FEHR PEERS

2013 - 2017 Travel Decision Survey Data Analysis and Comparison Report

Prepared for SFMTA

July 2017

EXECUTIVE SUMMARY

The SFMTA 2013-2018 Strategic Plan sets a goal to make transit, walking, bicycling, taxi, ridesharing, and carsharing the preferred means of travel in San Francisco. To monitor progress toward this strategic goal, SFMTA conducts travel decision surveys on an annual basis. This report analyzes data provided by Corey, Canapary & Galanis Research to examine overall travel trends in San Francisco from 2013 to 2017,[1] identify key demographics or trip purposes where the share of trips made by automobile exceeds the current goal, and compare findings to additional data sources documenting or forecasting travel behavior in San Francisco.

Based on 804 responses for 2017 and a total of 2,324 responses from 2013 to 2017, Fehr & Peers identified the following key findings:

San Francisco Drives Less than Half the Time

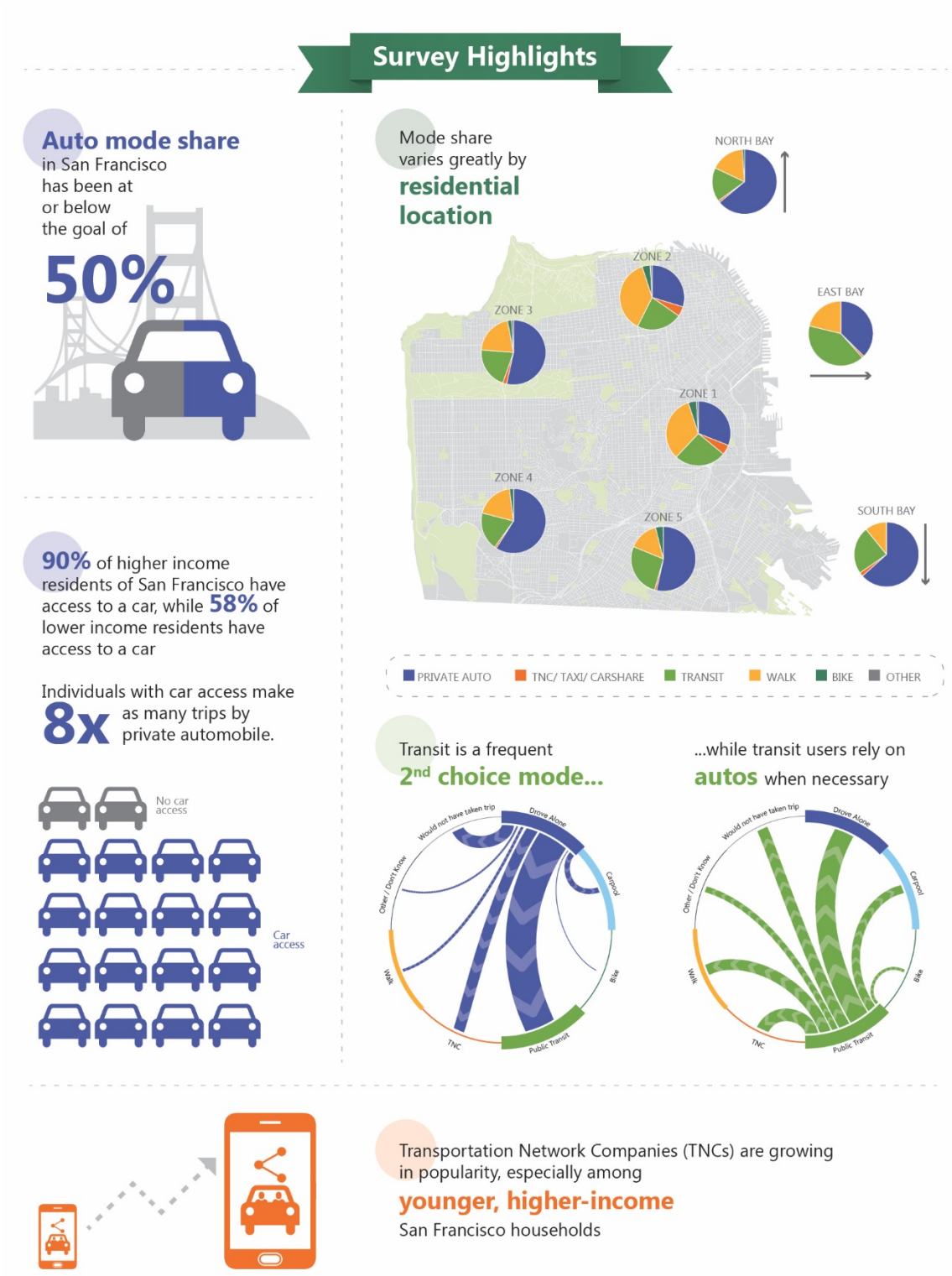
- The City has met its goal of having fewer than 50 percent of trips be made by private auto in every year since 2013, and total private vehicle mode share has decreased from 48 percent of trips to 43 percent of trips since 2013.
- Transit mode share has remained flat over time, with a slight increase in transit use among non-San Francisco residents in the past year.
- Walk and bike trips show a similar pattern to transit use, with minor fluctuations but no significant change since 2013. The bicycle mode share data suffers from a small sample size; however, other data sources indicate that bicycling has remained steady from 2013 to 2017, and has increased substantially from 2006 levels.
- Share of travel by private automobile also varies based on trip purpose; school and shopping trips in particular are more likely to be made by private vehicle than other types of trips.

San Francisco Walks

- Over the past five years, around one quarter of all trips in San Francisco has been made on foot.
- Patterns in other data sources such as the California Household Travel Survey and intercept surveys conducted for the San Francisco Planning Department indicate that walking rates may be even higher than indicated in the survey responses.
- If walking rates are higher, they likely correspond to a slight decrease in rates of taking transit and potentially rates of driving alone.

[1] Survey years are presented by fiscal year (i.e., the first survey conducted in FY12-13 is reported as 2013), while prior reports have been by calendar year.

Figure E-1: Summary of Survey Findings



Travel Decisions Vary by Geography, Income, and Auto Access

- Share of travel by private automobile varies widely based on residential location, with residents of outer San Francisco neighborhoods and the North and South Bay areas making more than half of their San Francisco trips by private automobile. This pattern has been consistent from 2013 to 2017.
- Higher income households in San Francisco make more trips by automobile. Much of this difference is associated with variations in auto access by income, with only 10 percent of households with incomes over $75,000 reporting no access to a vehicle, compared to 40 percent of households with incomes under $75,000.
- The difference in auto mode share between lower income households and higher income households is highest in the densest neighborhoods, even though these neighborhoods also have the lowest total private auto use.
- However, the strongest indicator of private auto mode share greater than 50 percent is place of residence, rather than income, with residents of the North and South Bay areas and outer neighborhoods more likely to make vehicle trips at all incomes.

San Francisco has a Diverse Set of Transportation Options

- Among individuals not using transit, transit was by far the most popular "second choice" of mode (i.e., individuals indicated that if they had been unable to drive / carpool / walk for a trip, they would have taken transit instead).
- Transportation network companies ("TNCs," such as Lyft and Uber) and taxis serve an important service as a "second choice" mode among transit users and drivers alike.
- Generally, only 15 to 20 percent of respondents across all modes indicated they would not have made a trip if their preferred mode was unavailable. The highest level of 'no trip' responses was for carpool trips. This indicates that most respondents felt they had multiple travel options available to them.
- Even so, driving is still perceived as being more convenient and faster than all other transportation options, based on responses from drivers.

Transportation Network Companies are Increasing in Popularity

- Use of TNCs has increased significantly over the past two years, with TNC trips now comprising approximately four percent of all trips made in San Francisco (+/- 1%).[2]
- Around a fifth of San Franciscans use a TNC at least once a week, with 40 percent using a TNC at least once a month.

[2] If TNCs were considered to be private automobiles for purposes of goal monitoring, the City would still be meeting its overall goals for 2017; however, total auto mode share would increase from a total of 43 percent to 47 percent.

- Frequent TNC users are more likely to be young (under age 35), high income, and live in dense, inner neighborhoods of San Francisco.
- Evidence from outside studies indicates that some of the increase in TNC mode share may be resulting in shifts away from transit use, walking, and bicycling.

Looking Forward

- Demographic and social trends such as labor force participation, household formation, economic growth, and the rise in on-demand and delivery services will all affect future levels of vehicle traffic on San Francisco's roadways.
- Technological innovations such as continued TNC operations and the introduction of autonomous vehicles may also have direct effects on travel in San Francisco, including increases in vehicle trips on City roadways, but these effects are difficult to project definitively.
- Ultimately, land use patterns and neighborhood characteristics, such as demography, neighborhood density, and income, tend to be the strongest indicators of mode share among individuals.

Implications for future surveys and the setting of future performance metrics largely revolve around measurements of total vehicle use. The Travel Decision Survey characterizes trips by modes such as taxi, TNC, or carshare as "non-private auto," rather than labeling such trips as "private automobile use." The goal set in the Strategic Plan specifically lists ridesharing and carsharing as modes to encourage, and the data regarding "second choice" modes indicates that they are a key component in creating a dense web of potential travel options. But while these modes were used infrequently in 2012, TNC use in particular has grown quite strongly, and preliminary evidence suggests that TNCs may be adding additional vehicle trips to the roadway by inducing vehicle trips and capturing mode shift from transit in particular.[3,4,5,6] Additionally, there is generally a distinction made between TNC or "ridehailing" type travel and "ridesharing," with ridesharing referring to traditional means of carpooling mechanisms and their evolutions, such as casual carpools or services such as Scoop. In comparison, most TNC activity is more comparable to taxi use.

The increase in TNC use over a period of five years also has some implications for handling future technological innovations. While autonomous vehicles (AVs) are currently under active development, and

[3] Anderson, D. 2014. "'Not Just a Taxi'? For-Profit Ridesharing, Driver Strategies, and VMT" *Transportation*. Volume 41, Issue 5, pp. 1099-1117.
[4] Henao, Alejandro. 2017. Impacts of Ridesourcing – Lyft and Uber – on Transportation including VMT, Mode Replacement, Parking, and Travel Behavior. University of Colorado Denver
[5] Rayle, Shaheen, Chan, et al. 2014. App-Based On-Demand Ride Services: Comparing Taxi and Ridsourcing Trips and User Characteristics in San Francisco. University of California Transportation Center.
[6] Schaller Consulting. 2014. *Unsustainable? The Growth of App-Based Ride Services and Traffic, Travel and the Future of New York City.*

may be consumer ready between 2020 and 2030, there is limited real world data for assessing their effects. Travel demand models modified to reflect key AV features (such as decreased parking costs, increased vehicle density during congested periods, etc.) generally show an increase in vehicle miles traveled (VMT) as more vehicles on the road are autonomous.[7]

Overall, however, survey results show that San Francisco has a diverse set of attractive travel options. Walking and transit together comprise more than half of trips in some areas of the City, and travelers from the East Bay in particular use transit at high rates. Further encouragement to take transit, walk, and bicycle can occur through continued investment in each of those networks, through implementation of Muni Forward and other transit enhancements, improvements to walking and bicycling facilities, and careful coordination with other agencies in the City family.

[7] Transportation Research Board. 2017. *NCHRP Report 845: Strategies to Advance Automated and Connected Vehicles: A Primer for State and Local Decision Makers.*

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1 INTRODUCTION

The SFMTA's 2013-2018 Strategic Plan establishes a goal that less than half of all trips to, from, or within the City are made by private automobile. The SFMTA conducts travel decision surveys by telephone once a year to monitor progress toward the City's goal. The SFMTA 50 percent goal target includes only trips made by driving alone or driving with others (i.e., carpool). Trips made by transit, walking, and bicycling, as well as trips made using Transportation Network Companies (TNCs, such as Uber and Lyft) and taxis have been categorized as "non-private auto" modes. Within this report, Fehr & Peers has introduced an additional designation, "auto modes," to include trips made by private vehicles as well as trips made by TNCs and taxis, due to their continued growth as a travel choice.

This report identifies trends in travel decision survey results from 2013-2017, as well as discusses potential demographics or geographic areas with potential for further reductions to private vehicle mode share. This report also introduces data from several additional sources when it serves to provide context, support, or additional information on the trends observed in the survey result data set. These data sources include monitoring reports from other SFMTA programs, data from projects undertaken for the San Francisco Planning Department, academic research on travel choices, and data from the California Household Travel Survey, last conducted in 2012.

Special focus is also given to particular modes of transportation and trends that may affect future travel decisions in unknown ways. This includes TNCs, as well as potential future shifts in demographics, social trends, or the introduction of autonomous vehicles (AVs) into the vehicle fleet. These trends, along with patterns identified through examination of the Travel Decision Survey data, may inform future policy decisions by SFMTA or other City agencies. Potential effects on future policy decisions are discussed further in this report as appropriate.

2 SUMMARY OF DATA SETS

Fehr & Peers used a database of survey responses collected by professional surveying and data collection firm Corey, Canapary & Galanis Research over a five year period. All surveys were conducted on the phone, and the most recent set of data was collected in Spring 2017. The initial findings report prepared by Corey, Canapary & Galanis Research includes further details on precise question wording and survey methodology. To prepare the database for additional analysis, Fehr & Peers added several calculated fields, as well as identified methods to reconcile slight variations in questions and response categories over the five year dataset.

2.1 DATA COLLECTION METHODOLOGY

Each year the TDS collects responses from approximately 750 Bay Area residents. In 2017, telephone surveying collected responses from 804 Bay Area residents aged 18 and older, representing a total of 11,899 trips made to, from, or within San Francisco. The margin of error at the 95 percent confidence level for 2017 data is +/-3.4 percent in the total sample (n = 804). For other sample sizes, the margin of error is as follows:

- n = 400. Margin of error = +/- 4.85%
- n = 100. Margin of error = +/- 9.80%
- n = 50. Margin of error = +/- 13.9%

Due to large margins of error, we have chosen not to include in this report certain data backed by fewer than 50 individual respondents for purposes of examining mode share by sub-groups. Notes throughout the text of this document indicate where data are not reported due to small sample size or other concerns with the sample.

In addition to providing analysis of data collected in the 2017 survey, this memorandum incorporates data collected from 2013 to 2016 to examine year-over-year trends, as well as provides five year averages for data points with small numbers of respondents in a single year. This method was primarily employed in examining mode share by trip purpose and mode share by place of residence.

2.2 DATA CONSISTENCY

For a subset of demographic questions, the surveys from 2013 to 2017 did not provide consistent response options when compared year to year. This section discusses how responses were adjusted to provide consistent categories for year to year comparisons.

2.2.1 Income

The 2016 and 2017 surveys provided eight response options for income, while the 2013, 2014, and 2015 surveys provided five response options. The 2016 and 2017 options were identical, and the 2013-2014 options were identical. The income range cutoffs for 2015 did not match those for the 2013-2014 surveys. To combine the five datasets, the 2016 and 2017 options were consolidated to more closely resemble the 2015 response options. The response options are listed in **Table 1**.

The consolidation of data categories for income does introduce some variation in the categories. For instance, the reported category of $76,000 - $100,000 in income includes individuals in 2013 and 2014 who responded with a household income between $71,000 and $75,000. Similarly, the category of $36,000 to $75,000 includes some responses from individuals earning between $31,000 and $36,000. Because prior data sets tabulate income by category rather than exact response, we have accepted that these categories are not fully in alignment, and believe that the recategorization is sufficient for comparison purposes.

Table 1: Survey Response Options for Income by Year

2017 & 2016	2015	2013 & 2014
$15,000 or less	**$35,000 or less**	$30,000 or less
$15,001 - $25,000		
$25,001 - $35,000		
$35,001 - $75,000	**$36,000 - $75,000**	$31,000 - $70,000
$75,001-$100,000	**$76,000 - $100,000**	$71,000 - $100,000
$100,001 - $200,000	**Over $100,000**	Over $100,000
Over $200,000		
Refused	**Refused**	Refused

2015 response options were selected for use in this report, as indicated in **bold**.

2.2.2 Age

The 2015, 2016, and 2017 surveys provided options for the respondent's age where the upper bound of the range's ones digit was a four (e.g. 24), while the 2013 and 2014 surveys provided options where the ones digit was a five. In addition, while the 2013, 2014, and 2016 surveys highest age bracket was either 55 years or 56 years and older, the 2017 survey included an additional response option, resulting in a category for those 65 years old and older. To combine the datasets, the 2016 survey was used as the standard. The 2017 "55-64" and "65+" options were combined.

Table 2: Survey Response Options for Age by Year

2017	2013-2016
18 – 24	**18 - 24**
25 - 34	**25 - 34**
35 - 44	**35 - 44**
45 - 54	**45 - 54**
55 - 64	**55 and older**
65 and older	
Refused	**Refused**

2013-2016 response options were selected for use in this report, as indicated in **bold**.

2.2.3 Mode

The 2015, 2016, and 2017 surveys included 12 consistent mode response options: drive alone, drive with others, carshare, TNC, taxi, transit, shuttle, bicycle, walk, scooter, other, and don't know. The 2014 survey included an additional option for carpool passengers. When the datasets were combined, this mode was aggregated with the "drive with others" category, which is reported as 'carpool' within this report. The 2013 survey included just eight modes, excluding carshare, TNC, shuttle, and scooter. In the tables below, no data is reported for these modes when 2013 information is presented.

Table 3: Survey Response Options for Mode by Year

2015-2017 Option	2014 Option	2013 Option
Drive Alone	Drive Alone	Drive Alone
Drive with Others	Carpool Driver Carpool Passenger	Drive with Others
Carshare	Carshare	N/A
TNC	TNC	N/A
Taxi	Taxi	Taxi
Transit	Transit	Transit
Shuttle	Shuttle	N/A
Bicycle	Bicycle	Bicycle
Walk	Walk	Walk
Scooter	Scooter	N/A
Other	Other	Other
Don't Know	Don't Know	Don't Know

2015-2017 response options were selected for use in this report, as indicated in **bold**.

2.3 DATA WEIGHTING

To ensure the survey responses were representative of the Bay Area population, the responses were weighted based on age. The proportion of survey respondents in each age bracket was adjusted to match the distribution of those age brackets within the region, based on the American Community Survey five-year data for the year of each survey. This weight was separate for the age distribution within San Francisco and the age distribution for the eight other Bay Area counties included in the survey.

For the 2014, 2015, 2016, and 2017 surveys, the weights were calculated by Corey, Canapary & Galanis Research. Fehr & Peers calculated and applied the response weights for the 2013 survey.

3 TRENDS IN TRAVEL BEHAVIOR

This review of travel trends focuses on assessing progress toward the goal of 50 percent of trips or less made by private vehicle, with a secondary goal of identifying key trip types or populations for which the existing private auto mode share is significantly higher than the goal of 50 percent. As such, we have presented travel trends for trips made only by San Francisco residents, for trips made only by individuals living outside of San Francisco, and for all trips.

3.1 OVERALL TRAVEL TRENDS

Overall, there have been minimal shifts in the percentage of individuals using each travel mode over the past five years. The largest apparent shift has been away from driving alone, potentially to either transit trips or to TNC trips. However, these fluctuations on a year-over-year basis largely fall within a typical margin of error, and are not considered statistically significant.

3.1.1 Automobile Travel

In 2017, fewer than half of trips taken in San Francisco were taken by private automobile (43 percent); this finding holds even when considering non-private automobile trips that nonetheless involve travel in an automobile, such as taxi, carshare, and TNC trips (47 percent). San Francisco residents have an overall lower private auto mode share than non-residents, although they are also more likely to use other forms of automobile travel such as carshare, TNC, and taxi services (see **Table 4, Table 5**, and **Table 6**).

Among trips made to, from, or within San Francisco by non-San Francisco residents, private vehicle mode share has decreased slightly from a peak in 2014 and 2015, from 56 percent to 48 percent, although this decrease is still within a margin of error of the two proportions.

To reach an average citywide mode share that includes both trips made by residents and non-residents, the data are weighted to reflect the total number of trips made by each group. Based on the SFCTA travel demand model, the San Francisco Chained Activity Modeling Process (SF-CHAMP), only 24 percent of trips within the city were made by individuals who live outside of San Francisco;[8]

[8] Results from SF-CHAMP model runs were used to estimate the share of trips within San Francisco made by residents as opposed to non-residents. Details are included in **Attachment A**.

as a result, the mode shift is muted when examining the overall private auto mode share as shown in **Table 6**. SF-CHAMP model results are discussed in more detail in Section 4.1.

Table 4: Auto Mode Share over Time by San Francisco Residents

Mode	2013	2014	2015	2016	2017
Drive Alone	26%	28%	25%	29%	27%
Carpool	22%	14%	20%	15%	15%
Total (Private Vehicles)	**48%**	**42%**	**45%**	**44%**	**41%**
Carshare	-	<1%	<1%	<1%	<1%
TNC	-	2%	2%	2%	4%
Taxi	2%	<1%	<1%	<1%	<1%
Total (All Vehicles)	**49%**	**45%**	**47%**	**47%**	**46%**

Source: Corey, Canapary & Galanis Research, 2017; Fehr & Peers, 2017

Inset Figure 1: Auto Mode Share by SF Residents Over Time

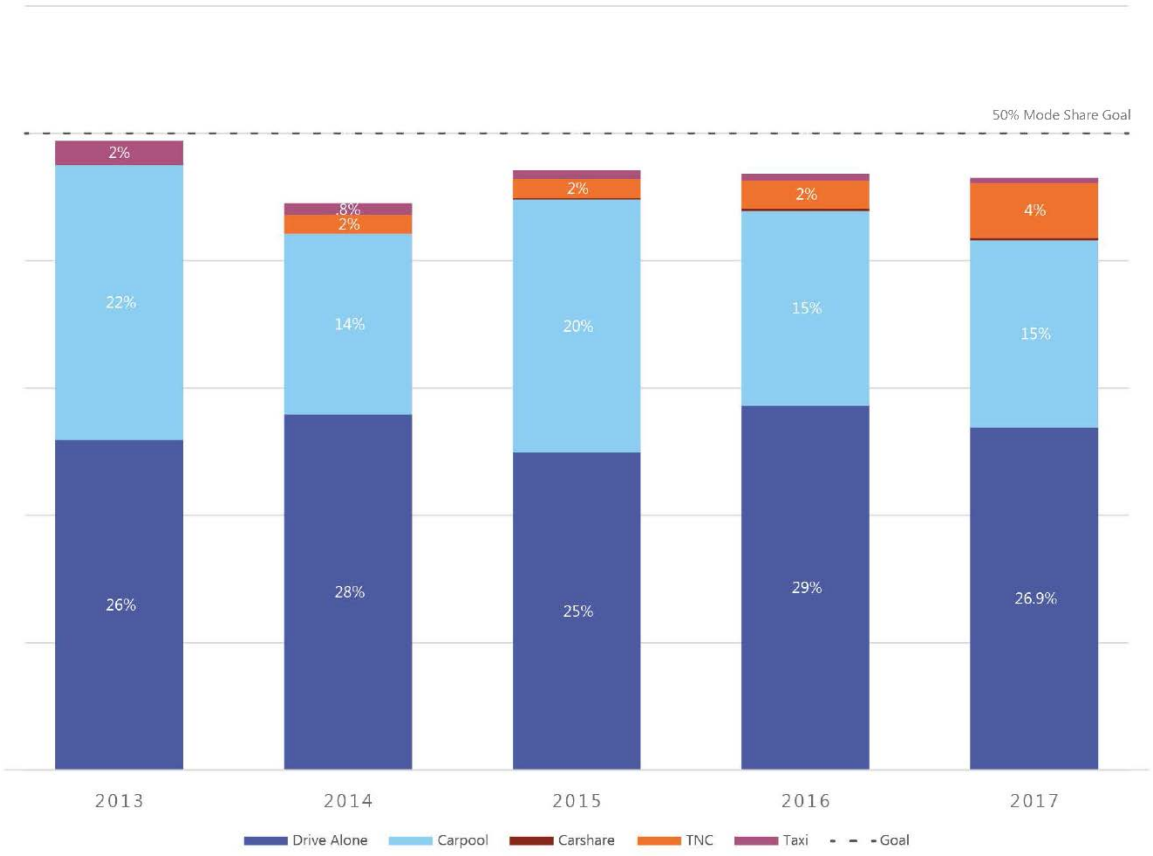


Table 5: Auto Mode Share over Time by Non-San Francisco Residents

Mode	2013	2014	2015	2016	2017
Drive Alone	27%	36%	34%	31%	31%
Carpool	24%	20%	23%	18%	17%
Total (Private Vehicles)	**51%**	**56%**	**57%**	**49%**	**48%**
Carshare	-	<1%	<1%	<1%	<1%
TNC	-	<1%	<1%	2%	2%
Taxi	<1%	<1%	<1%	<1%	<1%
Total (All Vehicles)	**52%**	**57%**	**58%**	**51%**	**50%**

Source: Corey, Canapary & Galanis Research, 2017; Fehr & Peers, 2017

Inset Figure 2: Auto Mode Share by Non-SF Residents over Time

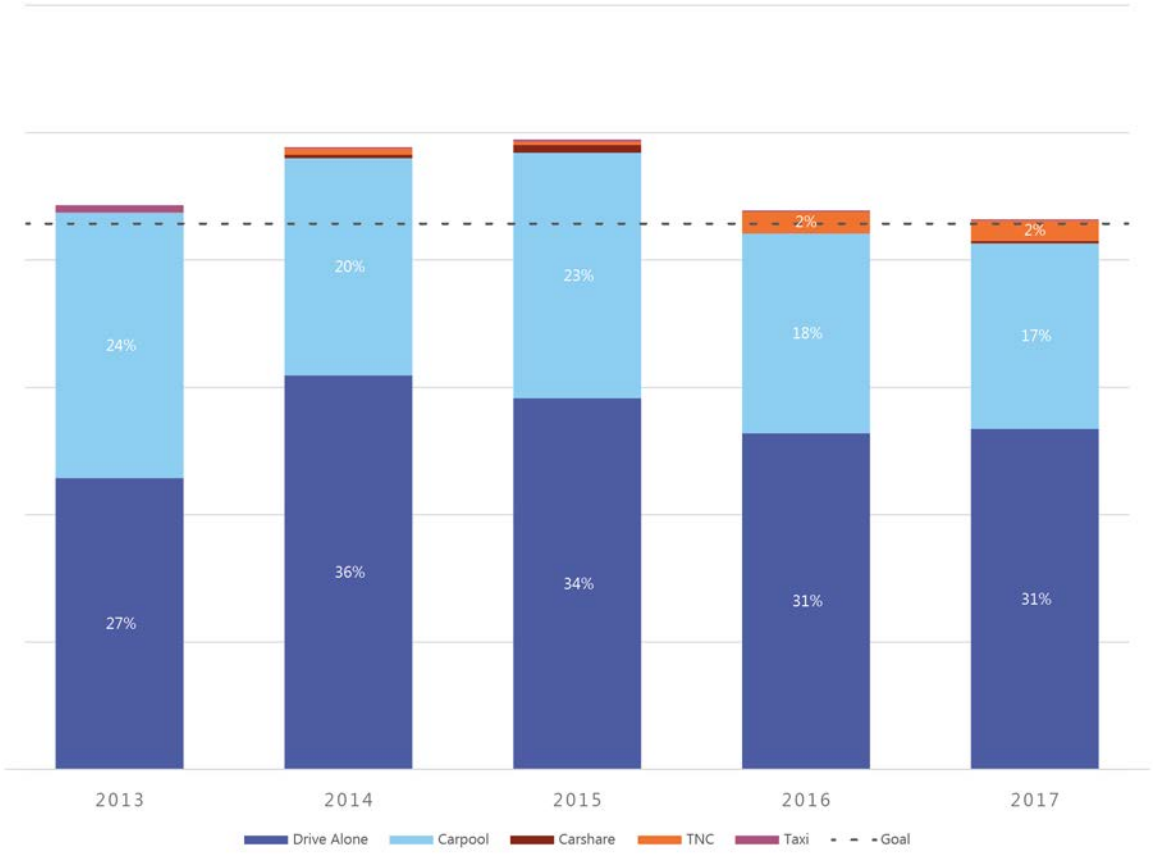
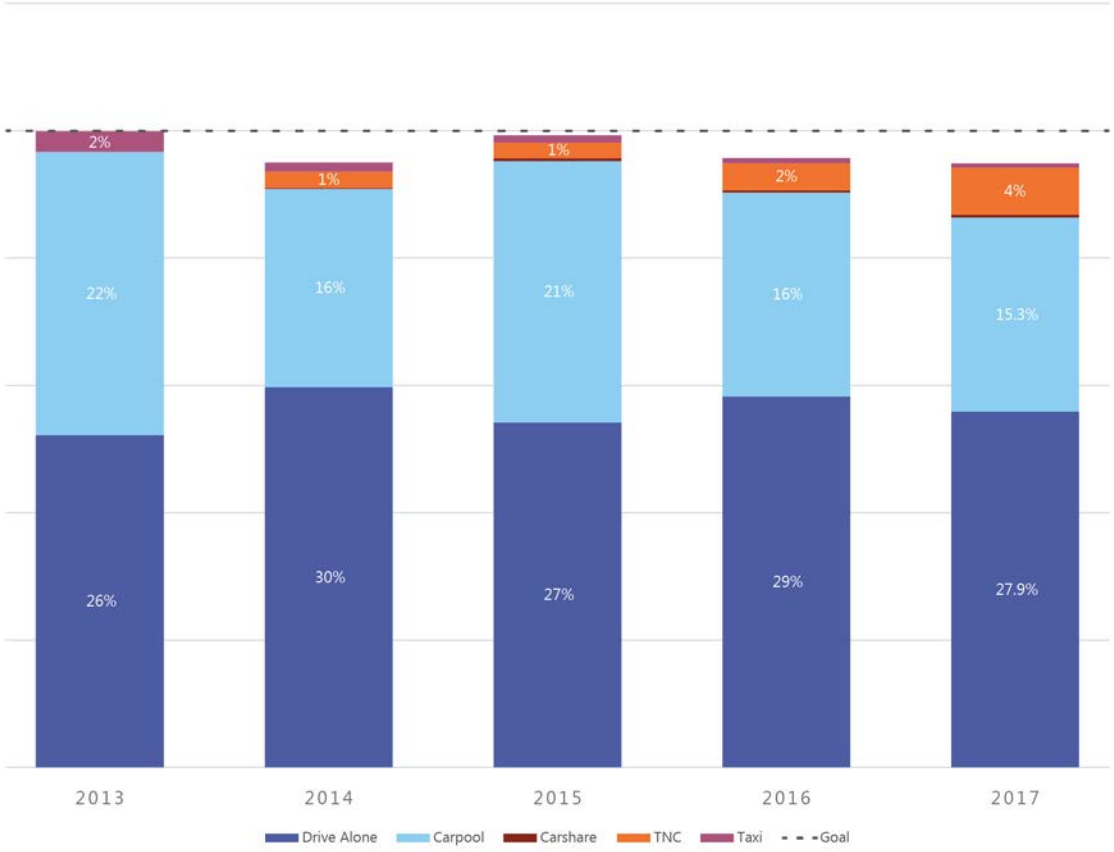


Table 6: Overall Auto Mode Share over Time

Mode	2013	2014	2015	2016	2017
Drive Alone	26%	30%	27%	29%	28%
Carpool	22%	16%	21%	16%	15%
Total (Private Vehicles)	**48%**	**45%**	**48%**	**45%**	**43%**
Carshare	<1%	<1%	<1%	<1%	<1%
TNC	<1%	1%	1%	2%	4%
Taxi	2%	1%	1%	<1%	<1%
Total (All Vehicles)	**50%**	**48%**	**50%**	**48%**	**47%**

Source: Corey, Canapary & Galanis Research, 2017; Fehr & Peers, 2017

Inset Figure 3: Total Auto Mode Share over Time (All Respondents)



While auto mode share has remained reasonably flat from 2013 to 2017, the 2015 Congestion Monitoring Program (CMP) Report indicates that average vehicle speeds on both arterials and freeway segments within San Francisco has decreased. On arterial roadways in the PM peak hour, vehicle speeds decreased 21 percent, from 16.0 miles per hour to 12.7 miles per hour, while on

freeway segments vehicle speeds decreased 11 percent from 29.5 miles per hour to 26.3 miles per hour.[9] These decreases reflect an increase in peak hour demand for space on the roadways in the CMP network. The likely explanation for the decrease in speeds on major arterials and freeway segments while total auto mode share remains constant is that the increase in regional population and economic activity led to more total trips being made on San Francisco roadways, and a corresponding increase in traffic density during the peak periods; even with mode share fairly static, an increase in number of trips represents a corresponding increase in vehicle trips on local roadways.

