# DRIVERS OF CHANGE IN TRAVEL PATTERNS- STOCKHOLM 1986-2004

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## ABSTRACT

This paper reports research on the travel pattern changes over 19 years in the Stockholm region and the influences of these changes. The study is implemented by comparing two large-scale travel surveys carried out in Stockholm County from 1986-87 and 2004. By use of statistical and econometric methods, this study analyzes changes in various dimensions of travel patterns, while controlling for changes in external factors, such as automobile accessibility, residence location, employment status and other socioeconomic indicators. Particular focus is given to how travel in different lifecycle groups (defined by gender, age and household composition) has changed. The findings show that while travel distance has increased overall, it increases at a higher rate for females than her male counterpart. In other words, women's travel behavior has become more similar to men's which explains the overall trend increase in travel distance. Interestingly, it is mostly women that increase automobile usage, since primarily single women have increased car accessibility between the years and a larger number of couples have two cars rather than one in the household. The share of automobile and public transit trips for both females and males has increased while little change in trip frequency is observed over the data collection years.

*Keywords: gender, commute trips, household travel, automobile saturation, travel survey*

# INTRODUCTION

Travel patterns change over time. Some of this change can be identified through observable variables and indeed, much transportation forecasting is based on the caveat that the influence of observable variables remains consistent over time. However, there are various unobservable or unquantifiable influences on travel behaviors which are difficult to capture in modeling; in other words, there are trends that occur by lifecycle. This paper will observe changes in travel behavior across lifecycle groups while controlling for a variety of conventional travel pattern influences.

This paper reports analyses on travel pattern changes over 19 years, and explores the influences of these changes. The study is implemented by comparing two large-scale travel surveys carried out in Stockholm County from 1986/87 (referred to as 1986 in this paper) and 2004. The data provides a unique and valuable opportunity because of its size and detail, but also because it captures the travel behaviors over time. There are no known studies in which two comparable travel surveys have been evaluated in a similar manner, either in Sweden or internationally. The data and materials are distinct and can therefore provide a unique and important contribution to research on the long-term change in people's mobility. Differences between females and males and trends within lifecycle groups will be addressed explicitly in the analysis.

The study finds that the average trip distance has increased from 9.0 kilometers (km) to 11.8 km, while average driving distance has increased from 10.9 to 13.9 km/trip and public transit trips have increased from 11.9 to 13.7 km/trip in 1986 and 2004, respectively. The share of trips made as an automobile driver has increased from 40% to 44%, while the share of public transit trips has seen a similar increase from 23% to 26% in 1986 and 2004, respectively.

Travel patterns change over time for several reasons. Some change is due to changes in the transportation system itself, for example, the supply of public transport. The changes in travel patterns may also be due to external factors, such as location of housing and automobile accessibility. Ultimately, changes in travel patterns also depend on something termed "lifecycle change" or "social change", in other words, people change their employment, household location, household composition and preferences.

Exploring how travel patterns change over time, and the driving influences behind this development, is interesting and important for several reasons. Most importantly is that it gives information on how travel patterns may evolve in the future and provide guidance on how to build a more sustainable transportation system. It creates the potential to make better long-term traffic forecasts and develop effective measures, since much transportation forecasting tools rely on the descriptive power of the explanatory variables.

This paper assesses the impact of the changes in a number of variables, such as automobile accessibility, residence location, employment status and household composition. Particular

focus is given to how travel in different lifecycle groups (defined by gender, age and household composition) has changed. The results show how much of the changes on the aggregate level can be explained by changes in measurable factors such as car accessibility, and employment status, and how much should be ascribed to lifestyle changes such as household composition.

The paper is organized as follows. The next section discusses previous trends in gender travel patterns. The data section introduces the data and data collection methods. The methods section presents and discusses the models employed in the analysis. The estimation results are presented in the results section and are discussed in the following discussion section. Finally the paper concludes in the conclusion section.

# LITERATURE

There is a large and established body of research dedicated to the differences in travel by gender, in other words, the differences in travel behaviors by females and by males (Rosenbloom, 2006). Many of these gender differences in travel are seen in the metrics analyzed in this paper: amount of daily travel, trip characteristics, mode choice and commuting.

Females make shorter and more frequent trips than males (Hanson and Hanson, 1981). Typically, this is explained through household roles: women account for more of the household trips and assume a greater proportion of recurring household chores (Wilkie et.al., 1998; Batalova and Cohen, 2002; Windebank, 2001). Similarly, these differences are captured in activity-based analyses on travel (Lu and Pas, 1999; Golob and McNally, 1997).

Females use public transit more often than males and use an automobile less (Best and Lanzendorf, 2005). These relationships tend to hold in Sweden, as well (Polk 2004). Polk (2004) found that even after controlling for a variety of gendered preferences, males were more likely to use an automobile. Including, and in addition to, these gendered preferences, there are a variety of explanations for the gender disparity: females have less accessibility to automobiles (Hanson, 2010) and females have differing environmental priorities than males (Matthies et.al, 2002).

Females make shorter commute trips than her male counterpart. Within the household context, females are more likely to work nearer to their home, thus have a shorter commute distance (MacDonald, 1999). This trend has remained consistent over time, even though recent evidence suggests that the gender gap in commuting is narrowing (Crane, 2007). However, females' job location is not entirely related to household responsibilities; due to labor market distribution, females are more likely to find a job nearer to home than her male counterpart (Hanson and Johnston, 1985; Hanson and Pratt, 1995).

Much discussion acknowledges that the differences observed by gender are most likely related to gendered roles in society and the household and are not simply genetic

(Rosenbloom, 2006). As previously mentioned, females are more likely to be responsible for household chores, household errands and childcare, thus significantly influencing their daily travel patterns.

Even as gender differences in travel have been well-documented over time, there is less research which attempts to describe the change in these differences over time using similar data. The current study utilizes a model approach, in that the analysis is based on the travel dimensions similar to traditional large-scale forecasting models that take a cultural and geographical approach based on a more descriptive analysis of travel over time using data collected over two time periods.

# DATA

The data is compiled from two separate travel surveys conducted in Stockholm County during the years 1986-1987 and 2004. Stockholm County includes the city of Stockholm, as well as surrounding suburban areas, including numerous islands in the archipelago. Stockholm County is home to more than one-fifth of Sweden's population while containing less than one and half percent of Sweden's total land area. The total population in 1986 was 1,593,333 and in 2004, was 1,872,900 with females accounting for a larger proportion of the population (51.6% and 50.9% for 1986 and 2004, respectively).

Both surveys provide data on the individual level and utilize mail-back travel diaries that represent the total daily travel for the individual respondent. Both surveys have sought a representative sample for the Stockholm County with regard to disparities between different geographical parts of the county. The surveys include important socioeconomic and household data, such as the employment status, household composition, residence location, number of automobiles in the household, gender and age of respondent. Weekdays and weekends are represented in the same proportion for both surveys.

Travel survey 1986/87 (RVU 86/87) was conducted between April 17, 1986 and 16 April 1987. The target population was made up of the inhabitants of the Stockholm County aged 12-74 years. The total number of respondents was 30,040 with a response rate of nearly 75 percent.

Travel survey 2004 (RVU 2004) was conducted in September and October 2004 and involved approximately 77,000 respondents. The target population was individuals in Stockholm County aged 12-84 years. The response rate was about 48 percent.

The two studies differ from each other mainly in terms of response rate and time of year. To achieve comparability, observations from winter month and holidays are discarded from the 1986/87 sample. The travel pattern in the remaining 1986/87 sample does not differ from the travel patterns observed in October 1986.

The difference in response rate between the two surveys is mainly due to the fact that the earlier study included a larger number of reminders. This difference may affect the

comparability, but it is concluded that this impact is limited because the responses received in the survey from 2004 are weighted with respect to gender, age, background and strata. Similarly, the 1986/87 sample is weighted with respect to residence location. A non-response survey was also carried out via telephone interviews in 2004, but showed no significant differences between the non-response and response group. Therefore, the data is determined to be sufficiently representative of the general population.

