variables and transportation behavior. In general, this research reveals relationships in four general categories of demographic variable:

- Population Variables,
- Household Structure Variables,
- Economic Variables,
- Structural and Locational Variables.

Each category is related to various transportation issues such as mode choice, overall travel, likelihood of autolessness, and so on. Population variables include those related to overall population growth and its patterns, age distribution, gender, and race and ethnicity distributions through the population. Household Structure relates to the household formation rates, distribution of family and non-family households, age of householder, household life cycle and variables related to family structure such as age of children and whether the head of the household is married or unmarried. Economic variables for this study refer to rates of growth in gross domestic product, labor force participation rates and family and per capita income. Finally, structural and locational variables include residence location with respect to region of the country and metropolitan or non-metropolitan locations, educational achievement, and internal migration.

<table>
<thead>
<tr>
<th>Demographic Variable</th>
<th>Transportation Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population growth</td>
<td>Increased travel</td>
</tr>
<tr>
<td>25-44 y/o</td>
<td>Most mobile, most employable</td>
</tr>
<tr>
<td>35-44 y/o, 25-34 y/o</td>
<td>Most travel, second most travel (check NPTS)</td>
</tr>
<tr>
<td>Age and Bicycling</td>
<td>16-24: 39%; 25-44: 34%; declining to 65+: 9%</td>
</tr>
<tr>
<td>Age and Walking</td>
<td>More than 80% 16-44; 66% for 65+. Black least likely, Hispanic most likely</td>
</tr>
<tr>
<td>Commute mode by age</td>
<td>More driving as commuters age, with alternate modes increasing at 65 yoa.</td>
</tr>
<tr>
<td>Commute mode by gender</td>
<td>M drive alone 81%, F drive alone 76%; M carpool 14%, F 19%; M transit 4%, F 4%; M nonmotor 1.3%, F 1.1%</td>
</tr>
<tr>
<td>Commute mode by Ethnicity</td>
<td>Nonwhites more likely to carpool, use transit.</td>
</tr>
</tbody>
</table>
patterns.

Population Variables

A number of salient relationships are identified in the literature correlating population variables to transportation behavior. Table 1 above summarizes several that are applicable to this study. Most important to this necessarily coarse analysis is the correlation between population growth and overall travel: greater population leads to increased person miles traveled.\(^9\) This is intuitively sensible, of course, as more people means more people traveling. Also relevant is the relationship of age to travel. In general, people between 35 and 44 years of age are the most employable and mobile, and demonstrate the greatest travel. They are followed closely by persons between 25 and 34 years of age. Travel generally declines with age after age 44.\(^10\) Age is also correlated to mode choice, although not particularly strongly, with personal vehicle use generally declining after age 74 for many types of trips.\(^11\) In addition, younger people tend to use bicycles for transportation, and the elderly tend to walk more than other age cohorts.\(^12\)

Gender is also correlated to mode choice, with slightly higher rates of commuting alone by men than women, and correspondingly higher rates of transit use and carpooling by females.\(^13\)

Finally, race and ethnicity are correlated to transportation behavior, although, as noted above, race and ethnicity may in some cases act as proxies for other economic social factors in some of these cases. In general, white persons record the highest rates of driving alone; non-whites are more likely to carpool (particularly Hispanics) and use transit (particularly African-Americans).\(^14\) In addition, whites and Hispanics bicycle more often than other races and ethnicities, while African-Americans are somewhat less likely to use non-motorized transportation, particularly walking.\(^15\)

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\(^9\) Leung, Kam S. *How Demographic Changes Affect Wisconsin’s Transportation System*. Wisconsin Department of Transportation. Division of Planning and Budget. Madison. December 1983.

\(^10\) Leung, Kam S. *How Demographic Changes Affect Wisconsin’s Transportation System*. Wisconsin Department of Transportation. Division of Planning and Budget. Madison. December 1983.


\(^12\) US Department of Transportation. “National Survey of Pedestrian and Bicyclist Attitudes and Behaviors.” 2002.

\(^13\) Ferguson, Erik “Demographics of carpooling.” *Transportation Research Record*, n 1496, Jul, 1995, p 142-150.

\(^14\) Ferguson, Erik “Demographics of carpooling.” *Transportation Research Record*, n 1496, Jul, 1995, p 142-150.

