How Americans' Time Use Patterns Have Changed From 2003 to 2017

Group July

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Introduction

The aim of this report is to discover how Americans' time use patterns have changed over the last 15 years, through discovering and analysing long-term trends over the years of 2003 to 2017. The datasets [1] used to tackle this comprise some of the results of the American Time Use Survey (ATUS) [2]. ATUS respondents were interviewed about how they spent their time on the previous day, where they were, and whom they were with. The survey records the time spent on 431 different activities that are grouped into 17 categories. During the analysis, these categories will often be referred to by a variable beginning with `tu` followed by a two-digit *category number.* The lexicon and data dictionary files found on the ATUS website offer identifications for each of these category numbers and the rest of the variables.

The Bureau of Labor Statistics website provides a number of charts looking at the 2017 annual averages for these categories. This report provides a more definitive conclusion on how time use patterns changed over the period, evidenced with statistical investigation of the data. The findings offer in-depth explanations as to where some of the biggest fluctuations are and suggests possible reasons for these fluctuations. Limitations to the analysis are noted where appropriate and these must be taken into account when performing any further analysis or summaries, and mentioned alongside any conclusions.

Usually when analysing data, statisticians will split the dataset into training data and validation data. This ensures that any conclusions drawn from exploratory data analysis (EDA) on the training data can be verified using the remaining "unseen" validation data. The analysis performed for this report follows this technique, splitting the data approximately in half to provide continuity and robustness in model fitting. The split was done by selecting even and odd months for training and validation data respectively, in order to ensure that seasonality did not cause incorrect rejections of hypotheses as well as ensuring there were no uneven gaps in the data which may lead to a loss of clarity in plotting. This split also allowed for conformity to the requirement that July was to be excluded initially and used for validation.

Two slightly different approaches to EDA were attempted; in the first section there were very few assumptions made, as inference was extracted from the data using its observed features, whilst the second section takes a more high level approach in posing a question to investigate and then forming hypotheses in the EDA section on training data which are to be validated.

The Compelling Change in Caring for & Helping Non-HH Members

Exploratory Data Analysis

In order to effectively discover trends in the data whilst still being able to validate these trends, the data was split as mentioned before by taking alternate months and assigning them to training and validation data sets respectively. The even months were used throughout the EDA in this part of the report as well as the EDA in the later part.

The ATUS dataset records time spent on activities in minutes. When all 17 variables are plotted it appears that there is more variation in the proportion of American's partaking in activities than there is in the raw time use values. Therefore, the EDA in this section initially focussed on looking at how the proportion of American's partaking in the 17 categories of activities has changed. The following table gives a summary of some of these changes. The activities included are those with a percentage change of

over 10% and a variance greater than 0.5, i.e those which are deemed to be of interest for further analysis and exploration.