## Designation of Variables

For the purposes of this study, the data is segmented into various lifecycle groups. The segmentations includes: gender, age and household composition. The age groups are defined as: youth (ages 12-17), young adult (ages 18-34), adult (ages 35-64) and retiree (ages 65 and older). Household composition is characterized by being single or partnered and if the household has children or no children. The distribution of the lifecycle groups is found in Table 1.

The data is first segmented by working age, in other words, into the following groups: youth, adult and retiree. Youth remain as a final lifecycle group, while retirees are further segmented by household composition (single or partnered). Next the adults (all observations aged 18-64) are segmented by children in the household. Those household with children are further segmented as single or partnered. With this designation, an observation in the lifecycle group single or partnered with children is aged 18-64.

Finally, the adults in households without children are segmented further by age with young adults representing observations aged 18-34 and adults representing observations aged 35-64. With these lifecycle segmentations the assumption is such that differences for households with children across all working-age age groups are less evident than those in households without children. Also, it is worthwhile to note that retired persons could have a household composition including children; however, the differences in travel behaviors of those with or without children are less strong.

Table 1: Data distribution by lifecycle group (in percentages)

| | Females | | Males | |
|---|---|---|---|---|
| Lifecycle Group | 1986 | 2004 | 1986 | 2004 |
| Youth | 0.08 | 0.08 | 0.10 | 0.09 |
| Young Single Adult | 0.06 | 0.06 | 0.08 | 0.06 |
| Young Partnered Adult | 0.14 | 0.12 | 0.16 | 0.12 |
| Single with Children | 0.02 | 0.03 | 0.00 | 0.01 |
| Partnered with Children | 0.14 | 0.19 | 0.14 | 0.21 |
| Single Adult | 0.07 | 0.12 | 0.07 | 0.10 |
| Partnered Adult | 0.34 | 0.26 | 0.34 | 0.27 |
| Single Retiree | 0.06 | 0.06 | 0.02 | 0.03 |
| Partnered Retiree | 0.09 | 0.08 | 0.09 | 0.11 |
| Total | 1.00 | 1.00 | 1.00 | 1.00 |

In addition to lifecycle indicators, the study uses various income proxy variables. Since the data does not include income, proxy variables such as employment, residence location and car accessibility in terms of household (HH) car competition are indicated for each individual

(Table 2). Employment status simply indicates whether the individual is currently employed and receiving full wages. Alternatively, if the respondent is not employed, it could indicate that the respondent is unemployed, on paternal or sick leave, or retired. Full-time employed respondents accounted for 67% of the 1986 data and 64% of the 2004 data.

Table 2: Income proxy variables by lifecycle group and year (in percentages)

| | Innercity Resident | | Inner Suburb Resident | | Outer Suburb Resident | | HH w No Automobile | | HH w Car Competition | | HH w No Car Competition | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lifecycle Group | 1986 | 2004 | 1986 | 2004 | 1986 | 2004 | 1986 | 2004 | 1986 | 2004 | 1986 | 2004 |
| Youth | 0.03 | 0.14 | 0.16 | 0.29 | 0.81 | 0.57 | 0.14 | 0.16 | 0.85 | 0.47 | 0.01 | 0.37 |
| Young Single Adult | 0.34 | 0.45 | 0.23 | 0.30 | 0.43 | 0.25 | 0.59 | 0.68 | 0.00 | 0.00 | 0.41 | 0.32 |
| Young Partnered Adult | 0.13 | 0.32 | 0.20 | 0.31 | 0.67 | 0.37 | 0.19 | 0.28 | 0.72 | 0.61 | 0.09 | 0.11 |
| Single with Children | 0.09 | 0.26 | 0.25 | 0.30 | 0.66 | 0.44 | 0.58 | 0.44 | 0.00 | 0.00 | 0.42 | 0.56 |
| Partnered with Children | 0.09 | 0.17 | 0.20 | 0.27 | 0.71 | 0.56 | 0.11 | 0.10 | 0.72 | 0.57 | 0.17 | 0.33 |
| Single Adult | 0.24 | 0.35 | 0.27 | 0.29 | 0.49 | 0.36 | 0.51 | 0.49 | 0.00 | 0.00 | 0.49 | 0.51 |
| Partnered Adult | 0.09 | 0.21 | 0.18 | 0.25 | 0.73 | 0.54 | 0.11 | 0.11 | 0.80 | 0.63 | 0.09 | 0.26 |
| Single Retiree | 0.26 | 0.27 | 0.30 | 0.28 | 0.44 | 0.45 | 0.83 | 0.61 | 0.00 | 0.00 | 0.17 | 0.39 |
| Partnered Retiree | 0.16 | 0.19 | 0.29 | 0.23 | 0.55 | 0.58 | 0.29 | 0.14 | 0.69 | 0.69 | 0.02 | 0.17 |
| AVERAGE | 0.16 | 0.26 | 0.23 | 0.28 | 0.61 | 0.46 | 0.37 | 0.33 | 0.42 | 0.33 | 0.21 | 0.34 |

*The figures are presented such that each lifecycle group by year sums to 100% for residential locations and car competition.

Residence location is segmented into three categories: inner city, inner suburbs and outer suburbs. In general, more people moved from the outer suburbs to the inner suburbs and the inner city from 1986 to 2004. This is true for all non-retirees, while retirees maintain nearly the same percentages in the outer suburbs and only move a few percentage points from the inner suburbs to the inner city.

Finally, automobile accessibility is measured in terms of car competition. If the household has access to at least one vehicle per driver, the household has no car competition; if the household has access to fewer vehicles than drivers, the household has car competition in that the drivers must compete for car usage. There is a third status for car competition that indicates there are no automobiles in the household. In general, households with no car competition have the largest, and only, increase from 1986 to 2004. Households with car competition have the largest decrease.

# METHOD

In order to capture a variety of dimensions of travel patterns, numerous econometric modeling techniques have been employed. The dimensions of travel patterns evaluated in this study include: trip frequency, mode choice and trip distance. For all three dimensions the same functions of independent variables are used to explain the dependent variable. However, different model specifications are used, adjusted to fit the type of dependent variables: trip frequency is a count variable, which is best modeled using a negative binomial generalized linear model (see Greene, 1993); mode choice is a choice between discrete variables and is represented as a logit model; trip distance is a positive, continuous variable and is represented as a log linear regression model.

The study methodology evaluates each travel dimension using three functions of independent variables, specified as in: $v_{1i}$, $v_{2i}$ and $v_{3i}$. Trip frequency and trip distance models are evaluated on the trip level (where $i$ represents the trip) and the mode choice model is evaluated on the individual respondent level (where $i$ represents the individual).

The first function of independent variables (1) is used to explore changes in the dependent variable, or travel dimension being modeled, over the data collection period (1986-2004).

$$v_{1i} = \beta_{2004} year2004_i \quad (1)$$

where $year2004_i$ is a Boolean variable representing the difference in data collection year. If $\beta_{2004}$ is statistically significant, the dependent variable, $v_{1i}$, is considered to have a statistically significant change over the data collection period.

In order to further refine the change in the dependent variable by lifecycle group, the second specification (2) uses Boolean variables representing each lifecycle group and the lifecycle groups are further segmented by data collection year (all and 2004). The "all" variables capture the differences in lifecycle groups by composition. The "2004" variables capture the change in the dependent variable for each lifecycle group over time. Trip type variables are added to identify trends by trip purpose. The trip type variables segment the data into commute trips and non-commute trips and further segmentation by data collection year.

$$v_{2i} = \sum_{j \in cycle} \left( \beta_{j_{all}} all_{j,i} + \beta_{j_{2004}} 2004_{j,i} \right) + \boldsymbol{\beta}_{\mathbf{x}} \mathbf{x} \quad (2)$$

where $\mathbf{x}$ represents a vector of trip type variables, $cycle$ is a set that contains all lifecycle groups, $all_{j,i}$ represents observations over all years and $2004_{j,i}$ represents observations for 2004.