Household Structure Variables

Table 2 shows a number of household and family structure variables that are correlated to transportation behavior. With this set of data, the relationships become more complex. For example, the number of households in America is positively correlated with increased travel and the use of automobiles,\(^{16}\) meaning that the rate of household formation – which is affected by incomes, divorce rates and longevity, among other factors – is correlated to overall travel. Meanwhile, an increase in the number of non-family households leads to higher peak hour travel rates, as these households are more likely to have multiple workers and carpooling is somewhat associated with families.\(^{17}\) Household composition is further correlated with transportation behavior in a number of ways. Couples with children, for example, are much more likely to choose modes other than private automobile than other types of households\(^ {18}\) and the presence of younger children lead to a measurable increase in carpooling over households with older children, and more people in a household is correlated with a slight

<table>
<thead>
<tr>
<th>Demographic Variable</th>
<th>Transportation Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>HH Cycle: Couple with children</td>
<td>Much less likely to walk/bike, a little less likely to carpool, less likely to use transit</td>
</tr>
<tr>
<td>Increased proportion of non-family residences</td>
<td>Increased peak hour travel</td>
</tr>
<tr>
<td>Increased number of households</td>
<td>Increased auto use</td>
</tr>
<tr>
<td>Commute mode by HH Lifecycle: number of adults</td>
<td>More adults, increased carpooling. Fewer adults, more transit.</td>
</tr>
<tr>
<td>Commute mode by HH Lifecycle: age of children</td>
<td>Younger children, increased carpooling.</td>
</tr>
<tr>
<td>Commute mode by HH Lifecycle: HH size</td>
<td>More people, increased carpooling, some transit increase.</td>
</tr>
<tr>
<td>Commute mode by HH Lifecycle: Vehicles available</td>
<td>More vehicles, more drive alone.</td>
</tr>
<tr>
<td>HH size to Autolessness (AL)</td>
<td>Majority (57%) single-person HH; less than 15% of AL HHs have more than 3 people</td>
</tr>
</tbody>
</table>

\(^{16}\) Leung, Kam S. *How Demographic Changes Affect Wisconsin’s Transportation System.* Wisconsin Department of Transportation. Division of Planning and Budget. Madison. December 1983.

\(^{17}\) Leung, Kam S. *How Demographic Changes Affect Wisconsin’s Transportation System.* Wisconsin Department of Transportation. Division of Planning and Budget. Madison. December 1983. Also Ferguson, Erik “Demographics of carpooling.” *Transportation Research Record*, n 1496, Jul, 1995, p 142-150.

increases in the likelihood of transit use.\textsuperscript{19} Household life cycle stage is similarly correlated with transportation. Households headed by the elderly, for example, have much lower overall rates of automobile ownership than others; in fact, 40\% of autoless households are headed by people over 65 years of age.\textsuperscript{20}

**Economic Variables**

As shown in Table 3, a number of economic variables, of course, clearly relate to transportation behavior. Though a number of these variables are not strictly “demographic,” most of them relate to household structure and other population factors. They are included here because they inform the demographic factors and in many cases are really inextricable from them. Increased per capital income, for example is very strongly related to increased use of automobiles. In fact, it has been noted that the correlation is significantly stronger than other strictly demographic factors.\textsuperscript{21} Income per capita, however, is a function of gross domestic product, inflation, labor force participation rate – itself individually positively correlated to auto use\textsuperscript{22} – and population growth, and thus intimately related to demographics.

Family income, measured as such, is also correlated to transportation. Members of families with incomes of less than $7,500 annually – the very poor – are much more likely to walk or bicycle than those with higher

\begin{table}[h]
\centering
\begin{tabular}{|l|l|}
\hline
Demographic Variable & Transportation Outcome \\
\hline
Increased real per capita income & Increased auto use, more important than demographics \\
\hline
Higher LFPR and per capita income & Increased car travel \\
\hline
Commute mode by Family Income & At lower income levels, carpooling declines with income growth; at $50+, mode split remains constant, with slight increases in carpooling and transit. \\
\hline
Housing cost on Auto Ownership (AO) & High housing cost to income decreases AO \\
\hline
HH Income <$7500 & More likely to bike/walk \\
\hline
Low-paid blue collar job & More likely to carpool, somewhat more likely to use transit, a little more likely to walk/bike \\
\hline
\end{tabular}
\caption{Economic Variables}
\end{table}