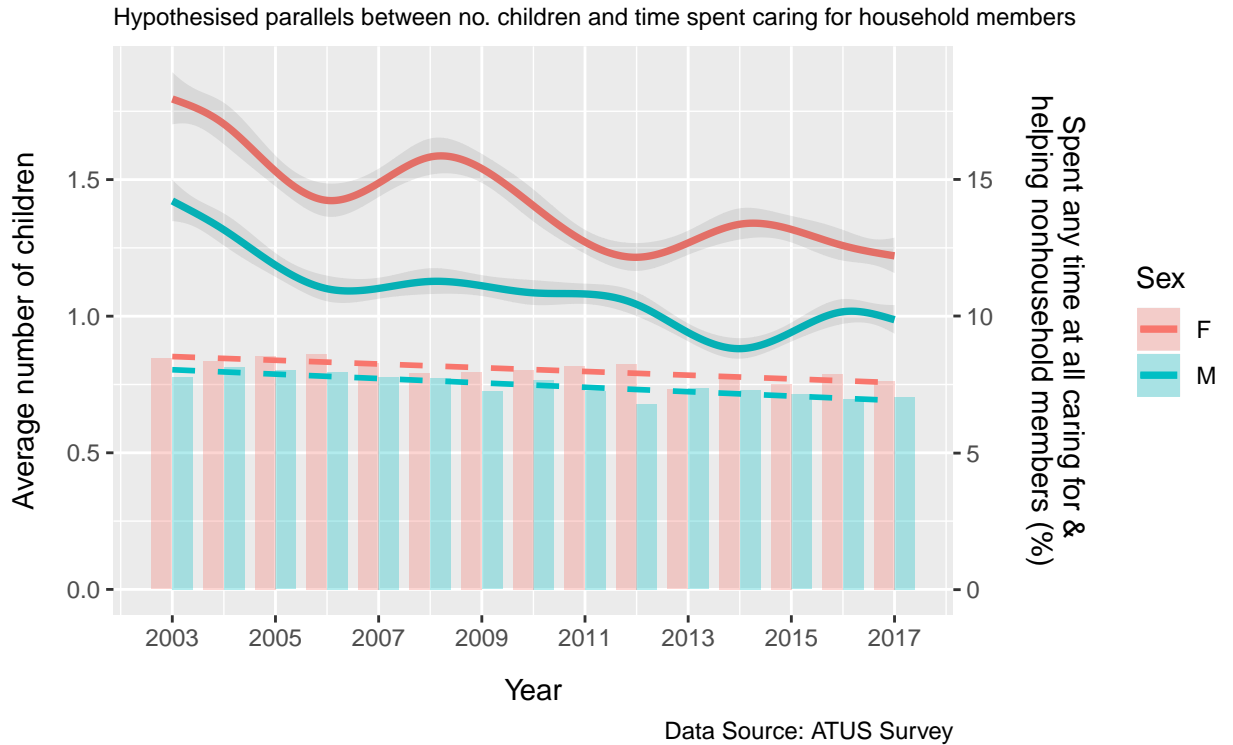Table 1: Change in Participation of Activities

Measure	tu04	tu08	tu13	tu14	tu16
Variance	2.54	0.89	1.44	0.60	1.93
% Change	-32.11	-26.46	10.17	12.32	-24.08

It is immediately clear that the most compelling change out of the 17 activity groups, over the period, is in *Caring for & Helping Non-household (Non-HH) Members* represented by `tu04` in the data. However, without some further exploration, this is arguably uninteresting.

When fitting a linear model, the method of best subsets with *Year* forced in as a variable tells us that the most significant variables to predict the proportion of American's spending time *Caring for & Helping Nonhousehold (NonHH) Members* are *Sex* and *Number of Household Children*. Ths model is not sufficient to accurately predict `tu04` participation, however it does give a good idea as to what is causing the change over the period 2003 to 2017.

The non-negative, non-linear nature of the continuous activity data also means a more complex model would be suitable. An *F*-test shows such a complex model which incorporates *Sex* is a significant improvement over such a model which doesn't include it. This confirms the belief that is has a significant effect on participation in caring for & helping non-household members.

The plot below is a graphical interpretation of the model, built on the training data, with the average number of household children, for each group of the population, displayed as **bars**. Participation percentage in caring for & helping non-household members is displayed as smooth lines.

Hypothesised parallels between no. children and time spent caring for household members

Data Source: ATUS Survey

The key observation is that, as the table suggested, over the period the participation in caring for & helping non-household members has decreased for both men and women. Building a linear model using Sex and Year and performing a *t*-test confirms this. There also appears to be a link between participation in caring for & helping non-household members and the number of household children. Updating the

