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Abstract

This thesis investigates how the energy intensity of consumption is affected by an increase in non-work time by estimating how retirement affects the consumption of gasoline and air travel. An estimable model is derived from Becker's (1965) theory of time allocation which is then estimated for a sample of 58-68 year old full-time workers and retired individuals that is taken from the 2014 Consumer Expenditure Survey made by the Bureau of Labor Statistics. Together with the estimation of a secondary model, it is found that retirement increases total energy intensity of consumption through an increase in airfare expenditure together with a slight decrease in gasoline expenditure. A simple test for extrapolation further suggests that extrapolation of the results for the whole working population might be possible.

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1 Introduction

Energy consumption has been increasing rapidly the last decades and the growth does not seem to be slowing down (International Energy Agency, 2015). This is problematic as energy consumption is closely linked with carbon emissions, which contribute to the global warming. One suggestion to decrease energy consumption is to scale down work time as this logically would lead to a scale down in production and therefore a scale down in energy use. While it might be a solution to lower total consumption, it is not the whole story when it comes to energy consumption as the energy-intensity of consumption might change when people get more non-work time at their disposal. If e.g. consumption is re-allocated from products with a low total energy use towards products with a higher total energy use the energy intensity of consumption increases. If such a re-allocation is made, the saved energy from the lowered earnings will be decreased partly or entirely depending on how much the energy intensity of consumption increases. In a worst case scenario it is even possible that total energy consumption increases due to the increased energy intensity, even though total consumption goes down. It is in other words important to investigate how increased non-work time affects the energy-intensity of consumption.

The general objective of this thesis is therefore to identify what effects an increased amount of non-work time have on the energy intensity of consumption. In order to investigate this, retirement is used as an exogenous event that drastically increases non-work time while keeping consumption constant, in accordance with an adapted Permanent Income Hypothesis where time use is included in the definition of consumption (Hurd and Rohwedder, 2003). Any changes in energy-intensity should therefore come from the increase in non-work time. The more specific objective of this research is in other words to identify how the energy intensity of consumption changes between the years before retirement and the years after retirement. The general research question that this paper aims to answer is thereby: *What effects does an increase in non-work time have on the energy intensity of consumption, ceteris paribus?* and the more specific research question that the paper addresses is: *How does energy intensity of consumption change due to the additional non-work time given at retirement?*

The research area is however new and only a few papers have been published that relate to the topic of interest. Two papers written on the topic are a paper by Brencic and Young (2009) who investigate how time-saving devices affect domestic energy use, and a paper by Nässen and Larsson (2015) who try to estimate how decreased work time affects the energy intensity of consumption. They both find small effects of increased energy intensity due to increased non-work time, but the analysis is likely to be suffering from self-selection and endogeneity respectively. Both papers also only focus on expenditure that is connected to day-to-day activities and leave out e.g. holiday spending. This together with the fact that no paper has been published where the effect of extra amount of non-work days have been investigated, atleast to the best knowledge of the author of this paper, show that a wide research gap exists that this paper aims to fill. This is especially true as so few papers have been published on the topic.

Whether an increased non-work time in the form of more non-work days would lead to an increased or decreased energy intensity is conceptually not clear. On the one hand it is easy to imagine that some people would choose to allocate the extra time into more time consuming, less energy intensive, activities when they get more time that they can choose freely how to use. They might e.g. walk or take the bike instead of taking the car, take the train or bus instead of flying or hang dry their clothes instead of using the clothes dryer. If the extra non-work time is in the form of fewer work days (as is the case for retirement) the extra time could also have the effect of fewer commutes. On the other hand, the extra amount of time could as well be used for energy intensive leisure activities which could increase the energy intensity of consumption. In particular, the extra amount of non-work days might be used to increase the amount and length of vacations and as especially air travel is a very energy intensive good this could shift the scales in the other direction. Based on this type of reasoning, the following hypotheses are formed:

1. *The expenditure on car travel will decrease upon retirement, resulting in a downward pressure on the energy intensity of consumption.*
2. *The expenditure on air travel will increase upon retirement, resulting in a upward pressure on the energy intensity of consumption.*
3. *Total energy intensity increases as the effect in* 2 *dominates the effect in* 1*.*

To answer the research questions and test these hypotheses, a model is derived using Becker's (1965) theory of time allocation as a foundation. This derivation yields an estimable equation where the share of total expenditure and expenditure on an energy intensive good, such as gasoline or air travel, is dependent on retirement status. Using the Consumer Expenditure Survey created by The Bureau of Labor Statistics (2015) in the United States of America, this model is then estimated with ordinary least squares (OLS) regression for a sample of 58 to 68 year old individuals that are either full-time workers or retired. As the derived model only allows for estimation of non-zero consumers of the energy-intensive good, something that limits the sample especially for air-travel, a complementing linear model based on methods in the literature on retirement consumption is also estimated using OLS. Control variables that are normally included in the retirement consumption literature are included in both estimations to control for omitted variable bias. In order to extrapolate the results from these estimations to the entire adult population, a t-test of the means of expenditure on air-travel and gasoline is done for each 5 year age-group from 23 up to 63. This is done in order to evaluate how consumption differs across different age groups and thereby get an indication of how it might change if the whole population would receive more non-work days.

The results of these estimations support the hypotheses, especially the first and third. The results from the primary model show that the share of air-travel expenditure over total expenditure increases at retirement while no significant effect of retirement on the share of gasoline expenditure over total expenditure is found. The results in the secondary model show a significant increase in airfare expenditure and a significant drop in the expenditure on gasoline. The t-test of means show that consumption of airfare and gasoline overall does not differ across the age-groups, especially when the share of total expenditure over gasoline or airfare is considered, which makes extrapolation not unreasonable. If you assume that vacations are a sought after good in all ages, and that people of all ages use the car to commute in the US, it is also plausible that similar effects would be visible if the number of work-days decreased across all ages but it is harder to say how strong these effects will be.

It is however also important to consider how reliable the used methods are and if the assumptions that are made in this research are valid. There are several concerns that can be made about the method and data that is being used, the main concerns being the possibility of self selection and the lack of individual price data. Using OLS as the method of estimation also has its disadvantages, the main being that separate estimations are made of gasoline and airfare expenditure without restriction on a total budget. There are however several possible biases that would also decrease the estimated effects, such as the occurrence of individuals who has retired from sick leave or unemployment. Overall therefore the estimated effects still gives valuable insight in how a large increase in non-work time affects the energy intensity of consumption.

The rest of the paper is structured as follows. Section 2 gives a background to the research in this paper and is primarily a literature review of the two main fields of research that this research draws upon. Section 3 gives a theoretical framework and shows how the estimable model is derived from Becker's (1965) model of time allocation. Section 4 describes the data that is used and how the samples are formed, the empirical models that are estimated and provides a discussion of other possible methods of estimation. Section 5 presents important descriptive statistics and the results from the two empirical models. The results are followed by a discussion of the legitimacy of the results. Section 6 concludes the paper.

2 Background

This section firstly introduces an important concept that are used throughout this paper, namely energy intensity of consumption. After this, the main existing literature on the two main areas of economic research that is of interest for this paper is presented: how consumption is affected by the amount of work, or non-work, time and how and why consumption changes at retirement.

2.1 Energy intensity of consumption

The phrase energy intensity of consumption will be used throughout this thesis and it is therefore important to define what is meant by it. In this thesis, energy intensity of consumption is thought of in similar terms as the European Environment Agency (EEA) (2015) defines it, although adapted to an individual household level. The EEA defines final energy consumption intensity as total final energy consumption divided by the GDP, where total final energy consumption includes the consumption of all types of transformed energy used in the production of all goods and services. I.e. the energy use in the production processes of various goods and services are also included in the total final energy consumption of that specific good. The same logic is used in this thesis, only that it is applied on individual households. In this case, the household GDP is total expenditure (how much the household has spent in total under a certain time period, such as a quarter) and the energy intensity of consumption is the final energy consumption for that household divided by the household's total expenditure. An increasing energy intensity of consumption therefore means that a larger share of total expenditure goes towards energy use. The energy intensity of total consumption is therefore a weighted average of the energy intensity of each good that is consumed, where the weight is the amount that is spent on that good. Different goods have different energy intensity levels where some are more energy-intensive than others and how much is spent on each good determines the energy intensity of total consumption.

As there exist sub-sets of goods within all categories of consumption that differs in energy efficiency, and thereby energy intensity, finding exact measures of energy intensities is difficult. This is especially so when one uses expenditure as a measurement of how much of a good, such as air-travel or gasoline, is used as prices might differ across time and across different types of the good (such as coach or business class). Several researchers have nevertheless tried to estimate the energy usage and energy intensity of different types of consumption categories. Jalas and Juntunen (2015) do e.g. find that the energy intensity of free-time trips, eating and commuting trips are the most energy intensive consumption categories. Nässen and Larsson (2015) do also find that direct energy use, such as the use of gasoline, is more than five times as energy intensive as total energy use and more than ten times as energy intensive as consumption of durable goods. Not surprisingly therefore, car and air travel have a high energy intensity of consumption, higher than the energy intensity of total consumption.