3.1.2 Transit and Shuttle Travel

For this analysis, transit modes include local and regional transit providers, such as Muni, Bay Area Rapid Transit (BART), Alameda-Contra Costa Transit (AC Transit), Santa Clara Valley Transportation Authority, Amtrak, and paratransit services. Shuttle modes include corporate shuttle, campus shuttle or similar (including University of California - San Francisco, California Pacific Medical Center, Art Institute, Chariot, Leap, and RidePal). In the Initial Findings Report,[10] shuttles and transit are aggregated into a single transit category. Year-over-year changes in use of both transit and shuttles are relatively small, and fluctuations fall within a margin of error of other years (see **Table 7** for more detail).

[9] *2015 Congestion Management Program*, San Francisco County Transportation Authority, 2015.
[10] *Travel Decision Survey Initial Findings Report*, prepared by Corey, Canapary & Galanis Research, 2017.

Table 7: Change in Transit Use over Time

Mode	2013	2014	2015	2016	2017
San Francisco Residents					
Transit	22%	24%	24%	22%	23%
Shuttles	-	<1%	<1%	<1%	<1%
Total	**22%**	**24%**	**24%**	**22%**	**24%**
Margin of Error	+/- 3%	+/- 4%	+/- 4%	+/- 4%	+/- 4%
Living Outside of San Francisco					
Transit	28%	31%	27%	28%	32%
Shuttles	-	<1%	<1%	<1%	1%
Total	**28%**	**31%**	**28%**	**29%**	**33%**
Margin of Error	+/- 4%	+/- 5%	+/- 4%	+/- 5%	+/- 5%
All Trips					
Transit	24%	25%	25%	23%	25%
Shuttles	-	<1%	<1%	<1%	1%
Total	**24%**	**26%**	**25%**	**24%**	**26%**
Margin of Error	+/- 3%	+/- 3%	+/- 3%	+/- 3%	+/- 3%

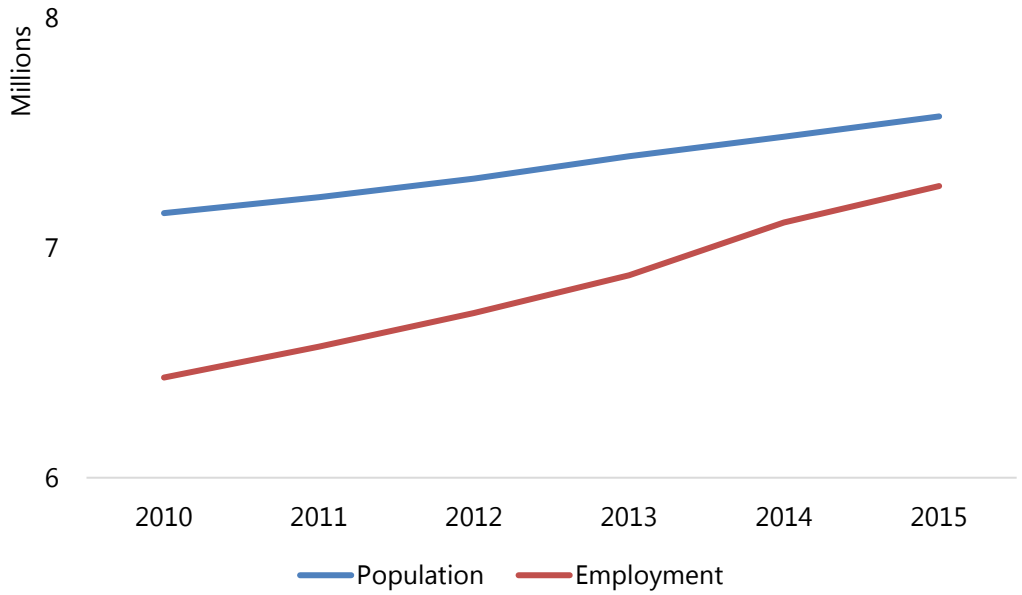
Source: Corey, Canapary & Galanis Research, 2017; Fehr & Peers, 2017

Inset Figure 4 shows previous travel decision survey results for 2013 through 2016 compared to total unlinked passenger trips (i.e., boardings) using all Muni services, as taken from the National Transit Database. Transit mode share for 2012 is taken from CHTS data due to a lack of available data for that year from the travel decision survey process. Both sets of data show an increase in ridership / transit use from 2013 to 14, and a subsequent decrease in following years.

Inset Figure 4: Comparison of Muni Ridership and Surveyed Transit Mode Share over Time

However, mode share and passenger boardings do not correlate precisely with each other due to economic growth and population changes occurring over the same period of time. With a growth in total person trips, the same level of transit mode share will result in an increase in passenger boardings on transit vehicles. A growth in total person trips can occur with a growth in regional population, or with increased economic activity that leads to additional travel. **Inset Figure 5** shows an overall increase in both Bay Area population and employment from 2010 to 2015. With this pattern of economic and population growth, we would expect to see total transit boardings increase, as was the case from 2012 to 2014. However, this still does not explain the reduction in boardings from 2014 to 2015, indicating that economic growth may have led to higher rates of driving, or that growth in ridership in that year primarily occurred outside of the Muni system (for instance, on BART or Caltrain).

Inset Figure 5: Bay Area Population and Employment, 2010 - 2015



Source: MTC Vital Signs, 2017.

3.1.3 Bicycle and Pedestrian Travel

As with transit and shuttle travel, survey responses show little change in bicycle and pedestrian behavior over time; fluctuations in mode share are within a margin of error year over year.

Variations in bicycle mode share may seem dramatic, with an apparent decrease in bicycle mode share among San Francisco residents from 2013 to 2017; however, this decrease largely reflects variation in the portion of the sample reporting a bicycle trip. In 2013, 17 respondents living in San Francisco reported a bicycle trip, with the average bicycle user reporting 9.8 trips over a three day period. In contrast, in 2016, only 12 respondents living in San Francisco were bicycle users, with an average of 4.6 trips each over a three day period. These small samples are the root of the apparent decrease in bicycle trip-making; the variation year over year falls within a margin of error based on this sample size and is not considered a significant shift.

In comparison, SFMTA's manual bicycle counts indicate that bicycle ridership at key intersections has remained largely flat since 2013, with between 10,500 bicyclists and 11,500 bicyclists observed in total at the 19 monitoring locations, and a total increase in bicycles observed of six percent between 2013 and 2016.

Table 8: Change in Bike/Walk Use over Time

Mode	2013	2014	2015	2016	2017
San Francisco Residents					
Bicycle	6%	3%	3%	2%	2%
Walk	22%	28%	25%	27%	27%
Total	**28%**	**30%[1]**	**28%**	**29%**	**30%[1]**
Margin of Error	+/- 5%	+/- 5%	+/- 5%	+/- 5%	+/- 4%
Living Outside of San Francisco					
Bicycle	<1%	<1%	<1%	<1%	<1%
Walk	20%	12%	14%	19%	17%
Total	**20%**	**12%**	**15%**	**20%**	**17%**
Margin of Error	+/- 4%	+/- 3%	+/- 3%	+/- 4%	+/- 4%
All Trips					
Bicycle	5%	2%	2%	2%	2%
Walk	22%	24%	23%	25%	25%
Total	**26%[1]**	**26%**	**25%**	**27%**	**26%[1]**
Margin of Error	+/- 3%	+/- 3%	+/- 3%	+/- 3%	+/- 3%

1. Individual modes do not sum to total due to rounding
Source: Corey, Canapary & Galanis Research, 2017; Fehr & Peers, 2017

3.1.4 Mode Trends from Other Data Sources

Additional data sources examining travel decisions within San Francisco include Census journey to work data (for commute trips), California Household Travel Survey data, and recent intercept surveys at various locations in San Francisco. Overall, Census data seem to confirm the travel trends noted in this report, particularly that travel decisions have not shifted strongly since 2013. However, both CHTS data and intercept survey data indicate that there may be some systemic under-reporting of walking trips in the travel decision surveys, and that San Francisco residents and visitors make a higher share of their trips by walking than is indicated in the Travel Decision Survey results.

3.1.4.1 Census Data

In addition to the sources referred to inline above, mode share data for commute trips only is presented by the American Community Survey, a project of the U.S. Census Bureau. These data, shown in **Table 9,** indicate that mode share has been largely stable for San Francisco residents on their way to work. The figures presented are five year averages, and may mute year-to-year differences, but do show a slight decrease in private auto mode share similar to the trend indicated by survey data.

Table 9: Mode Share Data from Additional Sources

Mode	2011[1]	2012[2]	2013[3]	2014[4]	2015[5]	2012	2013
	American Community Survey – Journey to Work (Age 16+)					California Household Travel Survey[6]	Travel Decision Survey Mode Share
Drive Alone	38%	37%	37%	36%	36%	18%	26%
Carpool	8%	8%	8%	8%	7%	24%	22%
Transit	33%	32%	33%	33%	33%	15%	24%
Walk	10%	10%	10%	10%	10%	38%	22%
Bicycle	3%	3%	4%	4%	4%	3%	5%
Work at Home	7%	7%	7%	7%	7%	-	-
Other	2%	2%	2%	2%	2%	1%	1%

1. American Community Survey 5-year, 2007-2011, Table S0801, San Francisco residents
2. American Community Survey 5-year, 2008-2012, Table S0801, San Francisco residents
3. American Community Survey 5-year, 2009-2013, Table S0801, San Francisco residents
4. American Community Survey 5-year, 2010-2014, Table S0801, San Francisco residents
5. American Community Survey 5-year, 2011-2015, Table S0801, San Francisco residents
6. California Household Travel Survey 2012, trips starting and ending in San Francisco

3.1.4.2 California Household Travel Survey Data

Also shown in **Table 9** are static data from the CHTS, last collected in 2012. The CHTS is a large scale survey asking residents to keep a detailed travel diary of all their trip-making activity over the survey period. It indicates that in 2012, 42 percent of trips starting or ending in San Francisco were made in a private automobile; this rate is largely similar to the mode share of survey respondents.

However, there are several key differences in the mode share data from the 2012 CHTS and the 2013 TDS. First, CHTS data show carpool rates substantially higher than drive alone rates, while survey results indicate a higher drive alone rate. This may reflect the shorter sample period of the TDS effort, or it may reflect that CHTS captures a larger number of recreational trips, trips made with children, or non-work trips, all of which are more likely to involve multiple occupants per vehicle. Second, CHTS data show substantially more walking trips and fewer transit trips than TDS data. This may indicate that the travel decision surveys exhibit a common reporting bias among

such surveys, where short walking trips are under-reported,[11] a hypothesis further validated by recent intercept surveys in San Francisco.

3.1.4.3 Intercept Surveys

The San Francisco Planning Department conducted intercept travel surveys at retail and residential land uses throughout San Francisco in Summer 2014, Summer 2015, and Fall 2016. This data collection effort, intended to help inform an update of the City's travel demand management guidelines for use in its development review process, resulted in site-specific mode share data for dozens of sites throughout the City. These intercept surveys differ in methodology in a few key ways from the telephone surveys conducted for the Travel Decision Survey:

- Surveys were focused on residential and retail sites only.
- Sites were selected to be representative of future development, and as such tended to be newer construction.
- Surveyors interviewed people who were entering / exiting the building, leading to an increased percentage of walking trips, which may be easily forgotten during a telephone travel diary interview.
- Surveys were conducted during the AM and PM peak periods only (7:00AM – 10:00AM and 3:30PM – 7:00PM).
- Information was only collected about the trip to the location being surveyed, and no data regarding trip chaining or a travel tour was collected (i.e., if an individual stopped at a site on their way elsewhere, the trip was still counted as a single person trip).

Table 10 compares the findings from the Travel Decision Survey to the results from intercept surveys at 15 residential sites and 22 retail sites throughout San Francisco. Retail sites were predominantly drugstores and grocery stores, while residential sites were a mix of rental and condominium properties built between 2000 and 2014. The primary differences in the results for the two surveys occur with carpool trips, walking trips, and transit trips. The intercept surveys tend to have a much higher share of walking trips than the telephone surveys, which may be due to several factors. First, the retail sites selected for intercept surveys tended to have a high volume of foot traffic, and may have a higher share of trips occurring as part of a trip chain. Second, sites in inner San Francisco neighborhoods are over-represented in the intercept survey sample, indicating that we would expect travel patterns to reflect the dominant mode choices in those zones, which

[11] McGuckin, N. (2012). Walking and Biking in California: Analysis of the CA-NHTS (No. UCD-ITS-RR-12-13).

have a lower rate of private auto use. In the case of the residential sites, the number of recreational walk trips (i.e., jogging or walking for health or enjoyment, or walking with a dog) may also have inflated the total share of walk trips as well.

However, as discussed above, the telephone surveys used in the Travel Decision Survey may tend to neglect short walk trips made within the neighborhood, while the intercept methodology tallies such trips as they occur. Given the similarity in walking mode share between the intercept surveys and the 2012 CHTS survey data, there may be an inherent bias in the Travel Decision Survey data causing walking trips to be underreported. If so, CHTS data and intercept survey data indicate that there may also be a corresponding decrease in transit trip mode share and, potentially, private auto mode share.

Table 10: Comparison of Intercept Survey and Travel Decision Survey Results

	Intercept Survey Mode Share	Telephone Survey Mode Share	Intercept Survey Mode Share	Telephone Survey Mode Share
Mode	**Residential Land Use[1]**		**Retail Land Use[2]**	
Drive Alone	20%	28%	27%	27%
Drive with Others	16%	18%	11%	21%
Walk	40%	21%	37%	28%
Taxi/TNC	4%	4%	<1%	2%
Bike	4%	3%	4%	1%
Transit	16%	25%	18%	20%
Bus	*4%*	-	*9%*	-
Light Rail	*7%*	-	*3%*	-
BART	*3%*	-	*5%*	-
Private Shuttle	*5%*	-	*0%*	-

1. Telephone survey mode share for residential land use is taken from trips with "Trip Purpose = Home"
2. Telephone survey mode share for retail land use is taken from trips with "Trip Purpose = Shopping/Errands"

Individual modes do not sum to total due to rounding.

Source: Corey, Canapary & Galanis Research, 2017; Fehr & Peers, 2017

3.2 MODE BY GEOGRAPHY

Travel patterns differ widely based on the types of neighborhoods in which individuals live, work, and visit. **Inset Figure 6** shows the residential zones, based on zip codes, used for analysis of trends by home location. Zones were developed to group neighborhoods with similar travel patterns;

however, each zone differs in terms of total population and number of households, with Zone 2 having the most households and the largest population.

In addition to these zones, we have also categorized trips by non-San Francisco residents as being associated with the North Bay (Marin, Sonoma, Solano, and Napa Counties), East Bay (Alameda and Contra Costa Counties) and the South Bay (Santa Clara and San Mateo Counties).

Table 11 and **Inset Figure 6** show a summary of the average mode share for each residential zone / region over the past five years (2013 – 2017). When examining mode share by location, five-year averages achieve a much lower margin of error than data from a single year.

Individuals living in San Francisco Zones 1 and 2, corresponding to the densest areas with the highest levels of transit service, have the lowest levels of private auto use. However, they also show the highest levels of use of TNCs, carshare, and taxi services. Individuals coming from the East Bay are less likely to travel in personal vehicles than even individuals in some San Francisco neighborhoods (Zones 3, 4, and 5); this likely reflects the presence of high-frequency transit service from the East Bay to key San Francisco locations.

Inset Figure 6: Map of San Francisco Residential Zones

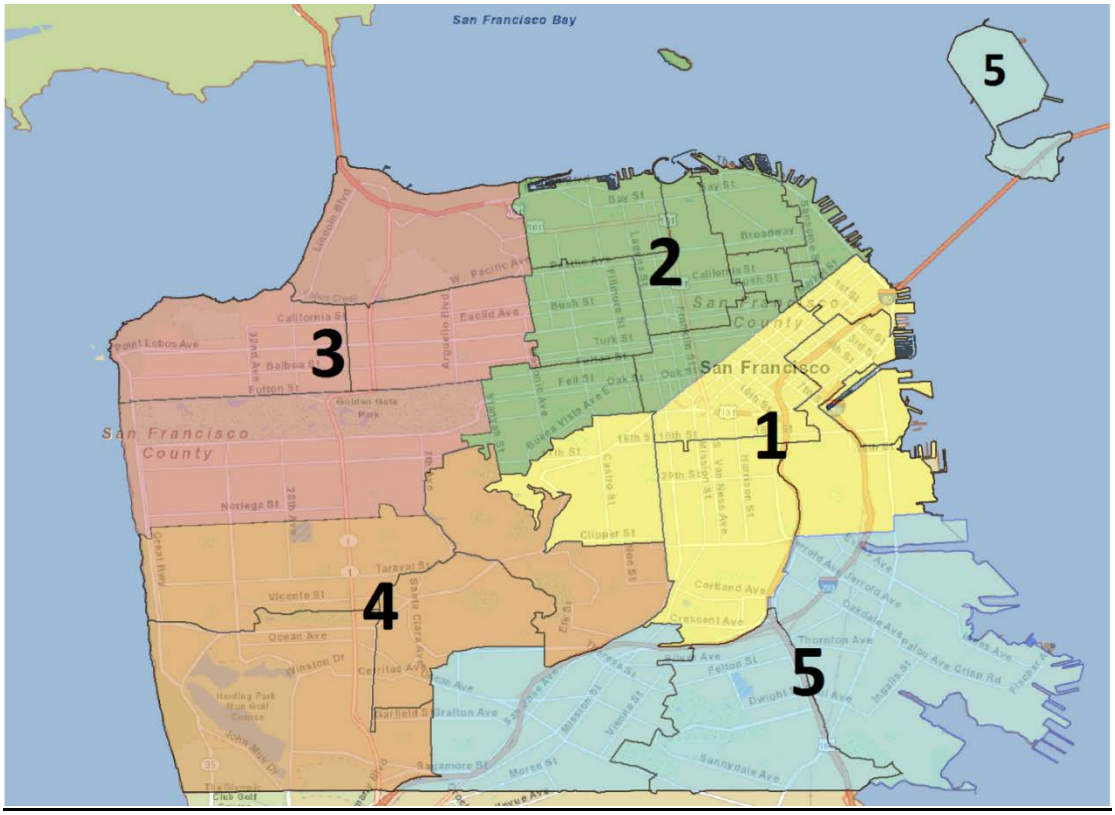


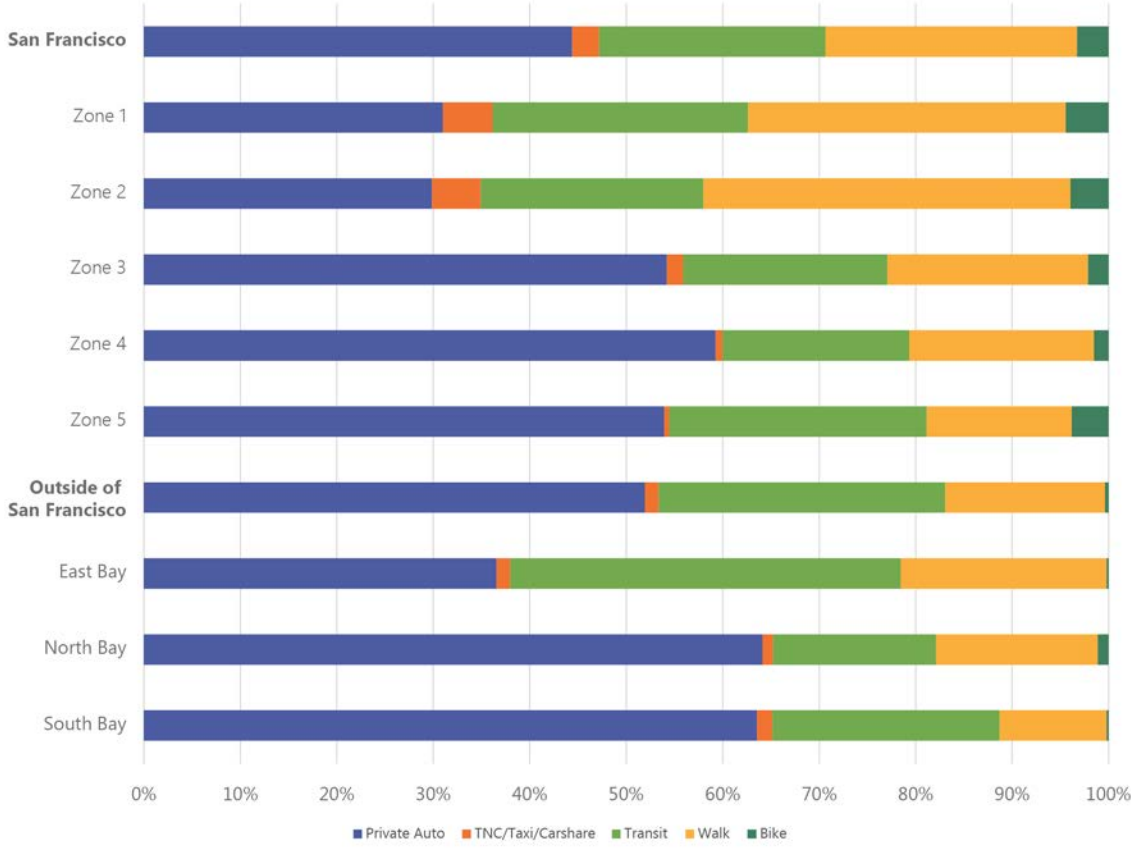
Table 11: Mode Share by Residential Location, Five Year Averages (2013 - 2017)

Place of Residence	Private Auto	TNC/ Taxi/ Carshare	Transit	Walk	Bike	Other
San Francisco	**44%**	**3%**	**23%**	**26%**	**3%**	**1%**
Zone 1	31%	5%	26%	33%	4%	1%
Zone 2	30%	5%	23%	38%	4%	1%
Zone 3	54%	2%	21%	21%	2%	1%
Zone 4	59%	1%	19%	19%	2%	<1%
Zone 5	54%	1%	27%	15%	4%	<1%
Outside of San Francisco	**52%**	**1%**	**30%**	**17%**	**<1%**	**<1%**
East Bay	37%	1%	40%	21%	<1%	<1%
North Bay	64%	1%	17%	17%	1%	<1%
South Bay	64%	2%	24%	11%	<1%	<1%

Shaded cells indicate mode share above 50% goal
Source: Corey, Canapary & Galanis Research, 2017; Fehr & Peers, 2017

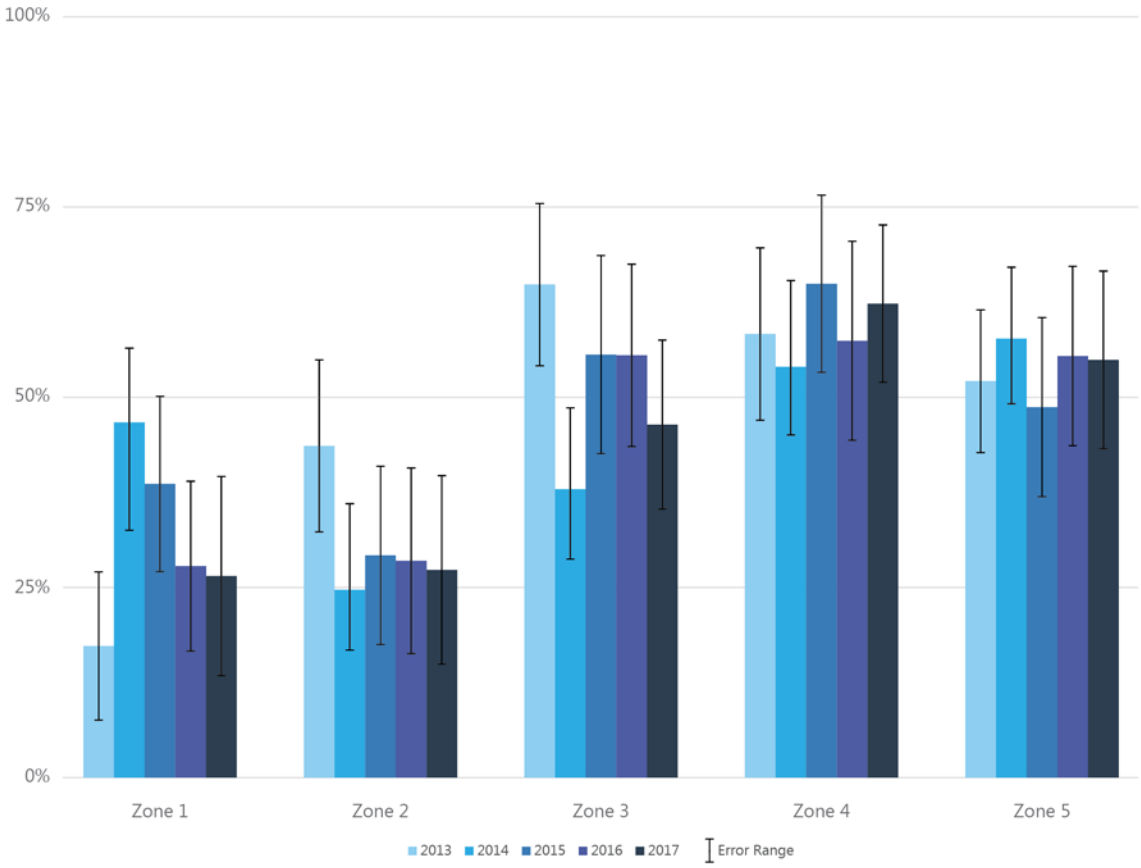
San Francisco Zones 3, 4, and 5 are all slightly above the target level for private vehicle mode share. They also tend to have significantly fewer walking trips than other neighborhoods in San Francisco, possibly due to several factors, including less dense development patterns, the balance of jobs and housing, and the mix of nearby land uses. The highest levels of private auto use for trips within San Francisco occur among North Bay and South Bay residents, with nearly two thirds of their trips to, from, and within San Francisco occurring in private vehicles.

Inset Figure 7: Mode Share by Residential Location, 2013 - 2017 Average



Tracking change over time among different residential locations presents some difficulty due to the small sample sizes, which tend to result in wide margins of error. A look at year-over-year trends by residential location reveals that most shifts have been within a margin of error, as shown in **Inset Figure 8**. The grey markers on each bar represent the margin of error for each year, with a confidence level of 95 percent; while levels of private vehicle use may seem to shift substantially, most of these shifts are in fact within a margin of error for each place type.

Inset Figure 8: Private Vehicle Mode Share of San Francisco Residents by Zone over Time



3.3 TRAVEL MODE BY INCOME AND AUTO ACCESS

Individuals living in lower income households tend to make fewer trips by private auto due to multiple factors. **Inset Figure 9** shows that among San Francisco residents, lower income households have consistently had a lower rate of private auto use than higher income households, with households making incomes over $76,000 having a significantly higher private auto mode share than households making $35,000 or less. This trend does not hold true for non-San Francisco residents, however. **Table 12** shows information in tabular format by year, as well as the average rate and rates for non-San Francisco residents.