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spline curve model to include the number of household children and then again testing this hypothesis with a *t*-test confirms this is also the case. Looking at the graph, fluctuations in the average number of household children, on the whole seem to be followed by but if the correlations between them are checked, they show this link is fairly weak (0.65 for Men and 0.49 for Women), suggesting there must be further reasons for this change; possibly not measured in this dataset. Therefore, further analysis must be done before a statistically sound conclusion on the causation of the changes can be made.
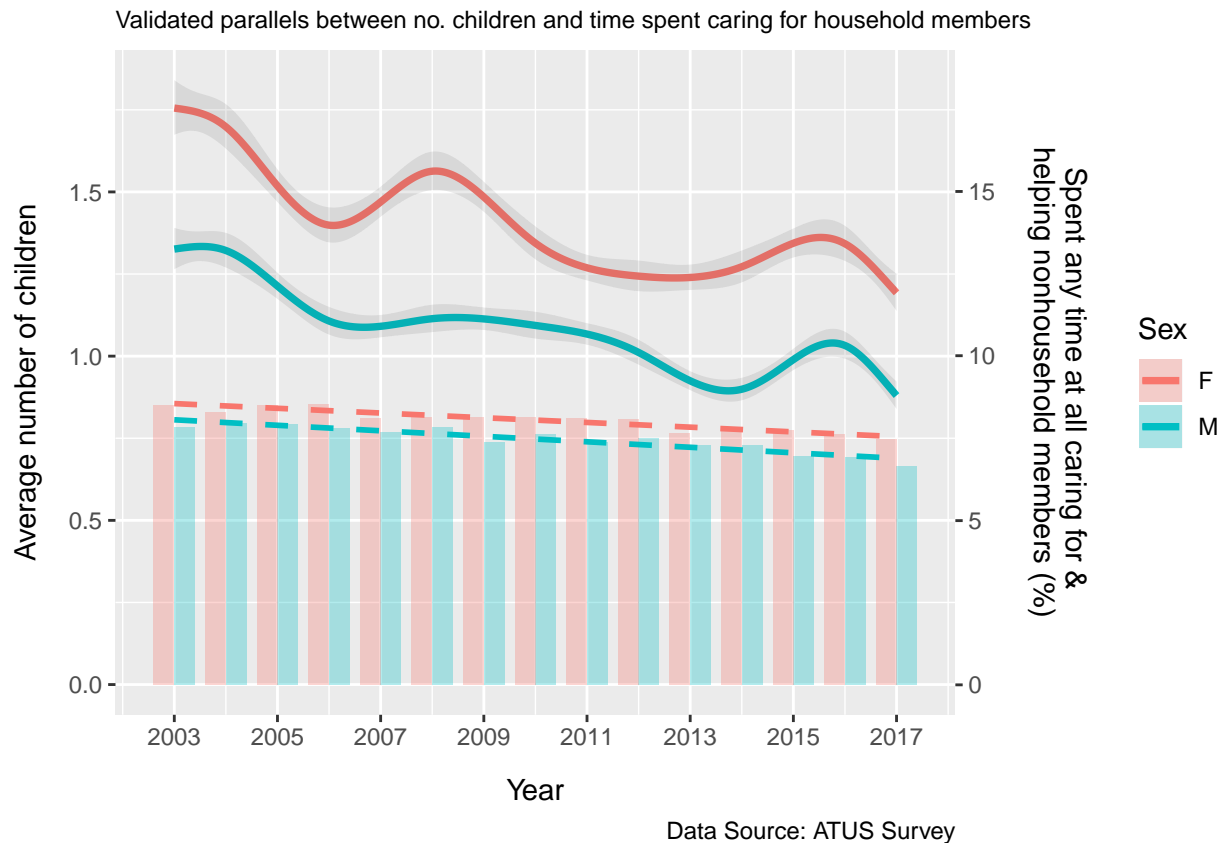
Validation

As in the EDA, but this time formally, a linear model is built using *Sex* and *Year* and a *t*-test performed. It gives a *p*-value < 0.05 (quite a bit less in fact). This means there is sufficient evidence to conclude that the proportion of American's who participate in caring for & helping non-household members has decreased over the period 2003-2017, as suggested by the EDA.

The initial thoughts about the link with the number of household children from the EDA again needed to be tested. A new model of the same structure was built. Another formal *t*-test could then be completed on an update of this model which includes the number of household children in its definition and fit.

With a *p*-value < 0.05, this test confirms this belief in the validation data.

It has now been verified that the conclusions suggested by the EDA are correct: the percentage of American's who partake in caring for & helping non-household members has decreased over the period from 2003 to 2017. There also seems to be a link between the number of children in the household and the participation percentage. The plot below gives a graphical interpretation of changes using a model fit on all the data, only excluding those responses taken in July for each year.