The focus in this thesis will however not be put on exact numbers of energy intensity of consumption, but rather on how the energy intensity of consumption changes when an individual receives more non-work time due to retirement. The idea is therefore that if the share of expenditure on car and air travel goes up, the energy intensity of total consumption increases as these goods are more energy intensive then the energy intensity of total expenditure. If the share decreases, the opposite happens and the energy intensity of total consumption decreases.

2.2 The effects of the amount of non-work time on consumption

The main effect that this research aims to estimate is how an increase in non-work time affects consumption and although this area is comparatively small, and also rather new, in the literature there have been a few attempts to estimate a time effect on consumption.

One paper that tries to find a relationship between the amount of non-work time available and energy consumption is written by Nässen and Larsson (2015) who make an attempt to address the effect that the amount of working hours have on energy use and emissions that comes from private consumption. Their objective is to identify both the income effect of consumption that comes from a decrease in income when the amount of working hours decreases as well as the isolated effect on consumption from increased amount of non-work time, the latter being of interest for this research. To estimate the time effect they use ordinary least squares (OLS) regression where time use on different activities (T_i) is regressed on working time (T_w), income (Y) and control variables (Z_i) as follows:

$$T_i = C + b_1 T_{work} + b_2 Y + b_i Z_i. \tag{1}$$

By mapping the energy intensity of each time-use category the effect of working time (and thereby indirectly non-work time) on energy use can then be estimated. They do also find that decreased working time leads to an increase in energy use when the income effect is excluded, which is in line with the hypotheses of this research, although the effect is small. There are however two problems with their research. Firstly, their estimated OLS-equation is likely to suffer from endogeneity. As the amount of time you choose to work likely is a decision taken jointly with how much time you allocate on other activities, and to some extent to how much income you take home, this is an issue when you try to establish causality from the amount of work time on other time-use categories. If there had been an exogenous event such as a new law that lowered the amount of working hours allowed, this type of regression would potentially hold more bearing. Secondly, they put a limit on expenditures to not be larger than the reported income. This is an issue as low-income individuals might consume more than their current income due to an expected higher life-time income, in accordance with the permanent income hypothesis. Students might e.g. spend a lot more than they currently earn as they expect a high life-time income and using this restriction their expenditure above their current income is excluded.

Brencic and Young (2009) investigate the relationship between amount of leisure time and energy consumption, but from a different angle. They try to address how the use of time-saving technologies, such as dishwashers or clothes dryers, affect the time and energy use in a household through the use of a Canadian Survey of Household Energy Use. Their logic being that when a time-saving device is purchased, time that previously was ear-marked for a certain household activity now becomes free to allocate towards leisure (such as watching television) or other housework. If the replacing activity is more energy-intensive than the chore that now is replaced by technology, the net effect of the time saving technology will be an increase in energy use. This is especially true if the time saving technology in itself is more energy-intensive than the manual work that it replaces. Using OLS they estimate both how time use for different household activities, as well as total energy use, changes due to the use of different time saving appliances.

The results in Brencic and Young's paper are however weak. They do find some small indirect time rebound effects, such as time saved on food preparation is used on another household chore instead. The only direct time rebound effect they find however is that low-income households owning a self-cleaning dishwasher load almost twice as many dishes as similar households who owns a dishwasher without this feature. When it comes to total energy use no effect is found from the mentioned time rebound effects however. The only significant effect on energy use that they find is that low-income families who own a washing machine and a clothes dryer use less energy than those without these appliances. In addition to the results being weak, Brencic and Young's analysis most likely also suffers from problems of self-selection. It seems e.g. reasonable that households that load twice as many dishes than other households would be more prone to invest in a self-cleaning dishwasher. The weak results together with the probable problem of self-selection results in that the contribution of Brencic and Young's paper is limited.

The papers mentioned so far have tried to estimate some kind of causal relationship between the amount of non-work time and energy usage, but in addition to this there are also papers that try to establish the energy or carbon intensity of different household and leisure activities. Examples of these are papers written by Jalas and Juntunen (2015) and Druckman et al. (2012). Using Laspeyre's decomposition Jalas and Juntunen (2015) find that increased energy intensity of consumption is the second largest factor to explain the increasing total energy consumption in Finland. They do also find that the energy intensity is highest for free time trips, eating and trips to work and study. Although the results are interesting and relevant for our research, the approach of decomposition is more of an attempt to get an overview of energy-consumption and time use than an estimation of the effect of the amount of non-work time on consumption. Druckman et al. (2012) focus on the usage of non-work time and how different activities leads to different amounts of carbon emissions, i.e. they focus on carbon intensity rather than energy intensity. What they find is that food preparation and commuting are the most carbon intensive activities, while leisure and recreation activities have a comparable low carbon intensity. However, Druckman et al. focus mainly on day-to-day activities and therefore leaves out holiday trips, and thereby air travel, which is of main interest for our research.

There are also papers that have a more qualitative approach and try to evaluate surveys without rigorous econometric methods. One such example is Aall et al. (2011) who focus on Norwegian leisure consumption, how it has changed and what the psychological drivers behind the consumption are. Their paper is a presentation of the overall results from two surveys, one of which the authors have conducted themselves. Some of the main results include that holiday journeys seem to be the most energy-intensive leisure activities, followed by other transportation intensive activities such as visiting friends and family. Over time, leisure activities in Norway also seems to have become more energy and material intensive. although the results are interesting, they are concluded through qualitative analysis and are therefore less trustworthy from an economics perspective. Due to their oil wealth Norway might also not be a representative country when it comes to consumption of leisure activities.

As have been shown, there are some papers written in the area of interest but even the most relevant papers gives an unclear picture of the effect of increased non-work time at best. However, as most of these papers excludes a very energy intensive commodity, namely air travel, it is definitely worth it to look into the issue further. In addition, the changes in non-work time have been small in all of the presented articles, which together with the issues of endogeneity in Nässen and Larsson's paper makes a case for the usage of retirement as a natural experiment to investigate the effects of increased non-work time on the energy intensity of consumption.

2.3 Changes in consumption due to retirement

As this research uses retirement as a natural experiment that changes the amount of non-work time available, the other main area of economic research that is of importance for this paper is the existent research on how and why consumption changes at retirement. In most countries, consumption seems to decrease at retirement (see e.g. Banks et al., 1998) and most of the available literature on the area of retirement consumption is focused on explaining why this happens as the simplest forms of the Permanent Income Hypothesis (also known as the Life-cycle Hypothesis) predicts that a decrease in consumption at retirement should not happen (Modigliani and Brumberg, 1954; Friedman, 1957). Different attempts have been made to explain this drop in consumption. Blau (2008) looks at the uncertainty of retirement age as an explanation and Bernheim et al. (2001) try to explain the drop through unexpectedly low pensions. The approach that is most relevant for this paper is however to expand the definition of consumption by including time usage, allowing for consumption smoothing to be achieved through a combination of money expenditure and non-work time use. The most relevant papers presented below have this approach, stemming from a theory developed by Becker (1965), and as the increased amount of non-work time is connected to changes in consumption these papers serve as a good background for my research.

One paper that uses the approach proposed by Becker (1965) is written by Aguiar and Hurst (2005) who look at how food consumption changes upon retirement. Their purpose is to investigate whether the permanent income hypothesis holds when time allocation is included in consumption. They thereby consider expenditure (how much money that is spent) as separate from consumption as their definition of consumption also includes time usage. Their rationale behind this is that retired individuals can spend more time on activities that were previously outsourced to the market by expenditure and uses food consumption to test this. Using two separate data sets, one on food expenditure and one with detailed information of time use during a day, they construct a consumption index ($\hat{C}$) that includes both expenditure on food and time use on food production in order to estimate how food consumption, not food expenditure, changes upon retirement. The main model they estimate is the following

$$\ln \hat{C} = \gamma_0 + \gamma_1 retired_{it} + \gamma_2 Z_{it} + v_{it}, \qquad (2)$$

where *retired* is a dummy variable for retirement and Z_{it} is a vector for control variables that were used. The model is then estimated using instrumental variable (IV) regression where age is the instrument for the dummy variable retired. The main findings in their paper is that while total expenditure on food decreases quite a lot at retirement, the increased amount of time spent on food production results in that the consumption of food does not decrease upon retirement. Consumption smoothing therefore seems to be achieved by substituting money with time, at least in the case of food production. Or in other words, the extra amount of non-work time given at retirement causes food expenditure to decrease.

