Peak Car for urban Swedish men?

Anne Bastian and Maria Börjesson

Centre for Transport Studies, KTH Royal Institute of Technology

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Abstract
We study long-term trends in regional car travel demand within and across socio-demographic groups in Sweden, using cross-sectional data from National Travel Surveys, spanning the period from 1978 to 2011. We find that the reduction in per-adult driving in Sweden mainly occurs among urban men. Urban men of all income groups reduced their driving for both commuting and non-commuting trips in conjunction with rising gasoline prices, which may have contributed to this development. We find that driving among those socio-demographic groups, who have better opportunities to reduce their driving, and driving for discretionary rather than commute purposes is being reduced over time. Sweden is ranked among the most gender-equal countries in the world; yet we find a substantial remaining gender gap in the share of adults driving a car on an average day, even when controlling for other socio-economic differences.

Keywords: Travel behavior: peak car; GDP elasticity; fuel price elasticity; car use

Centre for Transport Studies
SE-100 44 Stockholm
Sweden
www.cts.kth.se

1 INTRODUCTION

It is by now well-documented that the growth in car vehicle kilometers traveled per capita slowed down or declined after the mid-2000s in many advanced economies (Goodwin, 2013; Goodwin and Van Dender, 2013; Millard-Ball and Schipper, 2011). Bastian and Börjesson (2014) show that the trend decline in Sweden 2008-2012, which was stronger in urban areas than elsewhere, can be explained by fuel prices and GDP. That result, however, does not take into account the fact that car use has developed very differently in different socio-economic groups. For instance, Grimal et al. (2013) find signs of saturation of car use in the highest income group. Kuhnimhof et al. (2011 and 2013) find that among young adults, in particularly among men, car use plateaued in the 1990s and declined after the turn of the millennium in the UK and Germany. In Germany, it decreased to the extent that the gender gap in car use closed in this age group. In this paper, we explore car use trends and their drivers within different socio-economic groups, applying the Swedish National Travel Survey (NTS) conducted from 1978 to 2011.

The key issue in the Peak Car debate is whether the observed trend decline in car use is caused by factors other than the traditional socio-economic factors, for instance by changes in preferences, attitudes, and life-styles. We use descriptive statistics and regression models to describe the trends in car use and to explore to what extent they can be explained by socio-economic changes and to what extent the trends are driven by unobserved factors.

Because of substantial differences in car use and car use trends, we distinguish between urban and non-urban populations, men and women, and commuting and non-commuting trips. A Tobit model is applied, simultaneously modeling the probability of driving on a given day and the total distance driven within the day, given that the individual drives. The driving behavior is modeled as a function of a number of socio-economic controls including age, income, education level, household composition, type of house, public transport accessibility, and gasoline prices. We restrict the analysis to trips made as the driver of a car and only trips under 100 km in length.

Frändberg and Vilhelmson (2011) analyze the same data as we do but focus on the more general travel pattern. They show that there is a shift from regional and national to international travel and towards faster modes. In consistency with Grimal et al. (2013), we find that the effect of income on driving behavior is S-shaped in the cross-section, suggesting a saturation effect in the highest income segments.

Some of the trends in car use that we find cannot be explained by the controls; for instance, retired men and women drive more in the later years. Moreover, there was a substantial trend decline in the propensity to drive among young men from 1978/86 to the mid-1990s. Similar patterns are found in the UK and Germany (Kuhnimhof et al. 2013). Frändberg and Vilhelmson (2011) show, however, that the young men in this generation almost reached the license-holding and car-access levels of previous generations later in life. We also find that commuting distances by car have increased over time, which is not explained by the controls and is probably an effect of labor market specialization.

Our most striking finding is a trend decline in the probability of driving among urban men of all income groups, most strongly for non-commuting trips. This trend decline might be explained by increases in gasoline prices. However, gasoline prices have increased at a relatively constant rate over the time span we model. Hence, a potential response to increased gasoline prices cannot be distinguished from shifts in unobserved factors, such as preferences. Le Vine et al. (2013) find that reduced company car access explains some reductions in driving among British men. This is, however, not the case in Sweden, where company car access has remained stable.

Women appear to have remained less affected by higher gasoline prices, possibly because they find it harder to adapt their driving, since they already drive substantially less than men. The probability of driving for commute travel is less sensitive to gasoline price increases in any group.

2 DATA

In this paper, we analyze Swedish NTS data for the years 1978-1984, 1994-1997, 1999-2001, 2005-2006, and 2011. The annual samples are independent, i.e., they are not panel surveys. In the model estimation, we discard the 1978-1984 data, because some explanatory variables are not coded in these earliest surveys. Moreover, the interview method changed after 1984 from in-person to telephone interviews. Respondents in the NTS data are sampled randomly from the Swedish population. The sample is weighted to be representative of the Swedish population with respect to age, gender, and municipality of residence. The survey collects socio-demographic characteristics as well as the stated travel behavior on a random survey day for each respondent. The survey days are distributed evenly over the year.

Urban areas are defined as Stockholm County and the municipalities of Gothenburg and Mölndal. Respondents living in these urban areas are referred to as urban adults. We analyze trips among adults aged 18-84 where the respondent drove a car (not considering car passengers), and we limit our analysis to trips with less than 100 km between origin and main destination. Trips longer than 100 km induce a substantial random variation in driving distance across years due to the combination of low frequency and long average distance. The excluded long trips make up approximately 20 percent of the total vehicle kilometers travelled in Sweden.

We describe and analyze the respondents' driving behavior in two dimensions. First, we analyze whether the respondent is a driver. A respondent is defined as a driver if she drove a car on the survey day. Second, we analyze the total driving distance driven during the survey day, given that the respondent is a driver. Car passengers, who are not driving the car themselves, are excluded from the analysis, because the interest of this study lies in vehicle kilometer demand.

Public transport density estimates were provided by Trafikanalys Sweden. The metric used is the square root of (vehicle km per square kilometer) per municipality, considering all trips that began in each municipality in 2012. We use real annual average gasoline prices provided by the Swedish Petrol and Biofuel Institute (2014). We do not consider changes in diesel prices separately. Diesel volume prices in Sweden have increased at the same rate as gasoline prices over the most recent years, which is when most of the share increase of diesel cars in the Swedish car fleet took place. Gasoline and diesel price statistics are shown in the appendix.