Inset Figure 9: Private Auto Mode Share by Income, San Francisco Residents, 2013 – 2017 Average

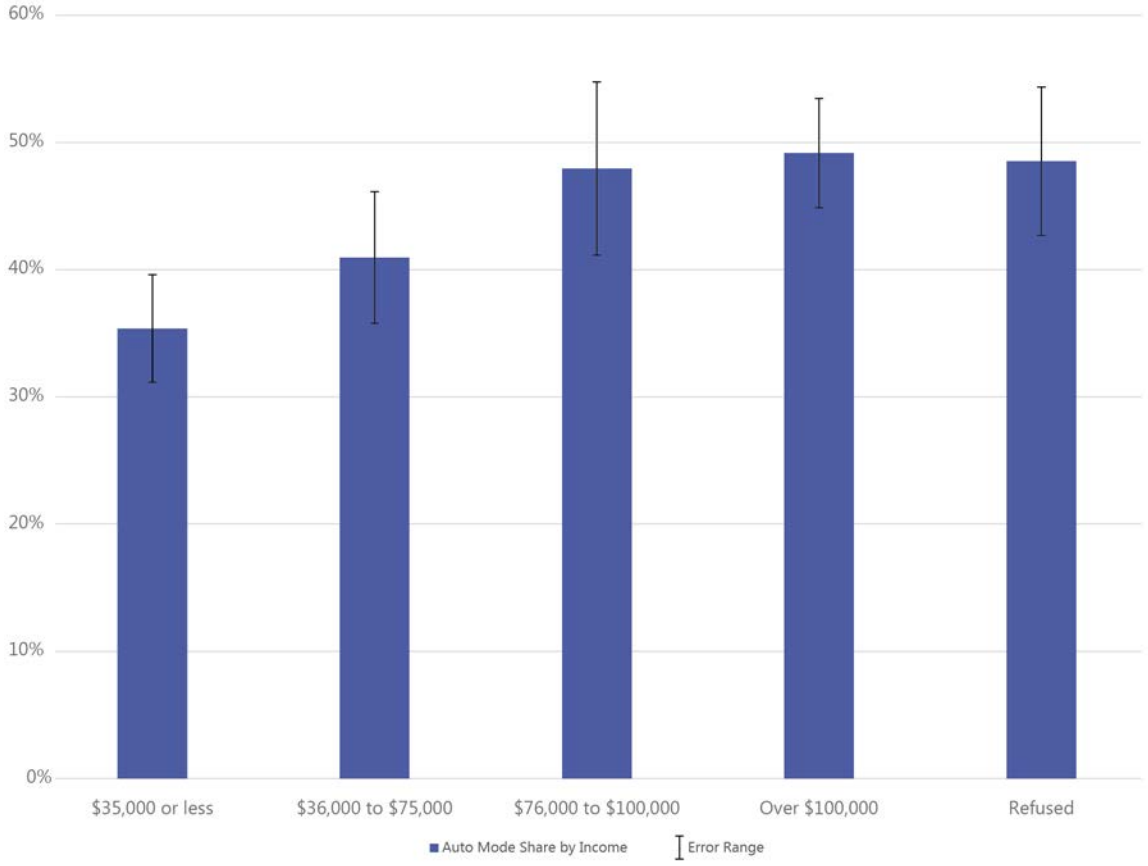


Table 12: Private Auto Mode Share by Income

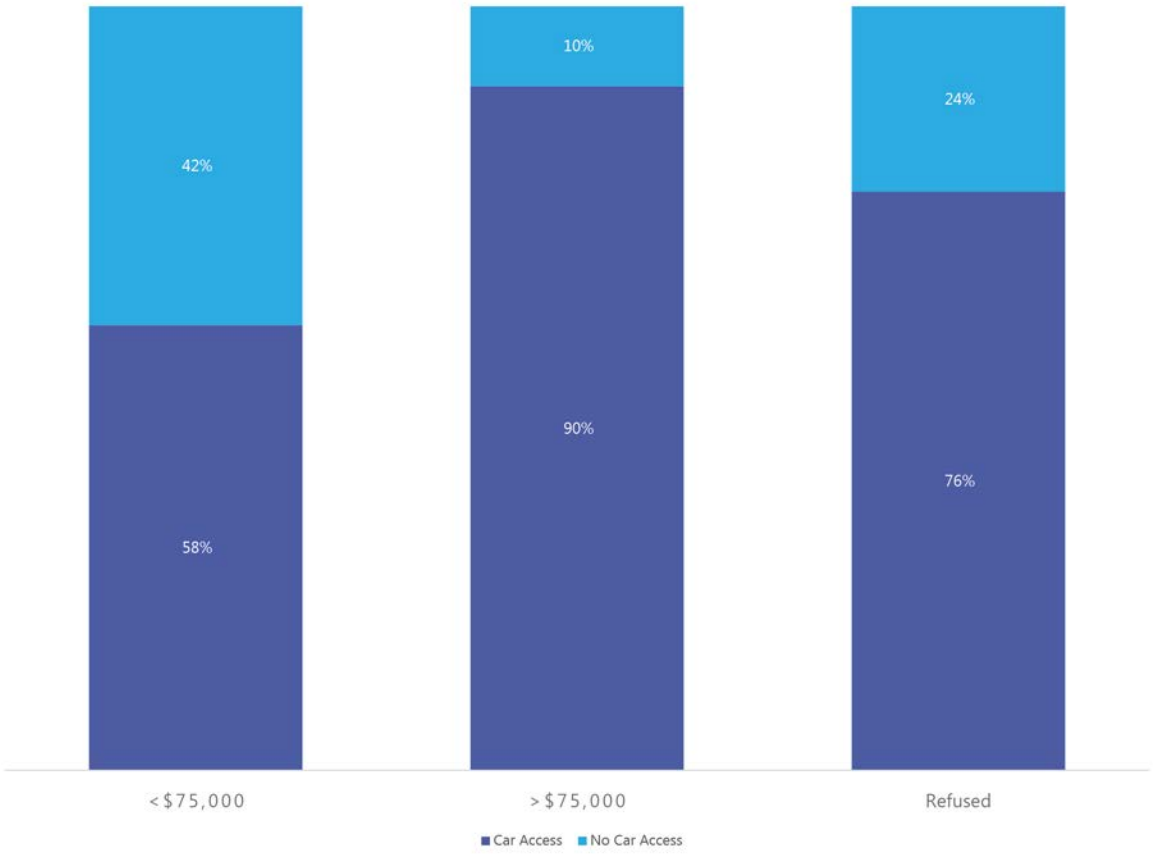
Income	Average	2013	2014	2015	2016	2017
San Francisco Residents						
$75,000 or Less	38%	42%	36%	40%	37%	32%
More than $75,000	49%	55%	44%	49%	48%	48%
Total	**44%**	**48%**	**42%**	**45%**	**44%**	**41%**
Living Outside of San Francisco						
$75,000 or Less	53%	53%	61%	50%	55%	45%
More than $75,000	52%	48%	57%	61%	45%	49%
Total	**52%**	**51%**	**56%**	**57%**	**49%**	**48%**
All Trips						
$75,000 or Less	42%	45%	42%	42%	41%	35%
More than $75,000	49%	54%	47%	52%	47%	48%
Total	**46%**	**48%**	**45%**	**48%**	**45%**	**43%**

Shaded cells indicate populations with private auto mode share above the 50% goal.
Source: Corey, Canapary & Galanis Research, 2017; Fehr & Peers, 2017

One of the factors contributing to lower auto mode share among lower income individuals is auto access: in general, lower income households are less likely to own a car, or may have fewer cars than a household of similar size with higher income.[12] **Inset Figure 10** shows that San Francisco households with less than $75,000 in household income are four times as likely as higher income households to have no vehicle available.[13] Furthermore, as shown in **Table 13**, respondents with vehicle access made more than half of trips by private automobile, while respondents without vehicle access, a much smaller share of the sample, made only six percent of trips by private automobile.

[12] This survey collected vehicle availability using the following question: Do you own a car or have regular access to a car through family or friends? As such, this is not a direct representation of vehicle ownership rates.
[13] Median household income in San Francisco in 2015 (the most recent available data) was $92,094 (American Community Survey Table S1903, 1-Year Estimates), with approximately 43 percent of households earning less than $75,000 (American Community Survey Table S1901, 1-Year Estimates).

Inset Figure 10: Car Access by Household Income, San Francisco Residents, 2017



As shown in **Table 13**, individuals without car access (who represent around 26 percent of the survey sample in San Francisco, and only around 5 percent of the survey sample among non-San Francisco residents) make substantially different travel decisions from those with car access. Most notably, they are around three times likelier to make a trip by transit than individuals who have car access, and among San Francisco residents, they are around twice as likely to make a trip by TNC, taxi, or carshare. Car access also has a higher relationship to private auto mode share in outlying neighborhoods of San Francisco, such as Zones 3, 4, and 5, as well as for residents of the North Bay and South Bay. This may reflect the more auto-oriented built environment in those areas, as well as the level of available transit service.

Table 13: Mode Share by Vehicle Availability (2015-2017)

Residence	n	Private Auto	TNC/ Taxi/ Carshare	Transit	Walk	Bike	Other
Access to a Car							
Living in San Francisco	**792**	**54%**	**3%**	**16%**	**24%**	**2%**	**1%**
Zone 1	149	42%	3%	20%	30%	3%	2%
Zone 2	184	41%	5%	16%	34%	2%	1%
Zone 3	148	59%	3%	13%	20%	2%	2%
Zone 4	145	68%	1%	12%	17%	2%	0%
Zone 5	166	65%	1%	17%	16%	0%	1%
Living Outside San Francisco	**1086**	**54%**	**2%**	**25%**	**17%**	**0%**	**1%**
East Bay	445	39%	2%	37%	21%	0%	1%
North Bay	229	64%	1%	14%	18%	1%	1%
South Bay	412	66%	2%	18%	13%	0%	1%
Total	**1878**	**54%**	**2%**	**22%**	**20%**	**1%**	**1%**
No Access to a Car							
Living in San Francisco	**283**	**7%**	**6%**	**46%**	**35%**	**3%**	**2%**
Zone 1	62	5%	9%	41%	37%	6%	2%
Zone 2	99	2%	7%	37%	46%	4%	4%
Zone 3	39	16%	4%	48%	27%	4%	2%
Zone 4	25	19%	0%	54%	27%	0%	0%
Zone 5	58	11%	1%	68%	21%	0%	0%
Living Outside San Francisco	**64**	**9%**	**1%**	**79%**	**9%**	**0%**	**1%**
East Bay	34	6%	0%	74%	13%	0%	7%
North Bay	7	54%	0%	31%	9%	6%	0%
South Bay	23	8%	5%	86%	1%	0%	0%
Total	**347**	**8%**	**5%**	**55%**	**28%**	**3%**	**2%**

Source: Corey, Canapary & Galanis Research, 2017; Fehr & Peers, 2017

3.4 INTERACTIONS BETWEEN MODES SHARE, INCOME, AND RESIDENTIAL LOCATION

As discussed above, multiple individual factors contribute to varying levels of auto use across the City. Geographically, individuals living in outlying neighborhoods (in Zones 3, 4, and 5) tended to

make more auto trips. Economically, individuals in households making less than $35,000 a year made a lower share of trips by car. In addition, households making less than $75,000 in income are less likely to have access to a car than households making more than that amount across the city. These demographic and geographic traits interact in complicated ways; with varying distributions of household types and travel patterns across San Francisco. For instance, as shown in **Table 14** and **Table 15**, the areas of San Francisco with the lowest total private auto mode share and the lowest rates of car ownership also have above average shares of higher income households. Similarly, Zone 5 has a rate of car access similar to more central neighborhoods, but still has a private auto mode share above the City's average.

Table 16 summarizes the five year average for private auto mode share by income and residential location. As a whole, San Francisco's private auto mode share is below the 50 percent goal. However, several locations and income groups exceed this threshold. All income groups in Zone 1 and Zone 2 complete less than half their trips by private automobile, while almost every income group within Zones 3, 4, and 5 does not meet the private auto mode share goal (with the exception of those with a household income of less than $35,000 in Zones 4 and 5 and income from $36,000 to $75,000 in Zone 3).

For non-San Francisco residents, the private auto mode share is 53 percent. However, mode share is not consistent across the East, North, and South Bays. The East Bay private auto mode share is less than the 50 percent goal for all income groups, while the North and South Bay exceed 50 percent for all income groups. Again, this imbalance likely results from the presence of high-frequency transit service from the East Bay to key San Francisco locations.

Generally, **Table 16** suggests that residential location may matter more than income in determining a household's level of private auto use. Many factors contribute to the increased auto use of households living in some zones or Bay Area counties; these may include land use characteristics such as walkability or transit access, as well as demographic characteristics such as family size. Notably, the largest difference in travel behavior between lower income and higher income households is in the areas with the lowest private vehicle use; in Zone 1 and Zone 2 of San Francisco, the highest income households are twice as likely to make trips by private automobile compared to the lowest income households. This may reflect the increased cost of owning and parking a vehicle in these areas, which may lead only higher income households to own a private automobile. Conversely, in outlying neighborhoods, lower income groups still rely on private auto use, even though their average auto mode share is below that of higher income individuals in similar

neighborhoods. In these areas, access to a car may be seen as more of a necessity for mobility, even if the cost of maintaining a vehicle represents a more substantial economic burden.

Table 14: Income by Residential Location (2013-2017)

Residential Location	< $35,000	$36,000 - $75,000	$76,000 - $100,000	>$100,000	Refused
San Francisco Total	**27%**	**19%**	**11%**	**29%**	**14%**
SF Zone 1	26%	16%	11%	33%	13%
SF Zone 2	24%	19%	9%	34%	15%
SF Zone 3	25%	19%	13%	28%	15%
SF Zone 4	23%	16%	14%	33%	14%
SF Zone 5	37%	26%	10%	13%	14%
Outside of San Francisco	**13%**	**18%**	**14%**	**37%**	**18%**
East Bay	15%	21%	13%	35%	17%
North Bay	12%	19%	14%	40%	15%
South Bay	11%	15%	16%	38%	20%

'Refused' indicates refusal to answer income question.
Source: Corey, Canapary & Galanis Research, 2017; Fehr & Peers, 2017

Table 15: Car Access by Place of Residence, 2015 - 2017

Residential Location	Car Access	No Car Access
Living in San Francisco	**74%**	**26%**
Zone 1	71%	29%
Zone 2	65%	35%
Zone 3	79%	21%
Zone 4	85%	15%
Zone 5	74%	26%
Living Outside San Francisco	**94%**	**6%**
East Bay	93%	7%
North Bay	97%	3%
South Bay	95%	5%
Total	**80%**	**20%**

Source: Corey, Canapary & Galanis Research, 2017; Fehr & Peers, 2017

Table 16: Five Year Average for Private Auto Mode Share, by Income and Residential Location (2013-2017)

Residential Location	$35,000 or less	$36,000 - $75,000	$76,000 - $100,000	Over $100,000	Total
San Francisco	**35%**	**41%**	**48%**	**49%**	**47%**
Zone 1	19%	33%	34%	38%	**31%**
Zone 2	15%	18%	30%	40%	**30%**
Zone 3	52%	40%	58%	60%	**54%**
Zone 4	46%	53%	62%	65%	**59%**
Zone 5	47%	58%	59%	54%	**54%**
Outside of San Francisco	**55%**	**52%**	**55%**	**51%**	**52%**
East Bay	35%	44%	40%	33%	**37%**
North Bay	77%	69%	79%	56%	**64%**
South Bay	68%	56%	61%	69%	**64%**

Shaded cells indicate populations with private auto mode share above the 50% goal.
Source: Corey, Canapary & Galanis Research, 2017; Fehr & Peers, 2017

Ultimately, income, geography, and land use decisions influence travel in complicated ways that cannot be fully accounted for through a telephone survey. However, all else being equal, the following findings remain:

- Lower income households are less likely to own vehicles, and less likely to use private vehicles to travel.
- Individuals living in central San Francisco neighborhoods with high quality transit and walkable destinations nearby are less likely to own vehicles, and less likely to use private vehicles to travel.
- Higher income residents of dense, central neighborhoods are still substantially more likely to use private vehicles than their lower income neighbors, while lower income residents of outlying neighborhoods are more likely to use private vehicles than individuals with similar incomes living in denser areas.
- Private auto mode share seems to vary more between residential locations than between income groups.
- Access to a vehicle (either through car ownership or through friends and family) is the strongest indicator of auto mode share in general, although the choice to own a vehicle is also tied to residential location and other travel options.

3.5 SECOND MODE CHOICE

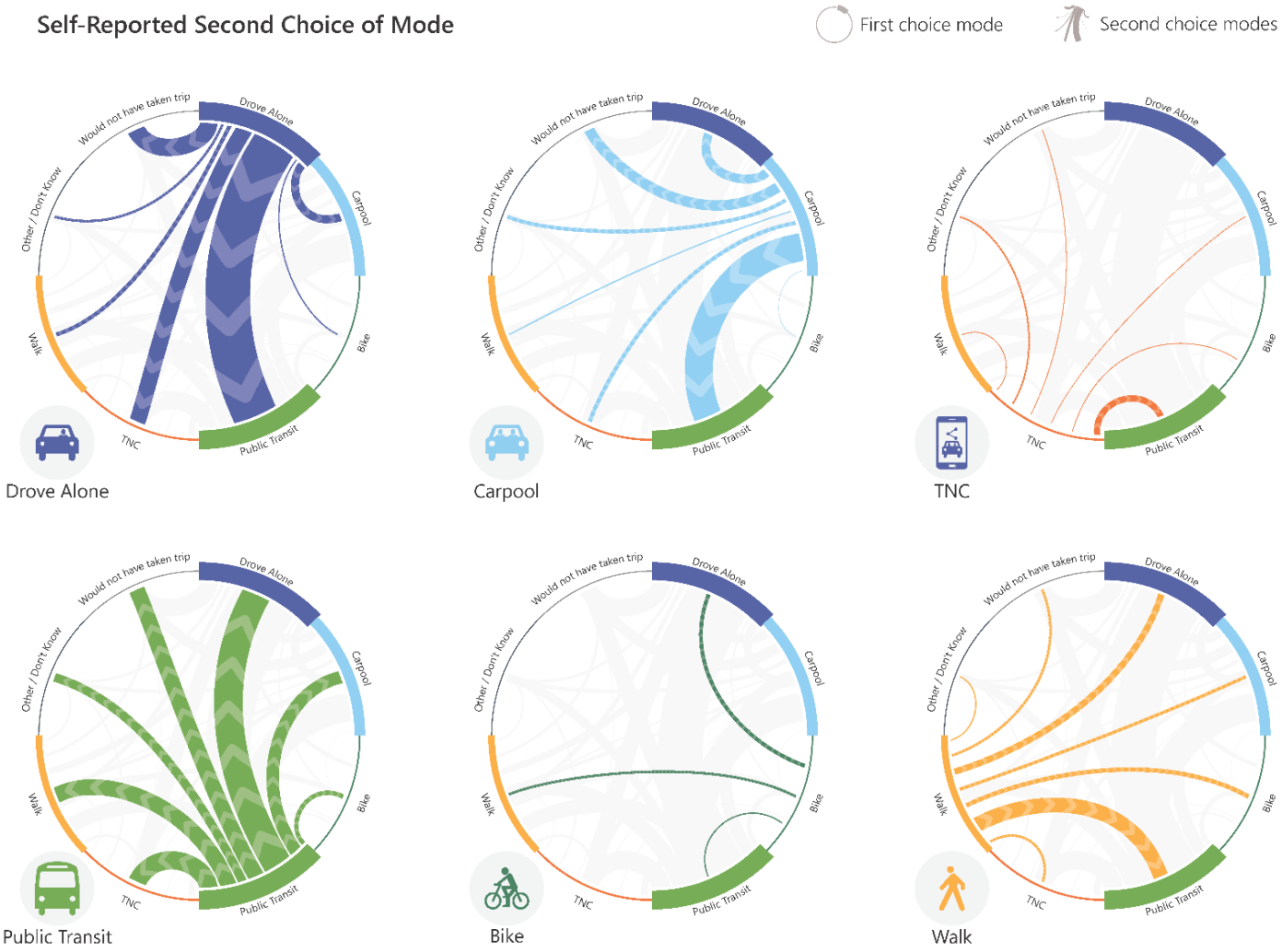
Survey respondents were asked what transportation mode they would have taken had their primary mode for the first trip of their day been unavailable. **Table 17** shows a summary of second mode choice by private auto / non-private auto modes, and generally indicates that around 43 percent of non-private auto trips would be made by private auto if the primary mode were unavailable.

Table 18 provides further detail for modes with adequate numbers of responses, for San Francisco residents only from 2014 to 2017; **Figure 1** illustrates these findings graphically. **Table 19** and **Table 20** provide information about second choice mode for respondents residing outside San Francisco and an aggregated dataset including both San Francisco and other Bay Area respondents from 2014 to 2017. Each table includes first choice modes of drive alone, transit, walk, and other modes, with the exception of **Table 19**, where walking is excluded. This question referred specifically to respondent's first trip. For those living outside of San Francisco, this trip is travel into the city, which cannot currently be made by walking from the East Bay or North Bay.

For both San Francisco residents and non-San Francisco residents, the most common second choice for all non-transit trips in San Francisco is to make the trip by transit. Transit comprised 30 percent of second choice modes for San Francisco residents and 36 percent of second choice modes for those living elsewhere in the Bay Area. When respondents' first choice mode is transit, respondents living outside of San Francisco are more likely to switch to driving than those within San Francisco (42 percent and 20 percent, respectively).

Over the past four years, for San Francisco residents, 11 percent of drivers and 11 percent of transit users view TNC service as a key transportation option, should their primary option not be available. These numbers have shifted over time; in 2017, 20 percent of drivers and 21 percent of transit users identified TNCs as their second choice mode. This may reflect a growing perception of TNC service as a valid complement to transit service (i.e., by providing a faster but costlier option for certain trips, or providing connections to transit) or a potential substitute for use of a private vehicle (thereby supporting households in choosing to own fewer cars, or by eliminating a need to find parking).

Figure 1: Second Choice of Mode by First Choice of Mode



These findings indicate that there is a fairly strong array of transportation options in San Francisco, with about 15 to 25 percent of individuals stating they would not have made the trip if their mode of choice were unavailable. Those living outside of San Francisco were more likely to not make a trip if their first choice mode was unavailable than San Francisco residents. In addition, people who make carpool trips are more likely to indicate that the trip would not have happened if their auto mode had been unavailable, while people who walk or bicycle for their preferred mode generally have other transportation options available. This may reflect that carpool trips are more likely to be made by families, who may be less willing to use public transit for a variety of reasons, that individuals receiving rides from others are less likely to accept other transportation options, or that carpool trips are more likely to be non-essential trips (such as those for recreation, shopping, or eating out, as discussed in Section 3.7).

Table 17: Second Choice Mode by Primary Mode (2017) - All Trips

Initial Mode	Second Choice: Private Auto	Second Choice: Non-Private Auto	Second Choice: Would not have taken trip	Second Choice: Don't know/ Don't remember
Private Auto	12%	67%	19%	2%
Non Private Auto	43%	42%	14%	1%

Shaded cells indicate most popular second choice of mode
Source: Corey, Canapary & Galanis Research, 2017; Fehr & Peers, 2017

Table 18: Second Choice Mode by Primary Mode (2014-2017) – San Francisco Residents

Year	N	Drove Alone	Carpool	TNC	Taxi	Transit	Shuttle	Bicycle	Walk	Other	No Trip
Drive Alone											
2017	114	-	7%	20%	2%	44%	-	2%	5%	2%	18%
2016	114	-	8%	14%	2%	44%	2%	-	8%	5%	18%
2015	99	2%	18%	5%	4%	46%	-	3%	10%	3%	9%
2014	97	4%	15%	2%	3%	47%	2%	2%	7%	3%	15%
Total	**424**	**1%**	**12%**	**11%**	**3%**	**45%**	**1%**	**2%**	**7%**	**3%**	**15%**
Carpool											
2017	51	14%	-	6%	6%	46%	2%	-	4%	2%	20%
2016	60	20%	-	12%	4%	41%	-	-	4%	2%	18%
2015	78	12%	1%	5%	6%	32%	1%	4%	10%	4%	24%
2014	41	6%	6%	6%	9%	35%	-	6%	3%	-	29%
Total	**230**	**13%**	**1%**	**7%**	**6%**	**38%**	**1%**	**2%**	**6%**	**2%**	**23%**
Transit											
2017	134	23%	7%	21%	9%	-	-	6%	20%	1%	14%
2016	109	16%	18%	10%	5%	1%	2%	7%	26%	1%	14%
2015	118	16%	19%	8%	5%	3%	-	3%	23%	3%	19%
2014	107	26%	15%	1%	19%	4%	2%	6%	14%	3%	11%
Total	**468**	**20%**	**15%**	**11%**	**9%**	**2%**	**1%**	**5%**	**21%**	**2%**	**15%**

Table 18, Continued: Second Choice Mode by Primary Mode (2014-2017) – San Francisco Residents

Year	N	Drove Alone	Carpool	TNC	Taxi	Transit	Shuttle	Bicycle	Walk	Other	No Trip
Walk											
2017	63	16%	9%	7%	2%	43%	-	13%	-	4%	7%
2016	75	15%	12%	3%	3%	39%	-	4%	-	3%	21%
2015	51	13%	2%	12%	2%	48%	-	8%	-	2%	13%
2014	66	11%	6%	-	3%	42%	-	8%	6%	3%	-
Total	**255**	**14%**	**8%**	**5%**	**3%**	**43%**	**0%**	**8%**	**2%**	**3%**	**11%**
Total											
2017	362	13%	6%	15%	5%	30%	-	5%	10%	2%	14%
2016	358	12%	10%	9%	5%	29%	1%	3%	12%	3%	16%
2015	346	10%	12%	7%	4%	30%	1%	4%	13%	3%	15%
2014	311	13%	12%	-	9%	30%	-	5%	9%	-	17%
Total	**1377**	**12%**	**10%**	**8%**	**6%**	**30%**	**0%**	**4%**	**11%**	**2%**	**15%**

Shaded cells indicate most popular second choice of mode. Only modes with more than 50 responses for second mode choice are included.

Source: Corey, Canapary & Galanis Research, 2017; Fehr & Peers, 2017

Table 19: Second Choice Mode by Primary Mode (2014-2017) – Non-San Francisco Residents

Year	N	Drove Alone	Carpool	TNC	Taxi	Transit	Shuttle	Bicycle	Walk	Other	No Trip
Drive Alone											
2017	136	-	10%	10%	-	53%	-	-	1%	4%	21%
2016	111	1%	14%	3%	1%	67%	-	-	-	1%	14%
2015	116	1%	12%	3%	-	62%	-	-	1%	1%	21%
2014	120	4%	18%	1%	2%	45%	-	1%	-	2%	29%
Total	**483**	**1%**	**13%**	**4%**	**1%**	**56%**	**0%**	**0%**	**0%**	**2%**	**22%**
Carpool											
2017	126	18%	-	8%	-	55%	1%	1%	-	2%	16%
2016	138	16%	-	1%	-	65%	-	1%	-	2%	14%
2015	144	6%	-	2%	1%	69%	-	1%	-	-	21%
2014	110	11%	7%	-	4%	51%	1%	-	-	3%	23%
Total	**518**	**12%**	**2%**	**3%**	**1%**	**61%**	**0%**	**1%**	**0%**	**2%**	**19%**
Transit											
2017	127	43%	27%	5%	1%	-	1%	-	1%	3%	19%
2016	122	45%	32%	2%	1%	-	-	1%	2%	4%	12%
2015	116	43%	31%	-	3%	-	2%	-	1%	-	21%
2014	119	39%	35%	-	1%	3%	-	-	2%	2%	18%
Total	**484**	**42%**	**31%**	**2%**	**1%**	**1%**	**1%**	**0%**	**1%**	**2%**	**18%**
Total											
2017	389	20%	13%	7%	-	36%	1%	-	-	3%	19%
2016	371	17%	13%	3%	1%	37%	1%	2%	3%	7%	13%
2015	376	13%	11%	2%	2%	38%	2%	2%	2%	3%	22%
2014	349	18%	20%	-	2%	33%	1%	1%	1%	2%	24%
Total	**1485**	**17%**	**14%**	**3%**	**1%**	**36%**	**1%**	**1%**	**1%**	**4%**	**19%**

Shaded cells indicate most popular second choice of mode. Only modes with more than 50 responses for second mode choice are included. Due to aggregating of modes, some rows may have responses listing second choice as same as first choice.

Source: Corey, Canapary & Galanis Research, 2017; Fehr & Peers, 2017

Table 20: Second Choice Mode by Primary Mode (2014-2017) – Total

Year	N	Drove Alone	Carpool	TNC	Taxi	Transit	Shuttle	Bicycle	Walk	Other	No Trip
Drive Alone											
2017	250	-	8%	18%	1%	47%	-	1%	4%	2%	19%
2016	225	-	10%	11%	2%	49%	1%	-	6%	4%	17%
2015	215	2%	17%	4%	3%	50%	-	2%	8%	3%	11%
2014	217	4%	16%	2%	3%	46%	2%	2%	5%	3%	18%
Total	**907**	**1%**	**12%**	**9%**	**2%**	**48%**	**1%**	**1%**	**6%**	**3%**	**16%**
Carpool											
2017	177	15%	-	6%	5%	48%	2%	-	3%	2%	19%
2016	198	19%	-	9%	3%	47%	-	-	3%	2%	17%
2015	222	10%	1%	4%	5%	41%	1%	3%	8%	3%	23%
2014	151	7%	6%	4%	8%	39%	-	4%	2%	1%	28%
Total	**748**	**13%**	**2%**	**6%**	**5%**	**44%**	**1%**	**2%**	**4%**	**2%**	**22%**
Transit											
2017	261	28%	12%	17%	7%	-	-	4%	15%	1%	15%
2016	231	23%	21%	8%	4%	1%	1%	6%	20%	2%	13%
2015	234	22%	22%	6%	4%	2%	-	3%	17%	3%	19%
2014	226	29%	20%	1%	14%	4%	1%	5%	11%	2%	13%
Total	**952**	**26%**	**19%**	**8%**	**7%**	**2%**	**1%**	**4%**	**16%**	**2%**	**15%**

Table 20, continued: Second Choice Mode by Primary Mode (2014-2017) – Total

Year	N	Drove Alone	Carpool	TNC	Taxi	Transit	Shuttle	Bicycle	Walk	Other	No Trip
Walk											
2017	63	16%	9%	7%	2%	43%	-	13%	-	4%	7%
2016	75	15%	12%	3%	3%	39%	-	4%	-	3%	21%
2015	52	10%	25%	9%	1%	37%	-	6%	-	1%	10%
2014	67	8%	5%	-	2%	56%	-	6%	5%	2%	15%
Total	**257**	**13%**	**12%**	**4%**	**2%**	**44%**	**0%**	**7%**	**1%**	**3%**	**14%**
Total											
2017	751	15%	8%	13%	4%	31%	-	3%	8%	3%	15%
2016	729	14%	11%	9%	3%	32%	1%	2%	9%	3%	16%
2015	723	11%	12%	6%	4%	32%	1%	4%	10%	4%	16%
2014	661	15%	14%	1%	8%	29%	1%	4%	8%	2%	17%
Total	**2864**	**14%**	**11%**	**8%**	**5%**	**31%**	**1%**	**3%**	**9%**	**3%**	**16%**

Shaded cells indicate most popular second choice of mode. Only modes with more than 50 responses for second mode choice are included.

Source: Corey, Canapary & Galanis Research, 2017; Fehr & Peers, 2017

3.6 REASONS FOR DRIVING

The 2014, 2016, and 2017 surveys included a question asking respondents' reasons for driving, if they reported a drive alone or carpool trip. **Table 21** includes 2014 responses by residential location. The response options in this survey highlight some of the limitations of other modes: "Transit is not convenient," "Biking and walking take too long or are not possible," etc. In contrast, the 2016 and 2017 survey response options focus more specifically on what benefits respondents feel they receive by choosing to drive, such as faster travel times, increased flexibility, etc. (**Table 22**). In all surveys asking respondents' reason for driving, respondents could report multiple response. The average number of selected options per respondent were four options (4.4 in 2014, 3.5 in 2016, and 3.7 in 2017).

Reasons for driving were similar for both San Francisco and other Bay Area residents. In both 2014 and 2016-2017, drivers overwhelmingly mention that driving provides them with additional convenience or time savings (i.e., it was the fastest/cheapest option); they also indicated that availability of parking near their destination was a key factor in their decision to drive. Free parking was also noted as an incentive for driving for all survey years. In 2016 and 2017, nearly 70 percent of respondents chose to drive because parking was close to their destination, and over 50 percent drove because parking at the destination was either free or "cheap." Parking is implicit in the first option of the 2014 survey, where almost 100 percent cite convenience as the reason for driving.