The third function of covariates adds socioeconomic covariates to the function (2) in order to elicit the influence of observed variables. These covariates are typically included in forecast models, namely residence location, car competition and employment status. Each of the income proxy variables is segmented by data collection year. These covariates are represented in (3) as the vector $\mathbf{I}$.

$$v_{3i} = \sum_{j \in cycle} \left( \beta_{j_{all}} all_{j,i} + \beta_{j_{2004}} 2004_{j,i} \right) + \boldsymbol{\beta}_{\mathbf{x}} \mathbf{x} + \boldsymbol{\beta}_{\mathbf{I}} \mathbf{I} \quad (3)$$

# RESULTS

## Trip Frequency

The mean trip frequency (the number of trips per person 18 years or older per day) remains stable. In 1986 the mean was 2.88 trips/day and in 2004 it was 2.72 trips/day. The proportion of people who do not travel at all during a working day remains unchanged around 15%. Considering the profound changes in society in terms of communication technology development, this is an interesting result; the number of out-of-home activities seems to be very stable. The estimation results for trip frequency models are found in Appendix 1.

Males show a small but significant decrease in trip frequency with 3.04 and 2.72 average trips per day in 1986 and 2004, respectively (Table 3). Females show no significant change in trip frequency with 2.73 and 2.71 average trips per day in 1986 and 2004, respectively. Youth have a somewhat larger decrease in trip frequency which is explained by the reduction of walking and cycling trips in this group.

The number of motorized trips remains relatively stable in the entire adult population, about 2.1 trips per day, but an analysis with respect to gender reveals some interesting trends. Males make more motorized trips per day than their female counterpart and show a slight trend decline. While females make fewer motorized trips than her male counterpart, the pattern is the opposite and females show a trend increase. Females significantly increase trip frequency in all locations except the inner city and males significantly decrease within the inner city. Presumably this is connected to the fact that in the inner city accessibility to non-motorized trips has remained comparatively higher than in the suburbs.

Table 3: Daily trip frequency

| | Females | | Males | | Youth | |
|---|---|---|---|---|---|---|
| | 1986 | 2004 | 1986 | 2004 | 1986 | 2004 |
| All Trips | 2.73 | 2.71 | 3.04 | 2.72 | 3.15 | 2.77 |
| Commute Trips | 0.47 | 0.44 | 0.65 | 0.53 | | |
| Motorized Trips | 1.85 | 2.03 | 2.39 | 2.20 | 1.47 | 1.89 |

Males that are employed full-time show a significant decrease in commute trip frequency. This is the same, irrespective of if there are children in the household or not. However, there is a strong geographical pattern of males in the suburbs reducing the frequency of commute trips.

In Table 4, the same negative binomial model is estimated segmented by household neighborhood in order to determine what locational effects are present in the commute trips trend. Males that are employed full-time and live in outer suburbs show a significant decrease in commute trip frequency. This indicates the effect of telecommuting within this group. For other trips by males, the geographical pattern is the opposite; these trips

decrease more in the inner city. There were no significant geographical trends for females for either commute or non-commute trips.

Table 4: Relative trip frequency by residence location for non-commuting trips and commuting trips (males only)

| | Non-Commute Trips | | | | Commute Trips | | | |
|---|---|---|---|---|---|---|---|---|
| | All | t-value | 2004 | t-value | All | t-value | 2004 | t-value |
| Intercept | **0.231** | **13.075** | | | -0.200 | -11.570 | | |
| Outer Suburbs | | | **-0.062** | **-2.697** | | | **-0.148** | **-6.233** |
| Inner Suburbs | 0.033 | 0.915 | **-0.132** | **-3.626** | -0.024 | -0.658 | **-0.103** | **-2.696** |
| Innercity | **0.178** | **4.344** | **-0.203** | **-4.051** | -0.041 | -0.940 | -0.081 | -1.661 |

## Mode Share

### *Automobile Share of Trips*

The share of automobile trips as a driver increased over the data collection years for both females and males, overall. In general, the females' automobile share of trips has increased from 24% in 1986 to 31% in 2004. For males, the increase has been less dramatic with automobile trips as a driver accounting for 55% in 1986 and 57% in 2004. Estimation results for automobile share of trips by gender are found in Appendix 2.

The share of automobile trips as a driver corresponding to model (2) is found in Figure 1. In 1986, retired females had the lowest car share with 5% while females with children in the household have the highest at nearly 35%. Automobile trips as a driver also account for a high share of trips for partnered females in households without children.

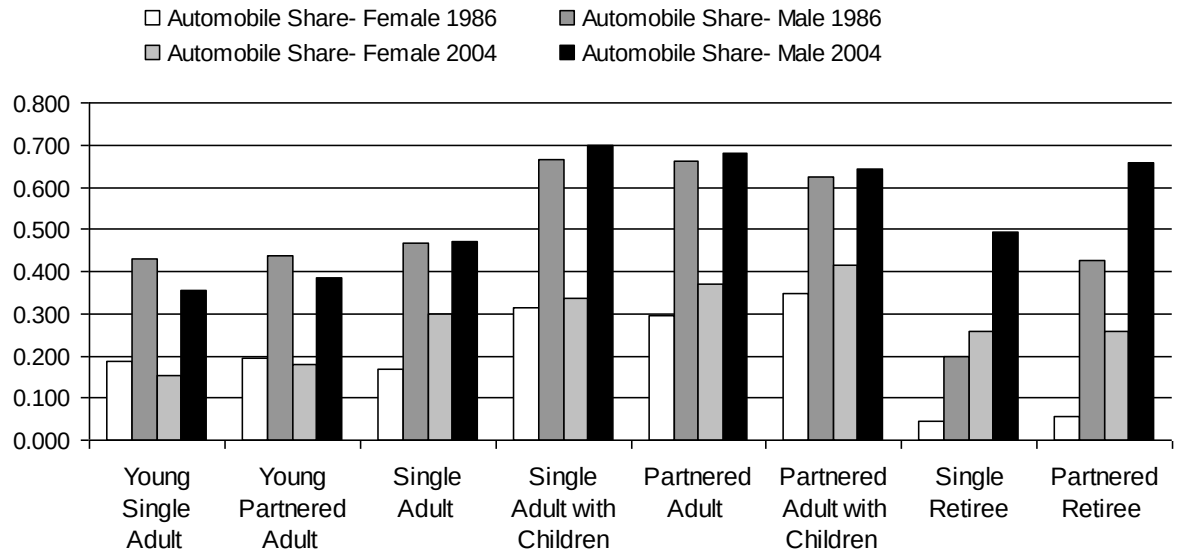


Figure 1: Automobile as a driver share of trips for all trips

In 2004, all lifecycle groups for both female and male show increases, except young persons. Particularly, retired persons increase up to 500%; they are the partnered adults from 1986.

Commuting trips show the opposite trend; they are significantly lower in share of automobile trips than other trips and have a greater decrease in share for males over time than other trips.

The explanatory variables, primarily car ownership, explain much of the increase in automobile share (see Appendix 2). It is only the retired lifecycle groups that still show significant influence on automobile share when controlling for the explanatory covariates. Overall, given the level of car access, there is no large effect on the share of automobile trips.

Employment has a positive influence on automobile share. Living further from the city center has a positive influence on the automobile share. The proportion of automobile trips is increasing more for men and women living in outer suburbs, also when controlling for car accessibility (which is higher in the outer suburbs).

The share of automobile trips is lower for commuting trips than other trips, for both men and women. For men the share of automobile trips shows smaller increase over time than other trips and for females there is no significant difference between commuting and non-commuting trips.