Changes in food consumption is a popular choice also for other researchers. Luengo-Prado and Sevilla (2013) e.g. focus on food consumption to investigate whether there exist a retirement consumption puzzle in Spain. Just as Aguiar and Hurst (2005) they include time usage in their definition of consumption. Their approach is to first estimate how both total expenditure and expenditure on food changes upon retirement by estimating the following equation where C_{it} is expenditure, R_{it} is a retirement dummy and X_{it} are control variables in the equation below:

$$\log \hat{C_{it}} = \alpha_i + \beta R_{it} + \gamma X_{it} + \epsilon_{it}. \tag{3}$$

As they find that total expenditure does not drop significantly but food expenditure does, they continue to investigate the behaviour of food consumption by estimating how time use on food production changes at retirement. This is also done using OLS where time spent on food shopping, cooking, eating at restaurants and eating at home is regressed upon a retirement dummy variable and control variables similar to the above equation. What they find is that the lower food expenditure is coupled with more time spent on both food shopping and cooking and they therefore conclude that there exist no retirement puzzle in Spain if time usage is included, similar to the conclusion in Aguiar and Hurst (2005). As they also estimate the average prices spent by the different households on food, and find that retired households pay lower prices, they conclude that the extra shopping time spent by the retired households is used to find bargains on food.

Both Aguiar and Hurst (2005) and Luengo-Prado and Sevilla (2013) paper are rigorously made and the results seem to be trustworthy as neither of the papers seem to suffer from issues such as selection bias or endogeneity. Both papers further test for other possible explanations for the results that are found. Aguiar and Hurst (2005) do e.g. test if nutritional quality of food intake changes upon retirement to make sure that the lower food expenditure is not due to purchase of less food or food with lower nutritional quality. As they both connect changes in expenditure at retirement to the extra amount of non-work time received upon retirement both of these papers are very relevant to this research.

Another paper that analyses changes in consumption upon retirement within the framework of the permanent income hypothesis is written by Miniaci et al. (2010) who look at Italian households. They hypothesize that a drop in consumption at retirement can be attributed to increased home production of services (due to increased non-work time) and the cut of work related expenses (such as commuting). Their hypotheses are therefore very similar to the hypotheses in this research. To investigate this they use cohort analysis where households are organized into different groups (or cohorts) based on background characteristics that are time invariant. This data is then used to create synthetic individuals that can be followed over time. OLS regression with a dummy for retirement as the main explanatory variable is then used in order to estimate how consumption for different expenditure groups (such as transportation, health and food) as well as total expenditure changes at retirement. Their most relevant results are that food and transportation expenditure drops at retirement but they do not find a retirement effect on holiday spending. Their overall conclusion is also in line with their hypotheses, i.e. that the drop in total expenditure at retirement can be explained by a decrease work-related expenditures and utilization of the increased amount of non-work time. As they focus on both direct time effects through increased non-work time as well as the indirect effect of decreased work-related expenditures it is naturally a relevant paper for this research. However, their method of cohort analysis and the construction of synthetic individuals before OLS-regression is applied makes it less transparent when it comes to the evaluation of the results.

There are also several working papers published by National Bureau of Economic Research (NBER) and the Center for Retirement Research on this topic. Examples are the papers by Fisher et al. (2008) and Aguiar and Hurst (2007). Given that they come up with similar results as have been presented so far and that they are not peer-reviewed, they will not be further presented here however.

As mentioned earlier, there are other attempts at explaining why total expenditure decrease at retirement. The mainstream view for now however seems to be that most of the reduction in expenditure comes from diminished work-related expenditure and decrease in food expenditure due to increased time-use in food production, which gives a good foundation for this paper to build upon.

3 Theoretical framework

In this section, a modified version of the Permanent Income Hypothesis including time use is firstly presented. This is followed by a derivation of an estimable model based on Becker's (1965) theory of time allocation.

3.1 Permanent Income Hypothesis

Modigliani and Brumberg (1954), with the additional help of Friedman (1957), developed the Permanent Income Hypothesis (PIH), also known as the Life-cycle hypothesis, that states that a rational individual will smooth his or her consumption over their lifetime through interaction with the credit market. The idea is that the individual adjusts his or her consumption after their permanent income, which is unit income calculated on the individual's entire lifetime, instead of their income level in any given period. This is achieved through borrowing (or use of savings) when the actual income is lower than the permanent income and through saving when the actual income is larger than the permanent income. This theory can therefore be applied to the event of retirement, when income goes from being positive to zero. As the individual's income was higher than the permanent income when the individual was working, the theory states that the individual saved the exceeding amount which is then used for consumption after retirement. As consumption is usually equated to expenditure, this has resulted in an expectation that total expenditure should be the same before and after retirement. As shown in the previous section, this is not the case however and the PIH has been further developed in order to explain why a drop in expenditure happens at retirement. Hurd and Rohwedder (2003) e.g. derive a model where the amount of leisure time is included in the utility function in addition to expenditure. Their model predicts that total expenditure drops at retirement since the amount of leisure time that is available to the individual drastically increases.

The PIH is important for this thesis as a change in expenditure at retirement should come by choice from the retiring individuals. They should not be forced to change their expenditure due to lower expenditure possibilities. As shown in the previous section, this theory is also likely to hold when time is included in the definition of consumption. In the next section, the idea to combine time-use and market goods in order to get utility will be developed further.

3.2 Derivation of model

Becker (1965) derived a theory of time allocation which will serve as a good foundation for the model that will be derived and used in this thesis. Becker starts in traditional theory where households maximize utility from goods but departs by including non-work time. This is done through the assumption that households combine time and market goods to produce commodities, Z_i, from which the households derive their utility. Hence Z_i is given by

$$Z_i = f_i(x_i, T_i), \tag{4}$$

where x_i is a market goods vector and T_i a time-input vector (to allow for a difference between non-working times at different times of the week) used in the production of the ith commodity. In other words, households are both seen as producing units, as they themselves produce the final goods through a combination of time and market goods, and utility maximizers, as they maximize a utility function in order to find optimal combinations of the commodities Z_i. Hence

$$U = U(Z_i, \ldots Z_m) \equiv U(x_1, \ldots x_m; T_1, \ldots T_m) \tag{5}$$

subject to

$$g(Z_i, \ldots Z_m) = Z, \tag{6}$$

where Z is the bound on resources and g is an expenditure function of Z_i. One approach is to assume that the constraint on the expenditure on market goods and time are separate constraints. If so, the constraint on expenditure on market goods can be written as

$$\sum_{1}^{m} p_i x_i = I = V + T_w \bar{w}, \tag{7}$$

where p_i is a price vector for the the unit prices of x_i, T_w is the hours spent at work and $\bar{w}$ is the wage (i.e. $T_w\bar{w}$ is salary earnings). V is other income, which in the this research can be considered as pension payouts. The constraint on time expenditure can similarly be written as

$$\sum_{1}^{m} T_i = T_c = T - T_w, \tag{8}$$

where T is total time available and T_c gives the total time spent at consumption. The production functions in (4) can thereby be written as:

$$\left.\begin{aligned} T_i &\equiv t_i Z_i \\ x_i &\equiv b_i Z_i. \end{aligned}\right\} \tag{9}$$

As time can be converted into goods by using more time for work and less time for consumption, (7) and (8) are not independent. Hence, a single constraint can be achieved by substituting the equivalent for T_w in (8) into (7) which gives

$$\sum p_i x_i + \sum T_i \bar{w} = V + T\bar{w}, \tag{10}$$

which can be written as

$$\sum (p_i b_i + t_i \bar{w}) Z_i = V + T\bar{w} \tag{11}$$

by combining equations (9) and (10).

The maximization problem is thereby given by:

$$\max \quad U = U(Z_i, \dots Z_m) \quad \text{s.t} \quad \sum (p_i b_i + t_i \bar{w}) Z_i = V + T\bar{w}. \tag{12}$$

From here, Becker's theory will be modified and built upon in order to adapt it to the specifics in this paper. This is done by assuming a Cobb-Douglas utility function with two commodities, one that is time-intensive and one that is market good intensive. In respect to this research the time intensive commodity can be considered to be air travel (proxied through airfare expenditure) or car travel (proxied through gasoline expenditure) and the market good intensive commodity can be considered to be a basket of all other goods (proxied through total expenditure). This would yield a Lagrangian-equation as follows:

$$\mathcal{L} = Z_M^{\alpha} Z_T^{\beta} + \lambda(V + T_w\bar{w} - p_M b_M Z_M + t_M \bar{w} Z_M + p_T b_T Z_t + t_T \bar{w} Z_T). \tag{13}$$

If it is assumed that the market-good intensive commodity, Z_M, is produced using only market goods (i.e. no time is used in the production of this commodity) then $t_E = 0$ and $b_E = 1$. The time-intensive good, Z_T, is assumed to be produced by both time and market goods, hence b_T and t_T are left as is. This, together with a normalization of the price of the market good to one ($p_M = 1$) gives the simplified Lagrangian below:

$$\mathcal{L} = Z_M^{\alpha} Z_T^{\beta} + \lambda[V + T_w\bar{w} - Z_M - Z_T(b_T p_T + t_T \bar{w})] \tag{14}$$