While on average most respondents provided multiple reasons for driving, 11 percent of respondents only provided one reason for driving in aggregated 2016 and 2017. From this sample, 52 percent of respondents reported deciding to drive because "Driving and parking is faster than other modes of travel." In 2014, two percent of respondents provided only one reason for driving (10 surveys). Of these surveys, seven (70 percent) indicated that "Driving is most convenient."

Table 23 provides reasons for driving by location, using survey responses from 2016 and 2017. While responses are generally consistent across different neighborhoods in San Francisco and regions in the Bay Area, Zone 5 is an outlier, with a higher proportion of respondents stating that that driving is safer than other modes (50 percent in Zone 5 compared to 37 percent for the entire region) and a high proportion of respondents stating that they "need to make multiple stops" (51 percent in Zone 5 compared to 42 percent for the entire region).

Table 21. Reasons for Driving (2014)

Reason	SF Residents	Live Outside San Francisco	Total
Driving is most convenient (parking is free/cheap /close, it is the fastest, need to make multiple stops, travel with others)	99%	97%	99%
Transit is inconvenient (i.e. does not come often enough, does not operate when I need it, too far from home/destination, takes too long)	76%	79%	77%
Biking and walking take too long or are not possible	82%	84%	83%
Need access to a car (Need access to car for work, my schedule is unpredictable or requires flexibility, need to transport something)	72%	76%	73%
Cost (already paying for car, need to cover cost of multiple travelers)	29%	26%	28%
Safety/Personal security (I don't feel safe walking, biking, or taking transit)	29%	31%	30%
Comfort (I don't feel comfortable walking, biking, or taking transit; personal preference)	65%	62%	64%
Don't know how to bike or take transit	16%	14%	15%

Table 22. Reasons for Driving (2016 & 2017)

Reason	SF Residents		Live Outside San Francisco		Total	
	2017	2016	2017	2016	2017	2016
Parking at my destination was free	49%	50%	44%	34%	47%	45%
Parking at my destination was cheap	8%	6%	7%	6%	8%	6%
Parking was available close to my destination	70%	68%	65%	69%	69%	68%
Driving and parking is faster than other modes of travel	72%	76%	66%	78%	70%	77%
Driving and parking is safer than other modes of travel	36%	38%	34%	43%	36%	39%
I needed to make multiple stops before returning home	41%	39%	49%	36%	43%	38%
I was traveling with children	20%	23%	26%	20%	21%	22%
I need to carry something	54%	49%	47%	40%	52%	46%

Table 23. Reasons for Driving by Location (2016 & 2017)

Reason	SF	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Outside SF	East Bay	North Bay	South Bay	Total
Parking at my destination was free	**50%**	40%	54%	52%	43%	56%	**39%**	38%	40%	39%	46%
Parking at my destination was cheap	**7%**	8%	8%	6%	6%	9%	**7%**	6%	6%	8%	7%
Parking was available close to my destination	**70%**	62%	63%	71%	72%	78%	**67%**	64%	69%	69%	69%
Driving and parking is faster than other modes of travel	**74%**	69%	72%	75%	72%	81%	**72%**	67%	73%	75%	74%
Driving and parking is safer than other modes of travel	**36%**	28%	33%	35%	31%	50%	**38%**	39%	36%	40%	37%
I needed to make multiple stops before returning home	**41%**	37%	42%	40%	34%	51%	**43%**	38%	42%	47%	42%
I was traveling with children	**22%**	23%	12%	24%	23%	25%	**23%**	22%	23%	24%	22%
I need to carry something	**52%**	52%	49%	55%	50%	54%	**44%**	43%	44%	43%	50%

3.7 TRIP PURPOSE

This section reviews mode share by trip purpose. For each trip taken, respondents were given the option to report that they were traveling to work, to school, for shopping and errands, for dining and recreation, back to their residence, or to other destinations. **Inset Figure 10** summarizes trip purpose for 2015 to 2017. Three trip purposes comprise the majority of trips: work (21 percent), shopping (19 percent), and dining (21 percent). About one third of trips are respondents returning to their residences.

Inset Figure 11: Trip Purpose (2015-2017)

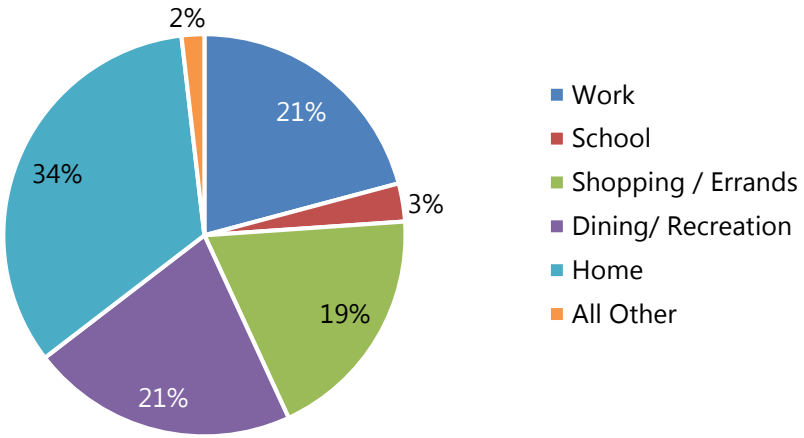


Table 24 summarizes the three year average for private auto mode share by trip purpose. Drive alone was consistently the highest portion of the private auto mode share, with exceptions for school and dining trips, where carpool exceeded drive alone. This is unsurprising, as school trips typically involve a driver and at least one student, and dining or recreation trips often involve multiple people in the same household traveling together.

Inset Figure 12 shows mode share by trip purpose for additional modes, and includes non-auto modes, averaged across a three year period (2015-2017). The trip purposes with the highest number of transit trips are work and school; trip purposes that generate the highest proportion of walking trips are shopping, errands, and recreation/eating out. This may reflect a tendency for people to run errands and seek out entertainment and dining in neighborhoods near their place of residence, or near another place they are visiting. Commute trips and school trips tend to occur during the

most congested periods of the day, when transit service is most frequent, which may account for the higher share of those types of trips by transit.

Inset Figure 12: Three Year Average Mode Split by Trip Purpose (2015-2017)

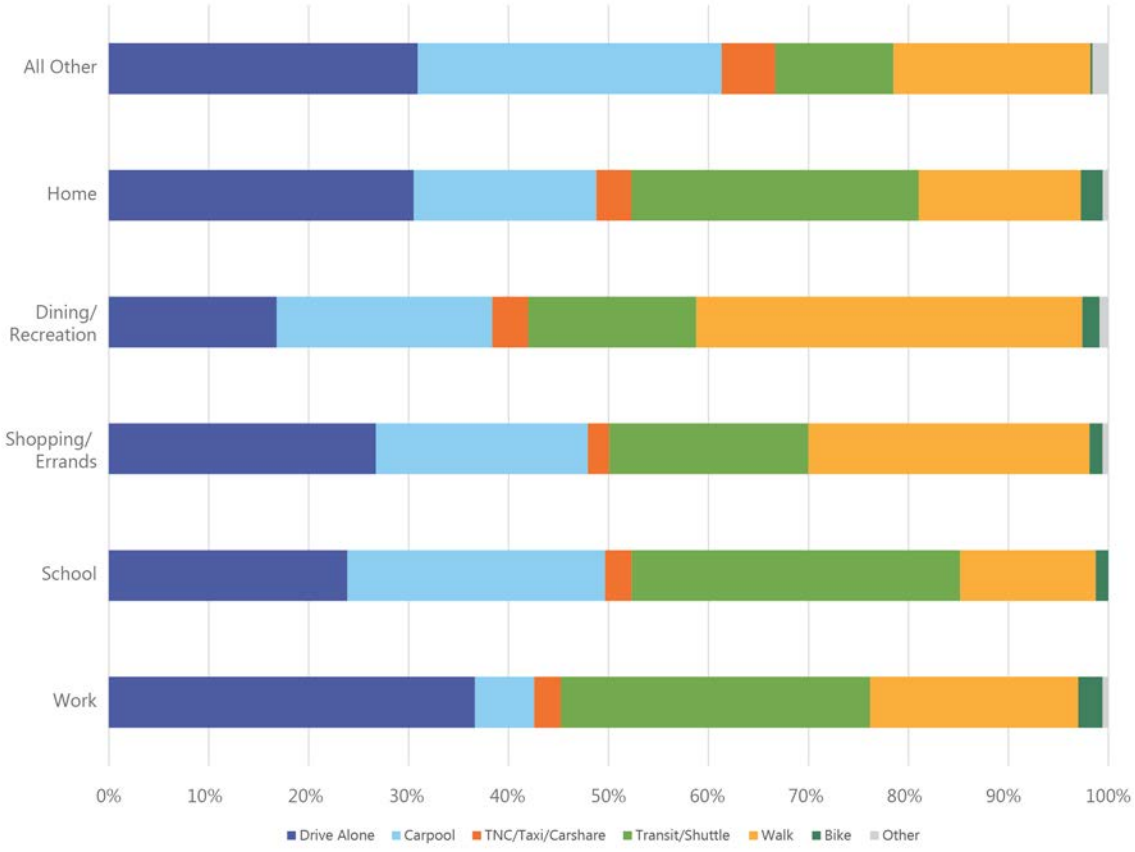


Table 24: Three Year Average for Auto Mode Share, by Trip Purpose (2015 – 2017)

Purpose	% of Trips	Drive Alone	Carpool	Private Auto Total	Carshare	TNC	Taxi	Auto Total
San Francisco Residents								
Work	18%	35%	5%	**40%**	0%	3%	<1%	**44%**
School	4%	23%	24%	**48%**	0%	3%	0%	**51%**
Shopping/Errands	21%	28%	19%	**47%**	<1%	1%	<1%	**49%**
Dining/ Recreation	21%	16%	20%	**37%**	<1%	3%	<1%	**40%**
Home[1]	34%	28%	18%	**46%**	<1%	3%	<1%	**50%**
All Other[2]	1%	27%	23%	**49%**	0%	4%	1%	**55%**
Non-San Francisco Residents								
Work	29%	40%	9%	**49%**	<1%	<1%	<1%	**50%**
School	2%	25%	30%	**56%**	0%	2%	0%	**58%**
Shopping/Errands	13%	23%	27%	**49%**	<1%	2%	<1%	**52%**
Dining/Recreation	22%	19%	25%	**44%**	<1%	3%	<1%	**47%**
Home[1]	32%	38%	20%	**58%**	<1%	1%	<1%	**60%**
All Other[2]	3%	18%	29%	**47%**	0%	1%	0%	**46%**
All Trips								
Work	21%	37%	6%	**43%**	<1%	2%	0%	**45%**
School	3%	24%	26%	**50%**	0%	3%	0%	**52%**
Shopping / errands	19%	27%	21%	**48%**	<1%	1%	0%	**50%**
Dining/Recreation	21%	17%	22%	**38%**	<1%	3%	0%	**42%**
Home[1]	34%	30%	18%	**49%**	<1%	3%	1%	**52%**
All Other[2]	2%	25%	24%	**49%**	<1%	3%	1%	**52%**

1. Home indicates the last segment of a trip, from a respondent's final non-home destination to home.
2. All Other includes refused to answer, religious/volunteer, medical appointments, etc.

Shaded cells indicate trip purposes with private vehicle mode share above the 50 percent goal.

Source: Corey, Canapary & Galanis Research, 2017; Fehr & Peers, 2017

4 TRAVEL TRENDS AND FORECASTS

One use of the data from the Travel Decision Survey effort is in forecasting and examining the potential effects of mode split trends on total vehicle travel in San Francisco. The measure of Vehicle Miles Traveled (VMT) is used to estimate the effects of travel decisions on roadway capacity and on greenhouse gas emissions.

4.1 SF-CHAMP FORECASTS

The SF-CHAMP model, developed and maintained by the SFCTA, represents existing and future transportation conditions in San Francisco. The model predicts all person travel for a typical weekday based on population and employment locations. Using outputs from the SF-CHAMP 5.0 2012 base year run for total number of person trips in San Francisco, Corey, Canapary & Galanis Research prepared the following projections of the total number of expected daily vehicle trips in San Francisco:

Table 25: Daily Trip Projections based on Total Daily Trips and Mode Share Survey, 2017

Mode	Estimated Weekday Trips
Private Auto	1,798,748
Non-Private Auto	2,361,238
Don't Know*	7,083

Source: Corey, Canapary & Galanis Research, 2017
*"Don't Know" represents individuals who could not remember / did not know how they took a reported trip when responding to the survey.

These projections indicate that in 2017, the model forecasts around 1.8 million daily person trips by private auto, and 2.4 million daily person trips by non-private auto. These estimates have been used to extrapolate the average daily person trips by mode, as well as to estimate vehicle trips by passenger vehicles (**Table 26**).

Table 26: Estimated Total Daily Trips by Mode

Mode	Percent of Trips	Estimated Number of Daily Trips[1]	Average Vehicle Occupancy[2]	Estimated Vehicle Trips
Drive Alone	28.0%	1,164,000	1.0	1,164,000
Carpool	15.0%	636,000	2.5	254,400
Carshare	0.2%	8,000	1.0	8,000
TNC	4.0%	155,000	1.0	155,000
Taxi	0.3%	14,000	1.0	14,000
Transit	25.0%	1,045,000	-	-
Shuttles	0.8%	35,000	-	-
Bicycle	1.6%	69,000	-	-
Walk	24.8%	1,034,000	-	-
Other / Don't Know	0.2%	7,000	-	-
Total	**100%**	**4,167,000**	**-**	**1,595,400**

1. Totals rounded to nearest 1,000 trips, and are based on non-rounded trip percentages.
2. Average vehicle occupancy reflects assumptions that all non-carpool trips are taken alone, and that carpool trips average between 2-3 occupants.
Source: Corey, Canapary & Galanis Research, 2017; Fehr & Peers, 2017

Overall, using conservative assumptions for passengers per trip for carshare, TNC, and taxi trips, projections show a total of 1,595,400 passenger vehicle trips (not including buses, freight and delivery vehicles, or shuttles). These assumptions are based entirely on total person trips as generated by SF-CHAMP. The resulting ratio of vehicle trips to person trips is 0.38, indicating that for every 100 person trips generated, we expect 38 vehicle trips, and a total auto mode share (including both private vehicles and TNC/taxi/carshare) of 47.5 percent. This analysis reinforces that the number of person trips involving a vehicle is not equal to the number of vehicle trips. As a result of carpooling, there are fewer vehicle trips than person trips involving a vehicle.

4.2 DEMOGRAPHIC TRENDS AND TRAVEL PATTERNS

Existing travel demand models may not fully account for anticipated changes to transportation. Disruptive forces include new technologies and shifts in demographics.[14, 15, 16] Fehr & Peers has consolidated available travel demand research on key factors into TrendLab+, a sketch planning tool that helps planners forecast total VMT in 2040 under a number of different scenarios. TrendLab+ is the result of research into how demographics, economic factors, and transportation innovations shape the rate of vehicle travel. While

[14] Fulton, L.; Mason, J., Meroux, D. 2016. *Three Revolutions in Urban Transportation: How to achieve the full potential of vehicle electrification, automation and shared mobility in urban transportation systems around the world by 2050.*
[15] McKinsey & Company and Bloomberg. 2016. *An Integrated Perspective on the Future of Mobility*.
[16] Arbib, J. and Seba, T. 2017. *Rethinking Transportation 2020-2030: The Disruption of Transportation and the Collapse of the Internal-Combustion Vehicle and Oil Industries.*

calibrated to national VMT levels, findings can generally be applied to San Francisco by examining the trend of future VMT per capita. As a sketch planning tool, TrendLab+ is valuable in examining how variations in trends may affect future VMT and, potentially, future auto mode share. In the four scenarios presented below, inputs reflect a variety of sources, from regional projections, to commonly discussed social shifts and policy changes, as well as trends revealed through examination of past travel decision surveys. More information on each of the variables can be found in **Appendix B**.

Scenario A: MTC Projections

This scenario assumes changes projected by MTC in *Projections: 2013***.** This includes an increase in the total share of the population of driving age, continued increases in traffic congestion, implementation of transit programs and first/last mile strategies, continued growth in area GDP, increased rates of growth in Alameda and Santa Clara counties compared to San Francisco, and increased rates of household formation.

Scenario B: Social Shifts

This scenario assumes that many widely theorized social shifts continue and accelerate. This includes a decrease in auto ownership, a continued increase in congestion, as well as increases in services such as home delivery, telecommuting, social networking, TNC activity, and the introduction of autonomous vehicles.[17]

Scenario C: Policy Changes

Scenario C examines a future with key policy changes at the local or state level, including stricter licensing requirements, and a potential gas tax or license fee that increases the cost of vehicle operation. It also assumes implementation of first/last mile strategies such as bicycle facilities between transit and common destinations, promotion of shuttle services, and pedestrian enhancements.

Scenario D: Travel Decision Survey Trends Continue

Scenario D selects a few key trends from responses to the travel decision survey. First, it assumes vehicle ownership will increase, based on a higher number of survey respondents indicating they obtained a new vehicle compared to those indicating they reduced the number of vehicles in their household. It assumes

[17] Circella, G. et al., 2016. "What Affects U.S. Passenger Travel? Current Trends and Future Perspectives" *National Center for Sustainable Transportation. https://ncst.ucdavis.edu/wp-content/uploads/2014/08/06-15-2016-NCST_White_Paper_US_Passenger_Travel_Final_February_2016_Caltrans3.pdf*

increased household income / GDP growth based on increases in average reported household income over the past five years, and also reflects an increase in TNC usage based on the increase in reported TNC trips.

Table 27: Summary of TrendLab+ Scenarios and Results

Variable	Scenario A MTC Projections	Scenario B Social Shifts	Scenario C Policy Changes	Scenario D TDS Trends Continue
Labor Force Participation	No Change	No Change	No Change	No Change
Driving Age Population	**Increase**	No Change	No Change	No Change
Vehicle Ownership	No Change	**Decrease**	No Change	**Increase**
Licensing Regulations	No Change	No Change	**Increase**	No Change
Auto Operating Costs	No Change	No Change	**Increase**	No Change
Congestion and Time Use	**Increase**	**Increase**	No Change	No Change
First/Last Mile Strategies	**Increase**	No Change	**Increase**	No Change
GDP/ Real Income Growth	**Increase**	No Change	No Change	**Increase**
Suburban Migration	**Increase**	No Change	No Change	No Change
Household Formation	**Increase**	No Change	No Change	No Change
Goods & Service Delivery	No Change	**Increase**	No Change	No Change
Telecommuting	No Change	**Increase**	No Change	No Change
Social Networking	No Change	**Increase**	No Change	No Change
Shared Mobility Services / TNCs	No Change	**Increase**	No Change	**Increase**
Autonomous Vehicles	No Change	**Increase**	No Change	No Change
VMT per Capita Estimate	**Increase 10%**	**Increase 4%**	**Decrease 4%**	**Increase 13%**

As shown in **Figure 2** and **Table 27**, these scenarios result in differing levels of change in VMT per capita. The reported VMT is based on national levels; however, the trend and percent change are more relevant to this discussion. In Scenario A, which focuses on demographic projections and policy trends prepared by MTC for use in regional forecasting, there is potential for a 10 percent increase in VMT per capita over the status quo. This change is driven largely by demographic changes and continued growth in the Bay Area economy at large, and shows the effect of both economic growth as well as population growth on VMT.

In Scenario B, which focuses on social changes, there is a more modest projection of a four percent increase in VMT. This increase is driven mostly by changes in service delivery and private sector trends, such as a continued increase in home delivery, telecommuting, and TNC use. The introduction of autonomous vehicles may also lead to increases in VMT based on preliminary models.

Scenario C focuses on policy changes, which could occur at either the state or local level – these policies are assumed to make vehicle ownership more onerous by increasing costs, potentially through taxes or fees, while also investing in first/last mile connections to facilitate use of transit. These changes could result in a four percent decrease in VMT.

Finally, Scenario D selects a few trends from the 2013 – 2017 travel decision surveys and examines their potential effect on VMT. Economic growth is likely tied to increased vehicle ownership, as well as the increase in use of TNCs; taken together, and with growth of these trends continuing in the future, there could very well be a resultant increase in VMT per capita in San Francisco, potentially up to 13 percent. This level of VMT increase would likely correspond to additional traffic on both local and regional roadways, and may reflect an overall increase in private auto mode share.

Additional information on TrendLab+ and its supporting white paper is included as **Attachment A.**

4.3 TECHNOLOGY AND MOBILITY ON DEMAND

The transportation landscape in San Francisco has changed significantly since the current Strategic Plan metrics were adopted in 2012, largely due to the introduction and growth of several new transportation options. Private shuttles such as tech buses and Chariot have become more common, with SFMTA launching a pilot program for managing their use of curb space, while TNC services such as Lyft and Uber have been used at least once by over 70 percent of survey respondents. Autonomous vehicles are being tested in locations nationwide, including San Francisco. While TNC use has been a growing and evolving piece of the transportation sector in San Francisco for several years, autonomous vehicles have yet to reach public markets. While AVs have fueled much speculation regarding their potential effects on overall travel behavior, the results of their introduction to the vehicle fleet remain to be seen.

4.3.1 TNC

While the current goal does not consider TNC trips to be private vehicle trips, they often result in adding additional vehicles to the roadway, to a degree similar to if not greater than private automobile trips. TNC services rely on having vehicles available on demand, which typically requires drivers to spend a portion of their time driving while anticipating a ride request. In addition, there is evidence from studies in San Francisco, New York City and Denver that TNC services induce trips that would not otherwise be taken, or that would otherwise use non-auto modes, such as transit[18] (**Table 28**). While the total share of trips by TNC remains relatively small, at around four percent in the latest Travel Decision Survey, TNCs currently represent a larger share of trips than carshare, bicycling, or private shuttle, despite having no presence in the transportation landscape prior to 2012.

[18] Henao, Alejandro. 2017. Impacts of Ridesourcing – Lyft and Uber – on Transportation including VMT, Mode Replacement, Parking, and Travel Behavior. University of Colorado Denver; Rayle, Shaheen, Chan, et al. 2014. App-Based On-Demand Ride Services: Comparing Taxi and Ridsourcing Trips and User Characteristics in San Francisco. University of California Transportation Center.; Schaller Consulting. 2014. *Unsustainable? The Growth of App-Based Ride Services and Traffic, Travel and the Future of New York City*.

Table 28: Summary of Findings from TNC Studies on Mode Shift

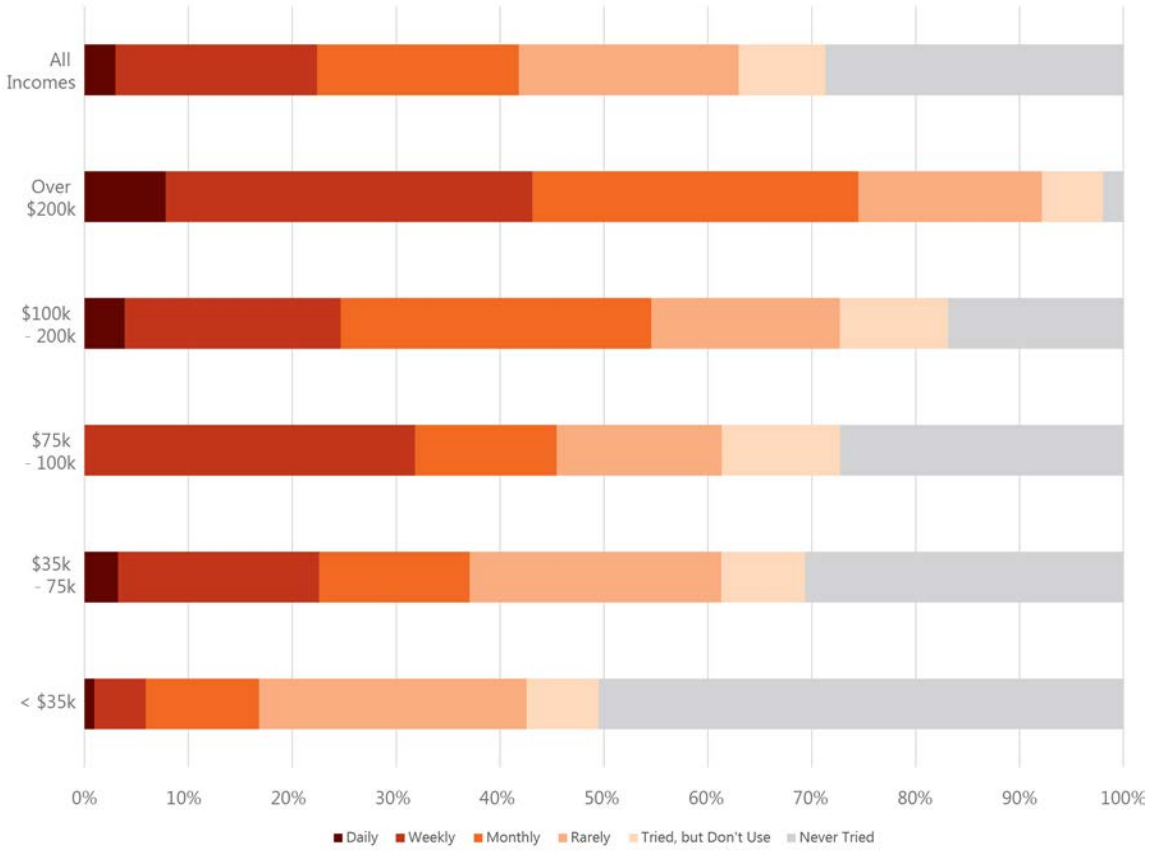
	San Francisco (Rayle, Shaheen, Chan, et al.)	Denver (Henao, 2017)	New York (Schaller, 2017)
Mode Shifts from:			
Taxi	36%	10%	81m annually
Transit	30%	22%	Not studied
Walk	7%	12%	Not studied
Bike	2%	Included in 'Walk'	Not studied
Private Vehicle	7%	31%	Not studied
Induced Trips (Trips otherwise not taken)	8%	12%	Not studied
Added Vehicle Trips (Shifts from Transit, Walk, Bike, plus induced trips)	47% of TNC trips	46% of TNC trips	Overall 7% increase in all vehicle trips
Added VMT per PMT (Includes shifted trips, trips otherwise not taken and deadhead)	Not studied	.75	Not studied

Sources: Henao, 2017; Rayle, Shaheen, Chan, et al., 2014; Schaller Consulting, 2017.

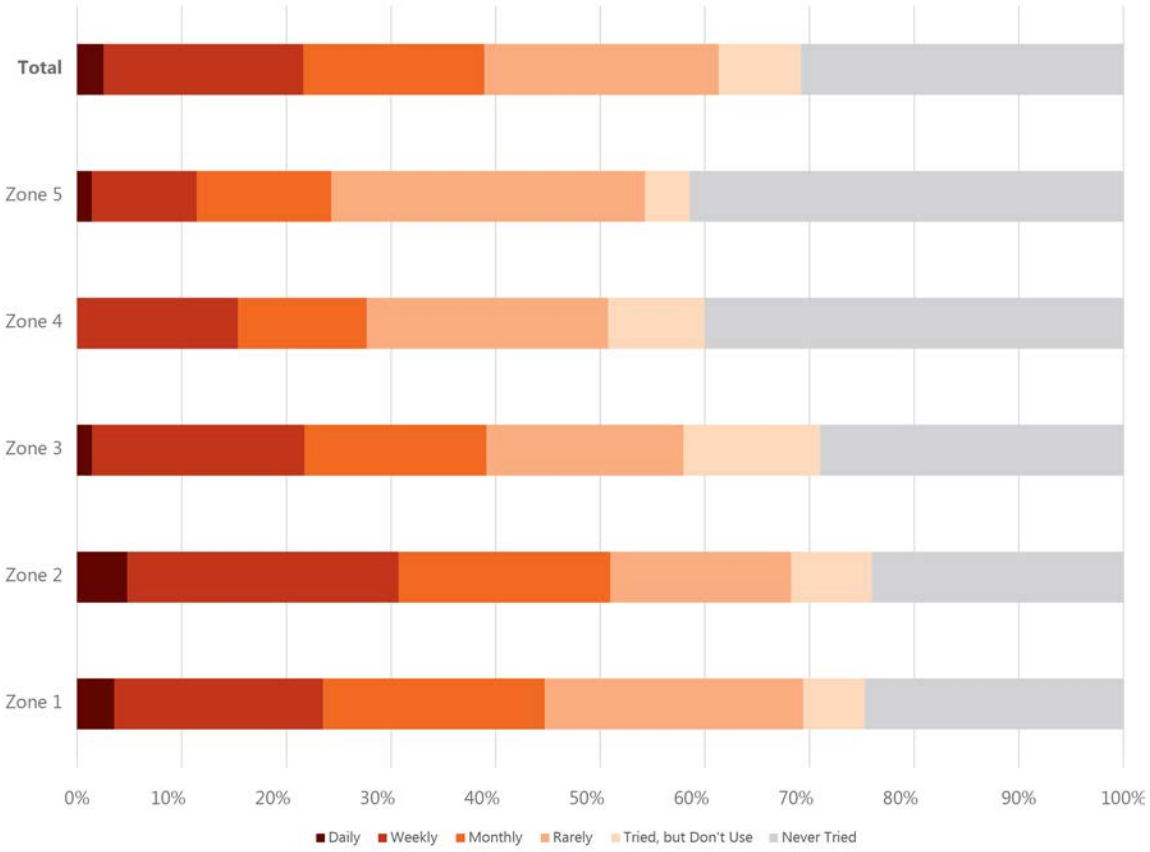
Additionally, use of TNCs varies substantially by income**. Inset Figure 13** shows responses to the survey question asking individuals how frequently they used TNC services. Overall, around 40 percent of survey respondents used TNC services at least once a month, with around 20 percent using them at least weekly. However, among the highest income earners (household income over $200,000), nearly three quarters use TNC services at least monthly.

TNC use also varies by place of residence, as shown for San Francisco residents of each zone in **Inset Figure 14**. Residents of Zone 1 and Zone 2 are most likely to use TNC services, with 45 to 50 percent of respondents using those services at least once a month. This contrasts sharply to responses from residents of Zone 4 and Zone 5, where 35-40 percent of respondents had never tried a TNC service. Zones with lower TNC usage coincide with the zones with the highest private auto mode share. In inverse, zones with high TNC use coincide with zones with the highest transit, walking, and bicycling mode share. This may reflect that TNC availability helps to enhance the overall network of transportation options, particularly in denser neighborhoods where car ownership is lower than the city average, and parking is less available, more expensive, or both.