\textsuperscript{19} Ferguson, Erik “Demographics of carpooling.” Transportation Research Record, n 1496, Jul, 1995, p 142-150.
\textsuperscript{20} Gardenhire, Alissa D. “Economic and sociodemographic influences on autolessness: Are missing variables skewing results?” Transportation Research Record, n 1670, 1999. p 13-16.
\textsuperscript{22} Leung, Kam S. How Demographic Changes Affect Wisconsin’s Transportation System. Wisconsin Department of Transportation. Division of Planning and Budget. Madison. December 1983.
In fact, mode choice is correlated with family income at all levels: at the lower end of the family income spectrum, carpooling declines with income growth; at the $50,000 level of annual income, mode split stabilizes and remains constant, with slight increases in carpooling and transit rates as income rises thereafter. Meanwhile, other costs also affect transportation; high ratios of housing cost to income decreases auto ownership, for example. So transportation is affected when housing rise quickly relative to income, as has been the case over the last half a decade.

**Structural and Locational Variables**

This set of variables, though sometimes strongly correlated with travel behavior, are problematic from the point of view of this research in that it is very difficult to forecast future values. Nonetheless, the variables shown in Table 4 inform the task of predicting the future state of America’s transportation systems, even if they require analysis methods that are “soft.” The most important of these variables is residence location and its relationship to mode choice: generally, the further one’s residence is located from the central city, the more likely one is to use and automobile as opposed to transit. Carpooling prevalence also drops with distance from central city, until that residence is located outside of metropolitan areas, at which point carpooling rates rise slightly.

<table>
<thead>
<tr>
<th>Table 4: Structural and Locational Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographic Variable</td>
</tr>
<tr>
<td>Structural Factors</td>
</tr>
<tr>
<td>Transportation Outcome</td>
</tr>
<tr>
<td>Commute mode by education</td>
</tr>
<tr>
<td>More education leads to more driving alone,</td>
</tr>
<tr>
<td>less carpooling. Less than HS use transit,</td>
</tr>
<tr>
<td>nonmotor high, then dips until grad school.</td>
</tr>
<tr>
<td>Commute mode by location of residence: urban</td>
</tr>
<tr>
<td>central city</td>
</tr>
<tr>
<td>Drive 74%, carpool 17%, transit 7%,</td>
</tr>
<tr>
<td>nonmotor 2%</td>
</tr>
<tr>
<td>Commute mode by location of residence: suburb</td>
</tr>
<tr>
<td>Drive 82%, carpool 14%, transit 3%,</td>
</tr>
<tr>
<td>nonmotor 1%</td>
</tr>
<tr>
<td>Commute mode by location of residence: rural</td>
</tr>
<tr>
<td>Drive 80%, carpool 18%, transit 0.5%,</td>
</tr>
<tr>
<td>nonmotor 0.7%</td>
</tr>
<tr>
<td>Region of residence to AO</td>
</tr>
<tr>
<td>40% of autoless HHs in NE; 32% in Mid-Atl.</td>
</tr>
</tbody>
</table>


24 Ferguson, Erik “Demographics of carpooling.” Transportation Research Record, n 1496, Jul, 1995, p 142-150.

Similarly, region of the country in which a household is located is also correlated to transportation. Forty percent of autoless households, for example, are found in the northeast, and another 32% are found in the mid-Atlantic states.\textsuperscript{26}

Finally, educational attainment is correlated to transportation behavior. In general, very low levels of education are positively correlated with transit use, higher educational attainment leads to more driving alone, until one reaches graduate education, at which point transit use and carpooling rates again rise slightly.\textsuperscript{27} It seems likely that this correlation is really a proxy for income and household location factors, as educational attainment is also positively correlated with earnings.

In all, there are few big surprises in the data, and the relationships between demographic variables and transportation behavior make sense intuitively, particularly given the nation’s transportation infrastructure priorities over the last half century. The correlations that apply to the data forecasts available and applicable to this research may be summarized thus:

- Aggregate travel increases with population.
- Car travel increases with income.
- Working-age people travel more than others.
- There exist some correlations between race and ethnicity and transportation behavior.
- Household and family structure impact transportation behavior in mode choice and overall household travel.
- Households with children travel more than those without and tend to travel more by car than other households.
- Suburban and rural residents travel more than urban residents and tend to travel more by car than urban households.

\textsuperscript{26} Gardenhire, Alissa D. “Economic and sociodemographic influences on autolessness: Are missing variables skewing results?” Transportation Research Record, n 1670, 1999. p 13-16.