F.O.C. w.r.t. Z_M and Z_T gives

$$\alpha \frac{U}{Z_M} = \lambda \tag{15}$$

and

$$\beta \frac{U}{Z_T} = \lambda(b_T p_L + t_T \bar{w}). \tag{16}$$

Hence:

$$\frac{\beta}{\alpha}\frac{Z_M}{Z_T} = (b_T p_T + t_T \bar{w}) \tag{17}$$

$$\frac{Z_M}{Z_T} = \frac{\beta}{\alpha} b_T p_T + \frac{\beta}{\alpha} t_T \bar{w}. \tag{18}$$

As p_T can be considered as constant in this case as only one time period is considered, thereby not allowing for any fluctuations in price over time, and β, α, b_T and t_T also are constants by definition, the above equation can be simplified further as

$$\frac{Z_M}{Z_T} = \gamma_0 + \gamma_1 \bar{w}, \tag{19}$$

where $\gamma_0 = \beta/\alpha b_T p_T$ and $\gamma_1 = \beta/\alpha t_T$. Now, as the effect of interest for this research is the effect of retirement, and not a marginal increase or decrease in the wage level, this model can be simplified further by allowing the wage variable $\bar{w}$ to be a binary variable. This is possible as retired people have by definition zero wage and working people have a positive wage, thereby giving the wage-variable a binary component when other zero-wage individuals are excluded (such as unemployed individuals). The use of binary variables to capture the effect of retirement is also well established in the literature that have been presented in Section 2. To make the interpretation simple, the wage variable is renamed to R_i, representing retirement, which takes the value 1 if the individual is retired and 0 if the individual is a full-time worker. We thereby have the following equation:

$$\frac{Z_M}{Z_T} = \gamma_0 + \gamma_1 R_i. \tag{20}$$

Using this equation it is possible to analyse how retirement affects the ratios of total expenditure over air-fare or gasoline. If $\gamma_1 > 0$, then retirement leads to a larger ratio of Z_M/Z_T. This means that the expenditure on Z_M has increased more than the expenditure on Z_T, or for that matter that the expenditure on Z_M has decreased less than the expenditure on Z_M. If $\gamma_1 < 0$, the opposite is true and Z_M increases less (or decreases more) than Z_T.

If the value of both γ_0 and γ_1 are known then the ratio of Z_M/Z_T can be calculated for both retired and working individuals. If the parameters are known, the ratio can also be inverted for easier interpretation. The inverted ratio of Z_M/Z_T makes more sense to interpret as this gives a more direct picture of the energy intensity of consumption. As the time-intensive commodities, Z_T, that will be considered are both also energy-intensive commodities that are more energy-intensive than the energy-intensity level of the basket of the rest of the goods, Z_M, how the ratio of Z_T/Z_M (i.e. the inverted ratio of Z_M/Z_T) changes gives direct insight in how the energy-intensity of total consumption changes. If this ratio goes up it therefore means that more of the total amount of money spent is allocated from the less energy-intensive commodity towards the more energy-intensive commodity, i.e. the energy-intensity of total consumption goes up. Hence if $\gamma_1 > 0$ the inverted ratio decreases when the individual retires and the total energy-intensity of consumption becomes lower. If $\gamma_1 < 0$ however, the inverted ratio increase upon retirement and the total energy-intensity of consumption increases. To put it even more clearly, inverted ratio $Z_T/Z_M = 1/\gamma_0$ for full-time workers and $Z_T/Z_M = 1/(\gamma_0 + \gamma_1)$ for retired individuals.

Beginning in the model of time allocation that Becker (1965) derived, a simple estimable model of how retirement affects energy-intensity of total consumption have been derived. Becker's model do also go well in hand with the previously presented Permanent Income Hypothesis as the expenditure constraint includes both salary earnings $(T_w \bar{w})$ as well as other income V which easily can be considered to be pensions for the retired individuals.

As have been showed, the values of the parameters γ_0 and γ_1 in equation (20) is of great interest in order to test the hypotheses of this paper and must therefore be estimated. The method of estimation will be presented in the coming section.

4 Quantitative methods and data

In this section, the empirical models that will be used to test the hypotheses of this paper will be presented. In addition to this, the chosen method of estimation will be presented along with a discussion of why this method was chosen over other possibly suitable methods. As a start however, the data that is used in this research will be described along with how the sub-samples that are used are created.

4.1 Data and sub-samples

The data that is used in this research is a Consumer Expenditure Survey conducted by The Bureau of Labor Statistics of the United States of America. The dataset is compiled yearly, but a survey is made each quarter on how much the interviewed households spent on different goods the previous quarter. This research uses the latest published data set which is for the year of 2014 and consists of five different quarterly surveys conducted in each quarter of 2014 and the the first quarter of 2015. Each survey is made on a new randomly selected sample. Only the last four of the surveys are included in this research as these cover the expenditure in the four quarters of 2014. All expenditure data presented in this thesis should therefore be read as quarterly. In addition to expenditure, the dataset also includes data on other characteristics that the interviewed household has. Data is therefore available on employment status and reasons for not being employed, the length of the usual work week, how many weeks that the individual worked the previous year and how big the reference person's (the one who is interviewed) family is, only to name a few.

The sample that is used in this research is constructed as follows. To start with, the sample is restricted to include only households where the reference person is is between the ages 58 to 68 years old, which includes those who are 58 and 68 year old. The reasoning behind this age bracket is to include five years before and five years after the average retirement age, as this should result in a balanced sample where there are the same amount of full-time workers as retired people. As there are different estimates on when the average retirement age is, ranging from 62 (Riffkin, 2014) to 66 (OECD, 2015) depending on the definition of retirement the sample was centred at the age of 63 as this gave the best balance between full-time workers and retired individuals (approximately 1500 in each group). As the idea is to compare individuals who soon will retire with individuals who have just retired, the age-bracket should preferably be more narrow, but as the sample was reduced too much by doing so this age bracket was chosen.

Next, the sample was restricted to only include individuals who either are full-time workers or retired. As there is data available on whether the reference person is retired or not, it was easy to sort out the retired individuals. When it came to full-time workers however, a definition must be chosen as it is not enough to merely consider yourself as part of the work force. The limits for a full-time worker was set at an individual who works more than 35 hours a normal work-week and who works 52 weeks per year (including vacation weeks). This then resulted in a sample of approximately 3000 individuals evenly divided between full-time workers and retired individuals.

As information on whether the reference person's spouse was retired or not is also available, a sample could have been constructed including only individuals where both the reference person and the spouse were either retired or full-time workers. This makes sense especially when it comes to the analysis of air travel as individuals who have a spouse that is still working might not travel that much more compared to when she was a full-time worker, but instead wait with the additional travelling until the spouse also is retired. As the sample became too small when this was done however, it is decided that focus is put on the reference person's retirement status only. Therefore the sample described in the previous paragraph with approximately 3000 individuals is used.

4.2 Model to be estimated and method of estimation

In the theoretical section, an estimable equation was derived, namely

$$\frac{Z_M}{Z_T} = \gamma_0 + \gamma_1 R_i, \tag{21}$$

where Z_M now is total expenditure, Z_T is expenditure on either airfare or gasoline and R_i is a dummy variable that takes the value 1 for retired individuals and 0 for full-time workers. although this model could be estimated directly using e.g. OLS or IV-regression, the model is very simplistic when it comes to an application on the real world. Surely there are other variables that either are correlated with retirement or also affect the ratio of total expenditures over airfare or gasoline expenditure. If these were to be left out of the equation when an estimation is made, it would lead to omitted variables bias and inconsistent estimates of the parameters of interest. Therefore, to control for this, a vector of control variables X_i is included in the empirical model. Hence, the empirical model will look like:

$$\frac{Z_M}{Z_T} = \gamma_0 + \gamma_1 R_i + \beta_i X_i + \epsilon_i. \tag{22}$$

According to Stock and Watson (2015, pp.385-386) omitted variable bias arises if either a variable that is correlated with the explanatory variables is left out or if a variable that is also affecting the dependent variable is left out, and these should therefore be included as control variables if possible. The control variables that will be considered are quarter dummys (to control for any time fixed effects), family size, region dummies in the US that the household resides in as well as the reference person's age, education level, race and sex.