Inset Figure 13: Self-Reported Frequency of TNC Use by Income (2017)



Inset Figure 14: Self-Reported TNC Use by Place of Residence (San Francisco Residents, 2017)



Age shows a similar pattern, with younger respondents (under age 35) much more likely to use TNCs on a regular basis than respondents over age 35. As shown in **Inset Figure 15**, nearly 30 percent of individuals under age 35 used a TNC service at least once a week, with half of them using a service at least once per month. In contrast, 40 percent of individuals over age 35 had never tried a TNC service. Survey responses also show a marked increase in TNC use among younger adults compared to older adults, as shown in **Table 29**.

Inset Figure 15: Self-Reported TNC Usage by Age

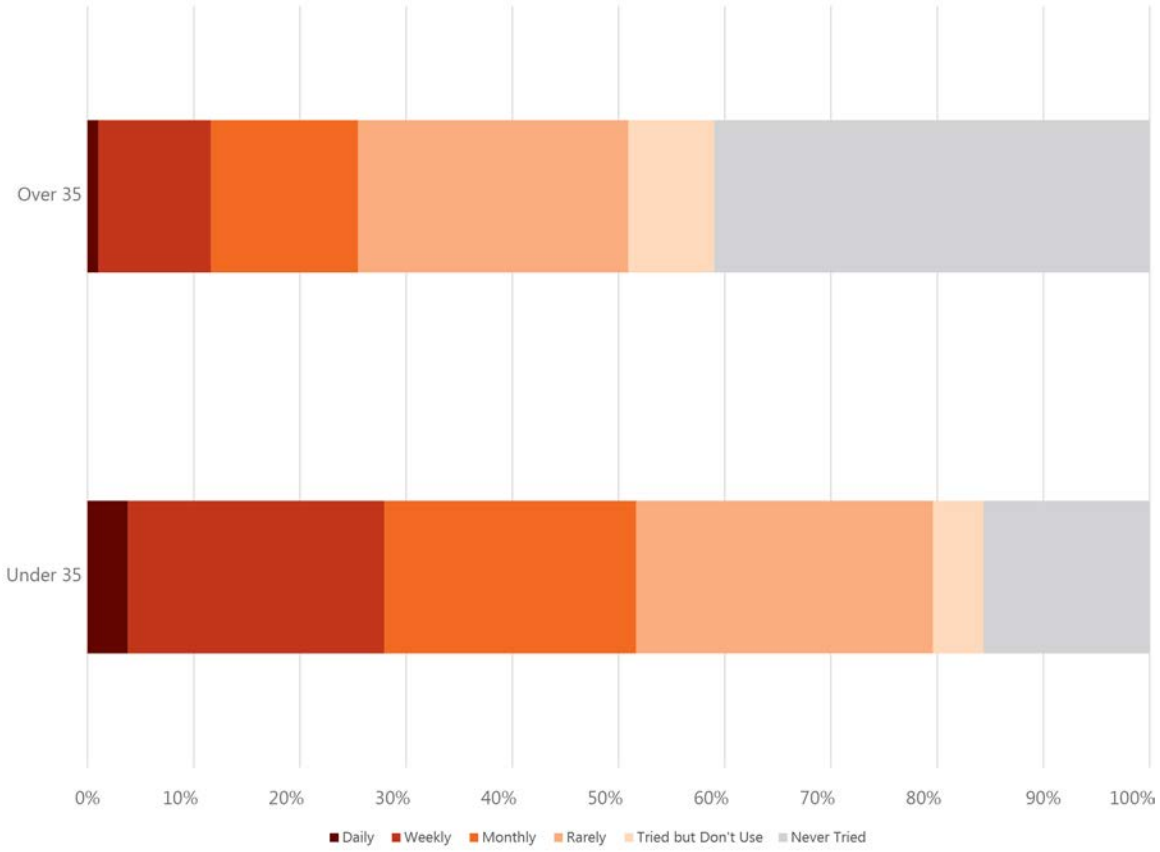


Table 29: TNC Mode Share by Age, All Trips

Age	TNC Mode Share
Under 35	7% (*+/-3.4%)*
35+	2% (*+/- 1.2%)*

Source: Corey, Canapary & Galanis Research 2017; Fehr & Peers, 2017

Finally, survey respondents were asked for their second choice of travel mode if their initial mode was unavailable for the first leg of their trip. Because only a small share of respondents reported a TNC trip, there is a large margin of error for these data, and they should be used with caution. Of the 14 TNC trips for which the second choice of mode question was asked, nine respondents reported that if they had not taken a TNC, they would have used transit. This, along with the results of prior studies as shown in **Table 28**, suggests that TNC trips may be substituting for transit trips at a fairly high rate; however, more study is needed to draw a conclusion regarding motivations for TNC use.

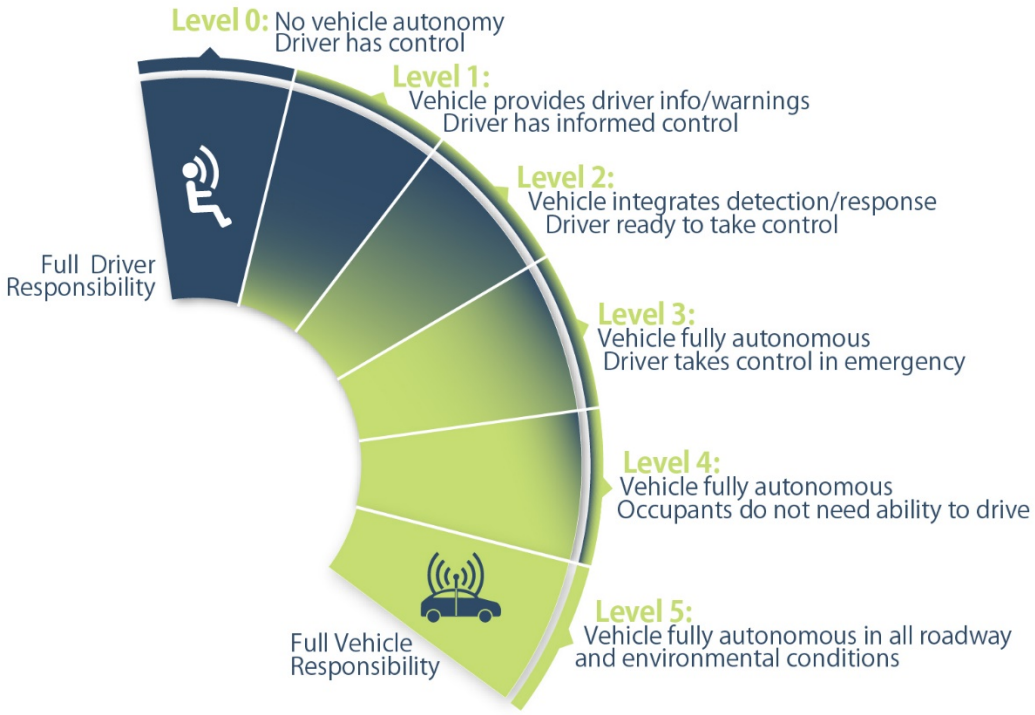
While TNCs may be providing a substitute for transit use among some users, for others they may simply represent an additional mobility option, particularly in cases where a trip made by transit would be

substantially longer than one made by TNC. Recent data on peak periods of TNC use indicate that TNC companies provide the highest volume of rides on weekends and in evenings, particularly in the late evening on Fridays and Saturdays.[19] These trips, likely reflecting recreational purposes such as socializing or eating out, occur during times when traditional transit service is less time-competitive due to decreased frequency of service.

4.3.2 Autonomous Vehicles

While not yet prevalent in the transportation market, AVs are being researched and tested on roadways nationwide. Vehicle autonomy is typically classified into five levels, illustrated in **Inset Figure 16**. Many new vehicles incorporate autonomy at Level 1, with features such as lane departure warnings or blind spot warnings. AVs at levels 3, 4, and 5 are currently being tested in road conditions by several technology and transportation companies; car makers expect AVs at this level of autonomy to be available between 2020 and 2030.

Inset Figure 16: Levels of Vehicle Autonomy



[19] "TNCs Today," San Francisco County Transportation Authority; June 2017.

AVs have the potential to also reduce or completely eliminate collisions. Ninety-four percent of vehicular collisions are related to driver behavior such as speeding or inattentive driving.[20] The combined package of sensors and collision avoidance systems may address these behaviors.[21]

AV adoption and the introduction of an AV fleet has aroused much discussion and controversy among transportation planners. Potential theorized effects of AV fleets include effects as varied as potential decreases in freeway congestion (due to reduced following distances), induced travel demand (due to reducing the stress of driving and allowing drivers the option to use travel time productively), increased surface street congestion (due to induced demand), increased auto availability due to concurrent innovations in mobility on demand, or the ability for individuals who cannot currently drive to use an AV for travel.

Further speculation includes discussion of how the initial entry of AV into the fleet may shape future patterns: for instance, if TNC companies are early adopters of the technology (which would substantially reduce their labor costs), AVs may become means to foster mobility on demand, in which individual auto ownership becomes less important due to the ubiquitous and cost-competitive AV TNC service. If AVs enter the market primarily as replacements for personal automobiles (i.e., continue to be individually owned), there may be relatively little disruption in travel choices in the medium term.

Initial looks at how various AV features and implementation scenarios affect vehicle travel have produced mixed results, based on how they incorporate the speculative effects discussed above. Existing travel models are capable of estimating the effects of AVs based on manipulating key inputs; initial tests of these models indicate that high levels of AV penetration may generate from around 3 percent to 25 percent more vehicle trips if there is no increase in ride sharing, and a slight reduction (-5 percent) to a slight increase (+5 percent) in vehicle trips if high levels of ride sharing are incorporated (a scenario that would likely involve regulation, and accelerated adoption by current TNC operators). A summary of model results from seven regional travel demand models is provided as **Appendix B**; generally, this shows a high level of uncertainty regarding the effects of AVs, but a trend toward an increase in VMT with increased AV penetration.

[20] National Highway Traffic Safety Administration. *Critical Reasons for Crashes Investigated in the National Motor Vehicle Crash Causation Survey*. February 2015.
https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812115
[21] McKinsey & Company and Bloomberg. *An Integrated Perspective on the Future of Mobility*. October 2016.

5 POTENTIAL POLICY IMPLICATIONS

Overall, the City is meeting its goals for private auto mode share. Fewer than half of trips made to, from, or within San Francisco are made by private car. However, realizing further reductions in auto mode share, if desired, may require additional planning and investment. Trends over the past five years largely show that the variation in private auto use falls within a margin of error on a year-over-year basis, and that the primary indicator of a household's auto mode share is its residential location. Additionally, the emergence of new modes such as TNCs or the introduction of autonomous vehicles may affect future travel patterns; from 2016 to 2017, the share of trips made by TNC doubled among San Francisco residents. Finally, shifts between the various automobile modes may have differing effects on total VMT, based on factors such as average vehicle occupancy.

5.1 THE IMPORTANCE OF RESIDENTIAL LOCATION

Private vehicle mode share varies based primarily on household location and trip purpose, with individuals living in areas with high quality transit access showing the lowest total auto mode share (such as in San Francisco zones 1 and 2, and in the East Bay, where BART provides high-frequency, time-competitive access to San Francisco).

To further reduce private vehicle mode share, the City will need to review reasons for variations in auto mode share. As discussed above, the convenience and frequency of transit service is one key element; however, the number of walking trips made in Zones 1 and 2 also surpasses those made by residents of other locations. Development patterns emphasizing walkable neighborhoods and providing key shopping, school, and entertainment options within walking distance may help further reduce the share of trips made by private vehicles.[22] Alternatively, if future growth in residential development is expected to occur largely in areas that already have lower private auto mode share, private auto mode share may decline over time as a larger share of the population lives in a low-auto-use area.

But while housing options for new residents, density, and land use mix play a key role in individual travel decisions, the process of planning for these land use elements involves coordination between multiple agencies and stakeholders. Transportation-focused interventions shown to increase the use of non-auto modes include increased frequency, reliability, and coverage of transit service[23] as well as providing new or

[22] Ewing, R. and Cervero, R. 2010. "Travel and the Built Environment: A Meta-Analysis" *Journal of the American Planning Association*. Volume 76, Issue. 3 (pages 265-294).
[23] Taylor, B. D., Miller, D., Iseki, H., & Fink, C. (2009). Nature and/or nurture? Analyzing the determinants of transit ridership across US urbanized areas. *Transportation Research Part A: Policy and Practice*, *43*(1), 60-77.

enhanced bicycle facilities including Class I and Class II bicycle lanes, secure parking, and other improvements.[24, 25]

In general, given that the most frequent reason for driving is that driving is faster and more convenient, strategies to reduce auto mode share will generally work by enhancing the perceived speed, convenience, and flexibility of other options such as walking, bicycling, and transit. Many of these changes include those listed above; for instance, increasing transit frequency decreases the total average travel time once waiting time is included. However, other factors than total time spent traveling may also contribute to the perceived cost and convenience of different modes. For instance, time spent on a transit vehicle may be less private or comfortable than time spent driving, but may also allow for other activities such as reading. As such, providing a more comfortable experience on transit may help to reduce its total perceived time cost even if travel times remain the same.

5.2 TNC EFFECTS ON THE TRANSPORTATION NETWORK

TNC usage as a share of trips taken in San Francisco has doubled in the last year. Survey questions asking about frequency of TNC use reflect that most San Francisco residents and Bay Area residents who visit San Francisco have used these services, and that many use them on at least a monthly basis. Recent research in San Francisco indicates that on Fridays and Saturdays, there may be more than 220,000 TNC trips made in San Francisco, with between 130,000 and 188,000 daily trips on weekdays. This represents around 20 percent of local VMT (i.e., trips within San Francisco only) and 6.5 percent of total VMT (including regional trips).[26] If, as suggested by recent studies, around 45 percent of TNC trips represent a shift from another mode,[27] the emergence of TNC services would account for a two to three percent net increase in weekday VMT in San Francisco. This increase in vehicle trips on local roadways may contribute to congestion, which may in turn create delay for transit vehicles, and increase the City's greenhouse gas emissions from transportation sources.

Several policy proposals have entered the public sphere based on the rise in popularity of TNC services, including potential operation, pick-up/drop-off, or curbside usage fees. Beyond the potential addition of vehicle trips to roadways, this trend may signal an increased demand for curbside passenger loading, and conversely a potential decrease in on-site parking demand at some destination types.

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[24] Hunt, J. D., & Abraham, J. E. (2007). Influences on bicycle use. *Transportation*, *34*(4), 453.
[25] Pucher, J., Buehler, R., & Seinen, M. (2011). Bicycling renaissance in North America? An update and re-appraisal of cycling trends and policies. *Transportation research part A: policy and practice*, *45*(6), 451-475.
[26] "TNCs Today," San Francisco County Transportation Authority, June 2017
[27] Rayle, L., Shaheen, S., Chan, N., Dai, D., & Cervero, R. (2014). *App-based, on-demand ride services: Comparing taxi and ridesourcing trips and user characteristics in San Francisco*. UCTC-FR-2014-08.

However, the effects of TNCs may be more complicated. Both Lyft and Uber offer some services that include a ridesharing component, allowing users to share rides for a portion of their trip based on a matching algorithm, with a corresponding lower fare. Similarly, peak demand for TNC services tends to occur outside of the weekday peak hours, with the highest volume of trips on Friday and Saturday nights between 6pm and midnight[26]. Trips taken during these hours, which may include trips for which a transit alternative would be substantially longer, begin in a location without high levels of taxi availability, or where the individual may have been consuming alcohol, may represent a general increase in mobility due to the presence of TNCs. Ultimately, policy decisions regarding TNC operations in San Francisco will involve careful weighing of individual mobility, equity considerations, and the City's transportation goals.

5.3 INTRODUCTION OF AUTONOMOUS VEHICLES

As discussed previously, AV technology is still under development, and much of the discussion surrounding its future effects on travel behavior and transportation facilities are speculative. However, as the technology emerges, regulatory frameworks, public projects and infrastructure may have some influence on the manner in which AV technology or other connected transportation technology is integrated into the fleet.

SFMTA has previously prepared proposals for several major projects integrating advanced transportation technology as a grant application for Advanced Transportation and Congestion Management Technologies Deployment Initiative grant funding. These include:

- Connected Carpool Lanes, integrating app-based carpooling with expansions of carpool lanes on the local and regional transportation network
- Smart Traffic Signals in Vision Zero Corridors, using dedicated short range communication technology to enhance signal coordination with high truck volumes and reduce pedestrian collisions
- Treasure Island Autonomous Shuttle, designed to provide fast, frequent service between Treasure Island and downtown San Francisco
- Treasure Island Congestion Toll infrastructure, designed to implement a variable toll structure for vehicle trips to and from Treasure Island

While not all of the projects under discussion are traditional AV projects, they all incorporate key aspects of technology associated with AVs and with coordinated or smart transportation systems. They also illustrate that as new technologies emerge, opportunities for grant funding and pilot programs will likely follow. A pipeline of innovative policies and strategies for approaching the different potential directions of AV implementation may help position the SFMTA favorably for these opportunities.

5.4 FUTURE METRICS FOR MODE SHARE

SFMTA currently sets its benchmark based on the proportion of person trips made by private automobile, which includes driving alone as well as driving with others/carpooling. It does not define trips made by taxi, TNC, or carshare as private auto trips. Because the number of people transported by each of these options differs, there are many configurations of total auto mode share that could meet the current goal while generating a wide range in the number of total daily vehicle trips. As an illustrative example, **Table 30** presents three hypothetical mode share scenarios and evaluates them using the existing mode share goal.

Scenario A represents the status quo, and assumes an average occupancy of 2.5 trips for carpool/drive with others, and an average occupancy of 1.0 for all other vehicle modes (not including a TNC driver). Scenario B includes an increase in private drive alone trips, as well as a shift from carpooling to TNC, with a slight increase in average occupancy for TNC trips. Scenario C shows a dramatic increase in carpooling, as well as an increase in average occupancy for TNC trips.

As shown in the table, Scenario A and Scenario B both meet the current mode share goal, despite Scenario B generating around 300,000 more daily vehicle trips than Scenario A. Scenario C, however, would result in a decrease in daily vehicle trips compared to Scenario A, yet would not meet the auto mode share goal as currently stated.

The past five years of monitoring have not shown shifts as dramatic as those in **Table 30**, which is intended as an illustration only. Overall, private vehicle mode share has been a reliable method of measuring the total share of vehicle trips in the city; it is only in the previous two years that increases in TNC usage have affected that metric. Including carpool/drive with others trips in auto mode share is also appropriate for trip purposes in which a driver is escorting a passenger, such as a guardian taking a child to school or a family member dropping another family member off at work. These trips likely comprise a large number of carpool/drive with other type trips. However, as TNCs and other technologies continue to grow in market share, it may be worth considering introduction of additional vehicle trip types into the monitoring goal.

Ultimately, the metrics used to assess progress toward the goals in the Strategic Plan should reflect the primary purpose of each goal, while also being feasibly measurable. In the case of the current goal, "Make transit, walking, bicycling, taxi, ridesharing, and carsharing the preferred means of travel," the division between private auto trips and all other trips is clear, and the current metric is sensible.

Table 30: Illustrations of Private Auto Goals and Vehicle Trips

Mode	Mode Share	Average Occupancy
Scenario A – Status Quo		
Drive Alone	28%	1.0
Carpool	15%	2.5
Carshare	1%	1.0
TNC	4%	1.0
Taxi	1%	1.0
Non-Auto	51%	-
Scenario B – Drive Alone and TNC Increase		
Drive Alone	35%	1.0
Carpool	10%	2.5
Carshare	1%	1.0
TNC	8%	1.2
Taxi	1%	1.0
Non-Auto	45%	-
Scenario C – Carpooling Increase		
Drive Alone	25%	1.0
Carpool	25%	2.5
Carshare	1%	1.0
TNC	4%	1.5
Taxi	1%	1.0
Non-Auto	44%	-

Table 31: Summary of Change in Vehicle Trips under Scenarios in Table 30

	Scenario A	Scenario B	Scenario C
Total Vehicle Trips	1,667,000	1,986,000	1,653,000
Meets Goal?	Yes	Yes	No

Vehicle trips are derived from mode share, average occupancy, and total daily person trips, as shown in **Table 26** above.
Source: Fehr & Peers, 2017

6 CONCLUSION

Fewer than half of Bay Area resident trips in San Francisco are made by private automobile, indicating that the SFMTA continues to meet its mode share goals under the current Strategic Plan. While rates of private and non-private vehicle use vary based on place of residence, income, age, car ownership, and other demographic factors, more trips are made to, from, and within San Francisco without a car than with one. Specifically, transit and walking accounted for nearly half of trips made by San Francisco residents in 2017, and those two modes account for up to 60 percent of trips in the densest neighborhoods in the city. These areas, which tend to have dense development patterns as well as frequent and high quality transit service, may serve as examples for reducing total auto mode share in other areas of the city through both transportation policy and urban planning.

Many of the factors influencing individual travel choices fall outside the traditional realm of transportation facilities. Land use planning, development, and personal choice play significant roles in travel decisions. Additionally, fluctuations in societal variables (such as labor force participation, household size, economic growth, and population demographics) and emerging technologies (such as AVs) can have a large effect on transportation trends, while also being difficult to forecast accurately. While Fehr & Peers has presented several feasible scenarios for some of these demographic and technology changes using TrendLab+, each of these factors is itself somewhat unpredictable. Ongoing monitoring of auto mode share, travel trends, and demographic relationships to those trends will be necessary to assess current goals and set future ones.

In particular, regional population and employment fluctuations will highly influence future transportation patterns. While mode share within San Francisco may very well remain stable, if additional trips are made due to growing population, patterns of housing development, or job creation, the total number of vehicles on local roadways will still increase. However, the patterns of this growth can also influence mode share in turn, particularly the locations of new housing and new employment centers within the region. The dense network of transportation choices currently present in San Francisco will likely shift naturally as individuals travel to and from the places they frequent most often: home, work, school, shops, and restaurants.

Transportation agencies like the SFMTA still have critical roles to play in influencing trip modes. Quality and frequency of transit service, cycling infrastructure, pedestrian safety, and public parking prices all affect travel decisions by individuals. As the SFMTA moves forward with pedestrian improvements on high injury corridors, enhanced bicycling services, bike share expansion, and continued implementation of transit service improvements, the attractiveness of walking, bicycling, or taking transit will likely increase and provide incentives for residents and visitors alike to choose a mode other than a private vehicle.

APPENDIX A: TRENDLAB+ DOCUMENTATION

FEHR PEERS
presents

research from our THINK initiative

Demographic Trends
and the Future of Mobility

By FP Think Working Group Members:
Lindsey Hilde, Alex Rixey, Eric Womeldorff, & Jerry Walters

February 2014

DEMOGRAPHIC TRENDS AND THE FUTURE OF MOBILITY

BY FP THINK WORKING GROUP MEMBERS:
LINDSEY HILDE, ALEX RIXEY, ERIC WOMELDORFF, AND JERRY WALTERS

FEBRUARY 2014

FEHR & PEERS

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APPENDICES

EXECUTIVE SUMMARY

Driving in the U.S. began to decline three years before the Great Recession. After 50 years of steady growth, total national vehicle miles traveled (VMT) leveled off in 2004 and declined by 8% between 2004 and 2012. Whether travel will return to growth rates of past decades, remain static, or continue to decline is of critical importance to decision-makers in business and government at the local, state and national levels. VMT growth is a key determinant of the cost, societal, and environmental impacts associated with public policy, community planning and infrastructure investment.

This paper investigates the reasons for the decline in VMT and attempts to determine whether the leveling and subsequent drop in VMT will be temporary or the beginning of a sustained downward trend. We examine demographics and intergenerational preferences, technology and social networking, the changing workplace and the "new economy." We focus on the different travel habits of Millennials and Baby Boomers, and how shifting lifestyle and social trends will influence society's transportation priorities over the next few decades. Lastly, we suggest means through which we can make more reliable forecasts of future travel, and better informed transportation plans and investments.

Research shows both cyclical recession effects and a fundamental, possibly permanent, leveling of the economy and travel, especially for present and future generations of 16 to 30 year-olds. Looking across the generations at Baby Boomers, Generation Xers, and Millennials we see the following trends discussed:

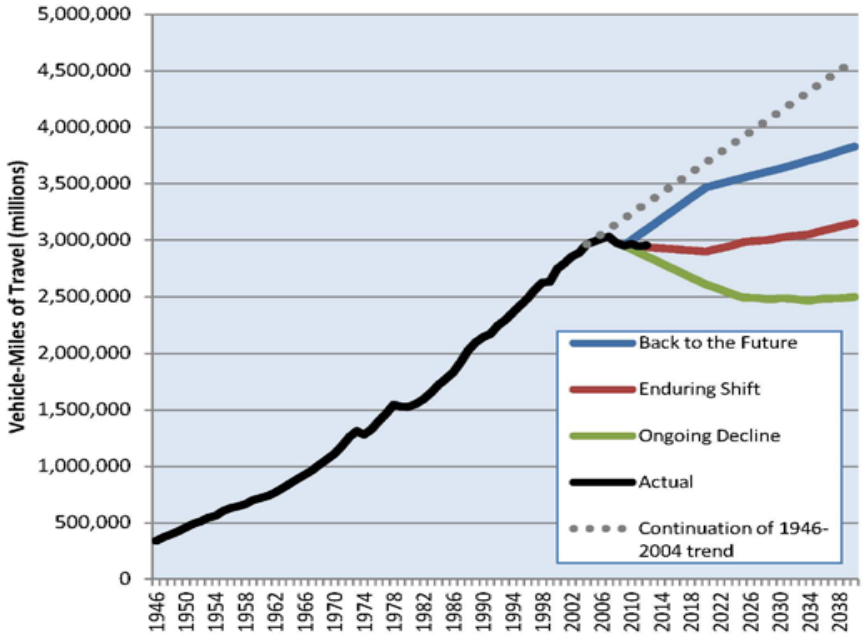
- The economy is having a substantial impact, especially for Millennials. In the words of political strategist James Carville, "It's the economy." [1]
- Millennials are favoring low-travel urban lifestyles with emphasis on walking, cycling, ride-sharing and transit, but many still prefer driving.
- Other common explanations for VMT decline – such as the effects of technology, urbanization and modal shifts for other generations – have modest effects.
- Key reasons behind the late-20th century VMT growth, such as escalating labor-force participation, may have reached saturation and diminishing returns.

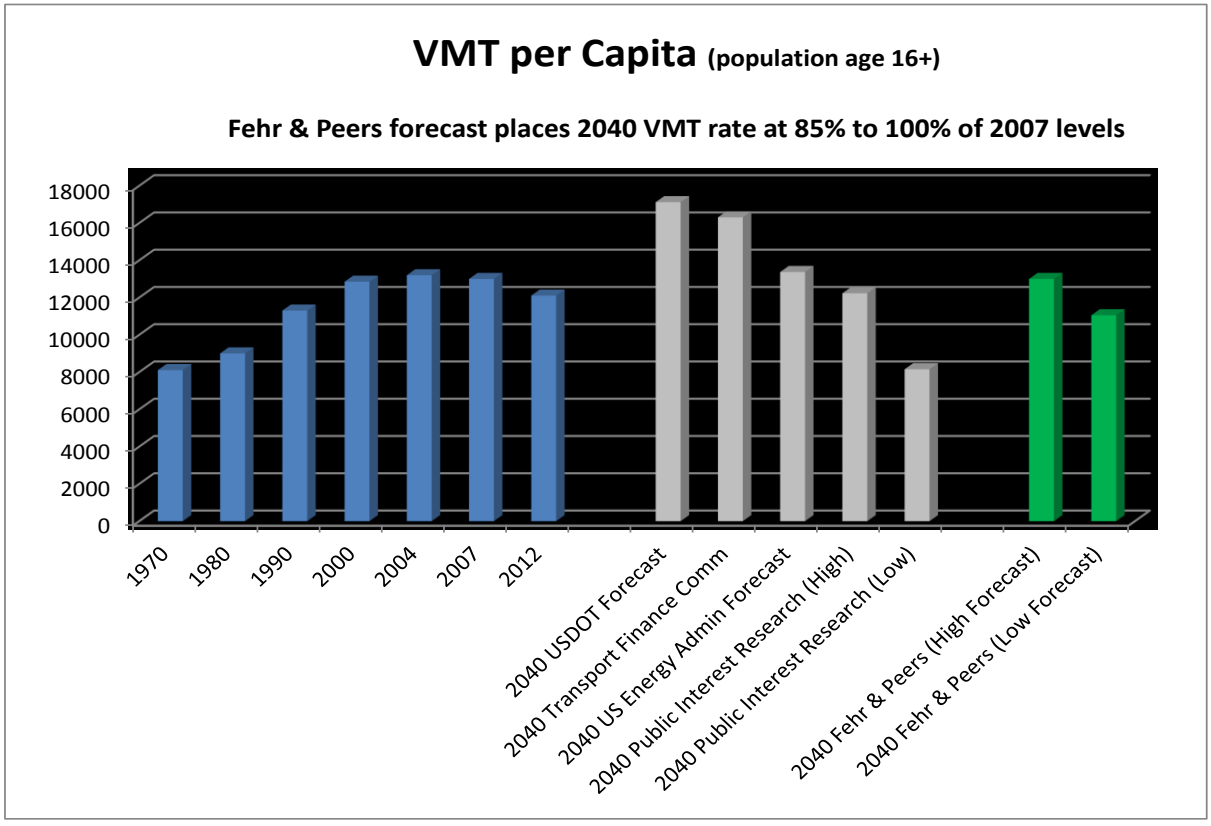
Putting the evidence together factor by factor and generation by generation indicates that growth will slow significantly and may even stabilize at pre-2000 VMT per capita levels. As a result, we forecast the following:

- By 2040, non-freight VMT will grow at less than two-thirds the pre-2004 rate.

[1] "It's the economy" is a slight variation of a phrase James Carville coined as a campaign strategist on Bill Clinton's 1992 presidential campaign.

- VMT per capita, which grew 17% between 1990 and 2004, will remain static or decline and will be between 85% and 100% of the 2004 VMT per capita, even through 2040.
- Between 2007 and 2040, non-freight VMT will grow at less than two-thirds the pre-2004 rate.





Finally, we make a series of recommendations for those involved in transportation policy setting and state, regional and local planning of infrastructure and transportation program investments, and for evaluating the impacts of travel on community well-being, economic productivity, air quality and other environmental issues.

RECOMMENDATIONS

Understand uncertainties, and forecast travel for scenarios or probable ranges of outcomes, not absolute values.

Discuss with clients and stakeholders the key underlying factors that influence VMT per capita, their recent trends and the plausible ranges of future trends.

Unless it's necessary to be ultra-conservative, forecast VMT growth at a rates lower than historic trends. Rather than continuing the upward trajectory exhibited from 1970 to 2004 (a 63% increase in VMT per capita), future VMT per capita will be flat or declining, with 2040 levels between 85% and 100% of the 2004 peak.

In regional, community and project planning, incorporate concepts attuned to demographic and economic shifts including balanced, multi-modal networks, mobility services, mobility management that reflect and accommodate stabilization of VMT per capita.