The survey was only conducted via land-line telephone interviews (1994-2011) and in Swedish only. Swedish-born respondents may, therefore, be overrepresented in the NTS data, particularly in the later years, when equipping a household with a land-line phone became less common (Swedish Post and Telecom Authority, 2014).

3 METHOD

The main question addressed by this study is whether the observed aggregate trend decline in driving behavior is driven by factors other than the traditional socio-economic factors.

In section 4, we describe the driving behavior based on the NTS data. Section 4.1 describes cross-sectional differences in driving behavior. Section 4.2 describes the trends in driving behavior within socio-economic groups. Section 4.3 describes how the socio-economic composition of the population has changed over the analyzed period, since this might have affected the aggregate trends in driving behavior.

Section 5 defines the Tobit model, and section 6 interprets the results. We estimate the model to explore to what extent the trends in driving behavior described in section 4 are statistically significant and whether they can be explained by the socio-economic controls. License holding and car ownership are not considered in any of our models. Our modeling aims at understanding the impact of socio-economic factors on the driving decision and distance, rather than modeling the underlying decision chain.

In section 6.3, we predict driving behavior based on the socio-economic population composition during different survey years, applying a model estimated on data from all survey years 1994-2011. Systematic gaps between the predicted and the observed driving behavior indicate an impact of unobserved factors on driving patterns.

4 DESCRIPTIVE RESULTS

4.1 Cross-sectional differences in driving behavior

This section describes cross-sectional differences in driving behavior according to the NTS data, referring to Figures 1 and 2. Figure 1 shows the share of drivers among adults by income quartile. Quartiles for real stated annual income are defined based on all adults in the pooled data sets from 1994 to 2011. Approximately 20 percent of NTS respondents have not stated their income in the survey. These respondents are treated as a separate income category. Figure 2 shows the share of drivers by age, gender and urbanity (urban versus non-urban adults).

Figure 2 shows that there is a larger share of drivers among men and among middle-aged respondents. There is a lower share of drivers in urban areas, possibly because urban residents have more attractive public transit and slow mode alternatives as well as a larger variety of local destination alternatives compared to non-urban residents. Hence, long-term demographic change, population location, and land-use are important for long-term trends in car use.

Figure 1 indicates a possible S-shaped relationship between cross-sectional income and driving probabilities. Thus, driving decisions among low and high income adults appear less affected by a marginal income differences. The share of drivers among high income adults varies by gender and urbanity, suggesting that saturation levels of driving vary and depend on geography, the availability of transport alternatives and possibly preferences.

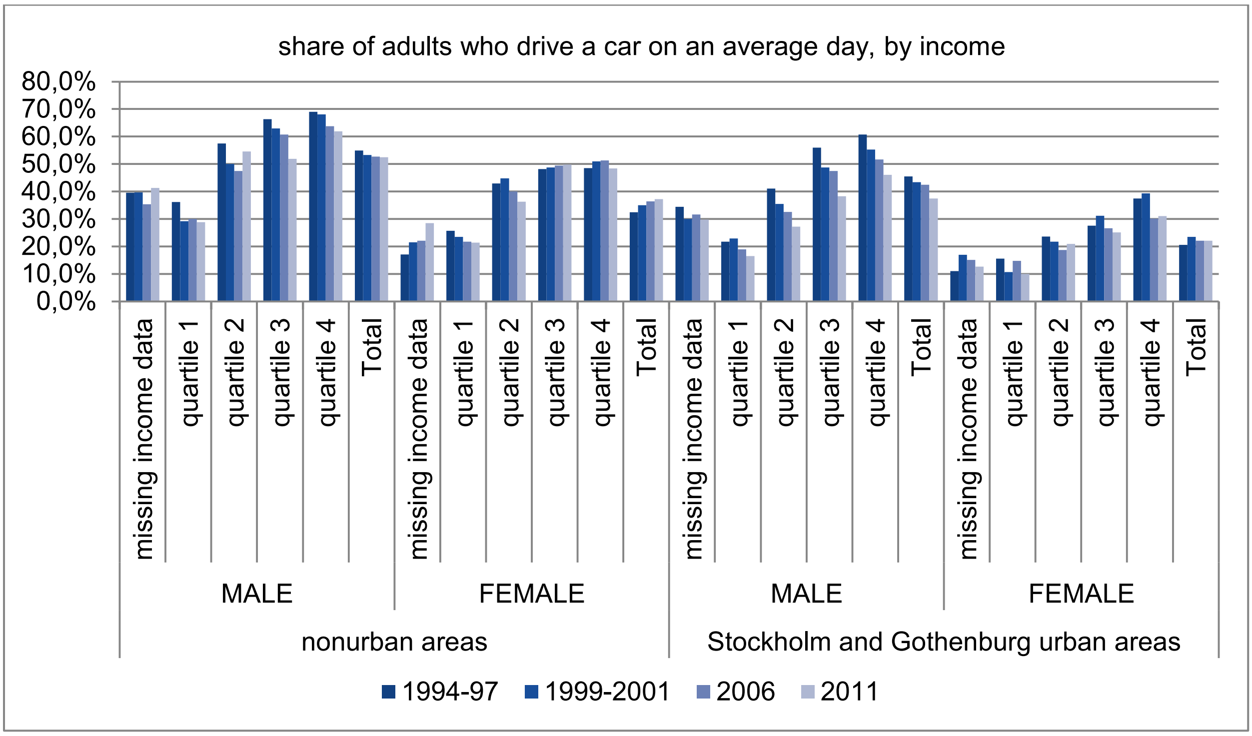

Figure 1: Share of adults who drive a car on interview day, by income.