There is however another issue that also has to be addressed, namely the fact that some of the individuals in the sample do not purchase gasoline and only a small share of the sample purchases airfare. As division with zero is undefined, this means that the samples will be restricted even further when the above equation is estimated. This issue is not that big for gasoline expenditure as almost everyone have a positive expenditure of it but as only 9 percent of the sample has a positive expenditure on airfare the issue becomes bigger. One way to approach the issue is to assume that the choice of air-travel is independent of retirement status, i.e. that a certain share of the population is air-travellers no matter if they are retired or not. Retirement would thereby not lead to more air-travellers and an estimation on only the sub-sample of air-travellers would not be biased (at least not due to increased number of air-travellers at retirement). It is possible that this assumption holds, especially when looking at the data where the share of air-travellers is close to identical in the group of full-time workers and in the group of retired individuals. That being said, it is still good to make an additional estimation where the zero-consumers are included. In order to do this, inspiration is taken from the relevant literature and a linear regression is estimated on the empirical model

$$Z_T = \alpha + \beta R_i + \gamma_i X_i + \epsilon_i, \tag{23}$$

where Z_T is expenditure on gasoline or airfare as before, R_i is the retirement dummy-variable as before and X_i are control variables as before but with one addition: total expenditure is included as a control variable. This addition makes sense as the consumption of both gasoline and airfare most likely are dependant on how much an individual spends, which must therefore be controlled for. When estimating this equation with OLS the zeroes will be included and the effect of retirement on the consumption of airfare and gasoline will be estimated for the whole sample. This will give valuable additional information to the estimations of the main model.

However, the problem that comes with the zero-consumers is not completely eliminated. This is so as all the zeros are treated in the same way, although some of the individuals that are zero-consumers are most likely closer to become a consumer than other. The data is in other words censored as if the true willingness to consume of each individual was represented correctly there would have to be negative values of expenditure included, which of course makes no sense in real-life data. This could lead to a bias, especially if the zero-consumers in the retired group and non-retired group have different "true" values of expenditure (Tobin, 1958). If there is an equal amount of zero-consumers in both the retired group and the group of full-time workers however, as is the case for the used sample, and their "true" values of expenditure are the same, then the risk for this bias should however be limited. This is particularly true if the assumption that only a certain share of the population consumes airfare independently from the retirement status holds, as all individuals that have zero expenditure on airfare then are equal as they by definition never would consume airfare.

To estimate this second model therefore makes sense and will add information concerning the changes in consumption of gasoline and air-travel that will be helpful in the analysis of changes in the energy-intensity of consumption. As the same sample is used for both the gasoline and airfare estimations in the secondary model, parallel estimation of the two equations will give the same estimates as joint estimation would if the same control variables are used in both estimations, which is done, and if the error terms are uncorrelated. This is according to the theory of Seemingly Unrelated Regressions (SUR), as explained by Zellner (1962), and provides an extra reason for estimating the secondary model.

In order to draw conclusions about how increased non-work time affects the energy-intensity of consumption for the whole working population, not only the sample of 58-68 year old individuals, the expenditure patterns for all different adult age-groups must be compared with the soon-to-be retired age group. To test for this therefore, the adult-working population is divided into age-groups of 5 years starting at 23. Using the same definition of full-time workers as before, only these were included. The mean expenditure on airfare and gasoline, as well as the mean ratio of interest Z_M/Z_T for both airfare and gasoline, is then calculated and using a *t*-test of group means they are compared with the reference group of 58-63 years of age (i.e. those that statistically soon will retire). One *t*-test is in other words conducted for each age-group testing if the means are significantly different from the means of the reference group. If the means of the different age-groups generally are not significantly different from the reference group, then this gives some evidence towards an extrapolation of the results for the whole working population being possible.

4.3 Consideration of alternative methods of estimation

When it comes to consumption or demand analysis there are several other methods available for estimation with a wide range of intricacy. One of the most common methods has been to estimate some type of demand system such as the Almost Ideal Demand System (AIDS) developed by Deaton and Muellbauer (1980). This method has several advantages and is especially suitable in estimating budget shares for different types of goods and how they change over time. Using this system it is also possible to estimate elasticities of substitution and also income and expenditure elasticity in a straight-forward fashion. This, or a similar demand system, could therefore be used in order to estimate how the budget shares of gasoline and air travel expenditure changes when a person retires, as well as estimating expenditure elasticities for the two goods separately for the retired and non-retired group of people. In order to do this however, price data for each good is first of all needed and this is something that is not included in the data set at hand and must therefore be acquired separately. Given that the sample includes people from all the states in the US average prices on gasoline could readily be calculated for each state, but when it comes to the expenditure on airfare the price data will be a lot harder to find as there is a lot of variation in airfare prices due to differences in distances flown and due to differences in the demand for air-travel at the time of ticket purchase. Uncertainty in prices would therefore most likely result in biased results. In addition to this, the main point of interest is not how the demand for gasoline and airfare is affected by price changes but rather how much a significant increase in free-time affects the expenditure on gasoline and airfare. The main variable of interest, whether the individual is retired or not, is also not easily incorporated in the AIDS-model directly but the model must be estimated separately for the retired group and the full-time workers. If accurate price data was available however the use of the AIDS-model, or similar demand system,would most likely be the best choice. With the uncertainty in prices however, it is better to consider another method of estimation, such as OLS.

Another method of estimation that is a bit more similar to OLS than the AIDS-model is instrumental variable (IV) regression. In this case the retirement variable could be instrumented by the age of the individual, something that e.g. Aguiar and Hurst (2005) did. There could be several advantages in doing this, one being that the risk of omitted variable bias decreases as age affects most likely only retirement status and not expenditure on airfare and gasoline (at least in a age-limited sample such as the one in question). However, as the sample has been narrowed down to span between 58 to 68 years of age, and as there are retired and non-retired individuals at almost all ages, the predictive power of age on retirement becomes limited. This together with the fact that precise data on whether a person is retired or not exists makes a case against the use of IV-regression.

A third method of estimation that could be considered is a method called matching. There are different types of matching, such as propensity score matching and exact matching, but the idea is the same in most of them. This idea, as explained by Caliendo and Kopeinig (2008), is that individuals who are very similar in most attributes (who have similar or exact so called covariates) but differs in the variable of interest, in this case retirement status, are matched together and any difference in the outcome variable of interest (i.e. gasoline or airfare expenditure) is attributed to the variable that differed. This is so as the so called treatment status, in this case the retirement status, can be considered as random for individuals that are correctly matched. The problem here however is that total expenditure most likely would be part of the covariates that individuals are matched upon and as it is known from the background section that total expenditure drops at retirement, this would cause individuals that actually are different in spending behaviour to be matched with each other. It would therefore be hard to match individuals who are retired and full-time workers correctly.

A fourth method that could possibly be used is regression discontinuity. As described by Stock and Watson (2015, pp.546-548) two common types of regression discontinuity exists, sharp and fuzzy designs. The idea in both designs is that treatment status is based on whether an observable variable, such as age, is above or below a certain threshold value and that it is random whether an individual has a value of the observable variable that is just above the threshold or just below. Individuals close to the threshold can therefore be considered as randomly selected to the treatment or non-treatment group. In the sharp design, everyone on a certain side of the threshold gets the treatment while everyone on the other side do not. In the fuzzy design the probability to get the treatment increases as the threshold is passed and an instrumental variable approach can be used in the estimation. It is clear that sharp regression discontinuity would not be suitable for this research as retirement can happen at all ages and not only at a fixed age. Fuzzy regression discontinuity could perhaps be considered, but similar estimation issues as in IV-regression, as discussed above, would most likely arise. As precise data on whether an individuals is retired or not is available, OLS with a dummy variable for retirement therefore becomes a better option.

As mentioned in Section 4.2, using OLS to estimate the secondary model might not be enough to solve the possible issue that comes with the individuals that have a zero expenditure of airfare and gasoline. Other methods such as the Tobit model introduced by Tobin (1958) or Heckman's Two-step Estimator suggested by Heckman (1976) could be used if a bias from the zero-expenditures is suspected. This do however come with additional possibilities for biases and since the share of zero-expenditure individuals is equal in both the retired and full-time worker group, the bias from the zero expenditure should be limited when OLS-estimation is used. Due to this, these methods are not used.

Although there exist several other methods that could be used to estimate the effect that is looked for, OLS seems to be the most fitting method, at least given the data at hand. In addition to this, OLS has the advantage to be easily interpreted and understood and in comparison to both the AIDS-model and matching it allows for a straightforward estimation of the model that was derived in the theoretical framework, which is a huge advantage by itself.

5 Results and discussion

In this section the results from the estimations of the primary and secondary models are presented together with descriptive statistics of the variables of interest. The plausibility of these results is then analysed and discussed through an examination of possible issues with the method of estimation, the data and the underlying assumptions of the estimated model. With the basis of a t-test of group means across different age groups, the possibility of extrapolating the results from the used sample to the population as a whole is also discussed.

To start with, descriptive statistics of interest are presented to get an overview of how expenditure in the working and retired group looks like. These statistics are presented in Table 1 below. As can be seen, total expenditure is 19 percent smaller in the retired group than in the working group, a difference that can be considered quite large. Given the presented theoretical framework, where time use is included in the definition of consumption, this drop is however expected due to the increase in non-work time that retirement provides. In similarity with total expenditure a drop in gasoline expenditure is also present and this drop is almost of the same size as the drop in total expenditure (-20 percent). Despite the substantial drop in total expenditure however, the average expenditure on airfare is almost 16 percent larger in the retired group than in the working group. Although these statistics only give a rough view of the differences in expenditure before and after retirement, the data looks promising thus far.