In travel behavior forecasts, include credible forecasts of driving age population, household formation, labor force participation, vehicle ownership, gasoline prices, relationship between time-use budgets and travel time growth, telecommuting, internet shopping, and delivery of goods and services.

Continue to research and narrow the range of uncertainty and strengthen the reasonableness of our forecasts. Suggested variables for statistical or structural equations modeling of factors correlated with annual VMT from 1950 to 2010 (a full list of suggested variables appears in Appendix A):

- The Economy
- Demographics
- Technology
- Urban form/built environment

Monitor changes in demographic and economic data and concurrent changes in VMT per capita to verify or adjust forecasting relationships.

INTRODUCTION

The impacts of the Great Recession reverberated through nearly every layer of the U.S. economy. As the gross domestic product (GDP) cycle shifted downward in 2008, so did vehicle miles traveled (VMT). How much of the VMT decline is due to the Great Recession? Understanding whether this trend is a temporary dip, a new baseline, or the start of a continuing downward trajectory for travel is of paramount importance to those planning future land use developments, transportation policies, infrastructure, and funding programs. Explaining the downward shift in VMT is not a simple task: travel behavior is an intricate, complex phenomenon affected by many forces. The economic downturn is not the only force behind automobile travel decisions: a number of other factors may be at play including socio-political factors, land use intensity, configuration, design, and transportation conditions.

This paper explores the reason for VMT decline by examining travel behavior trends of generational groups. In order to better understand the potential interrelationship between VMT and macroeconomic factors such as labor force participation, median household incomes, and GDP, we take a historical approach and examine VMT, mode shares, and macroeconomic cycles since 1970 and before. We also examine recent research on travel behavior trends of two key demographic groups, Millennials and Baby Boomers, seeking to determine if enough evidence is currently available to make reliable projections about their future travel behavior.

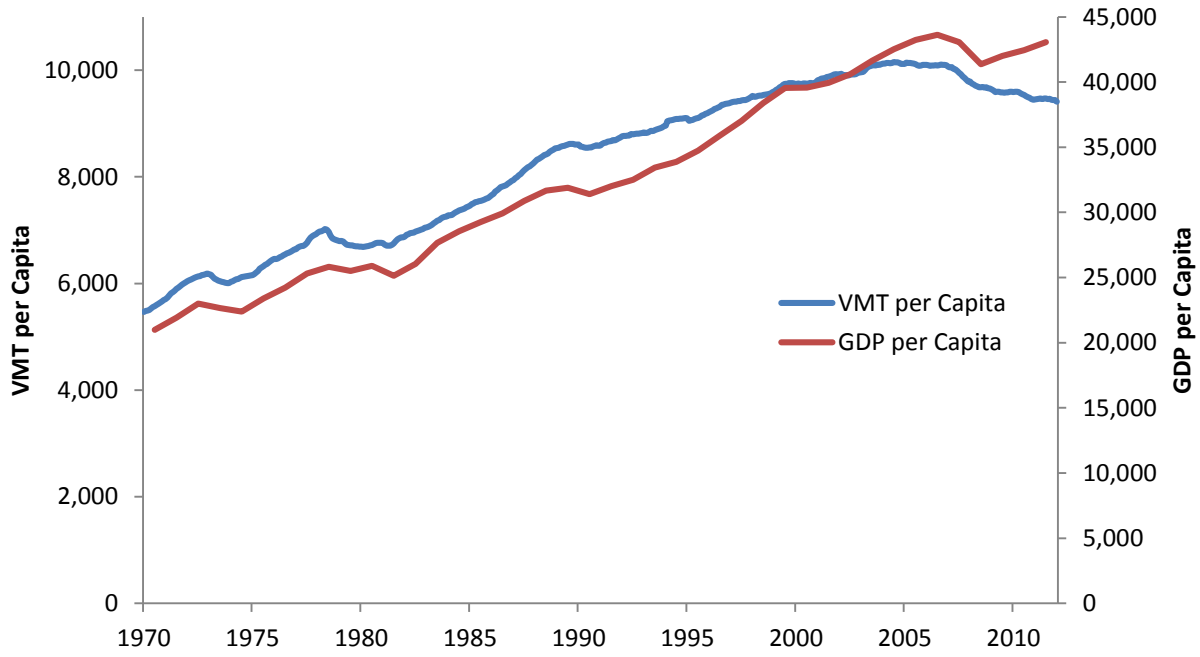
We begin with macroeconomic factors, including declining employment rates, changes in income and buying power, and housing location trends. Then we examine in depth trends in travel for the two largest generations, millennials and baby boomers, and we broadly consider key indicators for all segments of the driving-age population. Finally, we draw conclusions on the likely future of VMT, and we offer recommendations on how to consider these trends in our studies and advice to clients.

MACROECONOMIC FACTORS

Upon closer inspection, the economic decline may not fully explain VMT decline. Driving began to plateau in 2004, at least three years before the onset of the recession. After growing for over 50 years, it appears U.S. travel reached a turning point around the turn of the century.[2]

Meanwhile, GDP per capita continued to climb until the onset of the Great Recession in 2008. Although the macroeconomic decline reversed in 2010, VMT per capita has continued to decline (**Figure 1**).

Figure 1: VMT and GDP per Capita, 1970 – 2012



Source: Federal Highway Administration Office of Highway Policy Information; World Bank.

GDP per capita is a broad measure of the macro-economy's performance that captures the market value of goods and services produced per person. However, economic conditions experienced by the majority of traveling households do not always mirror the macroeconomic trend. Measures that more directly reflect the experience of travelers are employment rates and median household income and housing location trends, which more closely link economic conditions with automobile travel.

[2] Lynott, Jana and Figueiredo, Carlos. "*How the Travel Patterns of Older Adults Are Changing: Highlights from the 2009 National Household Travel Survey (Fact Sheet 218).*" American Association of Retired Persons (AARP) Policy Institute. Fact Sheet 218, April, 2011.

Employment and Travel

The rate of employment could affect VMT per capita from at least two perspectives: first, a higher rate of employment implies more commute trips to and from the workplace; second, a higher rate of employment can provide additional financial resources for leisure, consumption, and the purchase and maintenance of private automobiles. The number of registered vehicles per household has declined from its peak of 2.05 in 2006 to 1.95 in 2011, a decrease of nearly 5%.[3] Because the purchase of an automobile is a durable decision (the average age of a car in the U.S. is 11.4 years)[4] the effect of the currently suppressed employment rate could continue to contribute to VMT decline for a number of years.

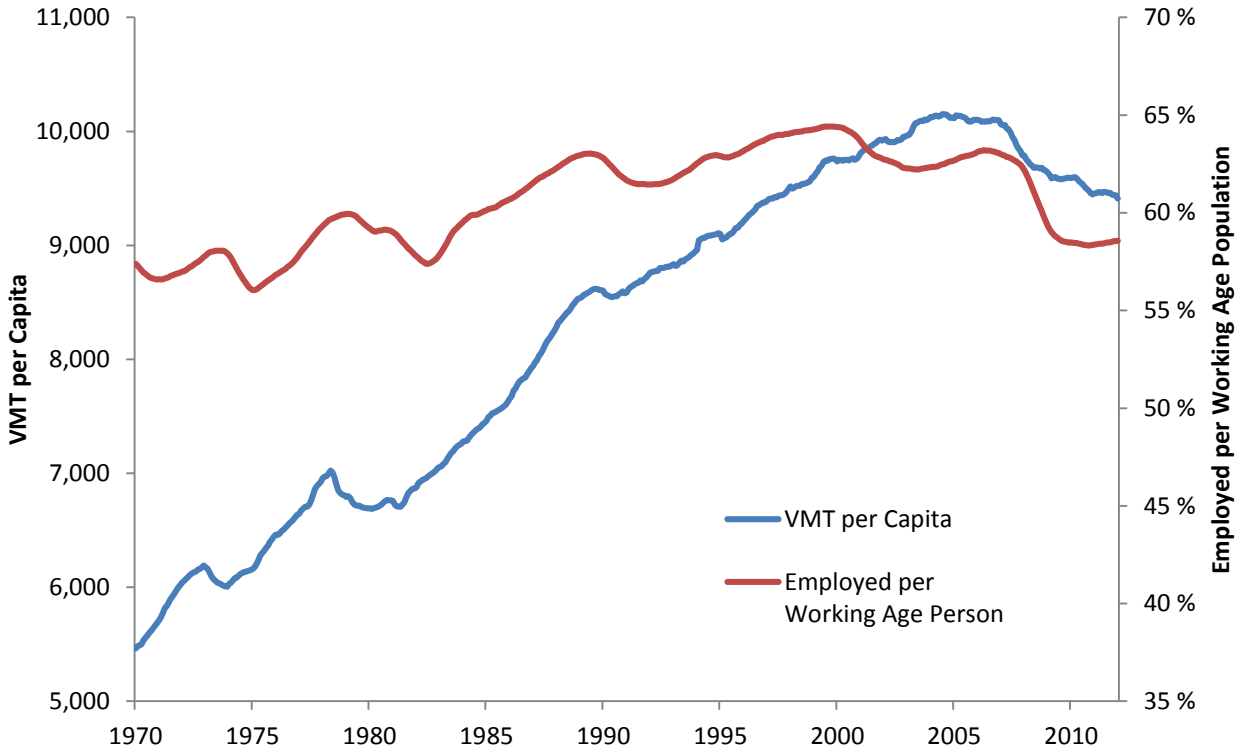
Declining Employment Rate

The employment rate is the percent of all working age people (those 16 years of age and older) who are employed. It includes in the denominator those who are either currently employed or looking for employment, as well as people who are of working age but not working for a variety of reasons including unemployment, retirement, or no desire to participate in the labor force. Thus, this is a more inclusive measure than the unemployment rate. The U.S. employment rate increased from about 57% in the early 1970s as Baby Boomers and higher numbers of women began entering the workforce. It reached a peak of almost 65% in 2000 with the dot-com boom. In 2000, predating both the onset of VMT decline in 2004 and the start of the Great Recession in 2008, the employment rate began to fall (**Figure 2**).By 2012 it had dropped more than 10% to 1970 levels.

[3] Cohn, D'Vera. "Data show a dent in Americans' love for cars." *Pew Research Center*. 1 July 2013. http://www.pewresearch.org/fact-tank/2013/07/01/data-show-a-dent-in-americans-love-for-cars/

[4] Hirsch, Jerry. "Average age of cars on U.S. roads hits record 11.4 years." *Los Angeles Times*. 6 August 2013. http://www.latimes.com/business/autos/la-fi-hy-polk-car-age-20130806,0,3174440.story#axzz2mRXwXkuc

Figure 2: VMT per Capita and Employment Rate, 1970 – 2012

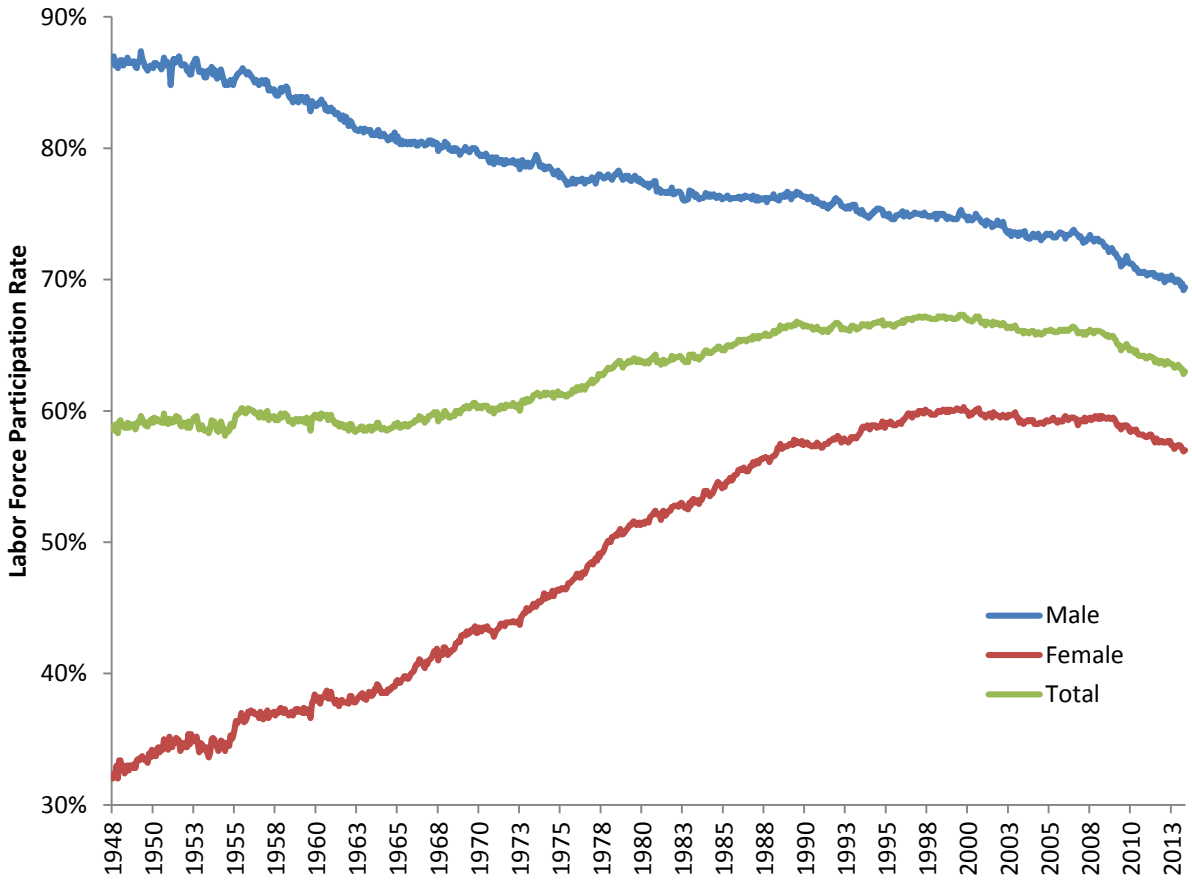


Source: Federal Highway Administration Office of Highway Policy Information; Bureau of Labor Statistics.

In 2006, Polzin suggested that the female labor force participation rate was stabilizing after decades of increases following World War II.[5] Indeed, it appears the female labor force participation rate plateaued between the late 1990s and the onset of the Great Recession in 2008, and has declined along with male participation since (**Figure 3**). Declining labor force participation could lead to a reduced need for commute- and work-related travel and reduce the amount of disposable income available for travel-related expenses, thereby dampening the growth in VMT per capita.

[5] Polzin, Steven E. "The Case for Moderate Growth in Vehicle Miles of Travel: A Critical Juncture in U.S. Travel Behavior Trends." *Center for Urban Transportation Research*, University of South Florida. April 2006.

Figure 3: Male, Female, and Total Labor Force Participation Rates, 1948 – 2013

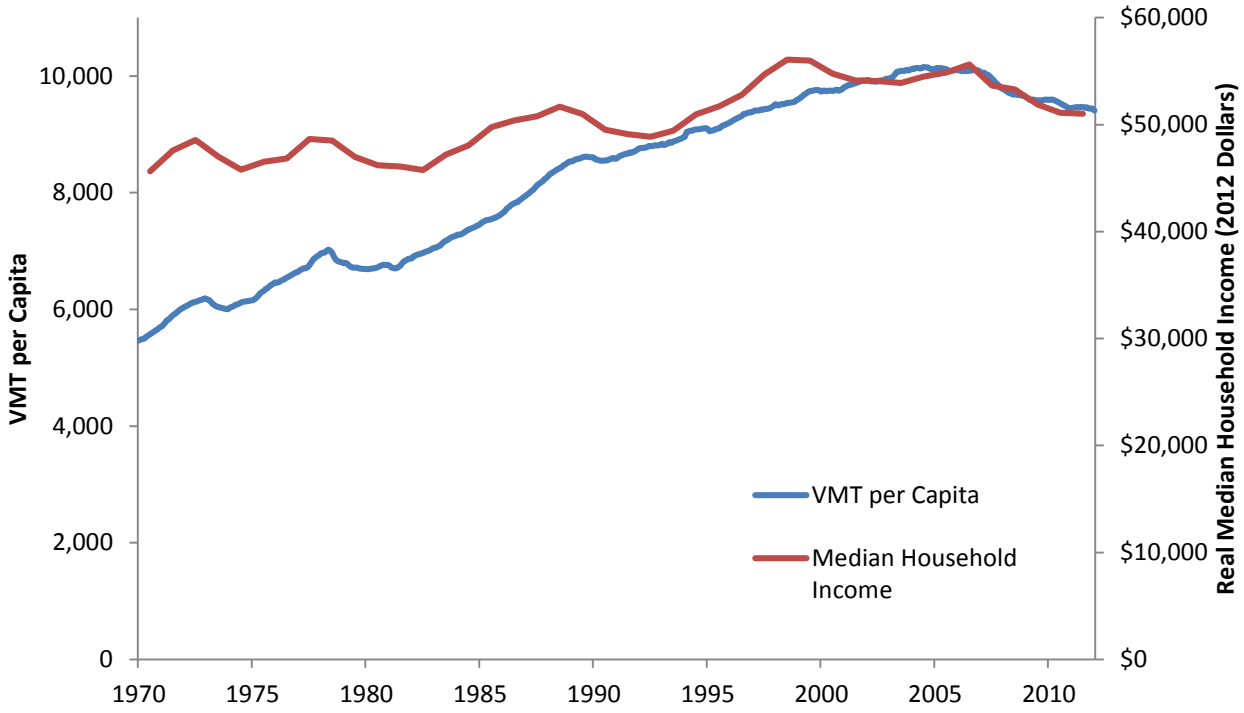


Source: Bureau of Labor Statistics.

Parallel Changes in Income and Buying Power

Incremental growth in median household income has been relatively stable over the last 40 years. Median income increased modestly from about $46,000 in 1970 to about $56,000 in 2000 (**Figure 4**). Beginning in 2000, median household incomes stagnated until the onset of the Great Recession, when they began to decline, dropping to $51,000 in 2012. Although GDP per capita began to recover in 2009, median household income has continued to decline. The stagnation in median household income predates the plateau in VMT per capita, though the subsequent decline in VMT per capita appears to track the decline in median household income. Similar to the effect of the declining employment rate, the decline in median household income tends to reduce VMT per capita, as households have less discretionary income available for travel and automobile purchase, maintenance, and operation.

Figure 4: VMT per Capita and Median Household Income, 1970 – 2012



Source: Highway Administration Office of Highway Policy Information; U.S. Census Bureau.

Housing Location Trends

Similar to median household income, though not at quite as stable of a rate, the home ownership rate rose from approximately 64% in 1970 to about 69% in 2005, followed by a subsequent decline to 66% in 2012.[6] Most of these homes were built in the suburbs rather than city centers, where there can be a dearth of access to transit or active transportation options, contributing to an increase in VMT per capita seen during this time period. The reasons for the majority of home growth being located in suburban, rather than urban, locations include access to cheaper land to develop and the building credit with which to do it, public subsidies of infrastructure and consumer preference. As they began raising families, Baby Boomers moved to the suburbs in pursuit of backyards and better schools. However, even prior to the 2008 recession, development in suburban or urban fringe areas began to slow, with three out of four large

[6] U.S. Census Bureau, 2013.

U.S. metropolitan regions experiencing an uptick in housing development in infill ("previously developed") areas[7] near city centers and inner ring suburbs where more transportation options traditionally exist.

Looking Forward

The relationships between VMT per capita, the employment rate, and median household income suggest that economic effects at the individual or household level are better indicators of vehicular travel decisions than the overall trend of the macro-economy. Although GDP per capita has already returned to an upward trend and will likely continue to rise, it is not clear that the rebound will translate to increasing VMT per capita.

A "jobless recovery" – in which the macro-economy experiences growth while maintaining or decreasing its level of employment or quality of employment (i.e., part-time workers who would prefer to work full time) – could suggest a new normal employment rate near 60% rather than a rebound to long-term highs near 65%. Conversely, if the male labor force participation rate returns to pre-recession levels and female labor force participation converges with the male rate, an overall 65% to 70% participation rate is possible over the next 20 to 30 years. This leads us to conclude that by 2040 the effects of labor force participation on VMT could range from 10% below to 10% above their peak levels to date.

Increases in median household income have not kept pace with increases in per-capita GDP since the late 1960s. In real terms, the value of median household income in 2012 was the same as it was 17 years earlier. A 2011 Wall Street Journal forecasting survey projects median household incomes will not recover to year 2000 levels until at least the year 2021.[8]

The limited upside potential for employment and labor force participation coupled with slow growth in median household incomes suggests a dampening effect on per-capita VMT growth. This dampening could be even more likely and more pronounced with a continued focus of new home construction in infill areas with multi-modal transportation options. Combined with the related decrease in average number of registered vehicles per household and an increase in the number of households with zero registered vehicles,[9] this trend could lead to an even deeper suppression of future VMT per capita.

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[7] Thomas, J. "Residential Construction Trends in America's Metropolitan Regions." U.S. Environmental Protection Agency. January 2009 and January 2010.

[8] Izzo, Phil. "Bleak News for Americans' Income." *The Wall Street Journal*. 14 October 2011. http://online.wsj.com/news/articles/SB10001424052970204774604576628981208827422

[9] "Commuting in America 2013: The National Report on Commuting Patterns and Trends." (September 2013) American Association of State Highway and Transportation Officials.

GENERATIONAL TRENDS

What are the current travel behaviors of generational groups in the U.S.? What choices will these groups make in the near future about transportation and housing? Baby Boomers are the generation born after World War II between the years 1946 and 1964. Generation X was born between 1965 and 1982. Millennials, also referred to as Generation Y, are the individuals born between 1983 and 2000.[10] Baby Boomers, currently between 49 and 67 years old, make up 26% of the population. By 2035, the U.S. population aged 65-84 will increase from 13% in 2015 to 18% (**Figure 5**).

The Millennials and Boomers are the two largest age cohorts alive today. They are also both directly affected by the economic downturn occurring at a pivotal time for their personal and professional life transitions. Millennials are transitioning into adulthood in a weak job market. Baby Boomers are transitioning into their senior years and some are experiencing trouble retiring due to the devaluation of the assets they worked to secure. Due to these challenges, it is likely Millennials and Baby Boomers will experience some of the most pronounced changes in lifestyle and travel behavior.

How Millennials Travel

Millennials are presently between 13 and 30 years of age and will be 45 to 62 by 2045, when they will make up over 25% of the total population (**Figure 5**). As Millennials transition into young adulthood, they have become objects of popular culture fascination, characterized in both negative and positive light by sociologists and commentators. Some researchers tout them as civic-minded, connected, and open to change,[11] while others see them as narcissistic, self-entitled "trophy children."[12] Millennials are highly-educated, with 40% in college, a historic high compared to previous generations. Of those currently in college, half would like to earn a graduate or professional degree upon graduating.

Millennials also stick out from the generational crowd because many of them were either entering the job market or trying to build their careers at the onset of the Great Recession. They have responded in various ways, ranging from moving in with parents to save on rent or continuing their education rather than face a weak job market. They also cut back spending more drastically than older people, including Baby Boomers, due to the recession. In addition, a higher share of Millennials experienced losing a job or

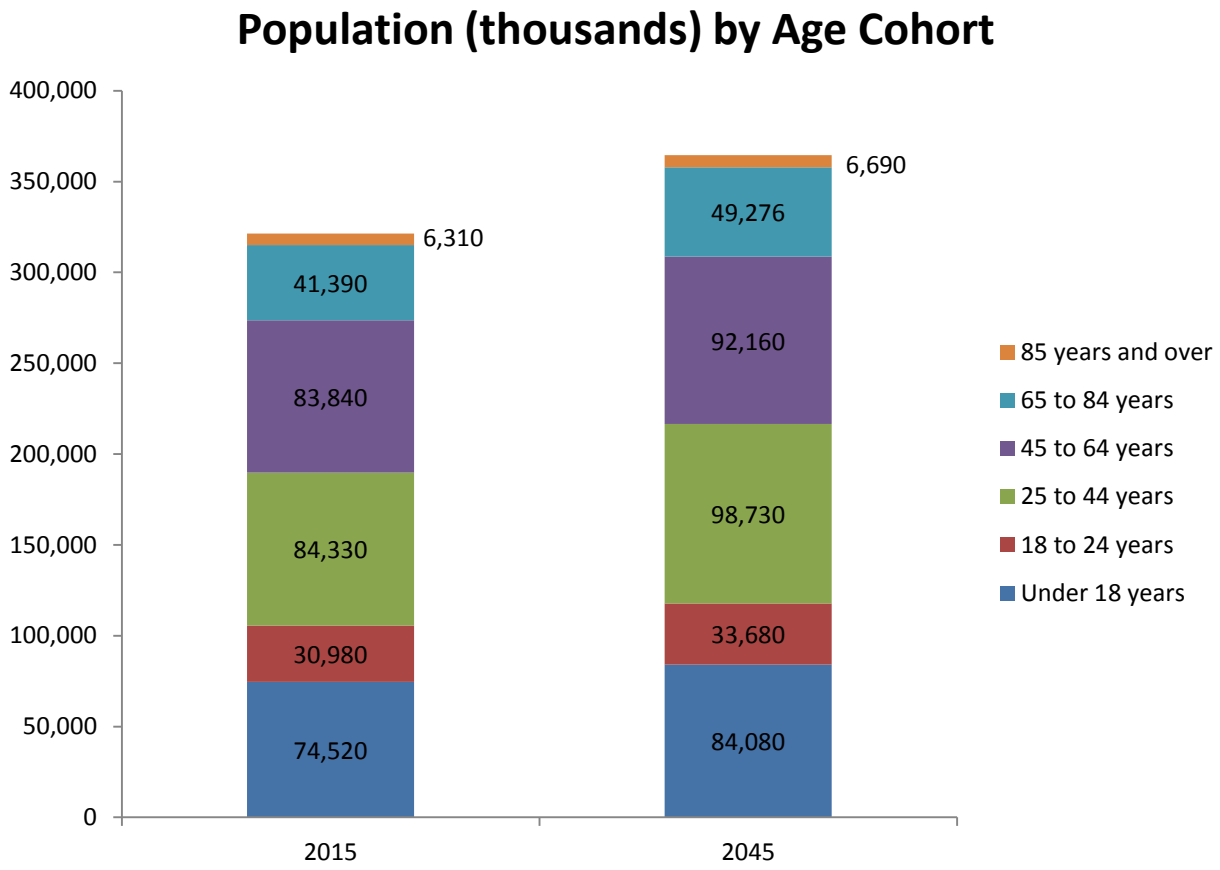
[10] PIRG, 2013, p. 20

[11] "Millennials: A Portrait of a Generation." (2013) Pew Research Center. http://www.pewresearch.org/millennials/

[12] Twenge, Jean M. "*Generation Me: Why Today's Young Americans Are More Confident, Assertive, Entitled--and More Miserable Than Ever Before*." (2007) Simon and Schuster, New York, NY.

lived with someone who lost a job than any other generational group.[13] Because of these factors, they may be forming perspectives and lifestyle choices that differ significantly from the prior two generations.

Figure 5: Population (In Thousands) by Age Cohort, Years 2015 And 2045



Source: U.S. Census Bureau, 2013.

Traveling Fewer Miles, but Tending to Commute Alone

In contrast to the travel behaviors of adults, our knowledge of youth travel behavior is limited and uneven. Most research focuses on rates of car crashes and driving fatalities among teens, with less attention paid to the rates of travel. A recent study conducted by University of California at Los Angeles sheds light on the travel behavior of Millennials, demonstrating that economic factors have a strong influence on their travel decisions. Drawing from the Nationwide Personal Transportation Survey in 1990 and the National

[13] "Gen Next Squeezed By Recession, But Most See Better Times Ahead." Pew Research Center. 5 June 2009. http://www.pewresearch.org/2009/06/05/gen-next-squeezed-by-recession-but-most-see-better-times-ahead/

Household Travel Surveys (2001 and 2009) Blumenberg et al. researched the influence of four main factors on travel behavior of youth:

- Rapid proliferation and adoption of new communication technologies
- Stricter teen licensing requirements in place in all 50 states
- High unemployment following the Great Recession
- Propensity to live with parents post-college due to inability to find work

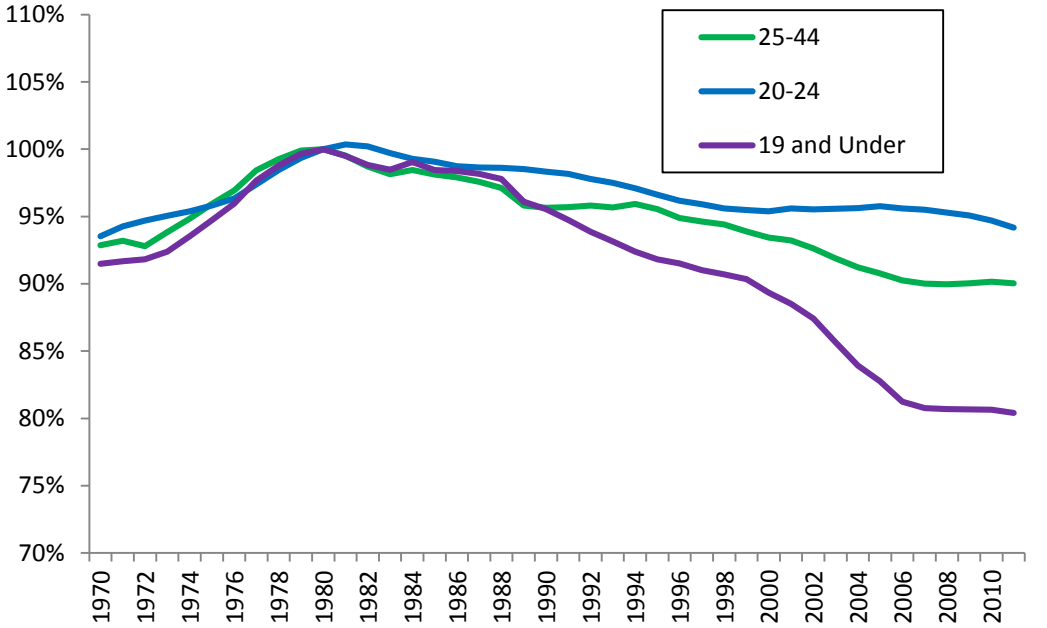
Blumenberg, et al. used these data to analyze how the travel behavior of Millennials compares with that of middle-aged adults (Generation X), whether the basic determinants of youth travel behavior are changing, and whether we see evidence that today's youth are likely to travel differently than adults of earlier generations. Overall, they found younger generations: a) travel fewer miles and b) make fewer trips than was the case for previous generations at the same stage in their lives. Surprisingly, their models show that, of those who do work, Millennial commuters appear to drive alone more frequently than similarly aged workers from previous generations. Economic factors, including employment status and household income, strongly influence the travel behaviors of Millennials, more so than the travel of older adult generations. Compared to the consistently strong travel behavior effects of the economy, related factors such as young adults living with their parents, the rapid spread of information and communications technologies use, stricter teen driver licensing requirements have had far milder and more mixed effects on VMT. Blumenberg et al. caution that their findings are only suggestive given the small sample sizes for some population groups studied and the lack of true cohort data from the same individuals over time.[14]

Millennials Are Less Interested in Car and House Ownership than Generation X

In 2010, adults between the ages of 21 and 34 bought just 27% of all new vehicles sold in America, down from the peak of 38% in 1985. Licensure rates are also down among the younger age cohorts. Since the peak of licensure among younger cohorts in 1979, licensure rates have declined 5% among those 20 to 24 years of age, 10% among those 25 to 44 years of age, and nearly 20% among those 19 and younger (Figure 6). Although the most precipitous decline in licensure among the youngest cohort occurred between 2002 and 2007, coinciding with the introduction of stricter teen licensing requirements, the downward trend long predates both the introduction of stricter requirements and the Great Recession.