### *Public Transit Share of Trips*

The share of public transport trips also increases significantly for females and males. The share of public transit trips for females increased from 29% in 1986 to 31% in 2004 and males increased from 17% in 1986 to 20% in 2004. Figure 2 represents the share of public transit trips segmented by lifecycle group, gender and data collection year. Females have a consistently higher share than her male counterparts for all lifecycle groups and over both data collection years. Model estimation results are found in Appendix 3.

All lifecycle groups increased their public transit share, except retired females. Young, persons (males and females) show the greatest increase from 1986 to 2004 and in 2004 have the highest share of public transit trips when comparing all lifecycle groups. For males and females alike, it is the young persons and retired persons that have the highest share of public transit trips.

From 1986, all female lifecycle groups increased their public transit share of trips in 2004, except retired persons. Males similarly increase the public transit share of trips for all lifecycle groups, except retired persons. Single male retirees show the greatest decrease in public transit share over time and while it is the partnered female retirees that show the greatest decrease.

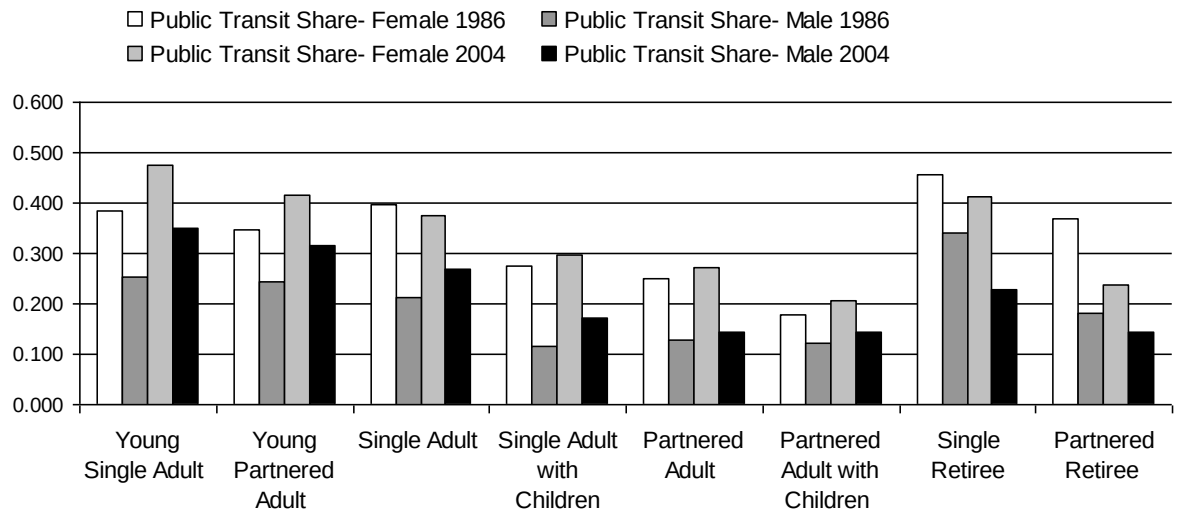


Figure 2: Public transit share of trips for all trips

Similar to the models estimated for automobile share, a third estimation is obtained specified as model (3). Lifecycle factors become more influential for all groups over time, except female and male partnered retirees and male retirees. This suggests that it is primarily the lifecycle factors that influence the change in public transit usage over time.

Outer suburb residences have a significant negative influence on females' public transit share. The same tendency is found for males, but less marked. Car competition has a significant reciprocal relationship to public transit share; as car accessibility increases, public transit share decreases.

The previous sections have shown that, in general, automobile shares and public transit shares have increased over time. These results indicate that the share of non-motorized trips has decreased over time.

## Trip Distance

### *Trip Characteristics*

Overall, the data show that both males and females have increased their average trip distance, yet decreased their average travel time per trip. For females, the average trip distance was 7.87 kilometers (km) in 1986 and 10.71 km in 2004. Males consistently have longer trips than their female counterparts, with males having an average trip length of 10.06 km in 1986 and 13.07 km in 2004. In general, it is the youth and retirees for both females and males that show the highest increase in trip distance, although all lifecycle groups show significant increases.

There is a trend of decreasing travel time per trip for both males and females. The average travel time per trip in 1986 was 29.70 minutes for females and 30.11 minutes for males, while 2004 shows an average of 25.92 minutes for females and 26.41 minutes for males. An ANOVA test shows that the difference in trip time over the years is significant; however, the

difference in travel time by gender is not statistically significant. Therefore, differences in travel time seem to be influenced by time period (in terms of year) but not by gender.

Overall, the data indicate that travel speeds have significantly increased over time for all persons, whether that increase is from mode changes, more efficient travel or greater traveler information.

### *Commuting Trips*

Both males and females have increased commuting distance over the years; however, the average commute time remains largely unchanged. The female average commute distance increased from 9.55 km in 1986 to 12.46 km in 2004, while the average commute distance for males increased from 12.15 km to 15.68 km, respectively. Although, there is a statistically significant trend for males to have longer commute distances on average than females, there is no significant difference in commuting time for males and females. Furthermore, ANOVA tests show that there is no significant difference in commuting time over the data collection years. Females had an average commute time of 30.52 minutes and 30.19 minutes in 1986 and 2004, respectively and males had a similar average commute time with 29.79 minutes in 1986 and 30.44 minutes in 2004.

### *All Trips- Model Estimations*

As discussed previously, there is a significant increase in trip distance over time for both females and males. Additionally, the results from model (2) in Appendix 4 show that the average trip distance increased over time for each life cycle group. In 1986, there is no significant difference between trip distance for young single adult, single adult, partnered adult and retired persons. In general, female adults without children in the household have no significant difference in trip distance. For males, the model suggests that males behave differently between all lifecycle groups; only young single adult, single adult males with children and retirees show no significant differences.

In 2004, the largest increases in travel distance for females are partnered adults both with and without children and retired persons. For males, the largest increases in travel distance for 2004 are the young single adults, single adults with children and partnered retirees.

Commuting trips for both females and males are significantly longer than other trips, in general. Yet in 2004, it is the female's commuting trip distance that increases less when compared to all other trips. Males' commuting trip distance shows no significant change in increase from all other trips in 2004.

The estimates from model (3) show that the female lifecycle group still has a strong influence on trip distance change over time (as shown by the 2004 parameters), even when considering covariates, yet the influence of lifecycle group on overall differences is less influential (as shown by the All parameters). However, in model (3) it is the young single adults and partnered adults without and with children in the household that show the

strongest increases in trip distance. Similarly, for males, there is a strong positive influence by lifecycle group for all groups on trip distance change over time. It is the same three lifecycle groups as in model (2) that show the greatest increase in travel distance: young single males, single males with children and retired males.

The covariates indicate that employment has a positive influence on trip distance for both females and males. Residential location has a significant influence on trip distance, in general, but also over time. For females and males, trip distance increases as the distance from the city center increases. Similarly, for both males and females there is a trend of trip distance increasing at a higher rate over time as residence location moves further from the city center.

Car competition shows a strong positive influence on trip distance for all trips for both males and females. However, the estimates indicate that males in households with car competition are increasing trip distance at a lower rate than males in households with no automobile or males in households with no car competition.

Interestingly, nearly all lifecycle group variables have a significant influence on travel distance, even when the covariates are considered (Appendix 4).

### *Travel Distance by Automobile*

The same methods described above are used to evaluate travel distance by automobile trips, as a driver, only (Appendix 5). The results of model (1) show there is a significant increase in trip distance by automobile for both females and males. Females increase their average automobile trip distance from 8.9 km in 1986 to 12.2 km in 2004. Similarly, males increase their average automobile trip distance from 11.7 km in 1986 to 14.9 in 2004.

Model (2) estimates show that, in general, females have the greatest relative increases in automobile trip distance. For both males and females, it is the retired persons that show the highest increases in automobile trip distance for 2004, while it is the same retired persons that show the shortest automobile trip distance, over all.