Table 1: Mean values of variables of interest in the working and retired group respectively

Variables	Working group	Retired group	Difference
Total expenditure,	10221.49	8248.37	- 1973.12 (- 19.3%)
Airfare expenditure,	75.66	87.44	11.78 (+15.6%)
Gasoline expenditure,	461.61	369.09	92.52 (-20.0%)
Age	61.6	64.7	
N	1569	1500	

NOTE. Data come from the 2014 Consumer Expenditure Survey by The Bureau of Labor Statistics. The unit for mean expenditure is dollars per quarter. The percentage difference in mean expenditure between the working group and the retired group are found in the parentheses.

In order to get further, the primary models, where the ratio between total expenditure and either airfare expenditure or gasoline expenditure (Z_M/Z_T) is the dependent variable, is estimated. The results from the final estimation of the model where the ratio between total expenditure and airfare is the dependent variable is presented in Table 2 below. This is the final model estimation where only the control variables that added accuracy and information to the model are included, all the other control variables are dropped.

Table 2: Estimated parameters of the primary model where Z_M/Z_T is the dependent variable and Z_T is airfare expenditure

Variables	Estimate, $/quarter	Standard error (*p*-value)
Intercept	133.00	33.810 (<0.0001)
Retired (R_i)	-45.42	23.362 (0.0530)
Quarter 2	-55.62	27.076 (0.0410)
Quarter 3	-63.58	26.932 (0.0190)
F-value: 3.16		
p-value: 0.0251		
R^2: 0.0241		
N=264		

NOTE. Data come from the 2014 Consumer Expenditure Survey by The Bureau of Labor Statistics. As the dependent variable is a share of total expenditure over expenditure on airfare, which has no unit, the estimated coefficients are also unit-less. They should therefore be interpreted as how much the share changes given the state of the explanatory variable in question.

As can be seen in Table 2 above, the estimated coefficient for variable of interest (R_i) has the value of -45.419 and is very close to significant at a 5 percent confidence level but definitely significant at a 10 percent level. This means that, all else equal, the ratio of total expenditure over airfare expenditure on average decreases with this amount when an individual retires. As mentioned in Section 3, the interpretation of this result becomes easier if the ratio is inverted, i.e. if the ratio instead is airfare expenditure through total expenditure. This can be done if we know the value for the other variables as well and as the other variables are control variables, a value of these can be chosen to calculate the reversed ratio for an imagined example individual. If an individual who was interviewed in the first or fourth quarter is used as an example individual, the reversed ratio can be calculated as follows if the individual is still working:

$$\frac{Z_T}{Z_M} = \frac{1}{133}. \tag{24}$$

This can be interpreted as a working individual spends on average $1/133th$ of her income on airfare in the first or fourth quarter. The question is however what happens when the individual is retired. For a retired individual who was interviewed in the first quarter, the reversed ratio is now as follows:

$$\frac{Z_T}{Z_M} = \frac{1}{133 - 45} = \frac{1}{88}. \tag{25}$$

As can be seen, the share increases a lot. The effect is even higher, in percentage terms, in the second and third quarter. The reversed-ratio for the working individual in quarter 2 is, when calculated in the same manner as above, 1/77 and if the individual would be retired the ratio is instead 1/32. For the third quarter the ratios are instead 1/69 and 1/24 respectively. The ratio of airfare expenditure over total expenditure is in other words more than twice as big in the second and third quarter for a retired person compared to a full-time worker. That the effect is largest in the summer half of the year is not surprising as these are most likely the months that both retired and working people prefer to go on vacation. That this ratio increases upon retirement is also consistent with the descriptive statistics in Table 1 as the average total expenditure decreased at the same time as the average expenditure on airfare increased.

As the ratio of airfare expenditure over total expenditure increases a lot due to retirement, and airfare expenditure is more energy-intensive than the average energy intensity of total consumption, this first result supports the hypothesis that energy intensity of total consumption increases at retirement due to increased consumption of air-travel.

Next, the same model is estimated using gasoline expenditure as the time-intensive commodity Z_T. Z_M is still total expenditure. The results of this estimation is found in Table 3 below.

Table 3: Estimated parameters of the primary model where Z_M/Z_T is the dependent variable and Z_T is gasoline expenditure

Variables	Estimate	Standard error (p-value)
Intercept	37.43	2.2383 (<0.0001)
Retired (R_i)	-0.14	2.02 (0.9452)
Quarter 4	7.04	2.2991 (0.0022)
Family size	-2.84	0.5161 (<0.001)
F-value: 4.84		
p-value: 0.0007		
R^2: 0.0053		
N= 2873		

NOTE. Data come from the 2014 Consumer Expenditure Survey by The Bureau of Labor Statistics. As the dependent variable is a share of total expenditure over expenditure on airfare, which has no unit, the estimated coefficients are also unit-less. They should therefore be interpreted as how much the share changes given the state of the explanatory variable in question.

As can be seen, all coefficients are significant except for the coefficient of the variable for retirement, R_i. It therefore does not seem to be a retirement effect on the expenditure on gasoline in relation to total expenditure, or this effect is too small to be captured in this estimation. When looking at the descriptive statistics in Table 1 this too makes sense as both the total and gasoline expenditure on average are smaller for the retired than for the working group, and the difference is almost the same in percentage terms (19 percent lower for total expenditure and 20 percent lower for gasoline). This result does in other words not support the second hypothesis, but this result together with the result for the share of total expenditure over airfare are in line with the overall hypothesis that energy intensity of total consumption increases at retirement.

As the primary model only can estimate results for individuals that have a positive expenditure on airfare or gasoline, it is important to also consider the secondary model where the whole sample is included. In Table 4 the main results of the estimates of the secondary model where airfare is the dependent variable are presented. In Table 8 in the Appendix the full results are presented including all control variables that were used.

Table 4: Estimated parameters of the secondary model where Z_T is the dependent variable and is airfare expenditure

Variables	Estimate, $/quarter	Standard error (*p*-value)
Intercept	-144.41	212,77 (0.4974)
Retired (R_i)	40.76	21.740 (0.0609)
Total expenditure	0.0155	0.00287 < 0.0001
F-value: 28.67		
p-value: <0.0001		
R^2: 0.0903		
N=3069		

NOTE. Data come from the 2014 Consumer Expenditure Survey by The Bureau of Labor Statistics. As the dependent variable is a share of total expenditure over expenditure on airfare, which has no unit, the estimated coefficients are also unit-less. They should therefore be interpreted as how much the share changes given the state of the explanatory variable in question.

As can be seen, the estimated coefficient of the variable of interest R_i is positive and significant. This can be interpreted as retirement on average have a positive effect on the expenditure on airfare when total expenditure is controlled for. Even though the number of fliers, i.e. those who have a positive expenditure on airfare, are so few compared to the non-fliers, the effect of retirement on airfare expenditure is still large enough to be captured in the estimated model.

Next, the secondary model where gasoline is the dependent model is estimated and the results are presented in Table 5 below. Just as with the previous estimation, only the intercept, the variable of interest (R_i) and total expenditure is included while the other control variables are presented in Table 9 in the Appendix.

Table 5: Estimated parameters of the secondary model where Z_T is the dependent variable and is gasoline expenditure

Variables	Estimate, $/quarter	Standard error (*p*-value)
Intercept	366.37	2.35 (0.0190)
Retired (R_i)	-38.40	14.75 (0.0093)
Total expenditure	0.0162	0.00133 (< 0.0001)
F-value: 95.95		
p-value: <0.0001		
R^2: 0.2540		
N=3069		

NOTE. Data come from the 2014 Consumer Expenditure Survey by The Bureau of Labor Statistics.

Interestingly enough there is a small negative and significant effect of retirement on the expenditure on gasoline. This effect is likely too small to be captured in the primary model, especially as both total expenditure and gasoline expenditure moves in the same direction. In the end, the results from the primary model holds more bearing as the main focus of this thesis is changes in the energy intensity of consumption, not absolute changes in consumption. This estimation does however give extra information and insight into how expenditure on gasoline changes upon retirement. As total expenditure is controlled for in this estimation, the estimated effect of retirement above should also be the pure retirement effect (given that the model is correctly specified and the underlying assumptions hold). This therefore gives an indication of a downward pressure on total energy intensity of consumption from the change in gasoline expenditure upon retirement, which is in line with the second hypothesis, although this effect is most likely too small to be captured in the primary model estimation.

To sum up the results so far, the estimations of the primary model gives strong evidence for an increase in energy intensity of consumption from an increase in airfare expenditure due to retirement among the non-zero consumers of air-travel. The effect was especially strong in the summer quarters. This result was supported by the estimation of the secondary model where the whole sample was included and airfare was the dependent variable. From the primary model estimations, no evidence was however found to support the hypothesis that decreased car travel would result in a downward pressure on the energy intensity of consumption. In the secondary model estimation however, a small negative effect from retirement on gasoline expenditure is found which indicates that a small downward pressure on energy intensity of consumption might be present as the total expenditure is controlled for in the estimation.