[14] Blumenberg, E., Taylor B., Ralph K., Wander M., Brumbaugh S. "*What's Youth Got to Do with It? Exploring the Travel Behavior of Teens and Young Adults*." (2013) University of California Transportation Center.

Figure 6: Index of Driver Licensure Rates by Age Cohort (Base Year = 1979). 1970–2010



*Note: Licensure rates are the number of licensed drivers per capita, averaged over the preceding five years. The index pegs th in 1979 to 100% and reports percentage changes. For example, if the licensure rate for a cohort were 60% in 1979 and the 2002 value of the index would be 110%.

Source: U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics*.

Where Millennials Prefer to Live… and Play

According to a Federal Reserve Study, the share of young people getting their first mortgage between 2009 and 2011 is half of what it was 10 years ago. Nine out of ten Millennials say they eventually want a place they own, according to a recent Fannie Mae survey. However, their path to ownership may be impacted by financial challenges such as rising student debt, low wages, low savings, and tighter lending standards from banks.[15]

Although not all Millennials have left the nest, either by virtue of their age or weak job market, those who have moved show a preference for medium or big cities, where land use and social scenes tend to be more dynamic with a mixture of activities and socioeconomic groups. In a recent Urban Land Institute survey[16] on how they perceive themselves, Millennials reported that:

[15] Thompson, D, Weissmann, J. "The Cheapest Generation." *The Atlantic*. 22 August 2012. http://www.theatlantic.com/magazine/archive/2012/09/the-cheapest-generation/309060/

[16] Lachmann, M. Leanne, Brett, Deborah L. "*Generation Y: Shopping and Entertainment in the Digital Age*." Urban Land Institute, 2013.

- 39% were self-identifying as "city" people
- 29% were self-identified "suburbanites"

Sixty-one percent already live in dense older suburbs, city neighborhoods or city downtowns.

Another recent nationwide survey[17] indicates that Millennials also show a strong preference (55%) for public transit, a hallmark of city living. This preference for the urban experience along with the similar preferences among the youngest of the Generation X is creating pressure on some developers to provide more urban housing stock (rental or owned) and for cities to zone appropriately to serve this demand. It is an open question whether Millennials will continue to display similar preferences in the future or if, similar to previous generations, with the onset of marriage and families the suburbs and its accompanying backyards and access to school options will beckon. Regardless, the creation of new housing stock in city centers and accompanying urban areas will play a role in how a large segment of the population choose to travel and the resultant effect that may have on VMT per capita. In fact, a recent Urban Land Institute report[18] posited that "the growth of 'Millenials' and its impact on all sectors of commercial real estate could be the singular most dominant trend for many years." Commercial real estate encompasses everything from "rental housing to collaborative office space to close-in warehousing to ensure same-day delivery from online retailers."

Looking Forward

Much discussion has been circulating about the effect of the sharing economy on the behaviors of Millennials. The sharing economy is generally comprised of goods and services that use connected applications to allow companies and families share otherwise idle goods, such as cars and housing. Zipcar, RelayRides, and Lyft are all examples of car sharing companies with applications that can be accessed through a variety of devices. Airbnb maintains a shared market place for bedrooms and other accommodations for travelers. Some posit that the proliferation of connected applications coupled with the sharing economy diminishes the need for face-to-face interactions to maintain social relationships. This in turn, results in a decreased demand for travel for social reasons. Speculation on the impact of the sharing economy on travel abounds in the media, but there is little research on the topic. We are interested in tracking this issue and its impacts on the travel behavior of Millennials as more data becomes available across multiple years.

Research such as the recent UCLA study described above demonstrates a growing interest in how Millennials travel now and how they might travel in the future. However, even such rigorous analyses

[17] "*America in 2013: A ULI Survey of Views on Housing, Transportation, and Community*." Urban Land Institute, 2013.

[18] "*Emerging Trends in Real Estate 2014.*" Urban Land Institute, 2013.

suffer from the limited time span of data on youth behavior in the unusual circumstances during which many Millennials came of age. For perspective, one might also observe that economic disruptions occurred in the recent past as well, including recessions in the 1970s, 1980s, 1990s and turn of the millennium as well as a decades-long trend in off-shoring manufacturing jobs. As the economy recovers, will Millennials contribute to substantial increases in VMT as Boomers and Gen Xers did in past recoveries? Given the major impact of the economy on Millennial travel today, it is reasonable to consider whether travel behavior of Millennials moving forward will closely track the economic vitality of the U.S. job market.

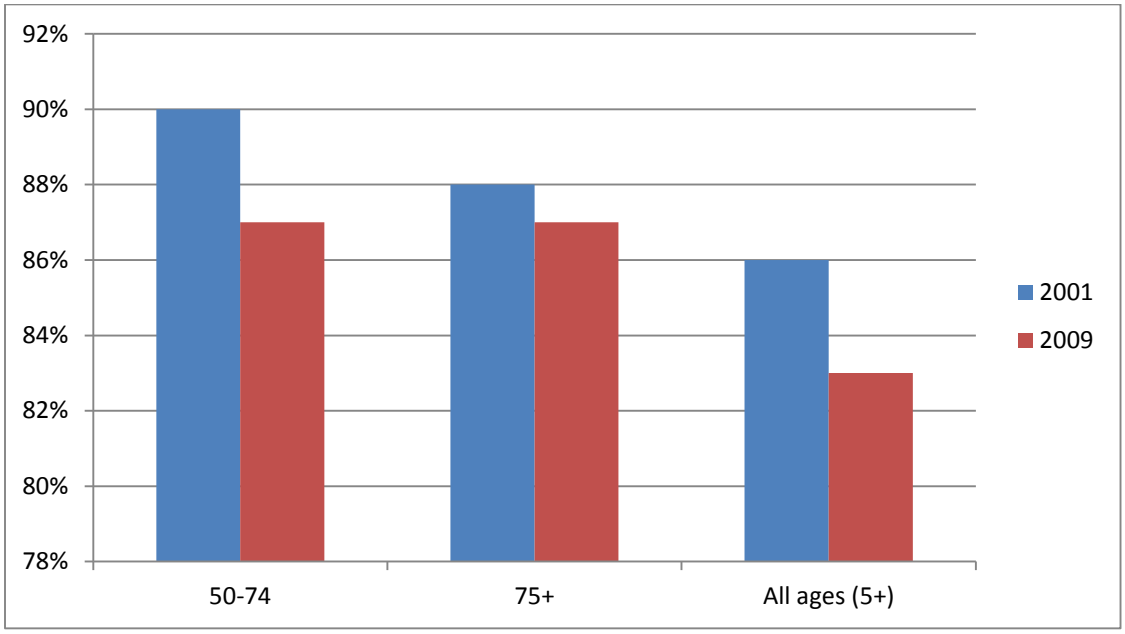
HOW BABY BOOMERS TRAVEL

How do Baby Boomers and persons aged 75 and older travel? Examining the travel habits of Baby Boomers shows us their preferences now — which may change in the future depending on health, financial, and housing location factors — so we also looked at how the mobility habits of the generation just beyond Baby Boomers can potentially provide insight into how Baby Boomers will travel when they reach their older years.

Travel by seniors was heavily auto-oriented in 2001, but recent NHTS data shows auto use is declining slightly. Per capita vehicle miles traveled for persons 65+ declined by 7%, compared to 11% for people of all ages. Gas prices play at least some role in this trend. In a separate survey by the American Association of Retired Persons (AARP) in July 2008, two-thirds of adults age 50 and older reported limiting their daily driving to accommodate higher gas prices, possibly due to living on fixed incomes.

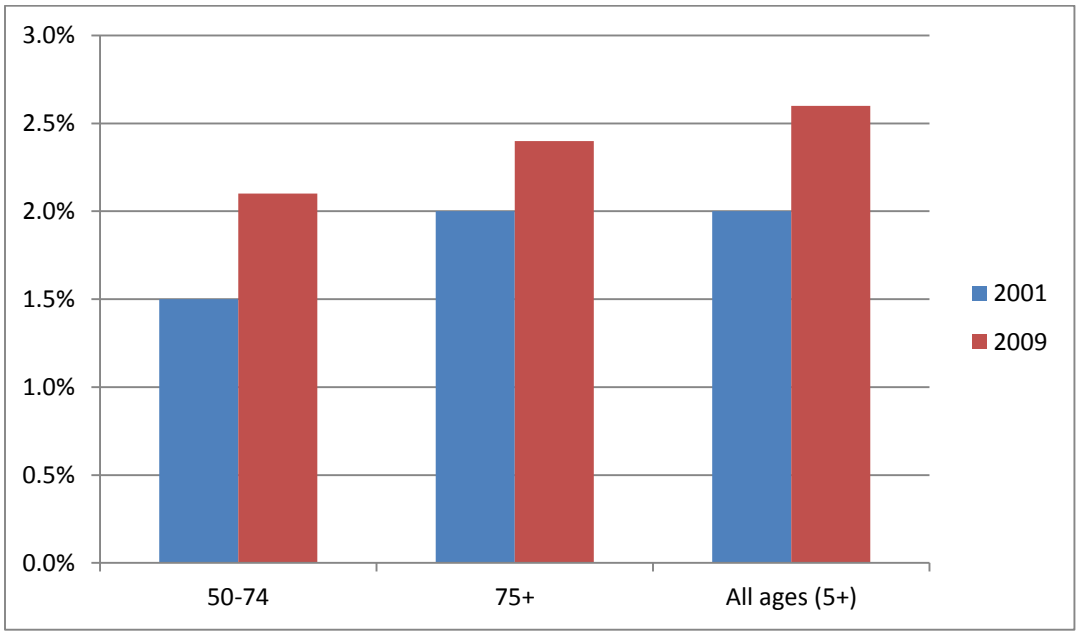
However, VMT does not explain the full picture. Mode choice trends since the early 2000s show that while older adults retained their preference for automobile travel, they chose public transportation for an increasing share of trips. **Figure 7** depicts share of trips by private vehicles in 2001 as compared with 2009. Baby Boomers in the 50-74 age category demonstrated higher auto-use than seniors aged 75 and older. In both generation groups, car mode share declined between 2001 and 2009, and did so more dramatically for Boomers, bringing the two groups into alignment with one another at about 87% auto share. In 2009, the driving rate of all those over age 50 was four percentage points higher than the rate for the population as a whole.

Figure 7: Share of Trips in Private Vehicles by Age, 2001–2009



Source: NHTS, 2009.

Figure 8: Share of Trips on Public Transportation by Age, 2001–2009



Source: NHTS, 2009.

Figure 8 depicts the share of trips made by public transportation by age group. Across all age groups, transit rose about 30% between 2001 and 2009 (from 2.0% to 2.6%). Among Baby Boomers we see an increase of about 40% (from 1.5% to 2.1%). Among persons aged 75 and older, public transit use also increased, although public transit remained the third most common means of transportation among older people. In both 2001 and 2009, the share of trips by walking ranked second after travel by car. Adults aged 50 and older now take about 9% of their trips on foot. These mode choice patterns signal that automobile travel will continue to be popular among aging adults who can drive, but some seniors may also want to live in walkable neighborhoods to get exercise, run errands, or make leisure trips. Transit use is rising and could make greater gains in the coming decades as Baby Boomers age.

Researchers expect Baby Boomers to be more active and mobile than the present senior population, just as the present senior population is more mobile than the generation before them. The big question is what will happen to them when they lose their ability or desire to drive? A growing body of literature is emerging on the travel and mobility needs of older people in the future. Because of the likely diversity of their desires and needs, planners and providers are recognizing the importance of offering a wide range of high-quality mobility services to seniors in the near future.

Baby Boomers Are Remaining in the Workforce Longer

As Baby Boomers have moved past their peak child-rearing years, their driving habits are changing. Driving is an activity that is dependent upon one's stage in life. People in their prime earning and child-rearing years tend to drive the most for commuting purposes, shopping for the household, and shuttling children to and from activities. In contrast, younger people and older people are less likely to drive as often. Many hold the belief that Baby Boomers have moved past their prime working years. Recent surveys of Baby Boomers show their definition of retirement may differ from their parents' definition. A recent survey conducted by the NORC Center for Public Affairs Research of adults ages 50 and over nationwide documents the attitudes and plans of Baby Boomers.[19]

The trend of older people choosing to continue working as they age has been growing since the late 1990s and they now represent the fastest-growing segment in the workforce. By 2020, an estimated 25% of workers will be 55 or older, an increase from 19% in 2010. This trend is gender neutral; both women and men are working longer. This is due at least in part to people generally becoming healthier and the duration of healthy age increasing as life span increases and illnesses occurring for shorter periods of time later in life. Baby Boomers are expecting to live healthier for longer, and in turn are choosing to remain in the workforce longer and defer tapping into their savings. As Baby Boomers' labor force participation

[19] Benz, Jennifer, et al. "Working Longer: Older Americans' Attitudes on Work and Retirement." NORC Center for Public Affairs Research. October, 2013.

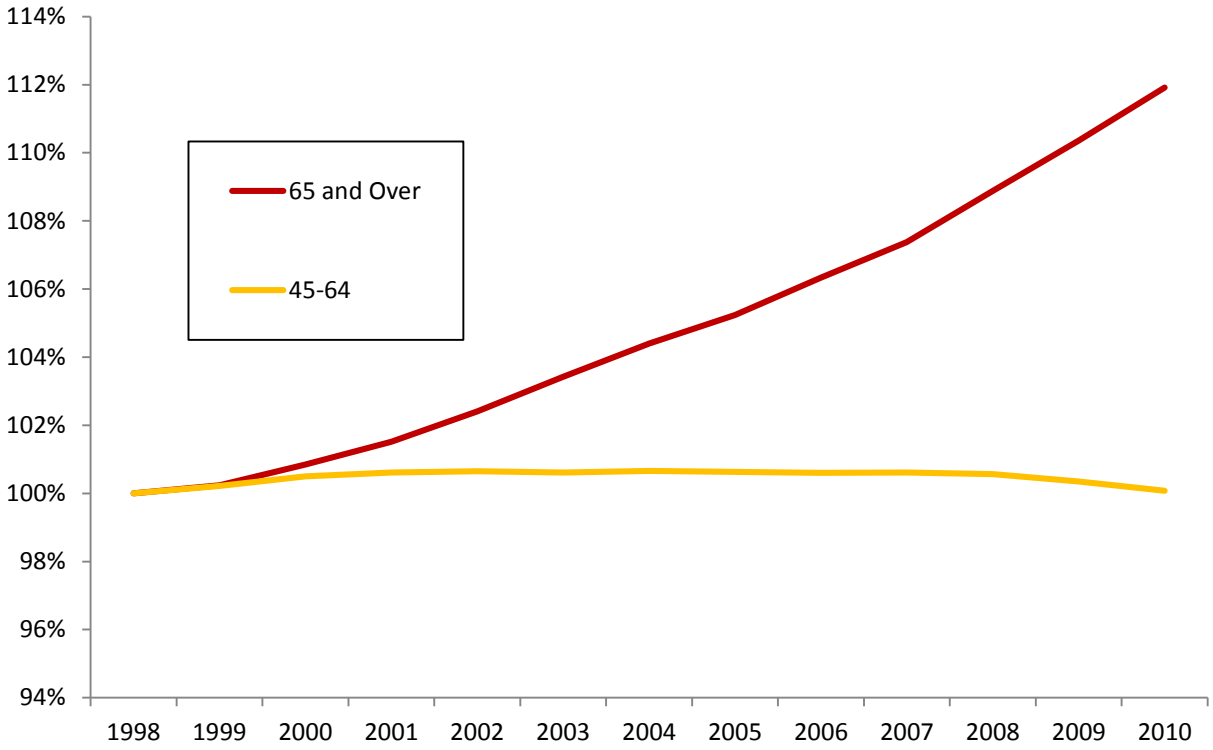
becomes less reliant on automobiles and more on mobility services, VMT within this generational group may also decline.

Many Baby Boomers intend to retire later than the previous generation and upon retirement some plan on working part-time or from home to earn supplemental income to slow the rate of savings spending. Among Baby Boomers who are working and not yet retired, 47% reported it is very likely they will do some work for pay during their retirement and 35% said this scenario was somewhat likely. There has been a marked shift in average retirement age since the Great Recession. Among those who report retiring before the Great Recession, the retirement average age was 57, while the average for those who retired afterwards is 62.

Licensure Rates among Those 65 and Older Are Increasing

Since 1998, licensure rates among Baby Boomers (roughly captured by the 45 to 64 age cohort) have been stable, but licensure rates among those 65 and older have increased nearly 12%, representing a shift in behavior by the Baby Boomers, who are now entering the 65 and over cohort, from the generation that precedes them.

Figure 9: Index of Driver Licensure Rates by Age Cohort (Base Year = 1998), 1998–2010



*Note: Licensure rates for the 65 and Over cohort were not available prior to 1998. Licensure rates are the number of licensed drivers per capita, averaged over the preceding five years. The index pegs the licensure rate in 1998 to 100% and reports percentage changes. For example, if the licensure rate for a cohort were 60% in 1998 and 66% in 2002, the 2002 value of the index would be 110%.

Source: U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics*.
Executive Office of the President Council of Economic Advisers, *Economic Report of the President*, 2012.

Where Baby Boomers Would Prefer To Live

Baby Boomers have by and large opted for the suburban experience for themselves and their families, and 73% of respondents of a recent survey of adults ages 45 and older conducted by AARP said they would like to live in their current residence for as long as possible as they age.[20] This "Age in Place" preference further increases with age. Whether it is master-planned communities in the American sun belt or more traditional suburbs, 90% of adults aged 65 and older would prefer to stay in their home as long as possible.[21] A preference for the suburbs is not necessarily to say Baby Boomers don't value public transportation options, as greater than 50% of them affirmed they do in a recent survey.[22] Aging in place

[20] Keenan, Teresa. "Home and Community Preferences of the 45+ Population." AARP. November 2010.

[21] "Aging in Place: A State Survey of Livability Policies and Practices."

[22] "*America in 2013: A ULI Survey of Views on Housing, Transportation, and Community*." Urban Land Institute, 2013.

requires a combination of good design in the home and connections to good social, health and transportation services.[23]

In general, researchers tend to agree that planners will face real challenges in meeting the mobility needs of at least some seniors in the future and that the interrelation of housing location and mobility choices will play a big role.

Aging in Suburbia

Some research on the future of Baby Boomers contends if suburban growth and automobile dependence continue, a mobility divide will emerge for Baby Boomers, characterized by mobility for those who can drive along with unprecedented isolation and dependency for those who cannot drive (Rosenbloom, 2012).

However, some suburban communities are determined to prove otherwise. One such community is the township of North Hempstead, New York. Located about 25 miles east of Manhattan, North Hempstead is very suburban. It boasts a population of about 225,000 (living mainly in single-family homes) and offers only a few public transit routes. In 2008, town leadership realized their population was mainly made up of seniors, with some census tracts comprised of 40 percent seniors. In response, the town applied for and received a NORC (Naturally Occurring Retirement Community) grant, administered by the U.S. Administration of Aging.

What has resulted is a town-wide program called Project Independence. Project Independence connects seniors to transportation, mobility management counseling (centered on alternatives to driving), fitness classes, social events, and Help at Home programs. The entire program pivots off of one main resource: a 311 call-in system. A senior or caregiver calls this line to connect to any service, such as a ride, a social worker or nurse, or a class. If a senior calls for a ride, a taxi is arranged in 24 hours. Also, within 24 hours of every call to 311, an operator calls back to check that a senior's needs have been met, even if a private group met the need.

Instead of the town government trying to provide all services to seniors, they act as the clearinghouse that connects seniors to the existing suite of private and public providers. The program is affordable for the government. In 2012, total program expenses totaled $1.8 million, less than five percent of the city's total budget. This is because few new services were provided and much of the programs are paid for by other groups, such as United Way (Davis, 2013).

[23] Davis, Lisa S. (2013) "Aging in Place Suburban Style." *Planning*, 79 (6), 24 -28.

IMPLICATIONS ACROSS THE GENERATIONS

The individual trends affecting Millennials and Boomers are foundational to recent and future changes in VMT generation. Completing the picture across all generations (Boomers, Gen Xers, Millennials, Post-Millennials), several studies have predicted the combined effects of demographic trends and the influences of economic and workplace conditions, advances in technology, and generational lifestyle preferences. They suggest the following implications:

- The economy is having a substantial impact, especially for Millennials. In the words of political strategist James Carville, "It's the economy."[24]
- Millennials are favoring low-travel urban lifestyles with emphasis on walking, cycling, ride-sharing and transit, but many still prefer driving.
- Other common explanations for VMT decline – such as the effects of technology, urbanization and modal shifts for other generations – have modest effects.
- Key reasons behind the late-20th century VMT growth, such as escalating labor-force participation, may have reached saturation and diminishing returns.

It's the Economy, Especially for Millennials

A Brookings Institution study[25] finds that while VMT leveling first began to appear in 2004, the statistical correlation between GDP and VMT correlation from 2000-2006 was identical to the overall correlation from 1956 to 2012. However, coinciding with the Great Recession, post 2007 the correlation is non-existent:

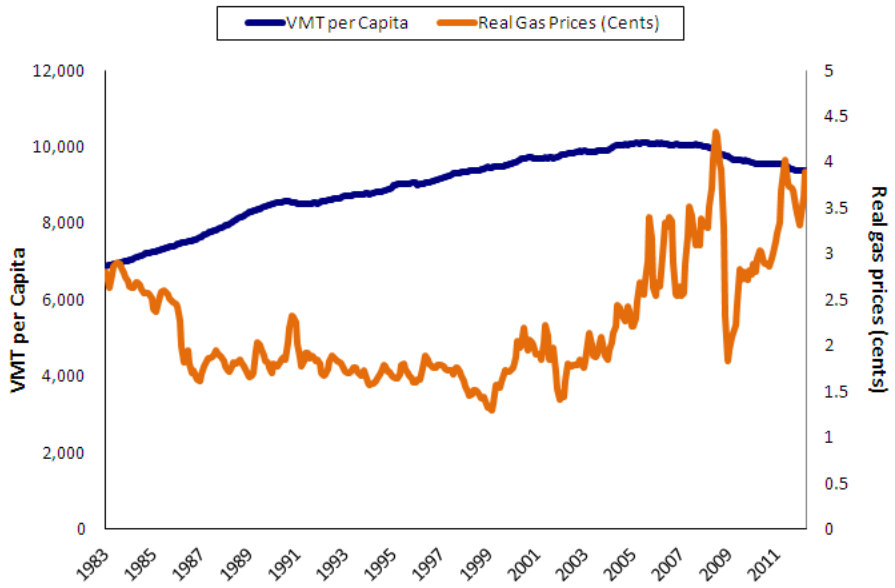
> *"While there are clearly major changes in American driving habits in recent years, the precise reasons for these changes remain elusive. A confluence of factors has introduced tremendous volatility into the transportation program."*

The study notes that VMT leveling in the early 2000s coincided with the sharp and bumpy rise in fuel prices, as shown below.

[24] "It's the economy" is a slight variation of a phrase James Carville coined as a campaign strategist on Bill Clinton's 1992 presidential campaign.

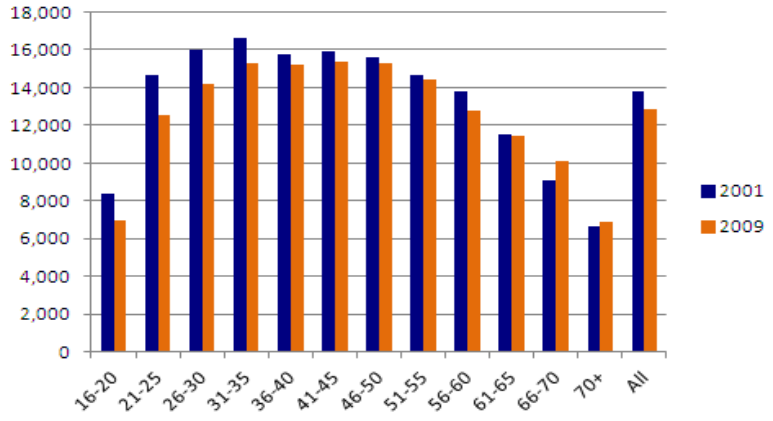
[25] Puentes, Robert. "Have Americans Hit Peak Travel? -- A Discussion of the Changes in US Driving Habit," The Brookings Institution, 2012.

US Vehicle Miles Traveled per Capita, Annualized and Real Gasoline Pump Prices, January 1991–March 2012



However, they also note the effects were not evenly distributed across the generations, with Millennial driving impacted to a far greater degree than those over 35.

Annual Vehicle Miles Traveled/Driver by Age Group, 2001 and 2009



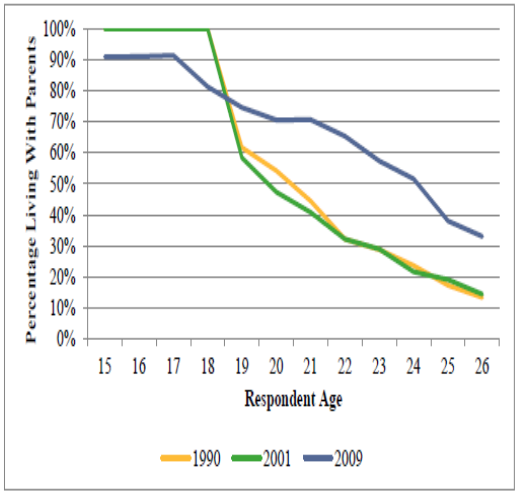
They conclude with the point that understanding how the trends will affect travel demand is critical to assessing both the needs for infrastructure by mode and future transportation revenue, especially from sources such as gas tax and VMT tax. As the Brookings study says, "… whether due to a momentary blip or long-term structural changes, policymakers are finding it difficult to react, perhaps because they do not

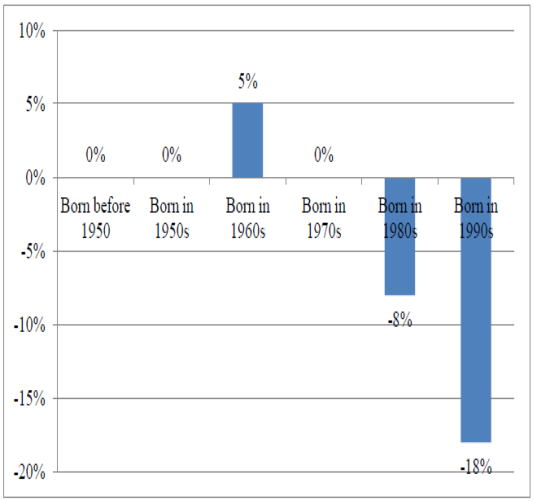
exactly know or understand the cause. Nevertheless there are direct implications, particularly with respect to how billions of dollars in public funding is spent." These implications extend to the question of what types of infrastructure we should continue to build given questions about affordability and environmental consequences.

The UCLA study cited previously[26] revealed from national household and personal transportation surveys in 1990, 2001, and 2009 that the effects on youth driving related to the economy were stronger than the effects of technology use and demographics in general. Their conclusions are that "the effects of young adults 'boomeranging' to live at home with parents, the explosion of information and communications technologies, and stricter driver's licensing requirements for teens" are far milder, and mixed:

- While more young adults appear to be living at home than in years past, the effects on travel behavior are ambiguous at best.
- Connected applications and the sharing economy were both mild and tended to be associated with increases in travel; information and communications technologies appear to be as a complement to travel and not a substitute for it.
- With stricter teen licensing requirements over the past two decades, Millennials are obtaining their licenses in their late teens and early twenties, but the effects of licensing on overall teen mobility are muted. Sixteen- and 17-year-olds are driving less, but they appear to be (eventually) getting driver's licenses and moving about as much as earlier generations of adults.
- Demographic travel distinctions such as race/ethnicity are still observed among adults, but are fading among youth.
- Evidence of generational shifts in travel behavior is mixed, with younger generations traveling fewer miles and making fewer trips than previous generations at the same stage in their lives, but younger commuters appear to drive alone to work more frequently than similarly aged workers from earlier generations (possibly due to a surge in auto availability and greater likelihood of boomerang youth living in suburbia?).

[26] Evelyn Blumenberg, et. al."*What's Youth Got to Do with It? Exploring the Travel Behavior of Teens and Young Adults,*" UCLA University of California Transportation Center, 2012.





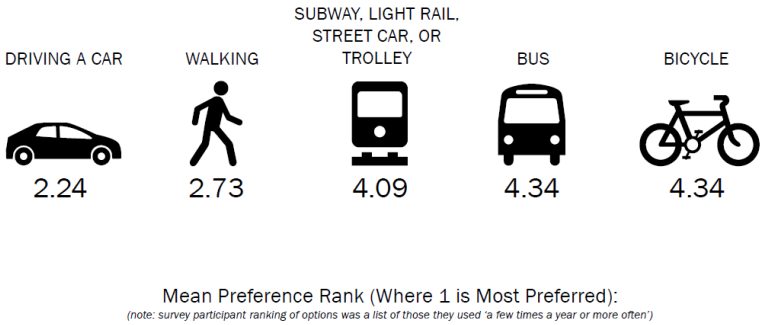
The researchers caution that due to data limitations their findings are suggestive rather than definitive.

Millennials Self-Select for Modal Options, but Still Prefer Driving

An APTA-sponsored TCRP study[27] on Millennial lifestyles and preferences found that:

- Millennials are attracted to communities with a full array of transportation mode choices including quality transit, bicycling, and walking environments
- The lower cost of transit and avoiding the burden of car ownership were key considerations to almost half of those surveyed in Millennial "hot spots:" Boston, Chicago, Portland, San Francisco, Seattle, and Washington D.C. Almost as many cited the fact that riding transit offers benefits for productive time use and digital socializing

However, the study also found that driving was the preferred mode of travel and almost two-thirds of those who don't own a car plan to buy one in one to two years.