For males, it is the partnered adults that have the longest automobile trip distance. Females show a similar trend while it is the single female with children that has the absolute highest automobile trip distance. For both males and females, it is the single retiree that has the shortest automobile trip distance.

When considering covariates in model (3), there are almost no significant differences in overall automobile trip distance captured by the “all” lifecycle parameters for females. Partnered males and partnered male retirees have a positive influence on automobile trip distance while there are no significant differences between the other male lifecycle groups.

In 2004, it is the single and partnered female that shows the strongest positive influence on automobile trip distance, while for males it is the partnered adult and retired persons. It is

both the young males and females that show the least increases in automobile trip distance over time.

For females, commute trips by automobile show no significant difference in distance from all other trips. Commute trips by automobile for males are greater in distance than all other trips. Employment has a significant positive influence on automobile trip distance for both females and males.

Residence location has a strong influence on automobile trip distance. Automobile trip distance increases as distance from the inner city increases. There is no significant difference in change between the inner city and inner suburbs; however residents of the outer suburbs increased their automobile trip distance at a greater rate in 2004 than other locations.

Automobile trip distance increases with automobile accessibility, or as car competition decreases. Households with no car competition had the highest automobile trip distance while those households with no automobile had the lowest. For females, the rate of change in automobile trip distance increases with increased car accessibility.

## Automobile Trip Distance Saturation Levels

In general, the data show that the average daily distance as a driver in an automobile has increased; the average total automobile distance as a driver for 1986-7 is 14.16 km and 18.47 km for 2004. Table 5 shows that for those with car competition in the household, the gap by gender is closing. In 2004, the average daily distance as a driver for females increased compared to 1986 and had no change compared to 1986 for males. For those households with no car competition (where the number of automobiles equals the number of drivers), the average daily distance as a driver is increasing for both females and males.

Table 5: Mean automobile distance (km/day) segmented by car competition in household

| | Females | | Males | |
|---|---|---|---|---|
| | **1986** | **2004** | **1986** | **2004** |
| Car Competition in Household | 7.87 | 10.06 | 25.06 | 25.00 |
| No Car Competition in Household | 19.19 | 24.72 | 31.57 | 39.35 |
| No Car in Household | 31.4% | 26.6% | 20.3% | 20.5% |
| Car Competition in Household | 57.3% | 45.4% | 62.3% | 47.3% |
| No Car Competition in Household | 11.3% | 28.0% | 17.4% | 32.2% |

Additionally, the data show that automobile accessibility is increasing for both males and females. In 1986, 31% of women had no automobile and 57% of women lived in households with car competition (households with less automobiles than drivers). In 2004, both of these percentages decreased where 27% of women had no automobile and 45% lived in a household with car competition. Therefore, the percentage of women living in households with no car competition (every driver has access to an automobile) increased from 1986, with 11%, to 2004, with 28%. Interestingly, it is males without automobile access who remain unchanged at 20%. Males in households with car competition made up 62% of males in

1986 and reduced to 47% of males in 2004. Similarly, males in households with no car competition increased from 17% to 32% of all males in 1986 and 2004, respectively. These results indicate that it is the female's access to automobiles that is increasing over time.

These results suggest that in households with car competition, the females' share account for a higher percentage of the automobile share time over time. While the data has been controlled for car accessibility, the data shows that daily automobile usage has not yet reached a saturation level. This explains in part the higher automobile distances over time, since not only are accessibility rates increasing, daily automobile distances are increasing as well.

# DISCUSSION

## The Gender Gap

The results presented in the previous section appear to show a trend of female travel behavior becoming more similar to male travel behavior. Females are increasing their automobile trip frequency, automobile trip distance and automobile accessibility. While males still dominate these travel dimensions, it can be seen repeatedly that the gender gap in many transportation behaviors is narrowing over time. This is particularly true for automobile share of trips and trip frequency.

However, the converse can also be seen. Male travel behaviors in some ways are becoming more similar to females. Males, overall, have significantly decreased their daily trip frequency, so much so that the average daily trip frequency for males and females in 2004 is the same. At least in some lifecycle groups, this reduction in trip frequency can be attributed to a decrease in automobile trips; young males are decreasing their share of automobile trips as a driver. Similarly, commuting trips for males has decreased, particularly in the suburbs. Because this locational trend is observed over all households, with or without children, it seems to indicate that the influence has less to do with household responsibilities and could more reasonably be explained by telecommuting availability or alternative work options.

## Retired Persons

Retired persons are becoming more individually mobile. Having greater access to an automobile has increased trip distances for all retired persons while significantly reducing travel time. The automobile share of trips as a driver has increased, as expected considering the increase in automobile accessibility for retired persons, and decreased their public transit share of trips. This indicates that retired persons are walking and cycling less and to a lesser extent, carpooling less (as automobile share of trips as a passenger decreases).

It may not only be automobile accessibility that is influencing the mobility of retired persons. The retired females of 2004 exhibit many of the transportation trends of the partnered adults and adults with children of 1986. It could be that retired females, particularly, are travelling

according to habit. For example, automobile usage increases for those households with children. It may be that even after the children have left the household, the parents (possibly now retirees) continue to travel with the travel behaviors adopted when the children were in the household.

## Households with Children

Households with children exhibit less change over time than their counterparts without children. Trip frequency for females with children in the household and partnered males with children in the household remains unchanged over the data collection years. Females without children in the household increase their share of automobile trips at a higher rate than their female counterparts with children in the household. In this case, the gap between automobile share for females in households with and without children is closing. Females in households with children had a higher share of automobile trips in 1986 than their female counterparts without children and in 2004 those differences are significantly less. Males are less affected by the presence of children on automobile share, as all non-retired adult males increase equally.

Males and females in households with children increase automobile distance as a driver at the lowest rate. This could indicate that their travel patterns are more established. In 1986 and 2004, it was the females in households with children that had the shortest average trip distance of all lifecycle groups. For males, this trend was not so evident; while single males in households with children showed some of the lowest average trips distances, partnered males in households with children had an average trip distance near to the overall male mean. These results indicate that households with children are more constrained in their trip movements in terms of length. They tend to travel nearer to home at shorter distances.

## Lifecycle Influence

The lifecycle variables estimated in the models show a significant influence in some travel dimensions, indicating that changes over time are not adequately captured using only the covariates presented. This is most clearly seen in the trip distance models, both for all trips and for automobile trips. For all trips, all lifecycle variables for both females and males significantly explain, in part, the increase in trip distance, while only locational variables capture some of the females' increase and both locational and car accessibility variables capture some of the males' increase in trip distance over the data collection years. This influence is slightly less obvious for automobile trips. The increase in automobile trips over the data collection years in explained by both the locational and car accessibility variables for females and males, yet many of the lifecycle variables remain significant. This indicates that while much of the increase in automobile trip distance can be explained by residential moves and increases in automobile accessibility, there are still some lifestyle preferences which influence this travel dimension.

The covariates in the model for trip frequency did not capture any of the change over time for males (there was no significant change in trip frequency for females over time). This

suggests that there is much unobserved influence for all males. It could be that trip frequency has less to do with availability of transportation and other income proxies and is more influenced by lifecycle influences, such as changes in daily activities and household responsibilities.

However, some of the change in travel dimensions over time is effectively explained using only covariates. This is true for the mode share models. In both automobile mode share and public transit mode share, nearly all the lifecycle variables become insignificant when the covariates are included. The exception is retired persons, for both females and males. While residence location and automobile accessibility explain much of the increases in automobile and public transit share for most lifecycle groups, the increases in these modes by retired persons is not. As mentioned before, this could be explained by habit. The retired persons of 2004 are the adults of 1986 and have maintained their learned travel behaviors (preference to automobile trips and automobile accessibility).