Validated parallels between no. children and time spent caring for household members

Data Source: ATUS Survey

How The Time Spent on Traditionally Gender Stereotyped Activities has Converged as Gender Roles have Broken Down

The discussion surrounding social division between genders in terms of roles and responsibilities has consistently been a major news topic in recent years. This debate has been fuelled by a new wave of feminism, as well as a number of different social media campaigns such as *'#MeToo'* and *'Times Up'*. Both of these movements aimed to address commonplace sexual harassment and discrimination, empowering women to take back control. Given this current social climate, it was decided that an interesting area of the ATUS data to focus on would be long-term changes in time use for different sexes. Specifically, areas of time use where pre-existing gender roles are present were examined.

Exploratory Data Analysis

Talcott Parsons' [3] study on gender roles - published in the 1950's - compared traditional gender roles with more liberal alternatives. A simplified version of this strictly traditional view of gender roles is detailed in the table below.

Table 2: Traditionalist Gender Actitivies

Male Activites	Female Activities
Working	Housework
House Maintenance	Cooking
Vehicle Maintenance	Childcare

The liberal viewpoint discussed by Parsons suggested an eventual balance of time for the genders in these roles. Whilst this study was developed over 50 years ago, a preliminary look at the data confirmed that this convergence had still not happened by 2003. Therefore, it was decided to investigate whether the time use of these specific activities was converging to equality or remaining stationary with noticeable differences between genders. In order to do this as rigorously and objectively as possible, weighted averages were calculated amongst each demographic to best represent how different groups of peoples' time uses had changed over time and to make up for any inconsistencies in the data.

Following some initial exploration of the data and breaking down the respondents into different generations [4], another layer of complexity to the analysis was developed. Splitting the data by age allowed for further hypotheses regarding progression through convergence of time use for both genders in the areas discussed above; it would perhaps be assumed that younger people would be more progressive in this respect. Using this generational approach provided a way of tracking a population over time without having to arbitrarily pick age categories. A small number of participants fell outside of these ranges, however, these represented only a small number of participants and so were added to the next nearest generation (e.g. if a participant was born in 1998, they would be added to the *Millennials* generation).

Table 3: Generations

Generation	Birth Years
Silent Generation	1928 - 1945
Baby Boomers	1946 - 1964
Generation X	1965 - 1980
Millennials	1981 - 1996

For each of the activities, a suitable generalized linear model was developed using *Sex*, *Year* and *Generation* as parameters. The values used to predict each model were constructed using the weighted mean formula provided in the *ATUS User's Guide*. Splines were added to the model for each year and graphical representations were produced. These allowed for hypotheses to be formulated regarding the change in time use for these gender-stereotyped variables over the period. It was from these hypotheses that validation could then be carried out to see if the conclusions were consistent and whether the trend was likely to be genuine.

It was decided to plot a line corresponding to each gender despite the interest of the analysis being in the difference *between* the genders. This is because having lines to associate with each gender is likely more clear to the reader and can more intuitively show any narrowing of the gap between genders for the variables of interest. As far as the hypotheses there are to validate, they can be summarised similarly for each variable: as first posed in the aforementioned 1950's study, it is likely that social changes will lead to an erosion of gender roles. The EDA suggested that this erosion has continued from 2003 to 2017 and so validation is required to attempt to confirm that the difference in time use for the relevant variables has indeed decreased as time has continued.

Validation

In order to validate the trends found in the EDA, the same approach to that taken in the first part of the report was followed: splitting the data set initially and using the unseen half to validate the observations and hypotheses made above by putting it through the same models formulated in the EDA and visually comparing the outputs. In addition to this more intuitive technique of validation, statistical *t*-testing was carried out to ensure significance in the shrinking difference between the two genders for the variables of interest. The models below showcase the results of the analysis after validation was carried out, plotting all of the data with the exception of July as required in the specification of this report. Despite using 11 months of the data here, it is critical to reiterate that all of the EDA and validation was carried out on entirely separate 6 month subsets of each year to ensure validity of the conclusions and testing.