\textsuperscript{27} Ferguson, Erik “Demographics of carpooling.” Transportation Research Record, n 1496, Jul, 1996, p 142-150.
Understanding these correlations allow planners to envision multiple variations of future needs with some understanding of the ways populations relate to transportation. In doing so, forecasters must rely on future behavior mirroring past behavior. This raises difficulties, of course. As a simple example, consider the relationship between population growth and vehicle miles traveled. As Table 5 shows, between 1950 and 2000, the population of the United States has increased 85%, but total vehicle miles traveled has increased at a much faster rate of 500% during the same period. In other words, vehicle miles traveled is not solely explained by growth in population. Demographers and transportation analysts point out that during this period, the baby boom generation entered age cohorts which have very high mobility, and thus VMT growth has outstripped mere populations increases. In this way, even simple or direct correlations may be much more complicated than they may at first appear. The question that pertains to the future is whether, over their elderly years, the baby boomers will settle for the limited mobility that the was the case with their own parents and grandparents. This is a question that a regression equation of course cannot answer, but the answer will largely determine transportation infrastructure developments over the next three decades.

The Demographic Forecasts

Population

Population forecasts for the United States are available from the census up to the year 2100. As mentioned in the section “Methodology” above, these forecasts depend on several variables that are difficult to predict: birth rates, death rates and immigration rates. Several theoretical questions obtain with this method, the most important of which is: “will the birth and death rates of immigrant groups converge over time with those of white Americans, or will they remain at current, higher levels?”

Table 5: US Travel and Population

<table>
<thead>
<tr>
<th>Year</th>
<th>Vehicle Miles Traveled</th>
<th>US Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950</td>
<td>458,246,000</td>
<td>151,325,798</td>
</tr>
<tr>
<td>2000</td>
<td>2,749,803,000</td>
<td>281,421,906</td>
</tr>
<tr>
<td>Percent Change</td>
<td>500%</td>
<td>86%</td>
</tr>
</tbody>
</table>

Source: US Census and FHWA

Due the uncertainty inherent in the exercise, the Census Bureau produces four projection series: high, low, middle and zero immigration. The high and low series are of particular interest, as they mark the extreme population cases in the future. Figure 6 illustrates the differences in the forecasts for US population in 2050 in the high and low series. The high series, assuming high birth rates and immigration, projects the country’s 2050 population to be 553 million people; the low series, with lower assumptions, projects only 314 million. To illustrate the breadth of this range, these forecasts represent a 94% increase over current population in fifty years at the high end, and only a 10% increase at the low end. As shown in Figure 7, the majority of this growth takes place in the South and West; of the 15 states with the highest projected growth rates over the next 25 years, none is in the Northeast or Midwest. These figures are at the heart of projecting the shape of future transportation systems.
As a proportion of world population, the US becomes less important demographically as the 21st century progresses, but only very slightly. In the century between 1950 and 2050, world population growth peaked in 1966 and 1967, with annual increases of 2.19% in each of those years. The rate of growth has been dropping ever since. In 2002, world population increased 1.18% over the previous year, and by 2050 the middle series projection sets average annual growth at less than 0.5%. Because of this declining growth, the US is put at less of a disadvantage demographically than one might expect. In 2002, the US was home to 4.62% of the world’s population. In 2050, the middle series projections put the US at 4.44% of world population. See Table 6. The small scale of the decline of US demographic clout over the coming decades could ensure continued economic growth compared to the world as the explosive population growth in other parts of the globe slows.

**Table 6: US and World Population Projections**

<table>
<thead>
<tr>
<th></th>
<th>2000 Actual</th>
<th>2050 Forecast</th>
</tr>
</thead>
<tbody>
<tr>
<td>World Population</td>
<td>6,079,006,982</td>
<td>9,084,495,405</td>
</tr>
<tr>
<td>US Population</td>
<td>281,421,906</td>
<td>403,686,852</td>
</tr>
<tr>
<td>US Proportion of World Population</td>
<td>4.62%</td>
<td>4.44%</td>
</tr>
</tbody>
</table>

Source: US Census Middle Series

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**Age, Race and Ethnic Distributions**

Figure 8 compares the present age group distribution in the United States with high and low series projections for 2050. Several interesting phenomena appear. First, there is in neither projection a “bulge” similar to that of the baby boom – peaking in the 40 to 49 cohort – in the 2001 distribution. Second, both projections include a much greater number of elderly Americans, particularly in the 80 to 89 and 90 and up cohorts. This phenomenon is the result of generally rising life expectancies, and can be expected to have significant transportation impacts. The low series projection posits a population that is middle aged – just out of its prime working years – while the high series shows a large increase in the numbers of young people, the result of continued high birth rates among the country’s immigrant population. In essence, the low series America doesn’t look too different from that of today, while the high series represents a significant youth movement.