Given that the model is correctly specified and that the underlying assumptions of both the method of estimation and model derivation are correct, the results are supportive of the hypotheses of this research. This must however be analysed further before any conclusions can be drawn. To start with, the method of estimation, OLS, has several assumptions that must be fulfilled in order for the estimations to be consistent and accurate. As random selection was used when the surveys were conducted by the Bureau of Labor Statistics the assumption that the used variables in the models are independently and identically distributed random variables most likely holds. As for the assumption that large outliers are unlikely an ocular inspection of the data is made in Figure 1 and 2 in the Appendix where one potential outlier is identified in both the gasoline and airfare expenditure data. To make sure that these outliers are not disrupting the estimations, four new estimations of the models are made (the main results are presented in Table 10 in the Appendix). As the results are only changed by a small amount, making the already found results slightly stronger, the potential outliers are likely not posing a major problem in the final estimations. As tampering with the data should be avoided if possible, they are therefore left in the actual model estimations above. Another assumption that should be fulfilled is that there should be no perfect multicollinearity, and even if this is not the case strong multicollinearity still poses a problem. As can be seen in Table 11, 12, 13 and 14 in the Appendix multicollinearity is most likely not an issue. Finally, heteroskedasticity could also pose a problem in OLS-estimation.

However, heteroskedsaticity robust standard errors were used in all estimations so this should not pose a problem either. The technical assumptions of the method of estimation therefore seems to be fulfilled.

In addition to the assumptions of OLS-estimation there are several other assumptions that have been made, either directly or indirectly. One such assumption is that retirement can be treated as an exogenous event in that individuals suddenly have a lot more non-work time on their hands from one day to the next, without much intervention of their own. This assumption is especially important as to avoid issues with self selection, i.e. that some individuals retire primarily to travel more. If this were the case it would bias the results and the effects of retirement would be exaggerated in the estimations. Although it is quite possible that a few in the sample of retired individuals did retire in order to travel the globe, this require long-term planning and extra saving in order to retire earlier than the norm. It is therefore plausible that most people follow the norm, plan their retirement savings after the standard retirement age and retire when it is expected from them. If most of the retired individuals are a part of the latter group, which is supported by (source), the assumption of an as-if-exogenous event of retirement most likely holds and the issue of sample selection is most likely limited. It is however important to keep the possibility of sample selection in mind when conclusions are drawn based on the presented results.

Another assumption that is made, although indirectly, is that individuals retire from being full-time workers. In the working group this is easy to control for as data was available of length of work weeks and number of work weeks per year for each individual in the sample. In the retired group however it is impossible to know whether the retired person retired from being a full-time worker or from some other status, such as part-time work sick leave, as such historic information is not provided in the data set. Given that there are a lot of individuals in the data that are neither retired nor full-time workers, there are almost certainly several retired individuals that did not retire from a full-time worker status. This matters especially for the analysis of changes in airfare expenditure as individuals who have not been working full time the last year(s) of their work-life might not be able to afford vacation travel due to insufficient pension funds. This is especially so as e.g. sick-leave is an unexpected and involuntary reason to be working less, which are hard do plan for when pension savings plans are set up. The inclusion of these individuals could bias the result negatively, i.e. underestimate the effects, in two ways. Firstly, fewer retired individuals could chose to buy air-travel due to lack of funds, i.e. the number of zero-consumers of air-travel is larger than it otherwise would have been. Secondly, the level of expenditure of the retired individuals who choose to consume air-travel could be lower than it otherwise would have been for the same reason. Given that it is likely that several of the retired individuals did not retire from being full-time workers, this is an indication of that the actual effect is even stronger than the ones estimated, especially when it comes to airfare expenditure.

A third assumption that is made in the model is that prices can be treated as constant. The reasoning behind this is that each individual is interviewed at one point in time, leaving little room for changes in price, and that different price levels of gasoline and airline tickets affect the working group and the retired groups equally. Given that four quarters are considered, there could of course be large differences in price levels of both gasoline and air-line tickets and as the retired group spends 20 percent less than the working group this could possibly affect the retired group more than the working group. In addition to this, the full-time workers and the retired individuals do not have the same opportunities when it comes to buying airline tickets. This is so as the full-time workers have a limited availability of vacation weeks, that often have to be planned in advance, which gives them little flexibility in choosing the price level of airline tickets. Retired individuals on the other hand have a larger flexibility to scout the airline market and buy cheaper tickets. There is also a possibility that working individuals value more expensive features in their flight experience, such as business or first class upgrades, more than the retired individuals and thereby buys more expensive tickets. The lack of individual price data and data on the number of flights that have been purchased is therefore on of the biggest limitations in the research. Due to the reasons discussed it is likely that this leads to a negative bias on the size of the effects, indicating that the estimated results are at least not exaggerated. This must necessarily not be the case however and cannot be established without the price data available. If individual price data was available this would also open up for the usage of more sophisticated method of estimation, such as AIDS-analysis, which also could give more precise results.

The question of whether the possibility of extrapolation exists also remains. As the analysis has only been focused on how the expenditure changes upon retirement in a quite narrow age-group there could be several reasons to why an extrapolation to the rest of the population is not applicable. The main concern would be that the soon-to-be retired individuals have different preferences for air and car travel and therefore consumes them in different quantities than full-time workers in other age-groups. In order to test this therefore, a t-test of group means is conducted both for the mean value of the ratio of interest, i.e. Z_M/Z_T, for both airfare and gasoline expenditure and for the actual expenditure on these two goods. In Table 6 below the results of these t-tests, as well as the actual means for the different age-groups, are presented for airfare expenditure.

Table 6: t-test of means of airfare expenditure between adult age-groups and the pre-retirement age-group (the reference group

	Total/Airfare expenditure		Airfare	
Age group	Mean	t-statistic (p-value)	Mean	t-statistic (p-value)
Reference group (age 58-63)	102.5		62.78	
23-27	41.87	-0.40 (0.0412)	37.24	-1.91 (<0.001)
28-32	78.16	-0.51 (0.6134)	53.24	-0.68 (0.4966)
33-37	148.2	0.43 (0.6721)	51.80	-0.67 (0.5047)
38-42	59.20	-1.34 (0.1817)	66.59	0.20 (0.8413)
43-47	49.47	-1.83 (0.0714)	82.75	1.15 (0.2504)
48-52	87.55	-0.37 (0.7101)	77.14	0.88 (0.3780)
53-57	79.03	-0.69 (0.4985)	107.3	1.64 (0.1013)

NOTE. Data come from the 2014 Consumer Expenditure Survey by The Bureau of Labor Statistics.

As can be seen, the ratio of Z_M/Z_T is only significantly different from the reference group in two of the other age-groups namely the youngest age-group that is included, 23-27 years of age, and the age group that covers 43-47 years of age, the latter being significantly different only on a 10 percent confidence level. All the other age-groups have ratio-means that are not significantly different from the soon-to-be retired age-group (i.e. the reference group). It is also noteworthy that the two ratios that are different from the reference group both are significantly lower than the ratio of the reference group, meaning that they spend a larger share of their total expenditure on airfare. When looking at the actual expenditure on airfare only one age-group is truly significantly different from the reference group, namely the age group 23-27 who have a significantly smaller expenditure than the reference group. The age-group just below the reference group in age, those who are 53-57 years old, do also almost have a significantly higher expenditure than the reference group. Overall therefore the soon-to-be retired group seems to be representable for the other age-groups in their consumption of air travel, which gives some evidence in favour of the possibility to extrapolate the results found in this research for the rest of the population. As those age-groups that deviates in their expenditure on airfare spends a higher amount of their total expenditure on airfare already it is also not unlikely that a similar, or even higher, effect could be found if they received the extra non-work time that the retired individuals received.

A similar analysis is also made for the gasoline expenditure and the results of these t-tests are found in Table 7 below:

Table 7: t-test of means of gasoline expenditure between adult age-groups and the pre-retirement age-group (the reference group)

	Total/Gasoline expenditure		Gasoline expenditure	
Age group	Mean	t-statistic (p-value)	Mean	t-statistic (p-value)
Reference group (age 58-63)	33.47		481.3	
23-27	31.40	-0.50 (0.6202)	351.8	-5.46 (<0.001)
28-32	30.28	-1.13 (0.2601)	411.4	-3.33 (0.009)
33-37	26.47	-2.65 (0.0082)	466.3	-0.64 (0.5227)
38-42	37.36	0.90 (0.3685)	528.4	1.98 (0.0478)
43-47	29.79	-1.37 (0.1713)	540.7	2.52 (0.0157)
48-52	27.73	-2.16 (0.0312)	481.3	3.25 (0.0012)
53-57	31.81	-0.56 (0.5759)	522.3	1.70 (0.0890)

NOTE. Data come from the 2014 Consumer Expenditure Survey by The Bureau of Labor Statistics.