Working

The plots below show the change in working patterns between three different generations.

Trends in working for each generation

Data Source: ATUS Survey
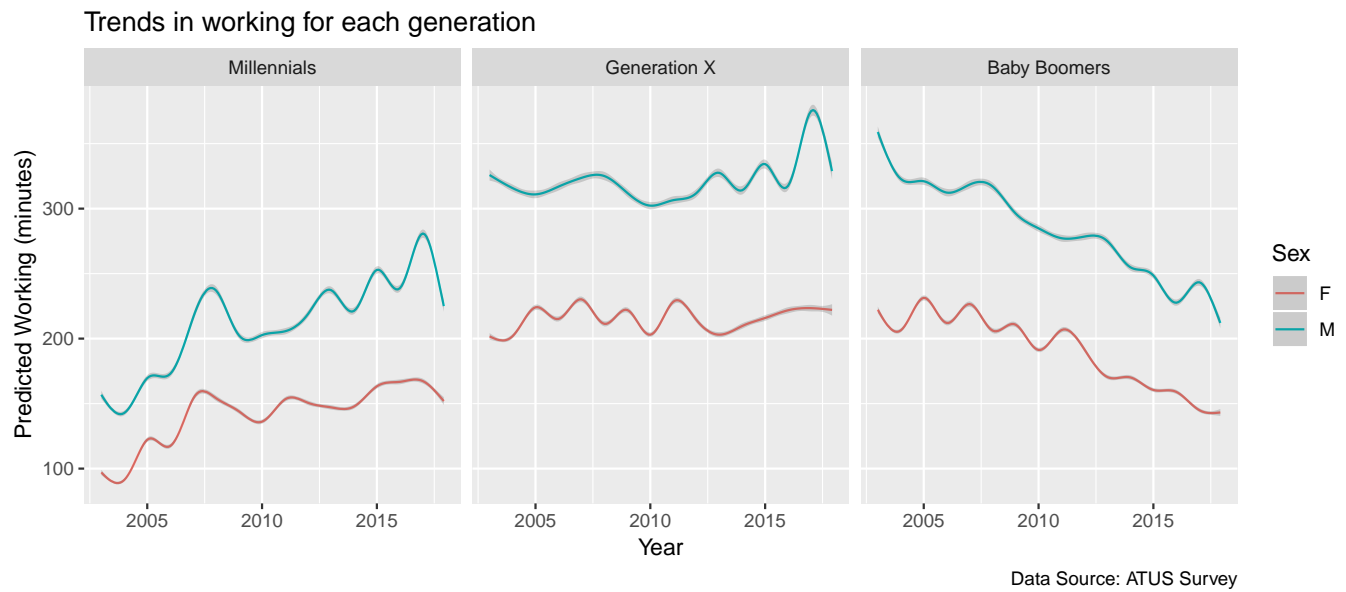
The *Silent Generation* have been excluded from these plots as the youngest of this generation would be 65 by 2010 which is retirement age, so most of the data points are very small. The same scale is used for

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each graph for ease of comparison, so including the *Silent Generation* would adversely affect the quality of comparison between other generations.

It can be seen that year on year there has been a slight contraction, especially visible in *Generation X* when the peak around 2016 is ignored. It is clear that generationally, working hours follow a fairly standard trajectory, peaking for people in their middle ages. *Millennials* have seen a steady increase in their time spent working as would be expected for people in that age range; the genders seem to have a much smaller gap between them when compared with *Generation X* though, which is testament to part of the hypothesis made above regarding progressive social norms propagating through younger generations.

House Maintenance and Vehicle Maintenance

For both of these variables, it was decided that the participation rate was too low to warrant deeper analysis. Whilst the EDA findings suggested that there existed a separation in gender, with men spending more time on both of these activities, the participation rates of around 3% for both reflected that these were more uncommon activities. As such, it was decided that there was not enough data to reflect the time spent in a suitable linear model; variance was much greater amongst the lower valued variables and these particular fluctuations did not seem to follow a clear long term trend.