The forecasted distribution of racial and ethnic populations is shown in Figure 9. The overall distribution pattern is projected to remain similar, but with a decrease in the proportion of the population that is white relative to other races. The percentage of the population that is Asian will at least double – from 4% to 7% – and could triple to 13%. The proportion of Hispanics of all races will double or increase 2 1/2 fold, to somewhere between 24% and 27% of the entire population.
The proportions of African-Americans and Native Americans are projected under all scenarios to remain stable. The transportation implications for these scenarios is largely centered on the residence locations of racial and ethnic minorities compared to white Americans. Racial minorities have tended to reside in central cities, and have tended to have lower incomes than whites. There is some evidence, however, that these patterns may be changing somewhat: the 1990s saw a significant increase in the number of African-Americans and Hispanics locating in non-metropolitan areas, part of overall high growth rates for rural areas. during the 1990s, non-metropolitan areas grew in population at higher rates than metropolitan areas for the first time.30

**Household and Family Structure**

It is difficult to project future household and family structures, largely because so many factor influence them. The Census Bureau provides projections only through 2010. The proportion family households has been slowly dropping over time, and it is likely safe to predict that it will continue to do so. People have tended to remain unmarried longer than in the past, high divorce rates lead to more non-family households, and rising incomes lead to higher rates of household formation, often single-person households as young people are financially able to “leave the nest” at relatively young ages. These trends may have been

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exacerbated by the baby boom moving through its life cycle stages, and may in fact level off somewhat over time, particularly under the low series forecasts, in which the population is predominantly middle aged. Meanwhile, the overall number of families with children is predicted to decline until at least 2010. This trend may be difficult to reconcile with the high series projections, which forecast that 30% of the population will be under 20 years of age in 2050, and likely reflects the high divorce rate among baby boomers. Figure 10 depicts the rates of change in family structure.

**Economic Forecasts**

Credible estimates put US economic growth, as measured by gross domestic product, at about 3% for the next 25 years.\(^1\) This represents moderate but healthy growth. The important aspect of this projection for the purposes of this paper is that no major long-term slow-down is expected, a slow-down which could have major impacts on transportation for both personal and infrastructure spending.

Growth in personal expenditures as a proportion of the GDP is projected to rise from 65.2% in 1980 to 68.5% in 2010, an average annual rate of about 3.5%. However, income from labor will grow at about 5.5% until 2010, having fallen as a proportion of income between 1980 and 2000. By 2010, income from labor will equal its proportion of income in 1980. In 2010, 83% of personal income will be spent on personal consumption. The proportion of income retained as savings, which plummeted 14% annually between 1980 and 2000 – from 9% of income to less than 1% -- is projected to decrease more slowly for at least the rest of this decade.\(^2\)

On transportation related spending, money spent on vehicles has grown at a robust 8% average annually in

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\(^1\) Wisconsin Department of Revenue. Special Report on Long Term Economic Growth. www.dor.state.wi.us/ra/wilg0501.pdf

the last decade. This is due to the amount spent on expensive SUVs and minivans. The rate is expected to drop to 3.7% annual growth until 2010. The amount spent on gasoline is expected to increase 2.2% annually over the next decade.  

Transportation Scenarios for 2050

When writing transportation scenarios for 2050, two issues related to the baby boom must be acknowledged. First, with no baby boom bubble to drive policy, the country will be in the middle of a 20-year long demographic holding pattern. Second, the baby boom generation, as it moves through retirement and old age, will likely continue to have a dramatic effect on transportation policy, depending on whether they follow historical patterns or continue to break them as they have throughout their lives.

Quick Growth Scenario

This scenario is based on the high series projection. Compared with today there are more elderly people and a much higher proportion of persons under 20 years of age. Overall, the US population has increased to 553 million people, many of them immigrants from Spanish-speaking countries and Asia. Most of the racial and ethnic minorities inhabit the central cities and first ring suburbs, although a much higher proportion of racial minorities now live in rural areas, continuing a trend that began in the 1990s. White people have settled increasingly in suburban, exurban and non-metropolitan areas, decreasing the population clout of cities.