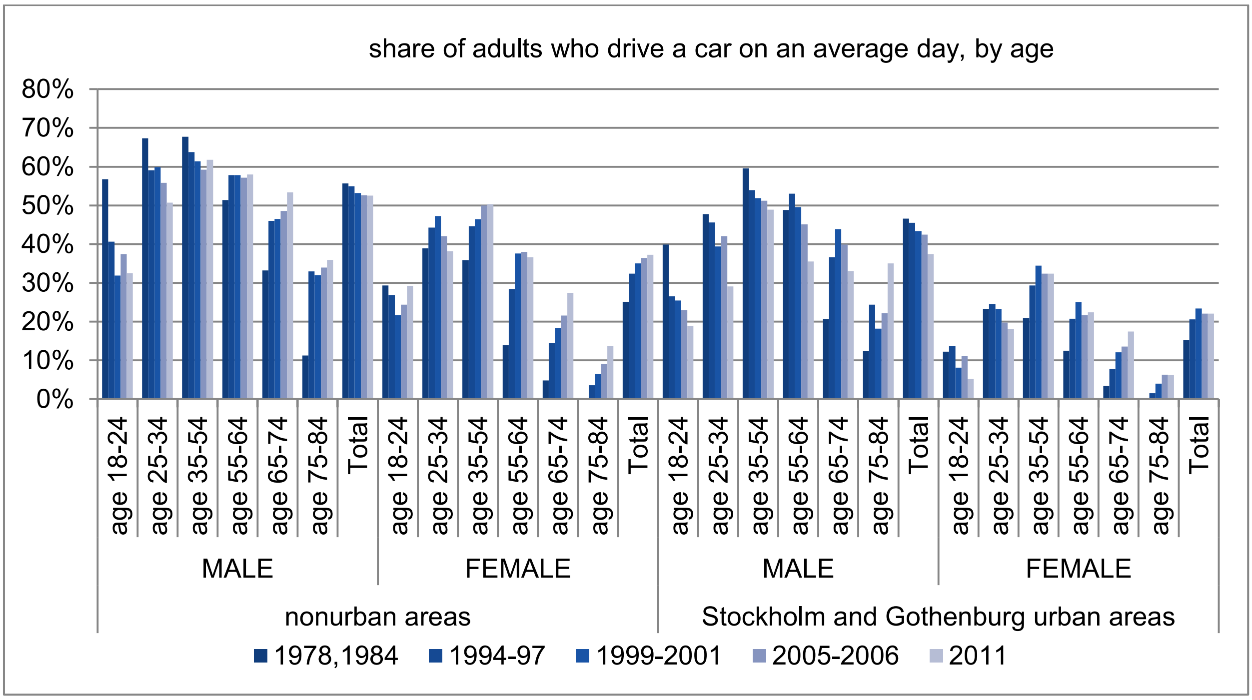

Figure 2: Share of adults who drive a car on interview day, by age group.

4.2 Driving trends over time by socio-demographic group

In this section, we describe trends in driving behavior by socio-demographic group and trip purpose, using Figures 1 and 2 in the previous section and Figure 3 and 4 in this section. Figure 3 and 4 show the share of drivers and the average driving distance per driver, considering commuting and non-commuting trips separately.

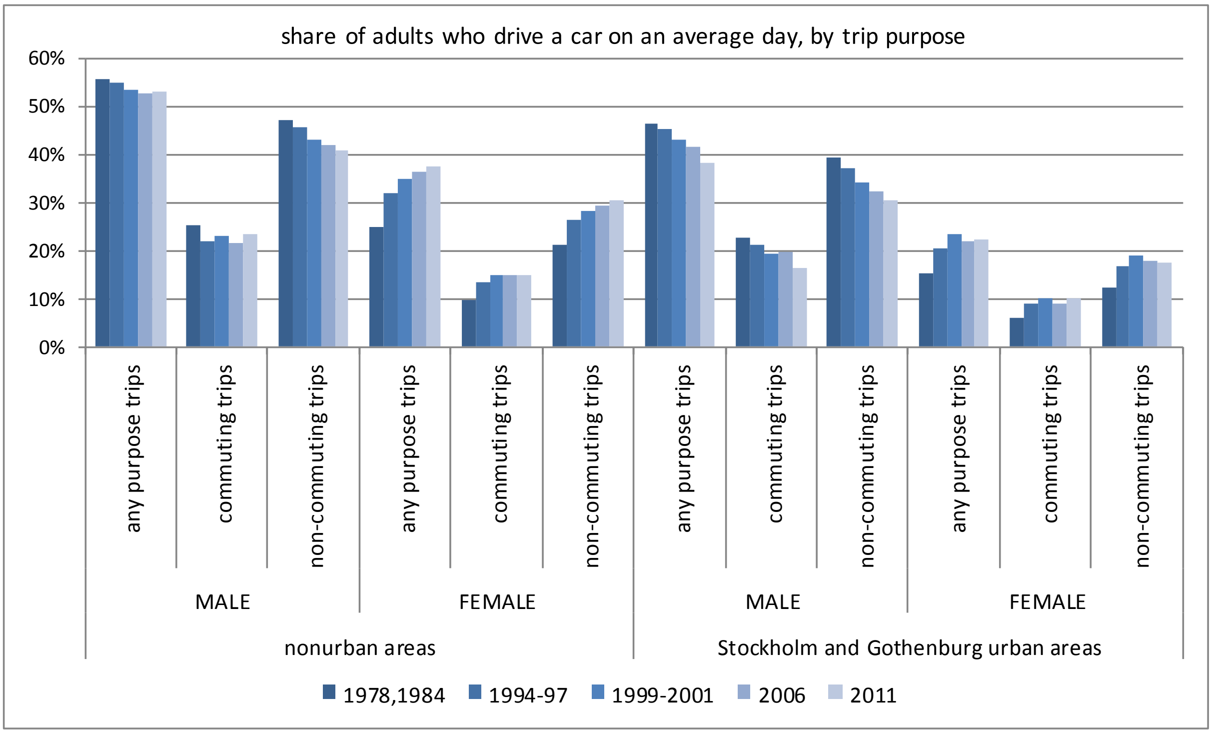

Figure 3: Share of adults who drive a car on interview day, by trip purpose.