Housework

Data Source: ATUS Survey
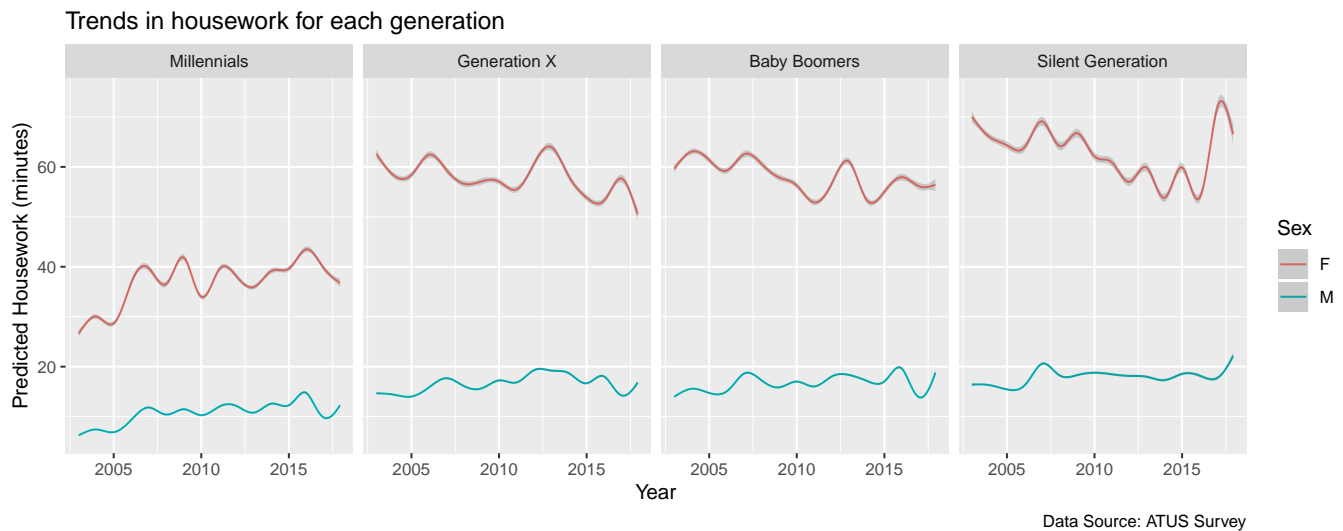
The graphs above show that for all generations, except for *Millennials*, there has been a decrease in the gap in time spent on housework between men and women. This is as a result of men spending more time and women spending less time on housework, although the decrease for women is sharper than the increase for men. This trend is reflected clearly in *Generation X*, the second youngest generation. However, there is also strong evidence for this trend in the *Silent Generation* despite the slight divergence in 2016. On the other hand, the gap seems to have increased slightly for *Millennials* - both sexes are increasing the amount of time spent on housework, but the increase is not as great for men. Notably, *Millennials* also spend substantially less time doing housework than the other generations, with the highest point being around 45 minutes per day (women in 2016), compared to around 62 in *Baby Boomers* and *Generation X* and 72 minutes in the *Silent Generation*. Therefore, whilst the gap is increasing for *Millennials*, it is still smaller than all of the other generations at around 25 minutes. Comparatively, the *Silent Generation's* gap started at over 50 minutes in 2003 and has decreased to just under 45.