# CONCLUSIONS

The share of public transit trips has not increased as much as automobile trips, in spite of major improvements to the transit infrastructure. The conclusion drawn on this is that there had been a trend of decline in public transit share without the improvements to the network. The trend decline could have been caused by the increase in automobile accessibility.

The travel distance has increased at a higher pace among females, while the travel distance among males increases at a lower pace. Similarly, travel distance by automobile has increased for both females and males, with females again showing a higher rate of increase. In other words, women's travel behavior is becoming more similar to men's which explains, in part, the trend increase in travel distance and automobile usage.

The driving distance has also increased on the aggregate level. Unfortunately, comparing groups with the same car accessibility between 1986 and 2004, the driving distance continues to increase in almost all cases. This result indicates there is not a saturation level in driving, when driving no longer increases since most people own a car, at this time.

Overall, automobile usage is increasing since primarily single women have increased automobile accessibility between the years and since a larger number of couples have access to two cars rather than one.

Retirees have shown the greatest differences in travel behaviors over the nearly 20 year period. Automobile accessibility has increased significantly and has therefore significantly increased the share of automobile trips. This is particularly true for retired women. However, not all of the changes in retirees' travel behavior can be attributed to automobile accessibility; in many travel dimensions there are significant, unobserved lifecycle influences that account for these changes in retirees' travel behavior over time.

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# APPENDICES

## Appendix 1: Trip frequency models estimated for all trips

**Model (1):**

| | Females | | | | Males | | | |
|---|---|---|---|---|---|---|---|---|
| | All | t-value | 2004 | t-value | All | t-value | 2004 | t-value |
| Intercept | **1.005** | **113.901** | | | **1.112** | **120.065** | | |
| Year 2004 | | | -0.007 | -0.655 | | | **-0.110** | **-9.496** |

**Model (2):**

| | Females | | | | Males | | | |
|---|---|---|---|---|---|---|---|---|
| | All | t-value | 2004 | t-value | All | t-value | 2004 | t-value |
| Intercept | **1.196** | **41.029** | | | **1.195** | **41.447** | | |
| Young Single Adult | | | **-0.085** | **-2.312** | | | **-0.143** | **-3.779** |
| Young Partnered Adult | -0.063 | -1.747 | **-0.092** | **-3.581** | -0.028 | -0.780 | **-0.145** | **-5.308** |
| Single Adult | **-0.172** | **-4.076** | **-0.081** | **-2.239** | -0.040 | -0.942 | **-0.264** | **-6.927** |
| Single Adult w Children | 0.059 | 0.863 | -0.076 | -1.075 | 0.230 | 1.454 | -0.293 | -1.780 |
| Partnered Adult | **-0.172** | **-5.301** | **-0.083** | **-4.427** | **-0.065** | **-1.988** | **-0.111** | **-5.592** |
| Partnered Adult w Children | -0.047 | -1.307 | 0.036 | 0.024 | 0.021 | 0.570 | **-0.091** | **-3.442** |
| Single Retiree | **-0.708** | **-15.067** | 0.020 | 0.414 | **-0.641** | **-8.901** | 0.076 | 0.964 |
| Partnered Retiree | **-0.775** | **-17.599** | 0.060 | 1.406 | **-0.533** | **-12.172** | 0.039 | 0.958 |

**Model (3):**

| | Females | | | | Males | | | |
|---|---|---|---|---|---|---|---|---|
| | All | t-value | 2004 | t-value | All | t-value | 2004 | t-value |
| Intercept | **1.0018** | **28.878** | | | **0.8465** | **21.796** | | |
| Young Single Adult | | | -0.007 | -0.151 | | | **-0.145** | **-2.985** |
| Young Partnered Adult | -0.045 | -1.152 | -0.043 | -0.949 | 0.033 | 0.829 | **-0.187** | **-3.856** |
| Single Adult | **-0.192** | **-4.529** | -0.059 | -1.211 | -0.079 | -1.832 | **-0.277** | **-5.721** |
| Single Adult w Children | 0.075 | 1.088 | -0.054 | -0.680 | 0.277 | 1.604 | **-0.411** | **-2.265** |
| Partnered Adult | **-0.186** | **-5.002** | -0.075 | -1.737 | **-0.076** | **-1.982** | **-0.171** | **-3.803** |
| Partnered Adult w Children | -0.034 | -0.853 | 0.045 | 1.029 | 0.013 | 0.315 | **-0.149** | **-3.136** |
| Single Retiree | **-0.554** | **-11.405** | 0.038 | 0.609 | **-0.448** | **-6.072** | 0.002 | 0.027 |
| Partnered Retiree | **-0.638** | **-13.355** | 0.075 | 1.299 | **-0.346** | **-6.927** | -0.039 | -0.668 |
| Employed | **0.155** | **11.528** | | | **0.174** | **9.466** | | |
| Inner City Residence | **0.092** | **3.640** | | | **0.134** | **4.803** | | |
| Inner Suburb Residence | -0.010 | -0.484 | 0.016 | 0.470 | 0.030 | 1.295 | 0.019 | 0.508 |
| Outer Suburb Residence | | | -0.018 | -0.576 | | | 0.046 | 1.334 |
| No Car in Household | | | -0.058 | -1.716 | | | 0.031 | 0.858 |
| With Car Competition for HH with Car | **0.061** | **2.486** | -0.020 | -0.617 | **0.174** | **6.100** | 0.010 | 0.306 |
| No Car Competition for HH with Car | **0.150** | **5.199** | | | **0.279** | **9.251** | | |

Figures in bold are statistically significant at the 95% level.

## Appendix 2: Mode share of automobile as driver trips

**Model (1):**

| | Females | | | | Males | | | |
|---|---|---|---|---|---|---|---|---|
| | All | t-value | 2004 | t-value | All | t-value | 2004 | t-value |
| Intercept | **-1.140** | **-58.880** | | | **0.201** | **12.460** | | |
| Year 2004 | | | **0.361** | **15.680** | | | **0.073** | **3.530** |
| R-squared | | | | 0.137 | | | | 0.011 |

**Model (2):**

| | Females | | | | Males | | | |
|---|---|---|---|---|---|---|---|---|
| | All | t-value | 2004 | t-value | All | t-value | 2004 | t-value |
| Intercept | **-1.440** | **-22.950** | | | **-0.260** | **-5.570** | | |
| Young Single Adult | | | **-0.233** | **-2.730** | | | **-0.261** | **-3.780** |
| Young Partnered Adult | 0.072 | 0.910 | -0.100 | -1.530 | 0.039 | 0.650 | **-0.186** | **-3.400** |
| Single Adult | -0.104 | -0.980 | **0.768** | **8.170** | **0.157** | **2.150** | 0.081 | 1.130 |
| Single Adult w Children | **0.688** | **5.250** | 0.121 | 0.920 | **0.982** | **3.910** | 0.189 | 0.700 |
| Partnered Adult | **0.633** | **9.130** | **0.351** | **8.350** | **0.971** | **18.130** | **0.128** | **3.070** |
| Partnered Adult w Children | **0.843** | **11.340** | **0.290** | **6.070** | **0.807** | **13.230** | **0.115** | **2.260** |
| Single Retiree | **-1.650** | **-7.430** | **2.040** | **9.120** | **-1.130** | **-6.260** | **1.370** | **7.090** |
| Partnered Retiree | **-1.350** | **-7.750** | **1.730** | **9.970** | -0.039 | -0.480 | **0.950** | **11.570** |
| Commute Trip | **-0.167** | **-3.750** | -0.021 | -0.390 | **-0.094** | **-2.610** | **-0.149** | **-3.170** |
| R-squared | | | | 0.170 | | | | 0.056 |