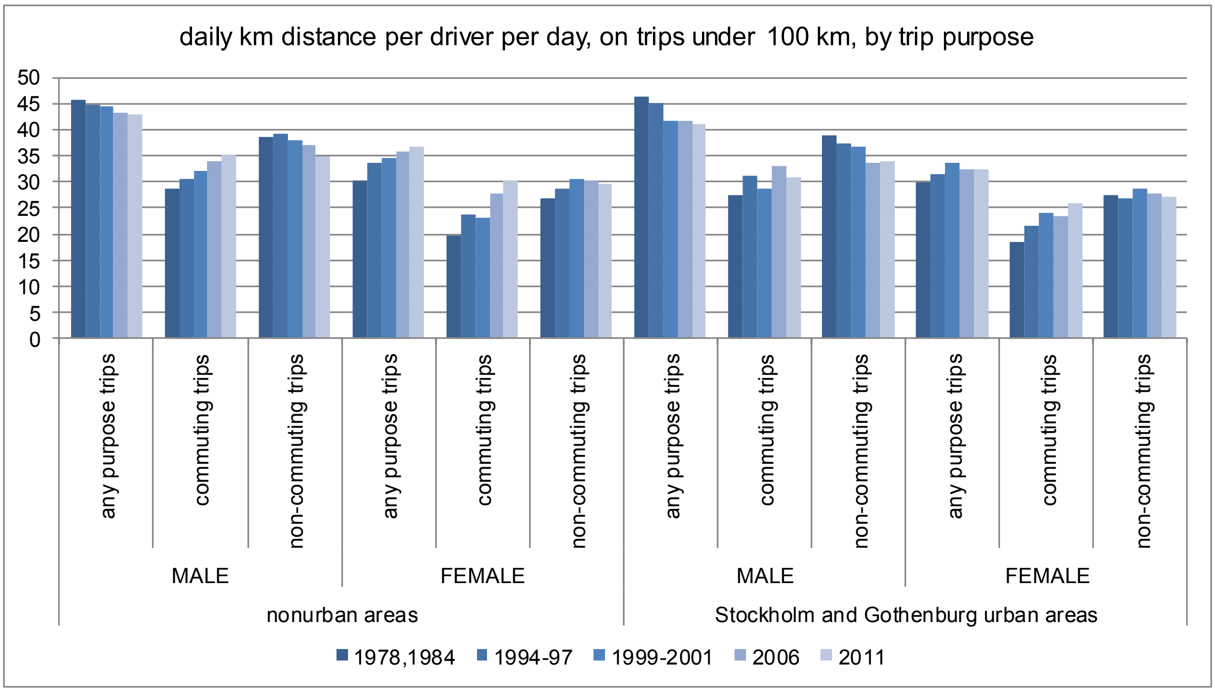

Figure 4: Average daily km distance driven per car driver, only considering trips under 100 km, by trip purpose.

Steep trend decline in driving among young men until the mid-1990s

According to Figure 2, the share of drivers among young men declined sharply from 1978/84 to the mid-1990s. A possible explanation is the economic crisis and rising levels of unemployment in the first half of the 1990s, hitting young adults the hardest (Statistics Sweden, 2005). Moreover, increasing shares of young adults acquiring higher education, postponing full-time employment and family formation, have contributed to widening the income gap between younger and older adults (Statistics Sweden, 2005). Since some of these variables are not available in the 1978/84 data, we cannot explore the extent to which they can explain the drop in young men's driving.

Retirees drive more over time

Among retirees, the share of drivers (see Figure 2) and the distances driven per driver (see Figure 6 in the appendix) have increased over time. The share of drivers among male retirees increased sharply between 1978/84 and the mid-1990s. Female retirees barely drove at all in 1978/84, but the share of drivers among them has increased gradually over the whole analyzed period. In absolute terms, however, retirees still drive less than adults of working age.

The share of drivers among urban men declines over time

The share of drivers among urban men has declined over the whole analyzed period in all income groups. The trend decline is stronger for non-commuting trips than for commuting. However, urban men are still much more likely to be drivers than urban women.

Among non-urban men, the share of drivers has remained more stable. There is some trend decline before the turn of the millennium, but only for non-commuting trips.

Gender gap narrowing but still substantial gender differences in car driving

Figure 2 shows that the average share of drivers among urban women has remained approximately stable since the late 1990s, but increased before that. This aggregate trend hides a trend decline among young women and an increase among older women. Among non-urban women, the trend increase in the share of drivers stretches over the entire period analyzed and is mainly driven by retirees. For women, the trend increase in the share of drivers has primarily occurred for non-commuting trips.

The gender gap regarding the share of drivers and in driving distance per driver narrowed sharply between 1978-1984 and 1994-1997, but has thereafter narrowed more slowly. Still, the gender gap in the share of drivers remains substantial even in 2011.

Focusing on car use, defined as being a car passenger or a driver, instead of driving, among partnered adults in Sweden, the gender gap is substantially smaller (see Figure 7 in the appendix). However, among single adults the gender gap remains substantial. One can interpret this as implying that, when a woman is partnered with a man, she joins him in the car, usually as a passenger, but that the preference for driving is higher among men.

Commuting distances increase over time

Figure 4 shows a trend increase in commuting distances driven by any group. Non-commute driving distances, however, are stable among women and decreasing among men.

Changes in population structure

The size of the non-urban population has remained relatively stable since the 1990s, but it has aged slightly. The share of adults aged 25-34 declined while the share of adults aged 55-64 increased (see Table 5 in the appendix). The net impact of this ageing process on driving behavior is limited, because the two age groups are similar with respect to the share of drivers and driving distance per driver (see Figure 2 and Figure 3). The adult age distribution in urban areas has not changed as much (see Table 4 in the appendix).

Population growth mainly occurs in urban areas. The urban population grew by 9% between 2006 and 2011. Urban adults now account for 28% of the national population. While this urbanization process is too slow to explain the decline in average driving distance per adult 2008-2012 (Bastian and Börjesson, 2014), it might be more important for future long-term trends in car travel.

5 MODEL SPECIFICATION

We model adults' decision to drive a car on their interview day (selection) and the daily distance driven by car on trips under 100 km length (outcome) via a Tobit-2 regression model, using the R package sampleSelection by Toomet and Henningsen (2008).