Food Preparation

Trends in food preparation for each generation

Data Source: ATUS Survey
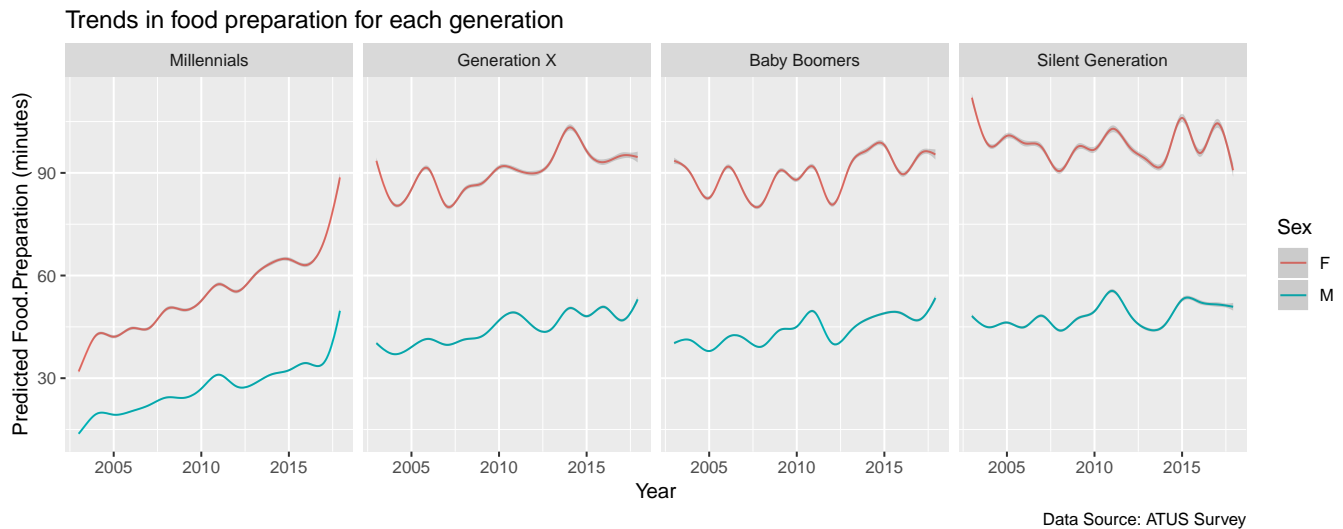
The graphs above show a very similar trend to `Housework` in the sense that the gap is decreasing and that all generations apart from *Millennials* spend a similar amount of time in general on this activity. However, the difference with this activity is that for *Baby Boomers* and *Generation X*, women are actually spending more time on this activity than they were previously - the decrease in the gap is as a result of a sharper increase for men perhaps as cooking and spending time at home is more normalised in society. For *Millennials*, the situation is slightly different: both sexes are spending more time on this activity but the increase for both is at an equal rate and so the gap is maintained. The *Silent Generation* is the generation showing the biggest decrease in the gap between sexes; this is due to the decrease for women and an increase for men, although this generation started off with the highest values for both sexes. This generation is likely to have more free time to begin with an thus exhibit more initial variance but then reflect the changes in society more clearly as cooking as an activity becomes more common amongst men.

Childcare

For similar reasons to `Working`, the *Silent Generation* has been excluded from this section as most of the people in this age range are unlikely to have any household children of their own. These graphs show perhaps the greatest change in gender roles.

Trends in childcare for each generation

Data Source: ATUS Survey
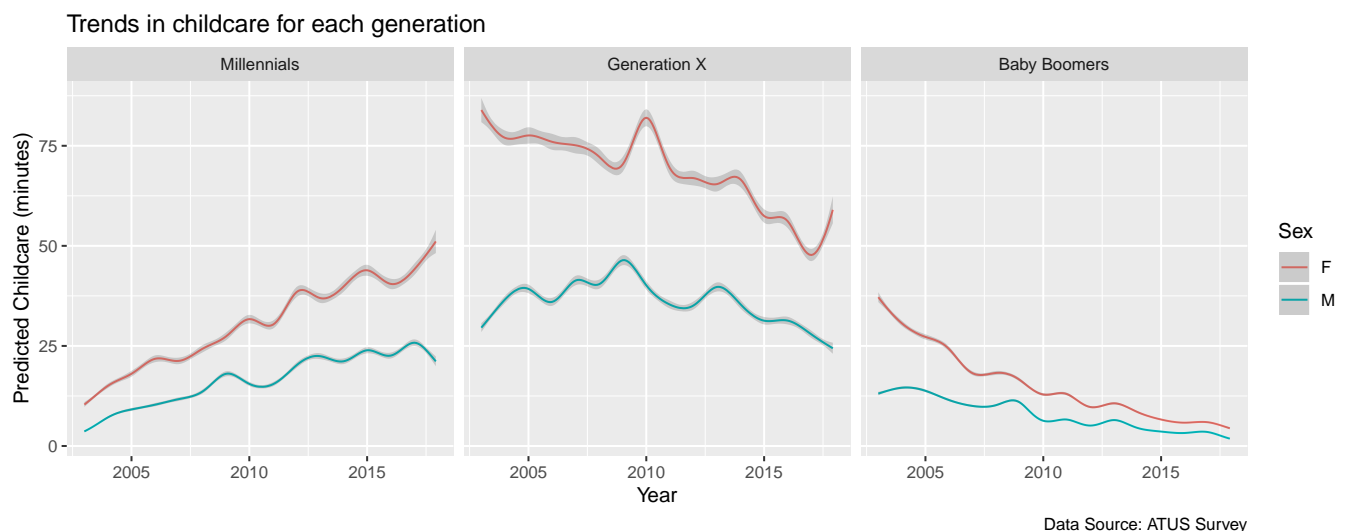
The data for *Baby Boomers* and the *Silent Generation* shows very little, likely as the variables