**Model (3):**

| | Females | | | | Males | | | |
|---|---|---|---|---|---|---|---|---|
| | All | t-value | 2004 | t-value | All | t-value | 2004 | t-value |
| Intercept | **-3.23** | **-29.14** | | | **-2.35** | **-26.32** | | |
| Young Single Adult | | | **-0.489** | **-4.260** | | | **-0.708** | **-7.190** |
| Young Partnered Adult | **-0.580** | **-5.530** | -0.138 | -1.360 | **-0.607** | **-7.050** | -0.107 | -1.140 |
| Single Adult | **-0.565** | **-4.480** | **0.291** | **2.420** | **-0.717** | **-7.690** | 0.017 | 0.180 |
| Single Adult w Children | -0.037 | -0.220 | -0.088 | -0.490 | 0.316 | 0.970 | -0.563 | -1.640 |
| Partnered Adult | -0.174 | -1.770 | -0.037 | -0.420 | -0.050 | -0.600 | 0.102 | 1.180 |
| Partnered Adult w Children | 0.044 | 0.440 | **-0.173** | **-1.980** | **-0.216** | **-2.470** | -0.052 | -0.590 |
| Single Retiree | **-0.750** | **-3.140** | **0.769** | **3.110** | **-0.904** | **-4.330** | **1.300** | **5.740** |
| Partnered Retiree | **-1.280** | **-6.970** | **0.977** | **5.260** | 0.185 | 1.690 | **0.610** | **5.260** |
| Commute Trip | **-0.285** | **-6.020** | -0.094 | -1.610 | **-0.237** | **-5.990** | **-0.159** | **-3.050** |
| Employed | **0.618** | **17.210** | | | **0.971** | **21.720** | | |
| Inner City Residence | **-1.130** | **-8.280** | 0.203 | 1.380 | **-0.996** | **-11.020** | **0.220** | **2.150** |
| Inner Suburb Residence | **-0.326** | **-6.220** | | | **-0.129** | **-2.950** | | |
| Outer Suburb Residence | | | **0.286** | **4.630** | | | **0.337** | **6.010** |
| No Car in Household | | | **0.394** | **3.460** | | | **0.218** | **2.280** |
| With Car Competition for HH with Car | **2.210** | **22.540** | 0.037 | 0.530 | **2.410** | **30.820** | **-0.159** | **-2.240** |
| No Car Competition for HH with Car | **3.460** | **36.450** | | | **3.070** | **39.980** | | |
| R-squared | | | | 0.319 | | | | 0.213 |

Figures in bold are statistically significant at the 95% level.

## Appendix 3: Mode share of public transit trips

**Model (1):**

| | Females | | | | Males | | | |
|---|---|---|---|---|---|---|---|---|
| | All | t-value | 2004 | t-value | All | t-value | 2004 | t-value |
| Intercept | **-0.874** | **-48.010** | | | **-1.560** | **-73.630** | | |
| Year 2004 | | | **0.076** | **3.440** | | | **0.195** | **7.330** |
| R-squared | | | | 0.113 | | | | 0.295 |

**Model (2):**

| | Females | | | | Males | | | |
|---|---|---|---|---|---|---|---|---|
| | All | t-value | 2004 | t-value | All | t-value | 2004 | t-value |
| Intercept | **-0.737** | **-14.190** | | | **-1.330** | **-24.310** | | |
| Young Single Adult | | | **0.429** | **6.390** | | | **0.481** | **6.370** |
| Young Partnered Adult | **-0.232** | **-3.470** | **0.439** | **7.920** | -0.079 | -1.140 | **0.419** | **6.690** |
| Single Adult | -0.123 | -1.450 | 0.022 | 0.280 | **-0.360** | **-4.080** | **0.369** | **4.160** |
| Single Adult w Children | **-0.504** | **-3.790** | 0.156 | 1.110 | **-1.040** | **-2.810** | 0.539 | 1.390 |
| Partnered Adult | **-0.839** | **-13.630** | **0.229** | **4.790** | **-0.994** | **-14.970** | **0.227** | **3.770** |
| Partnered Adult w Children | **-1.080** | **-14.880** | **0.259** | **4.250** | **-1.020** | **-12.690** | **0.278** | **3.680** |
| Single Retiree | **0.552** | **5.440** | -0.188 | -1.770 | **0.650** | **4.150** | **-0.557** | **-3.140** |
| Partnered Retiree | **0.204** | **2.170** | **-0.633** | **-6.380** | -0.194 | -1.910 | **-0.291** | **-2.710** |
| Commute Trip | **1.130** | **27.030** | **-0.262** | **-5.120** | **0.855** | **18.790** | **-0.130** | **-2.250** |
| R-squared | | | | 0.166 | | | | 0.332 |

**Model (3):**

| | Females | | | | Males | | | |
|---|---|---|---|---|---|---|---|---|
| | All | t-value | 2004 | t-value | All | t-value | 2004 | t-value |
| Intercept | **-0.276** | **-4.08** | | | -0.0714 | -0.91 | | |
| Young Single Adult | | | **0.574** | **6.230** | | | **0.911** | **8.510** |
| Young Partnered Adult | **0.185** | **2.300** | **0.445** | **4.640** | **0.429** | **4.790** | **0.467** | **4.140** |
| Single Adult | 0.040 | 0.440 | **0.450** | **4.250** | **0.318** | **3.020** | **0.562** | **4.650** |
| Single Adult w Children | -0.237 | -1.620 | **0.358** | **2.170** | -0.563 | -1.300 | **1.460** | **3.220** |
| Partnered Adult | **-0.285** | **-3.680** | **0.447** | **4.830** | -0.068 | -0.740 | **0.360** | **3.170** |
| Partnered Adult w Children | **-0.563** | **-6.580** | **0.513** | **5.260** | -0.110 | -1.090 | **0.464** | **3.860** |
| Single Retiree | -0.036 | -0.330 | **0.563** | **4.250** | 0.117 | 0.650 | -0.070 | -0.330 |
| Partnered Retiree | 0.076 | 0.720 | -0.134 | -1.050 | **-0.479** | **-4.030** | 0.224 | 1.550 |
| Commute Trip | **1.320** | **29.560** | **-0.208** | **-3.850** | **1.170** | **22.800** | **-0.171** | **-2.700** |
| Employed | **-0.484** | **-15.390** | | | **-0.934** | **-20.550** | | |
| Inner City Residence | **0.403** | **5.010** | **-0.331** | **-3.700** | 0.177 | 1.810 | -0.100 | -0.920 |
| Inner Suburb Residence | **0.449** | **9.950** | | | **0.351** | **6.580** | | |
| Outer Suburb Residence | | | -0.046 | -0.830 | | | -0.093 | -1.380 |
| No Car in Household | | | **-0.148** | **-2.000** | | | **-0.388** | **-4.390** |
| With Car Competition for HH with Car | **-0.854** | **-15.600** | -0.085 | -1.040 | **-1.640** | **-24.700** | 0.026 | 0.270 |
| No Car Competition for HH with Car | **-1.800** | **-26.870** | | | **-2.480** | **-32.500** | | |
| R-squared | | | | 0.226 | | | | 0.411 |

Figures in bold are statistically significant at the 95% level.