We estimate separate models for men versus women, urban versus non-urban adults, and commute versus non-commute trips. We do this to account for the substantial differences in driving behavior and driving behavior trends among these groups and trip types. All adult respondents of all survey years from 1994 to 2011 are considered in the non-commute trip models. Commute trip models are estimated for employed adults only.

Explanatory variables considered are real annual average gasoline price per liter, survey year indicators, real individual annual income (piecewise linear effects), single vs. partnered, apartment vs. single family home, employed vs. non-working, children aged 0-18 in the household vs. no children, age group, highest education level ,and the public transit supply in the home municipality. We have taken out all insignificant explanatory variables from the models.

As indicated by the descriptive results, we find significant cohort effects (difference across generations) for non-commute driving decisions. We therefore include interactions of age-groups and survey-year-groups in the non-commute driving decision models.

6 MODEL RESULTS

6.1 Cross-sectional differences

The estimation results for commuting and non-commuting trips are shown in Table 1 and Table 2. In general, we find that factors influencing driving decisions also influence driving distances. Hence, adults with a high probability of being a driver also tend to drive longer distances, given that they do drive.

Living in a single family house and in a municipality with low public transit supply substantially increases the probability of being a driver, considering both commuting and non-commuting trips. Having at least a senior high school education and having children in the household increase the probability of being a driver for non-commuting trips. Parents are more likely to be drivers, partly directly because of the children and partly because they are more likely to live in a single family house. Yet parents, primarily mothers, commute shorter distances than drivers without children. Fathers in urban areas do not commute shorter distances than men without children.

Partnered men have a significantly higher probability of being a driver than single men, considering non-commuting as well as non-commuting trips (except for non-urban male commuters). Yet, for non-urban women, partnership appears to have the opposite effect.

The estimation results for urban adults confirm an S-shaped cross-sectional income effect on the probability of being a driver. Among non-urban adults, driving probabilities already increase significantly with marginal income differences in the lowest income group.

When pooling men and women into one model (results details are not shown to save space), we find that gender is the strongest predictor of whether an adult is a driver and how far they drive, even after controlling for socio-economic differences

6.2 Trends over time

The gasoline price has a significant negative impact on the probability of being a driver for non-commuting trips in all groups except non-urban females. For commuting trips, the negative effect of gasoline price on the probability of being a driver is only significant for urban men. For distances driven per driver, the gasoline price effect is not negative and significant in any of the models and therefore excluded.

The model estimates in Table 1 and Table 2 suggest that gasoline price elasticity is closely linked to the possibility (or the disutility) of adjusting. Men have a high probability of being drivers in general, and most urban men have also a variety of attractive mode and destination alternatives. Both factors could imply than men and urban populations can more easily adjust to higher gasoline prices by reducing their driving. It would explain why men, and in particular urban men, adjust by reducing driving frequencies in response to rising gasoline prices more than women. The effect of gasoline price on the probability of being a driver is larger for non-commuting trips, indicating better possibilities to adjust the driving behavior for these trips than for commuting trips. Possible adjustment strategies, resulting in decreasing driver shares, might include trip canceling, more efficient activity coordination or mode changes.

After accounting for gasoline prices, we find no significant year indicator effects for the probability of being a commuting driver. Significant year effects would suggest a trend that cannot be explained by other variables. For commuting distances, we find a significantly increasing trend over the years. This confirms the pattern of longer commuting distances found in Section 4.

For non-commuting trips, we find a significant decline between 1994-1997 and 1999-2011 in the probability of being a driver among young urban women and young non-urban men; this decline is not explained by the other variables. For retirees, we find an increase in the share of drivers, which is not explained by the other variables. We found no significant trend in the distances driven on non-commute trips.

The strong decline in the share of drivers among urban men could be explained according to the model by high gasoline price elasticity. Since, however, the gasoline price has increased at a relatively constant rate over the entire modeled period, some of the trend decline picked up by the parameter for gasoline price might be due to unobserved factors that correlate with gasoline prices trends. In other words, if there is a preference shift away from driving among urban men, we cannot, based on the present data, distinguish this from a response to gasoline price increases.

Table 1: Model results for commute driving per day among employed adults, only trips under 100 km. Indicator variable values that have been defined as the base case are displayed as empty rows. Income effects were modeled as piecewise linear.

	urban females		non-urban females		urban males		non-urban males	
commute	estimate	t-value	estimate	t-value	estimate	t-value	estimate	t-value
Selection (driving decision on interview day)								
(Intercept)	-1.22	-5.46	-1.05	-8.11	-0.55	-2.38	-0.90	-6.90
gas price					-0.56	-5.36		
missing income data			0.24	2.46	0.58	2.85	0.39	3.66
income slope Q1	0.19	1.48	0.22	3.05	0.27	1.65	0.22	2.72
income slope Q2	-0.06	-0.52	0.22	3.79	0.37	2.63	0.28	3.49
income slope Q3	0.27	3.28	0.14	2.48	0.10	1.39	0.08	1.85
income slope Q4	0.01	0.51	-0.03	-1.01	0.01	0.82	-0.02	-2.02
single								
partnered			-0.15	-4.76	0.13	3.26		
apartment								
single family home	0.46	10.41	0.42	14.19	0.14	3.81	0.22	8.56
age 18-24	-0.34	-3.48						
age 25-34			0.10	3.48			0.11	4.25
age 35-54								
age 55-64	-0.10	-2.01	-0.14	-4.57				
age 65-74					-0.44	-3.01	-0.46	-4.69
Pre-senior high			-0.11	-3.46			-0.08	-3.17
Senior high school								
Post-senior high			-0.13	-4.73	-0.17	-4.60	-0.15	-5.59
public transit density	-0.04	-5.10	-0.05	-3.91	-0.04	-5.75		
Outcome (distance driven per driver per day)								
(Intercept)	29.55	4.95	26.56	9.48	36.37	10.88	27.40	8.58
years 1994-1997								
years 1999-2001								
years 2005-2006			3.76	2.95			3.89	2.66
year 2011	5.42	2.70	7.42	5.95			5.38	3.85
single								
partnered	-4.39	-2.58			3.54	2.15		
apartment								
single family home	4.83	2.33	4.57	3.70	8.22	5.89	9.71	8.28
no children								
has children	-6.05	-4.00	-5.35	-6.00	-4.40	-2.99		
age 18-24								
age 25-34	3.75	2.27	2.17	2.13				
age 35-54								
age 55-64			-2.55	-2.06	-5.78	-3.18	-4.21	-3.20
age 65-74	-14.98	-2.21	-13.03	-2.66				
sigma	21.33	35.20	24.25	69.86	28.25	43.83	32.45	95.76
rho			-0.15	-2.10	-0.27	-3.58		