[27] American Public Transit Association. "Millennials and Mobility – Understanding the Millennial Mindset," TCRP Project J-11.

Other Common Explanations Are Largely Mistaken, but Not Entirely

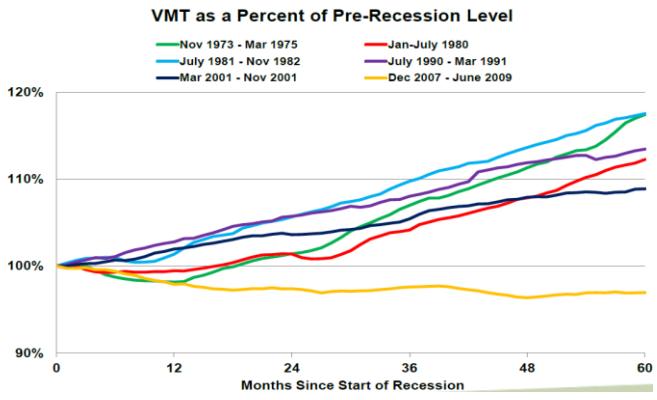
Volpe Center[28] research debunks some of the conventional wisdom on the reasons for VMT decline:

- Transit use accounts for only about 1% of the VMT decline, and bicycling and walking accounts for only a few percentage points of the decline
- Internet shopping accounts for only about 10% of all purchases, and 80% of Internet purchases generated VMT increases by delivery vehicles
- Telecommuting effects are still small, with only 4.3% of employees working from home in 2010 compared with 3.5% in 1970
- Resurgence in urban living is concentrated among higher-income young adults without children, plus a few of the affluent retired, while the jobs and residence locations for the rest of the population continues to disperse
- It is still not clear whether trip sharing, car sharing and short-term rentals substitute for car ownership or supplement it

They observe that key uncertainties remain, including the extent of continued employment and auto use among older Americans, particularly women; and the degree to which the continuing suburbanization of jobs and its effects on household locations and driving will respond to continuing increases in car ownership costs and fuel prices.

However, the study finds several key underlying trends, including a core reduction in youth driving and differences among generations that are amplified by the recession:

- Prior recessions (1975, 1980, 1982, 1990, 2001) saw VMT recovery, like jobs recovery, much sooner than the 2007 "Great Recession." Within 60 months of the start of earlier recessions, VMT had grown to between 9% and 18% above pre-recession levels, while Great Recession VMT is still several percentage points below 2007 levels.



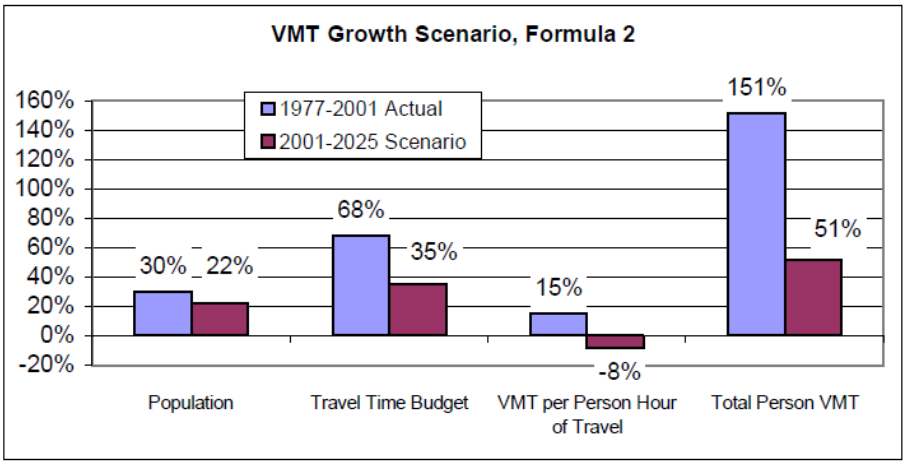
[28] Volpe National Transportation Systems Center. "Driven to Extremes -- Has Growth in Automobile Use Ended?" FHWA Office of Highway Policy Information, May 2013.

- Labor force participation has dropped dramatically since the early 2000s, particularly among young adults. Across the generations, those who are employed drive almost twice as many miles as those not employed
- Many young adults also carry significant student loan debt, making purchase of homes and cars difficult
- Driving among 16-19 year-olds began to decline in 1990, at least in part due to graduated licensing, and never recovered; and driving declines among older groups (even 20-34 year-olds) didn't begin to decline until after year 2000
- Household income boosted car ownership and use through the 1970s and 1980s, but many households have reached "saturation"
- Costs of owning and maintaining a car rose rapidly during the 1980s and 1990s; gas prices have risen significantly since 2005

Their conclusion: when the economy recovers, the pace of driving growth per capita will continue to slow, as before the recession. Most future growth in driving will result from population increases, rather than from increased driving per person.

Key Growth Drivers Have Reached Saturation

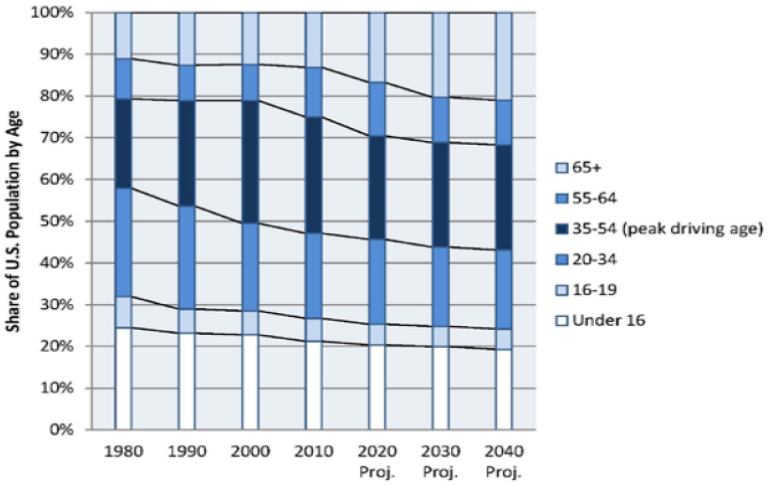
A 2006 study for USDOT[29] concluded that growth in VMT per capita would decelerate due to structural factors such as household formation and travel time budgets unrelated to the recession. They anticipate the rapid growth in labor force participation (especially among women), smaller family size, income growth, auto availability, and drivers licensing restrictions as well as travel time budgets have reached their limits and will slow VMT growth to about one-third the level experienced during the preceding generation.



[29] Polzen, Steven. "The Case for Moderate Growth in Vehicle Miles of Travel: A Critical Juncture in U.S. Travel Behavior Trends." Center for Urban Transportation Research, University of South Florida for US DOT, 2006.

Putting It Together, Factor by Factor and Generation by Generation

The U.S. Public Interest Research Group[30] examined a full range of socio-demographic and economic variables likely to affect VMT per capita. Noting that driving by young people declined between 2001 and 2009 both for those with jobs and without, with a 16% reduction in VMT per capita among 16 to 34 year-olds, they projected future changes in factors that would affect each key age cohort over time.



They arrayed the potential effects into three possible growth scenarios:

Back to the Future

- economic growth and lower gas prices return
- driving among age groups return to 2004 levels by 2020 and continue at those levels
- housing and transportation preferences of Millennials increasingly come to mimic previous generations, returns
- net effect of sharing economy and connected applications minimal

Enduring Shift

- shift in driving is lasting
- housing preferences continue to trend toward walkable neighborhoods with a range of transportation choices
- gasoline prices remain high
- economic revival does not result in a proportional increase in vehicle travel

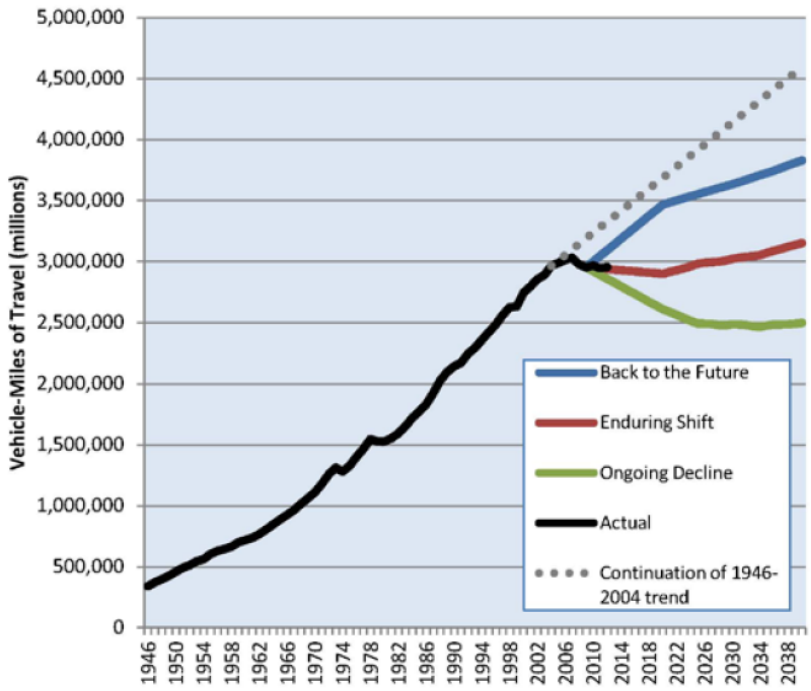
[30] US Public Interest Research Group. "A New Direction -- Our Changing Relationship with Driving and the Implications for America's Future," 2013.

- advances in connected applications use continue to alter patterns of vehicle ownership to the degree they have already
- reduction in driving in each cohort retains the same relative size as they age

Ongoing Decline

- decline in driving is the beginning of a deeper change in transportation patterns
- driving patterns of the young are the start of a broader shift driven by changes in technology and consumer preferences
- higher gas prices, concerns about the environment, or prolonged economic malaise increase preferences for alternative modes
- driving will stabilize at a lower level per-capita, with reduction in driving by each cohort between 2001 and 2009 replicated between 2009 and 2025

They conclude that, under all three scenarios, VMT growth will dampen considerably. They project an upper bound on VMT between one-third and one-half the continuation of the 1984-2004 trend line, and a lower bound returning to and stabilizing near 1995 levels of VMT per capita.



FP THINK CONCLUSIONS AND RECOMMENDATIONS

The FP Think working group on Demographic Trends, authors of this white paper, have translated the findings of the research described above into a set of recommendations on travel forecasting and transportation planning at Fehr & Peers.

Conclusions

The table below summarizes the factors discussed in this paper and lists some possible outcomes and events that could contribute to either a continuation of the recent downward trend in per-capita VMT or a rebound to renewed per-capita VMT growth. References to VMT in the table indicate VMT per capita. The "Our Prediction" column provides the authors' informed opinion on the direction of influence: a green background indicates VMT growth; red background indicates decline; and grey background indicates a neutral or unclear effect.

Factor	Continued Decline (red)	Renewed Growth (green)	Our Prediction
GDP per Capita	• GDP per capita stagnates or declines • VMT per capita does not rise with rising GDP per capita	• VMT per capita follows the recent rebound in GDP per capita	VMT has decoupled from GDP per capita, or was actually linked to other economic indicators.
Employment and Labor Force Participation	• A "jobless recovery" leads to stagnating employment • The trend of increasing female employment peaks	• Millennials enter workforce in larger numbers • Boomers continue working beyond traditional retirement age • Improving economy increases employment	Rebound in total employment will lead to moderate VMT growth.
Median Household Income	• Recovery is not reflected in median household incomes	• Improving economy increases median incomes	It will be difficult to match the income growth of the past 50 years. Moderate income growth will dampen VMT growth over the next decade. Registered vehicles per household has also been dropping

Factor	Continued Decline (red)	Renewed Growth (green)	Our Prediction
Housing Supply	Housing developers, private investment, and government reforms to encourage infill housing will allow housing supply to keep pace with changing preferences	Housing developers won't be able to keep pace with demand, and some will even be hesitant to invest money in urban housing	Although reforms are being made to make it easier to develop in infill areas, investors will need to see a longer shift in preferences before they totally embrace a shift. NIMBYs will also continue to limit the potential for infill in established residential communities
Millennials' Housing Decisions	Millennials will continue to prefer housing that supports a diverse set of transportation choices	Although they may be committed to urban living now, Millennials may be more like their parents than they care to admit, moving to the suburbs in order to raise their families.	The preference for urban living is real, and coupled with a de-emphasis on auto ownership, it will have consequences.
Boomers' Housing Decisions	Mimic those of previous generations, toward lower VMT, using their wealth to invest in one of the safest investments that can be made – new housing in urban, walkable locations.	Boomers will stick with what they know, primarily houses in the suburbs, as they age in place. Their travel will not change substantially, because they'll retire later, remain active and live longer than prior generations.	Home is where the heart is, and Boomers don't plan on leaving theirs soon. To the degree they favor walkable neighborhoods and broader transportation choices, that effect on VMT will be offset by the fact that they remain active and mobile longer than prior generations
Generational lifecycles	Millennials are setting a new social and environmental agenda focused on urban living and are foregoing car ownership	Boomers also flocked to cities as Millennials now do, but once they began forming families, they moved to suburbs in search of good schools and backyards and as a result, VMT per capita has tripled	VMT per capita tripled during the time that Boomers were getting established in the workforce and beginning to raise families
Driver's licensing laws	Stricter teen licensure laws have curtailed licensure rates among Millennials	Millennials will reach licensure rates of previous generations once they reach their late 20s and early 30s	Even a few-year delay in licensing would reduce the number of eligible drives per capita
Boomers' driving habits	Boomer retirements represent the biggest outflow from the labor force in history.	Boomers are more active, retiring later, living longer. As a result, they will continue to drive and remain mobile via their cars.	Combined, these two trends will be a wash.

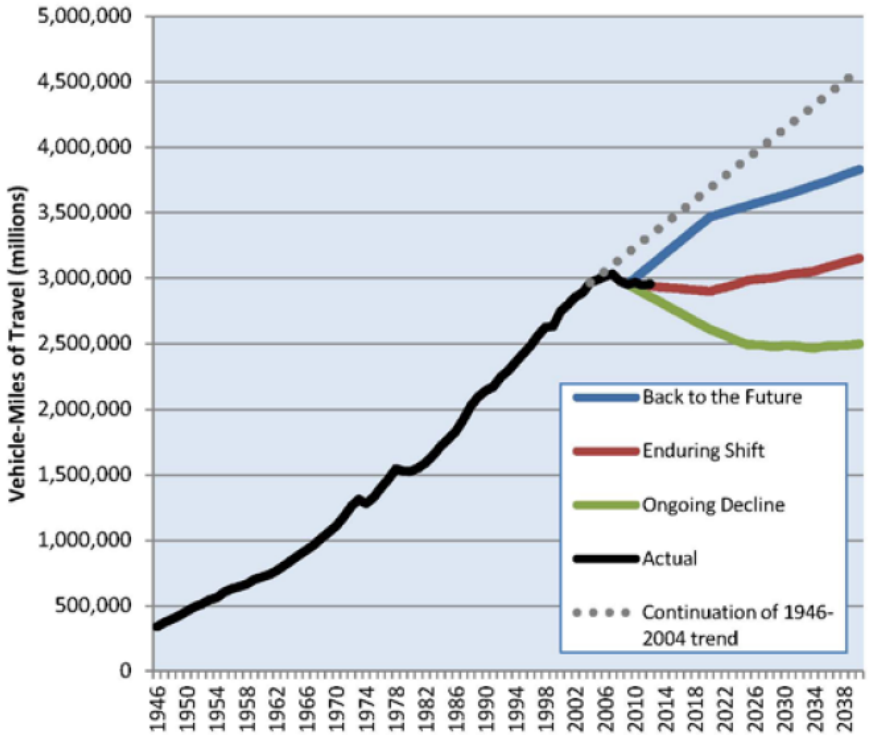
Factor	Continued Decline (red)	Renewed Growth (green)	Our Prediction
Approaching peak transit	Transit ridership grew twice as fast as population from 1995 to 2011 thanks to centralization of development and investment in transit. Developer and community-planned focus of new housing and jobs in transit priority areas (especially around the west) maintains this trajectory in urban preference patterns	Planned transit capacity expansions cannot keep pace with planned concentration on TOD	There is considerable pressure on the most effective urban transit to keep pace. For example, in Northern California both BART and Caltrain are near capacity and will not be able to expand enough to keep pace.
The net effect connected applications and sharing economy on demand on for driving	Play a bigger and bigger role in human interaction, further reducing travel for in-person encounters	Minimal to non-existent. They will continue to alter vehicle ownership and per-capita driving, but only to the degree they have already done so	Tech will produce continued downward forces on the amounts of personal and business travel.
The new economy or primed for post-recession growth and consumerism?	In terms of the economy, this is the new normal. If there's a recovery, it will be a jobless recovery	Recessions have occurred every 5-10 years since we've been tracking the economy, and recoveries have occurred at the same frequency. GDP is up, and we're seeing strong signs that the Great Recession is ending.	This is a new economy, wherein employment rates are lower on average than they have been over the past 25 years.
Price of Gasoline	Projected to remain at high levels that helped produce the VMT slowdown in the early 2000's	Vehicle fuel efficiency and North America energy independence will result in stable to lower cost per mile	Neither a significant upward or downward force on driving.
Effect of Travel Time Budgets	"Marchetti's Constant" suggests that all people have a maximum amount of travel they will conduct during the course of each day. Recent analyses of relatively constant travel times indicate we have reached the maximum travel budgets. Polzin's historic look at the American travel behavior shows that while travel times (and therefore travel budgets) in the US have increased, additional increases at high rates are unlikely.	To the extent that travel time can be used for productive purposes (autonomous vehicles, premium comfortable transit) travel time budgets will increase	Tolerance for travel time may rise due to reduced stress and increased productive use of time while travelling, but will be counteracted due the increasing number of things that can be done without traveling (video conferencing), high congestion, and the rising value of time

Factor	Continued Decline (red)	Renewed Growth (green)	Our Prediction
Demographic Trends in Total	Considering all cohorts (Boomers, Gen Xers, Millennials, Post-Millennials), driving among members of a particular age group will continue to decline. Post-Millennials will drive even less than Millennials do today, meaning VMT will continue to decline from generation to generation.	Return to 2004 levels, but will not increase due to travel time budgets	Continue to be suppressed relative to the preceding generation; e.g., even as they age Millennials will always drive 20% less than Gen Xers.
Non-household travel will be affected by internet ordering, 3D printing, and same day delivery.	Technology will allow VMT associated with goods and services to decline.	Small order, just-in-time shipping will increase VMT for goods and services.	Non-household travel, including deliveries, will remain stable on a per capita basis.
In Conclusion, the Recent Decline in Driving is Due Primarily to …	Factors that will lead to an even more substantial per capita decline in the future (such as lifestyle changes and further advances in communications)	Cyclical economic factors that will rebound in the near- or mid-term (gas prices and GDP)	Stable, real and lasting shift in driving behavior from the growth trend of 1950-2004 (due to factors such as stricter licensing laws and the internet) largely off-setting a full recovery of the economy, when it occurs.
How should we respond?	The combined power of these economic, social and technological trends is undeniable and cannot help but suppress driving	We need more time to see how it plays out. Five years does not define a long-term trend, and until we can get more evidence on the various cyclical and structural elements, we should not make major changes to our travel forecasting approaches.	There is no single assured answer. Our forecasts should display a range of uncertainty, with one boundary assuming that pre-2000 trends continue and one that assumes that labor force participation, technology and social preferences continue to track post-2000 trends

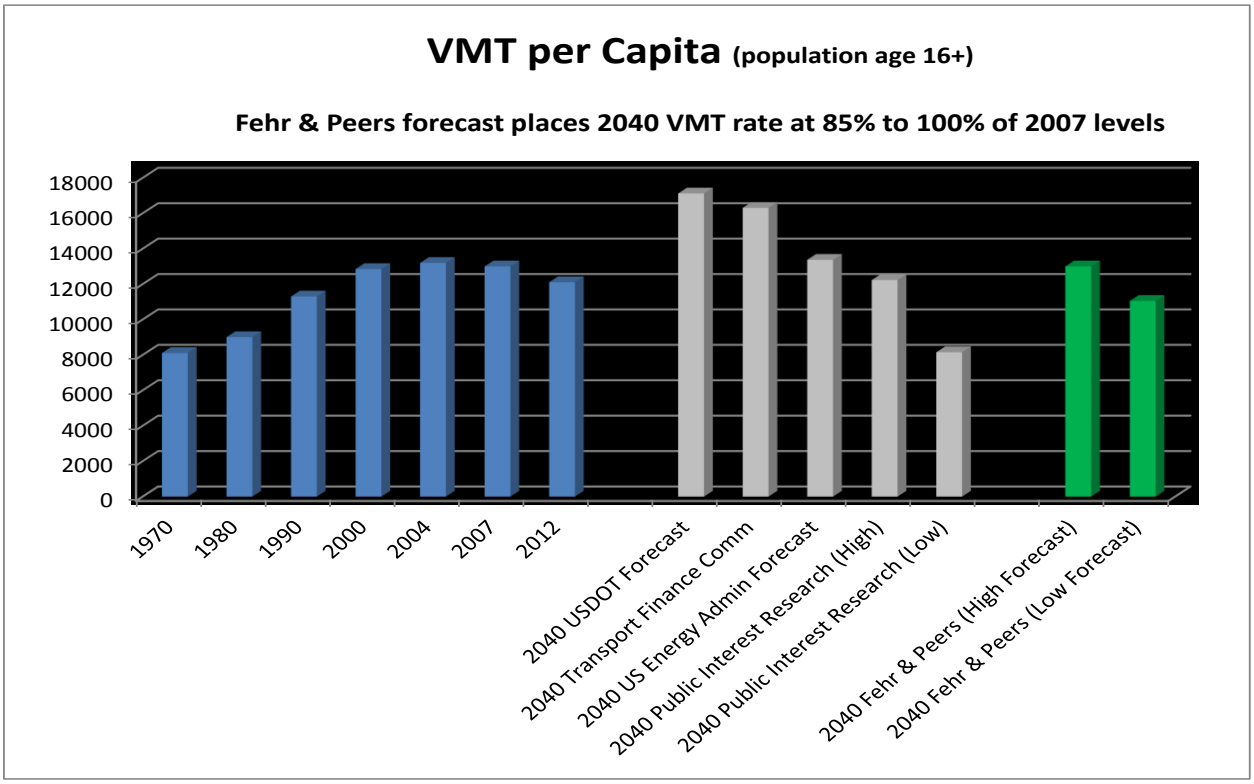
Based on these observations, we estimate demographic trends and the state of the U.S. economy will significantly dampen the historic rate of per capita VMT growth. We project that, as illustrated in the following graph, growth:

- Between 2007 and 2040, non-freight VMT will grow at less than two-thirds the pre-2004 rate

VMT per capita, which grew 17% between 1990 and 2004, will remain static or decline and will be between 85% and 100% of the 2004 VMT per capita, even through 2040. Our estimate of the range of plausible VMT growth trajectories is shown in the following figure.



FP Think Estimate of Plausible Trajectory of VMT Growth



Recommendations

Based on these findings, we offer the following recommendations for Fehr & Peers travel behavior forecasting and transportation planning.

RECOMMENDATIONS
Understand uncertainties, and forecast travel for scenarios or probable ranges of outcomes, not absolute values.
Discuss with clients and stakeholders the key underlying factors that influence VMT per capita, their recent trends and the plausible ranges of future trends.
Unless it's necessary to be ultra-conservative, forecast VMT growth at a rates lower than historic trends. Rather than continuing the upward trajectory exhibited from 1970 to 2004 (a 63% increase in VMT per capita), future VMT per capita will be flat or declining, with 2040 levels between 85% and 100% of the 2004 peak.
In regional, community and project planning, incorporate concepts attuned to demographic and economic shifts including balanced, multi-modal networks, mobility services, mobility management that reflect and accommodate stabilization of VMT per capita.
In travel behavior forecasts, include credible forecasts of driving age population, household formation, labor force participation, vehicle ownership, gasoline prices, relationship between time-use budgets and travel time growth, telecommuting, internet shopping, and delivery of goods and services.
Continue to research and narrow the range of uncertainty and strengthen the reasonableness of our forecasts. Suggested variables for statistical or structural equations modeling of factors correlated with annual VMT from 1950 to 2010 (a full list of suggested variables appears in Appendix A): • The Economy • Demographics • Technology • Urban form/built environment
Monitor changes in demographic and economic data and concurrent changes in VMT per capita to verify or adjust forecasting relationships.

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APPENDIX A:
Concept Design for Modeling Relationship between VMT and Economic/ Demographic Trends

For statistical or structural equations modeling of factors potentially correlated with annual VMT from 1950 to 2010 (by US region):

The Economy

1. GDP per household
2. Total income per household
3. Discretionary income per household
4. Labor force participation (jobs)
5. Average fuel price in real dollars
6. Household formation (% of 18-35 cohort in traditional households vs family sofa)

Demographics

1. Employed households with children
2. Employed households
3. Licensed drivers per capita
4. Labor force entrants (18-30 year olds) as percentage of adult population (>18)
5. Retirees (65+) as percentage of adult population
6. Licensed drivers as percentage of adult population
7. Average K-12 school enrollment

Technology

1. Internet access adults as percentage of adult population
2. Telecommute jobs as percentage of total jobs
3. Internet purchases (transactions) as a percentage of all purchases

Urban Form/ Built Environment

1. Percent of households living in urban centers
2. Percent of population in CBGs with high 2010 SLD scores
3. Percent of population in CBGs with low commute SOV shares in nearest Census
4. Regional sprawl indices and D factors from US EPA Smart Location Database

APPENDIX B: AUTONOMOUS VEHICLE MODELING RESULTS

What We Did	What We Thought	Results						
Model Test	**Professional Perceptions & Expectations**	**Model A**	**Model B**	**Model C**	**Model D**	**Model E**	**Model F**	**Model G**
VEHICLE MILES TRAVELED								
[1]Decrease Access Time	Some mode shift to auto, slightly longer trips	-0.7%	1.4%	-5.8%				0.5%
[2]Decrease Parking Costs	Some mode shift to auto	0.1%	1.0%	0.0%	-0.1%	14.6%	0.1%	1.1%
Decrease Vehicle Operating Cost	Some mode shift to auto						11.1%	
[3]Decrease Impact of lost Auto Travel Time	Big mode shift to auto, willing to travel longer distances	1.8%	39.3%	41.4%		1.4%	9.1%	25.8%
[4]Increase Auto Availability	People reliant on transit shift to auto	0.7%	0.5%	0.7%				0.5%
[5]Increase Freeway Capacity	More and longer distance auto trips	5.8%	-0.5%	3.6%	2.0%	3.6%	3.6%	4.5%
[6]Increase Non-Work Trip Making	More auto and transit trips	7.5%	8.7%	15.5%	10.0%			5.2%
[7]Increase Vehicle Occupancy	More shared trips results in fewer vehicles and less VMT	-10.7%	-21.5%	-14.5%				-6.2%
	[8]ALL Tests Combined (No Veh Occ)	**16.5%**	**45.8%**	**67.6%**	**12.0%**	**19.6%**	**23.9%**	**45.3%**
	[8]ALL Tests Combined	**3.6%**	**16.3%**	**42.6%**				**26.7%**
VEHICLE TRIPS								
[1]Decrease Access Time	Some mode shift to auto	0.0%	1.7%	0.1%				0.9%
[2]Decrease Parking Costs	Some mode shift to auto	0.2%	0.4%	0.0%	1.0%	2.4%	0.1%	2.8%
Decrease Vehicle Operating Cost	Some mode shift to auto						0.5%	
[3]Decrease Impact of lost Auto Travel Time	Big mode shift to auto	0.6%	3.7%	2.4%		0.0%	1.2%	4.5%
[4]Increase Auto Availability	People reliant on transit shift to auto	1.1%	1.3%	2.8%				1.3%
[5]Increase Freeway Capacity	Some mode shift to auto	0.4%	0.0%	0.5%	1.0%	2.4%	0.8%	0.0%
[6]Increase Non-Work Trip Making	More auto and transit trips	12.3%	15.1%	20.8%	15.0%			13.2%
[7]Increase Vehicle Occupancy	More shared trips results in fewer vehicles	-11.8%	-21.9%	-22.3%				-13.1%
	[8]ALL Tests Combined (No Veh Occ)	**15.0%**	**19.4%**	**26.4%**	**16.0%**	**2.5%**	**2.6%**	**24.3%**
	[8]ALL Tests Combined	**0.9%**	**-6.6%**	**-1.7%**				**5.2%**
TRANSIT TRIPS								
[1]Decrease Access Time	Some mode shift to auto	-4.3%	-10.4%	-14.9%				-15.3%
[2]Decrease Parking Costs	Some mode shift to auto	-5.0%	-3.2%	-0.3%	-1.0%	-11.5%	-4.1%	-7.0%
Decrease Vehicle Operating Cost	Some mode shift to auto						-12.5%	
[3]Decrease Impact of lost Auto Travel Time	Big mode shift to auto	-10.8%	0.3%	-18.9%		0.0%	-24.6%	-1.8%
[4]Increase Auto Availability	People reliant on transit shift to auto	-23.9%	-6.3%	-31.2%				3.5%
[5]Increase Freeway Capacity	Some mode shift to auto	-0.7%	0.0%	-1.6%	1.0%	3.8%	-1.1%	-3.6%
[6]Increase Non-Work Trip Making	More auto and transit trips	9.2%	10.3%	10.1%	5.0%			6.2%
[7]Increase Vehicle Occupancy	Fewer vehicles may induce a small mode shift to auto	0.0%	0.0%	0.0%				-4.7%
	[8]ALL Tests Combined (No Veh Occ)	**-38.9%**	**15.8%**	**-42.9%**	**5.0%**	**-7.7%**	**-42.4%**	**-18.3%**
	[8]ALL Tests Combined	**-38.9%**	**15.8%**	**-42.9%**				**-19.8%**

Notes:

[1]Decrease Access Time – set auto walk and park access times to 0 (door-to-door service)

[2]Decrease Parking Costs – halved parking costs (parking cost reduction)

[3]Decrease Impact of lost Auto Travel Time – halved auto skim time matrices (willingness to travel longer amounts of time because you can do other things)

[4]Increase Auto Availability – households determined by the model to have 0 autos were manually adjusted to have 1 auto available to them (all households have an auto available to them)

[5]Increase Freeway Capacity – set freeway capacity to 3,300 vehicles per hour per lane (closer following distances and higher speeds results in higher capacity)

[6]Increase Non-Work Trip Making – increased non-work trip generation rates by 25% (young and elderly and others currently unable to drive can make discretionary auto trips)

[7]Increase Vehicle Occupancy - shifted 50% of drive alone person trips to shared ride 2 person trips

[8]ALL Tests Combined - performed single model run with modifications from all individual model tests