## Appendix 4: Trip distance models estimated for all trips

**Model (1):**

| | Females | | | | Males | | | |
|---|---|---|---|---|---|---|---|---|
| Parameters | All | t-value | 2004 | t-value | All | t-value | 2004 | t-value |
| Intercept | **1.233** | **138.730** | | | **1.593** | **179.500** | | |
| Year 2004 | | | **0.448** | **40.510** | | | **0.354** | **31.430** |

**Model (2):**

| | Females | | | | Males | | | |
|---|---|---|---|---|---|---|---|---|
| Parameters | All | t-value | 2004 | t-value | All | t-value | 2004 | t-value |
| Intercept | **1.150** | **38.925** | | | **1.290** | **46.676** | | |
| Young Single Adult | | | **0.497** | **13.328** | | | **0.497** | **13.488** |
| Young Partnered Adult | **0.195** | **5.431** | **0.373** | **14.039** | **0.285** | **8.377** | **0.261** | **9.675** |
| Single Adult | -0.045 | -1.047 | **0.454** | **11.986** | **0.107** | **2.656** | **0.403** | **10.651** |
| Single Adult with Children | **-0.167** | **-2.472** | **0.282** | **4.026** | 0.086 | 0.592 | **0.548** | **3.626** |
| Partnered Adult | 0.051 | 1.572 | **0.589** | **28.563** | **0.325** | **10.549** | **0.353** | **17.119** |
| Partnered Adult with Children | **-0.238** | **-6.610** | **0.530** | **21.551** | **0.224** | **6.480** | **0.340** | **13.202** |
| Single Retiree | -0.069 | -0.069 | **0.514** | **9.158** | -0.071 | -0.902 | **0.364** | **4.159** |
| Partnered Retiree | -0.069 | 0.641 | **0.552** | **11.282** | -0.055 | -1.229 | **0.647** | **14.895** |
| Commute Trip | **0.455** | **19.367** | **-0.082** | **-2.793** | **0.395** | **18.296** | -0.002 | -0.075 |

**Model (3):**

| | Females | | | | Males | | | |
|---|---|---|---|---|---|---|---|---|
| Parameters | All | t-value | 2004 | t-value | All | t-value | 2004 | t-value |
| Intercept | **1.208** | **34.468** | | | **1.302** | **33.841** | | |
| Young Single Adult | | | **0.348** | **6.958** | | | **0.516** | **11.191** |
| Young Partnered Adult | 0.043 | 1.106 | **0.226** | **4.863** | **0.137** | **3.647** | **0.369** | **7.993** |
| Single Adult | **-0.106** | **-2.505** | **0.233** | **4.692** | 0.001 | 0.035 | **0.411** | **8.774** |
| Single Adult with Children | **-0.328** | **-4.825** | 0.098 | 1.248 | -0.193 | -1.270 | **0.566** | **3.529** |
| Partnered Adult | **-0.146** | **-3.920** | **0.346** | **7.795** | **0.089** | **2.447** | **0.414** | **9.448** |
| Partnered Adult with Children | **-0.424** | **-10.763** | **0.259** | **5.812** | 0.007 | 0.180 | **0.351** | **7.778** |
| Single Retiree | -0.001 | -0.012 | **0.198** | **2.943** | -0.011 | -0.136 | **0.288** | **3.098** |
| Partnered Retiree | 0.003 | 0.051 | **0.182** | **2.957** | -0.097 | -1.936 | **0.637** | **10.954** |
| Commute Trip | **0.439** | **18.920** | **-0.092** | **-3.170** | **0.370** | **17.430** | 0.007 | 0.271 |
| Employed | **0.074** | **5.229** | | | **0.131** | **6.980** | | |
| Inner City Residence | **-0.411** | **-15.878** | | | **-0.568** | **-21.179** | | |
| Inner Suburb Residence | **-0.064** | **-2.909** | **0.128** | **3.655** | **-0.147** | **-6.657** | 0.018 | 0.495 |
| Outer Suburb Residence | | | **0.352** | **11.026** | | | **0.118** | **3.571** |
| No Car in Household | | | -0.004 | -0.112 | | | -0.055 | -1.534 |
| With Car Competition for HH with Car | **0.128** | **5.072** | 0.011 | 0.351 | **0.185** | **6.598** | **-0.119** | **-3.769** |
| No Car Competition for HH with Car | **0.242** | **8.366** | | | **0.211** | **7.284** | | |

Figures in bold are statistically significant at the 95% level.

## Appendix 5: Trip distance models estimated for automobile trips

**Model (1):**

| | Females | | | | Males | | | |
|---|---|---|---|---|---|---|---|---|
| Parameters | All | t-value | 2004 | t-value | All | t-value | 2004 | t-value |
| Intercept | **2.135** | **37.760** | | | **6.277** | **69.410** | | |
| Year 2004 | | | **1.687** | **23.910** | | | **2.092** | **18.180** |

**Model (2):**

| | Females | | | | Males | | | |
|---|---|---|---|---|---|---|---|---|
| Parameters | All | t-value | 2004 | t-value | All | t-value | 2004 | t-value |
| Intercept | **1.578** | **8.335** | | | **4.043** | **14.341** | | |
| Young Single Adult | | | 0.382 | 1.597 | | | 0.659 | 1.748 |
| Young Partnered Adult | 0.311 | 1.349 | **0.475** | **2.781** | 0.654 | 1.881 | 0.511 | 1.855 |
| Single Adult | -0.151 | -0.551 | **2.452** | **10.060** | **1.093** | **2.656** | **2.146** | **5.535** |
| Single Adult with Children | **1.594** | **3.678** | 0.272 | 0.605 | 2.534 | 1.717 | **3.041** | **1.971** |
| Partnered Adult | **1.018** | **4.865** | **2.229** | **16.800** | **3.447** | **10.967** | **2.763** | **13.058** |
| Partnered Adult with Children | **1.183** | **5.131** | **1.675** | **10.610** | **2.602** | **7.367** | **1.980** | **7.505** |
| Single Retiree | **-1.163** | **-3.546** | **2.008** | **5.539** | **-2.098** | **-2.617** | **4.740** | **5.271** |
| Partnered Retiree | **-0.997** | **-3.265** | **2.455** | **7.786** | 0.438 | 0.962 | **4.952** | **11.121** |
| Commute Trip | 0.065 | 0.434 | 0.327 | 1.734 | **1.279** | **5.808** | 0.096 | 0.337 |

**Model (3):**

| | Females | | | | Males | | | |
|---|---|---|---|---|---|---|---|---|
| Parameters | All | t-value | 2004 | t-value | All | t-value | 2004 | t-value |
| Intercept | 0.192 | 0.867 | | | -0.305 | -0.787 | | |
| Young Single Adult | | | **1.078** | **3.418** | | | **2.117** | **4.540** |
| Young Partnered Adult | -0.344 | -1.394 | **1.065** | **3.628** | 0.003 | 0.007 | **2.128** | **4.568** |
| Single Adult | **-0.592** | **-2.216** | **1.769** | **5.642** | -0.198 | -0.489 | **2.855** | **6.024** |
| Single Adult with Children | 0.534 | 1.249 | 0.015 | 0.030 | -0.274 | -0.179 | 2.676 | 1.655 |
| Partnered Adult | 0.037 | 0.157 | **1.655** | **5.902** | **1.391** | **3.793** | **3.468** | **7.836** |
| Partnered Adult with Children | 0.118 | 0.476 | **0.885** | **3.148** | 0.645 | 1.664 | **2.293** | **5.028** |
| Single Retiree | 0.383 | 1.169 | 0.450 | 1.059 | 0.461 | 0.576 | **3.704** | **3.932** |
| Partnered Retiree | -0.335 | -1.055 | **1.169** | **2.996** | **2.058** | **4.089** | **4.501** | **7.659** |
| Commute Trip | -0.090 | -0.616 | 0.227 | 1.243 | **0.972** | **4.538** | 0.083 | 0.300 |
| Employed | **0.913** | **10.199** | | | **2.494** | **13.133** | | |
| Inner City Residence | **-1.131** | **-6.932** | | | **-2.960** | **-10.950** | | |
| Inner Suburb Residence | **-0.842** | **-6.063** | 0.259 | 1.174 | **-1.986** | **-8.929** | 0.368 | 0.773 |
| Outer Suburb Residence | | | **1.290** | **6.394** | | | **1.465** | **4.375** |
| No Car in Household | | | **-1.174** | **-5.366** | | | **-1.602** | **-4.435** |
| With Car Competition for HH with Car | **1.797** | **11.270** | **-0.854** | **-4.143** | **4.809** | **17.026** | **-1.989** | **-6.220** |
| No Car Competition for HH with Car | **4.728** | **25.923** | | | **6.478** | **22.150** | | |

Figures in bold are statistically significant at the 95% level.