Table 2: Model results for non-commute driving per day, only trips under 100 km. Indicator variable values that have been defined at the base case are displayed as empty rows. Income effects were modeled as piecewise linear.

	urban females		non-urban females		urban males		non-urban males	
non-commute	estimate	t-value	estimate	t-value	estimate	t-value	estimate	t-value
Selection (driving decision on interview day)								
(Intercept)	-0.70	-4.86	-0.81	-9.37	-0.30	-2.23	-0.17	-1.98
gas price	-0.28	-2.55			-0.62	-6.48	-0.57	-8.81
missing income data			0.06	1.43	0.25	3.36	0.21	4.85
income slope Q1	0.05	0.96	0.20	6.81	0.18	2.92	0.31	9.20
income slope Q2	0.04	0.44	0.11	2.44	0.40	4.32	0.12	2.34
income slope Q3	0.27	3.95	0.08	1.57	0.08	1.35	0.10	2.88
income slope Q4	0.01	0.83	-0.04	-1.61	-0.01	-0.90	0.02	2.27
single								
partnered			-0.17	-7.60	0.24	7.50	0.12	5.67
apartment								
single family home	0.53	15.68	0.37	17.83	0.29	9.72	0.20	10.41
no children								
has children	0.18	4.90	0.33	14.91	0.20	5.81	0.13	5.99
age 18-24	-0.22	-3.10	0.09	2.16				
age 25-34			0.11	3.61				
age 35-54								
age 55-64	-0.16	-3.34	-0.07	-2.42				
age 65-74	-0.41	-4.99	-0.32	-7.39			0.13	3.43
age 75-84	-0.84	-7.37	-0.74	-12.50	-0.18	-2.19	-0.11	-2.36
Pre-senior high	-0.30	-6.68	-0.21	-9.08	-0.14	-3.90	-0.18	-9.02
Senior high school								
Post-senior high					-0.09	-2.98	-0.03	-1.17
missing education data	-0.17	-2.53	-0.30	-7.34	-0.13	-2.30	-0.13	-3.75
public transit density	-0.04	-6.28	-0.06	-5.90	-0.03	-5.81	-0.05	-5.14
years 1999-2011 * age 18-34	-0.16	-2.76					-0.07	-2.06
years 1999-2001 * age 65-84	0.22	2.21	0.17	3.36				
years 2005-2006 * age 65-84	0.31	2.19	0.25	3.40				
year 2011 * age 65-84	0.39	3.03	0.36	5.17			0.22	3.49
Outcome (distance driven per driver per day)								
(Intercept)	38.87	6.19	35.18	12.97	43.53	12.93	38.22	13.46
single								
partnered	-7.41	-4.29	-3.77	-3.61				
apartment								
single family home							5.70	5.72
age 18-24	-7.30	-2.05					-4.80	-2.95
age 25-34								
age 35-54								
age 55-64								
age 65-74	-6.64	-2.10	-3.33	-2.01			-5.67	-4.07
age 75-84	-18.41	-2.89	-8.57	-2.90	-10.16	-3.04	-12.20	-6.47
sigma	30.88	64.95	33.39	118.12	37.10	72.71	41.16	150.75
rho					-0.18	-2.99		

6.3 Predicting the impact of socio-demographic change

In this section, we predict driving behavior based on the socio-economic composition of the population of different survey years, applying a model estimated on all years 1994-2011 and all trip purposes. Systematic gaps in the predicted and the observed driving behavior indicate an impact of unobserved factors on driving behaviors.

The prediction models include the same controls as the models in Table 1 and Table 2, except gasoline prices or year indicators. We exclude the gasoline price since it remains unclear whether this variable picks up trends in driving behavior due to unobserved factors. The difference between the predicted and observed driving demand in each time period indicates the combined impact of unobserved factors and increasing gasoline price.

Table 3: Predicted (by change in socio-economic population composition) versus actual driver shares and distances driven, trips under 100km length.

prediction results		urban females		nonurban females		urban males		nonurban males	
		actual	predicted	actual	predicted	actual	predicted	actual	predicted
driver share	1994-1997	21%	21%	33%	33%	46%	43%	55%	53%
	1999-2001	24%	22%	35%	35%	44%	44%	53%	54%
	2005-2006	22%	24%	37%	36%	43%	45%	53%	56%
	2011	22%	24%	37%	37%	38%	44%	53%	56%
km driven	1994-1997	32	32	34	35	45	43	45	44
	1999-2001	34	33	35	35	42	43	44	44
	2005-2006	33	33	36	35	42	43	43	44
	2011	33	33	37	35	41	43	43	44

Table 3 compares the predicted share of drivers and the average driving distances with the observed. It indicates that socio-economic variables do not explain the observed decline in the probability of driving among men, especially not for urban men. Hence unobserved factors or gasoline prices, neither of them included in the prediction model, are key drivers of the trends in driving behavior.

The predicted results for non-urban women closely match their observed increases in the probability of driving over time. The predicted increases are mainly due to increasing income and education levels among non-urban women (see Table 5 in the appendix).

7 CONCLUSIONS

In this paper, we have used descriptive statistics and regression models to explore the trends in driving behavior over the years 1978-2011, and to what extent they can be explained by socio-economic controls. Some of the trends that we find cannot be explained by the controls. However, some of these trends point to a decline in driving and others to an increase. Hence, we find no clear evidence that overall car use has peaked.