However, a large group of baby boomers did return to the downtown areas of many cities, raising property values and revitalizing downtown cores. Their legacy, as they aged and were less and less inclined to drive, was to effectively lobby for and obtain better public transit infrastructure in the hearts of central cities and better and safer road systems in the far-flung rural communities where they vacationed. Now, those systems are taken advantage of by young people in cities – many of whom are minorities in lower income brackets – and by the waves of new retirees who are moving away from metropolitan areas.

The young people in America – now in significantly greater proportions than at any time in a century – have transportation needs that are dissimilar to those of middle-aged people. They provide the workforce of 2050.

and fuel the economy, and provisions must be made for their self-transportation, either through walking or transit in the central cities, and through improved public transit networks to the far suburbs. The suburban improvements, however, have been modest, as the ring of low-income households has spread from the central city to the inner and second ring suburbs. These newly low-income communities cannot afford to make major investments in infrastructure, and must rely on maintaining existing networks as best they can. These systems are overwhelmingly automobile-based, and so the need for low-wage workers to expend large proportions of their incomes on private vehicles is unabated.

The number of non-family households now approaches that of family households. That fact, along with the relatively high number of children and overall population growth means that travel overall has risen dramatically. Though the rate of increase of vehicle miles traveled leveled off somewhat as the baby boomers aged, the land use systems they had created – covering large land areas with relatively low density settlement patterns – means that their children and grandchildren have also continued to spend more and more time in transit. So, though the baby boomers traveled less themselves as they aged, succeeding generations have continued to increase VMT at rates faster than population growth.

This trend has been compounded by the fact that most of the population growth in America has been centered in the South and West, areas which have historically had high correlations with auto ownership and high rates of travel. Some of the largest cities in these areas have invested in public transportation, both for the elderly people that congregate there and for the poor minority population that fills the service jobs that cater to them, but for the most part, the sprawling development patterns established in the 20th century continue to make private automobiles the mode of necessity.

In summary, the quick growth scenario could lead to an overall expansion of transportation systems to serve the much greater population of 2050. The nation has built more and better roads in rural and suburban areas, and improved transit infrastructures in the central business districts of many large and medium-sized cities. In addition, some transit improvements have been made between central cities and further suburbs to move minority workers to jobs. Steady economic growth, and the continued intensive settlement of rural areas leads to a blurring of the line between long and medium-distance trips, as Americans continue to travel – drive automobiles, that is – more and more.

**Slow Growth Scenario**
This scenario is predicated on the low series forecasts, in which US population in 2050 is only 10% greater than in 2000, with relatively little change in racial and ethnic make-up of the country. America, under this scenario, is somewhat middle aged, with a significantly smaller proportion of households with children than is currently the case.

In this America, modest population growth leads only to modest changes in the current transportation system. The slow influx of immigrants into central cities doesn’t overtax existing public transit systems. The baby boomers, meanwhile, reached the peak of their spatial expansion and sprawl began to slowly recede as they died, aged in place in their suburbs, or reconcentrated in retirement communities in the south and west. The greater number of elderly people and smaller proportion of young persons means that there is no great pressure to change transportation systems from their present configurations. Growth in vehicle miles traveled has stabilized, and rises only slightly faster than population.

The great age of spending on transportation infrastructure in non-metropolitan areas ended around 2035. Modest population growth has meant slower economic growth than in the past, which leads to less funding for infrastructure in general; consequently jobs tend to be concentrated in metropolitan areas where infrastructure grids are already in place. This stay-the-course scenario is the product of lack of demographic pressure. Although incomes are rising, there exists no great pressure to develop land in any particular pattern, neither overcrowding in central cities nor excessive sprawl at the fringe.

These scenarios represent, of course, only two possible outlines for the shape of future transportation systems in America, at least insofar as they are shaped by demographics. Naturally, the real shape of those systems will fall somewhere in between them. They are unable to account for energy supply, technological change, economic or environmental exigencies, or unforeseeable political issues that may mold the ways Americans travel in the future. As such, they are really outlines of the ways in which demographic changes affect transportation behaviors of individuals and thus of systems as they are conceived, designed and built.
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