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comprising `Childcare` relate only to caring for household children, where a child is defined as someone below the age of 18. It is unlikely that many people within these generations would have children living with them at this age (in fact checking the data confirms that only 9% met this criteria in 2017). Furthermore, at this age their children are likely to be older and more independent, leading to the more interesting trends exhibited by the other generations: *Millennials* and *Generation X*. For reasons similar to the older generations, the drop off in childcare at the end of *Generation X* can likely be explained by children maturing. However, it is important to note that the drop off for women is sharper than it is for men, leading to a convergence in the weighted means for both. The gap has decreased substantially, from 50 minutes per day in 2003 to less than half that, around 20 minutes in 2017. This could be attributed to the decrease in working time for this generation, noted above. The *Millennials* on the other hand exhibit an increase year on year for activities in childcare. Whilst the gap increases slightly over time, it doesn't ever reach a similar point to that of *Generation X*, with the biggest difference being around 40% compared to 60%.

Conclusions

In conclusion, embarking upon EDA from multiple perspectives offered up a lot of potential trend analysis amongst the data. It can be seen that both of the main hypothesis groups constructed above were validated succesfully and provide some interesting insight into long term trends in the ATUS dataset. From a societal perspective, much has changed in a short length of time and these trends following on from projected changes in studies like the one referenced from the 1950's will likely continue into the future.

Generating demographics and utilising the weights provided in the dataset allowed for more focussed analysis of what initially appears to be somewhat uninteresting data; no doubt there are many other trends to be uncovered given the resources and inspiration. Links such as number of children and time spent caring for others in a household were also discovered and highlight how interactions between factors can influence long term trends.

Limitations of the Data

One of the major limitations imposed on this research is the length of the period within which the data was gathered: 15 years is a short amount of time to observe trends amongst such a large population. This meant that often the data had to first be subsetted or transformed as no immediate trends were visible at the surface, this led to sporadic subset size (as mentioned with respect to Vehicle and House Maintenance) due to the number of filters required to get down to the demographics that were desirable to investigate.

Another notable limitation is the reliance on people to remember the way in which they spend their time. It is likely that they would forget smaller tasks and focus on more memorable or time-consuming ones, this issue is excaserbated due to data only being collected for the previous 24 hours rather than over a larger period for each respondent's data point.

References

[1] "ATUS datasets." https://www.bls.gov/tus/datafiles_0317.htm.

[2] Bureau of Labor Statistics, "The american time use survey." https://www.bls.gov/tus/, 2017.

[3] T. Parsons, "Age and sex in the social structure of the united states," *American Sociological Review*, vol. 7, no. 5, pp. 604–616, 1942 [Online]. Available: http://www.jstor.org/stable/2085686

[4] "Millennials projected to overtake baby boomers as america's largest generation." http://www.pewresearch.org/fact-tank/2018/03/01/millennials-overtake-baby-boomers/.