We find an increasing trend in the probability of driving among retired men and women across the thirty-three years that we analyze. This trend cannot be explained by the socio-economic controls. Similar patterns are found in the UK and Germany (Kuhnimhof et al. 2013). Frändberg and Vilhelmson (2011) suggest that the main reason is that retirees acquired car-dependent life styles earlier in their lives. For retired women, the trend increase is partly an effect of increasing license holding (Bastian and Börjesson, 2014). The gender gap in license holdings among Swedish-born retirees is now nearly closed (Bastian and Börjesson, 2014), indicating that the growth in female retirees' driving could level off in the future.

We find a strong decline in driving between 1978/84 and the mid-1990s among young men. Unemployment, postponed family forming, and longer education have contributed to this decline, but we cannot rule out a preference shift away from car use in this group.

We find a significant trend decline in the probability of driving among urban men over the thirty-three years that we analyze. One interpretation, which is supported by our model results, is high price elasticity in driving decisions among urban men. However, gasoline prices have increased at a relatively constant rate over the years that we analyze. Based on the present data, we cannot, therefore, distinguish responses to gasoline price increases from a shift in preferences away from driving or changes triggered by other unobserved factors. If there has been a preference change, it seems likely that it would have been induced in the long run by economic changes, such as gasoline price increases (Bastian and Börjesson, 2014). Separating preference effects from gasoline price and other economic effects may therefore not be possible.

Assuming that the trend decline in driving is explained by gasoline prices, our results would imply that even high-income urban men reduced driving considerably in response to gasoline price increases, although their driving behavior is insensitive to marginal income differences in the cross-section. Urban men appear to have the best possibilities of reducing their driving. They tend to have attractive mode and destination alternatives available, and they drive substantially more than urban women. It is well known that elasticities differ substantially between individuals depending on the availability of alternatives (Blow and Crawford, 1997; Santos and Catchesides, 2005; Wadud, et al., 2009; 2010). Driving behavior among women and non-urban men appears to have remained less affected by gasoline price increases, presumably because they find it harder to adapt.

The probability of driving to work is much more stable over time than the probability of driving for other trips in all groups. This contradicts the hypothesis that the trend decline among urban men is driven by increased congestion.

The trends in driving distances differ from the trends in the probability of driving. Commute driving distances increase in all groups, whereas distances for non-commute driving have remained more stable. The trend increase for commuting distances is not explained by the socio-economic controls and is probably an effect of labor market specialization.

While the gender gap in driving has narrowed during the analyzed period, we find a substantial remaining gender gap in driver shares, even when controlling for other socio-demographic differences. The gender gap in driver shares is larger in urban areas than in non-urban areas. Focusing on car use, however, defined as being a car passenger or a driver, among partnered adults, the gender gap is substantially smaller. However, among single adults, the gender gap remains substantial. This is striking given that

Sweden is ranked among the most gender-equal countries in the world (United Nations, 2014). It could suggest that women on average have a lower preference for car driving than men.

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Appendix

Table 4: NTS urban demographic population structure over time.

	Stockholm and Gothenburg urban areas									
	FEMALE					MALE				
	1978,1984	1994-97	1999-2001	2005-2006	2011	1978,1984	1994-97	1999-2001	2005-2006	2011
age 18-24	13%	11%	8%	11%	11%	14%	11%	10%	12%	12%
age 25-34	21%	21%	22%	20%	17%	21%	20%	23%	21%	18%
age 35-54	32%	36%	35%	36%	39%	36%	39%	37%	37%	40%
age 55-64	13%	11%	15%	16%	14%	14%	13%	15%	17%	16%
age 65-74	14%	12%	11%	10%	13%	10%	10%	10%	9%	11%
age 75-84	8%	9%	8%	7%	6%	5%	7%	5%	5%	5%
no edctn. data		15%	11%	8%	1%		14%	8%	6%	1%
pre gymnasium		22%	19%	14%	14%		21%	21%	16%	17%
gymnasium		38%	38%	37%	36%		38%	37%	39%	38%
past gymnasium		26%	32%	41%	49%		27%	34%	38%	44%
employed	63%	58%	61%	61%	63%	75%	68%	71%	70%	71%
median income (000 SEK)		181	224	253	273		244	290	322	327
children in hh	35%	32%	33%	33%	34%	32%	28%	29%	31%	33%
partnered	63%	65%	65%	65%	65%	73%	69%	69%	70%	69%

Table 5: NTS non-urban demographic population structure over time.

	non-urban areas									
	FEMALE					MALE				
	1978,1984	1994-97	1999-2001	2005-2006	2011	1978,1984	1994-97	1999-2001	2005-2006	2011
age 18-24	12%	11%	10%	11%	12%	13%	12%	11%	12%	13%
age 25-34	19%	17%	16%	14%	13%	19%	19%	17%	16%	15%
age 35-54	32%	36%	35%	35%	35%	34%	36%	37%	35%	33%
age 55-64	14%	13%	16%	18%	16%	15%	14%	16%	19%	17%
age 65-74	14%	13%	12%	13%	14%	13%	12%	11%	11%	14%
age 75-84	9%	10%	11%	10%	9%	6%	7%	8%	7%	7%
no edctn. data		15%	11%	9%	1%		14%	8%	7%	1%
pre gymnasium		30%	27%	20%	20%		31%	31%	23%	23%
gymnasium		37%	42%	42%	43%		39%	42%	45%	47%
past gymnasium		18%	21%	30%	37%		16%	19%	25%	28%
employed	56%	54%	55%	55%	56%	72%	62%	65%	65%	66%
median income (000 SEK)		151	189	216	232		221	249	278	303
children in hh	38%	33%	32%	32%	32%	35%	29%	29%	29%	30%
partnered	72%	70%	70%	71%	70%	77%	74%	74%	74%	74%

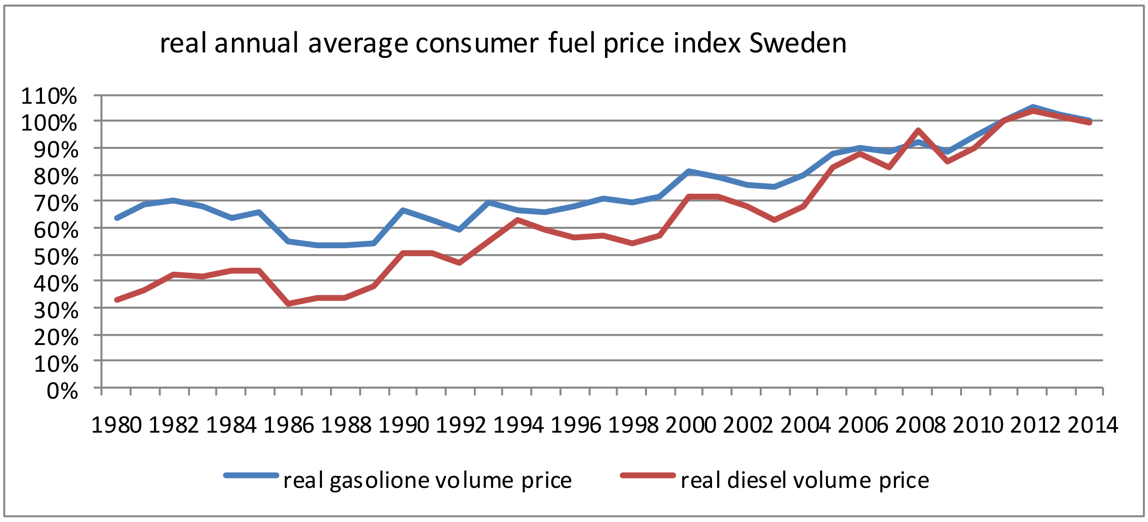

Figure 5: Real annual average fuel volume prices at the pump, index versus 2011, from spbi.se.

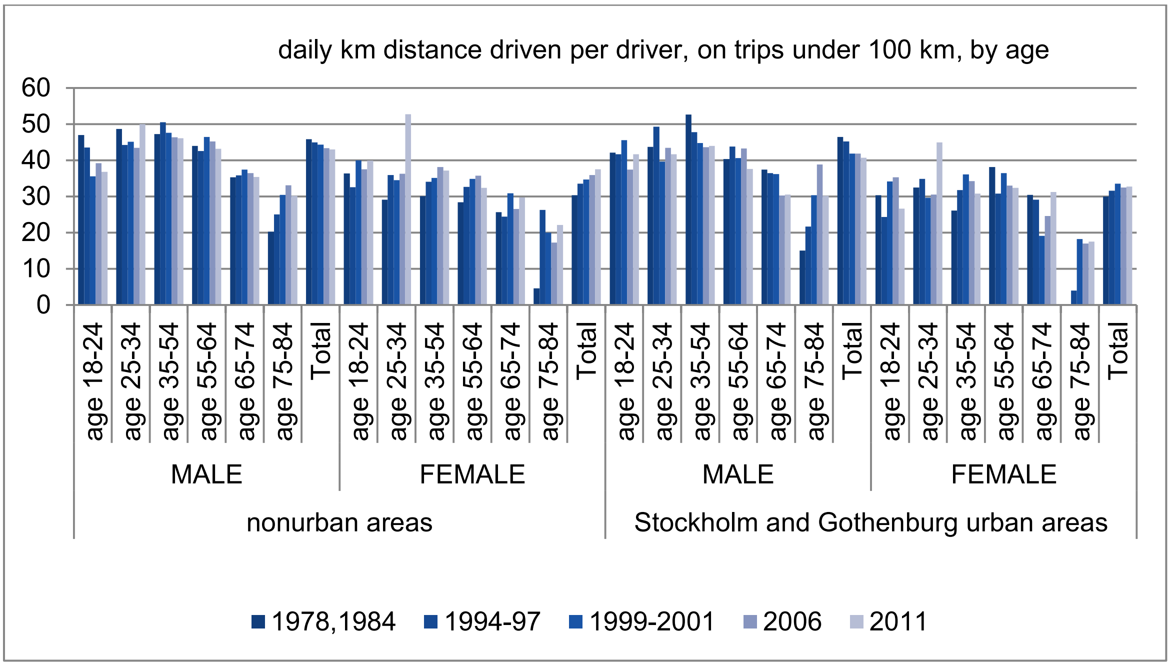

Figure 6: Average daily km distance driven per car driver, by age group, only considering trips under 100 km.

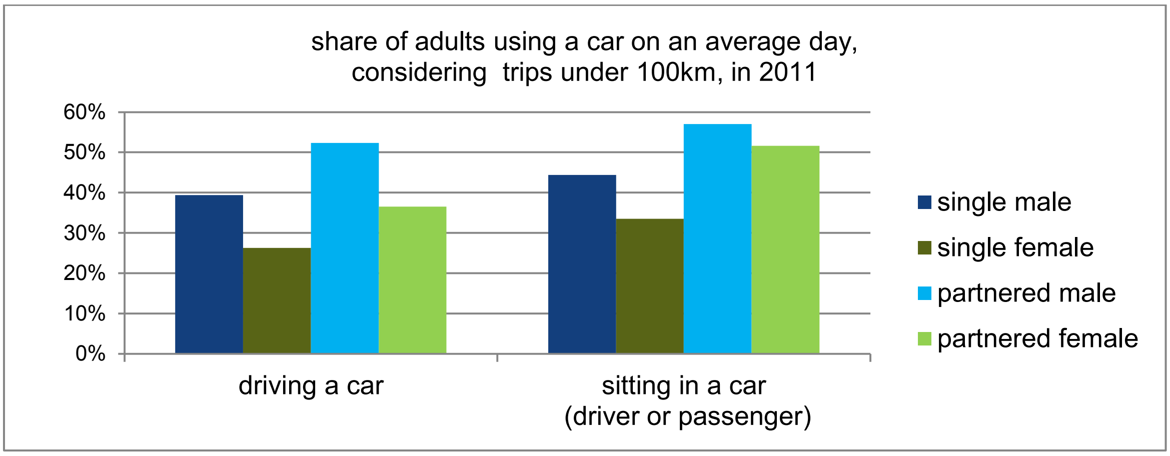

Figure 7: Car driving and car use shares per day, by gender and partnership status, data from NTS 2011.