The results for the ratio of Z_M/Z_T where gasoline is now the Z_T variable are similar to the results for the ratios when airfare is used. Two age-groups have different ratios than the reference group, namely age-groups of age 33-37 and 48-52 and both these groups spend a higher amount of their total expenditure on gasoline than the reference group. This is however not as important in the gasoline case as no effect of retirement was found on this share. Looking at actual expenditure on gasoline on the other hand, most age-groups have a different average expenditure on gasoline than the reference group. Most of the age-groups have a higher expenditure than the reference group, while the two youngest groups have a lower average expenditure. Given this, it is possible that the estimated effects could be stronger for the oldest age-groups but lower for the youngest. It is also possible that an effect could be found on the ratio of interest if the whole population received additional non-work time. Given these results, it is unlikely that the results would be weaker if the whole population was given the same amount of non-work time as the retired individuals.

Given this simple test for the possibility of extrapolation, no evidence against extrapolation have been found. This does not mean that extrapolation can be done without further consideration. It is important to keep in mind that the used methodology to test the possibility of extrapolation is very simplistic and that there could be other issues that would disrupt it. Nevertheless, some light on the issue have been provided.

In addition to the issues of extrapolation is is also important to consider the fact that focus has only been put on two goods, namely gasoline and airfare. This choice was based in part on logical reasoning of what might change when an individual retires, but it does also have some support in the considered literature (see e.g. Blau 2008). When considering the change in energy intensity of total consumption there could however be changes in other expenditure categories that are important but left out from this analysis. One such category is food expenditure, which is known to decrease at retirement mainly due to increased food preparation at home (see e.g. Aguiar and Hurst 2005 and Aguila et al. 2008). As this most likely have small net-effects on the energy intensity of consumption (as they still eat the same amount of food) it most likely would not affect the overall results in this research. It is of course also possible that the expenditure on some other important energy-intensive good could have been left out from the analysis in this research, but given the previous literature on the subject and the logical reasoning behind the changes in consumption behaviour at retirement this seems unlikely.

Finally, it is also important to identify and discuss ethical aspects of the research that has been conducted and two main issues are relevant to bring forth. Firstly, as the research is based on surveys it is important that the anonymity of the participants in the surveys are ensured and that identification of the participants is not possible from the presentation of the data and results. This should not be an issue as the Bureau of Labour Statistics used anonymous identification numbers of the participants in the data sets. These identification numbers have further not been presented in anywhere in this thesis. Anonymity should therefore be ensured. Secondly, how the results of this thesis are used could possibly raise ethical considerations. As the main result is that energy intensity of consumption increases as individuals get more non-work time, this could hypothetically result in that policy decisions about the length of work weeks or retirement age are affected. If the result is that people are forced to work more than before due to this research, this could give rise to an ethical discussion whether it is fair or not. Policy instruments such as taxes could potentially also be used to target consumption of individuals that have more non-work time, such as retired individuals. A tax on air travel specifically for senior citizens could e.g. be proposed as a result of this research, which could possibly be considered unethical. This is of course very hypothetical, and it is very unlikely that this research by itself would have such policy implications. However, if further research finds similar results it might affect policy decisions at some point and these ethical issues should then be considered.

When summing up the results and discussion, the results are supportive of all three hypotheses, particularly the first and the third. When examining the assumptions that the analysis is based on and other limitations of the research it can be established that there exist several possible sources for bias. Most of these biases are however likely to lower the estimated effects rather than increase them.

6 Conclusion

This thesis set forth to answer one general and one more specific research question namely: *What effects does an increase in non-work time have on the energy intensity of consumption, ceteris paribus?* and *How does energy intensity change due to the additional non-work time given at retirement?*. Three hypotheses were formed and to answer these questions and test the hypotheses an estimable model was derived from Becker's (1965) theory of time allocation where the share of total expenditure and expenditure on airfare or gasoline is modelled by the retirement status of an individual. Using a Consumer Expenditure Survey, this model was then estimated together with a complimentary model based in the retirement consumption literature.

The result was that the energy intensity of consumption increases at retirement. This comes mainly from an increase in the share of airfare expenditure but also from a small decrease in gasoline expenditure. While the increase in the share of airfare expenditure was clear, the decrease in gasoline expenditure was too small to give an effect on the share of total expenditure as total expenditure also decreases at retirement. The hypotheses were therefore generally correct.

In order to answer the more general research question, an extrapolation of the effects of retirement for 58-68 year old individuals must be made for the whole population. To investigate how reasonable such an extrapolation might be, the expenditure of the soon-to-be retired individuals of age 58 to 63 was compared with the expenditure of seven other age-groups, starting at the age of 23. As the expenditure of both gasoline and airfare overall were not that different in the other age-groups, this provides no evidence against the possibility of extrapolation. It is possible therefore that the whole working population would react similarly if additional non-work time was given to them, which would provide an answer to the more general research question. These results could therefore affect policy decisions as the energy intensity of consumption possibly could be affected through regulation of length of vacations, retirement age and possibly also the length of work weeks. To the very least, consideration to these results should be put before reduction in work-time is implemented. In addition, policy instruments such as taxes could potentially also be used to target consumption of individuals that have more non-work time, such as retired individuals.

It is however important to be aware of the limitations of this research. The main limitation is that individual price data was not available in the data set, which also limited the choice of estimation methods. In addition to this, other potential sources of bias exists. It is e.g possible that some self selection into retirement is made and that some individuals in the retired group did not retire from being full-time workers. While most of the biases are likely to lower the estimated effects, the estimated results should still be interpreted with some care. The question of extrapolation towards the whole working population is also not completely answered.

These limitations do however give rise to opportunities for further research. If detailed price data can be incorporated in the analysis, more sophisticated methods such as the Almost Ideal Demand System can be used and the effects of retirement on budget-shares be estimated with more precision. In addition, this analysis was limited to only two types of goods, gasoline and airfare. Better and more general conclusions could therefore be drawn if more goods were considered.

Despite the possible extrapolation problems, the results of this research suggests that the use of retirement as an as-if exogenous event that increases the non-work time of individuals is a good idea and a research area that should be considered further. This is especially so as the limited previous literature on the area, such as Nässen and Larsson (2015) and Brencic and Young (2009), struggled to find non-work time-increasing events that were big enough to find significant time-effects. This thesis has therefore contributed to this research topic of by providing stronger results than previous research. In addition to this, the research has contributed to the research on retirement consumption, a research area that primarily has been focused on food consumption before the contribution of this research.

7 Appendix

In this section, the full estimations of the secondary model is provided as well as OLS-diagnostics for the estimations of both the primary and secondary models.

7.1 Full model estimations

In order for parallel equation to be equal to joint estimation within the SUR framework, the same explanatory variables should be included in both estimations. In the estimations of the secondary model, the same control variables are therefore used when both airfare and gasoline expenditure is the dependent variable, even though some of the estimated coefficients are not significant when airfare expenditure is the dependent variable. The full estimations including all used control variables are found in Table 8 and 9 below:

Table 8: Estimated parameters of the secondary model where Z_T is airfare expenditure, including all control variables

Variables	Estimate, $/quarter	Standard error (*p*-value)
Intercept	-144.41	212,77 (0.4974)
Retired (R_i)	40.76	21.740 (0.0609)
Total expenditure	0.0155	0.00287 < 0.0001
Quarter 1	23.49	25.094 (0.3493)
Quarter 2	27.05	25.001 (0.2793)
Quarter 3	35.94	24.925 (0.1494)
Age	0.62	3.2275 (0.8468)
Family size	-21.35	8.3768 (0.0108)
North-East	19.97	22.925 (0.3837)
West	98.89	22.981 (<0.0001)
Sex	29.70	17.935 (0.0979)
High education	15.85	19.149 (0.4078)
F-value: 28.67 *p*-value: <0.0001 R^2: 0.0903 N=3069		

NOTE. Data come from the 2014 Consumer Expenditure Survey by The Bureau of Labor Statistics.

Table 9: Estimated parameters of the secondary model where Z_T is gasoline expenditure, including all control variables

Variables	Estimate, $/quarter	Standard error (*p*-value)
Intercept	366.37	2.35 (0.0190)
Retired (R_i)	-38.40	14.75 (0.0093)
Total expenditure	0.0162	0.00133 (< 0.0001)
Quarter 1	36.61	18.349 (0.0461)
Quarter 2	79.78	18.281 (<0.0001)
Quarter 3	52.73	18.226 (0.0038)
Age	-4.46	2.3600 (0.0589)
Family size	89.03	6.1252 (<0.0001)
North-East	-113.09	16.763 (<0.0001)
West	-42.24	16.805 (0.0120)
Sex	32.19	13.114 (0.0142)
High education	-23.56	14.002 (0.0926)
F-value: 95.95 *p*-value: <0.0001 R^2: 0.2540 N=3069		

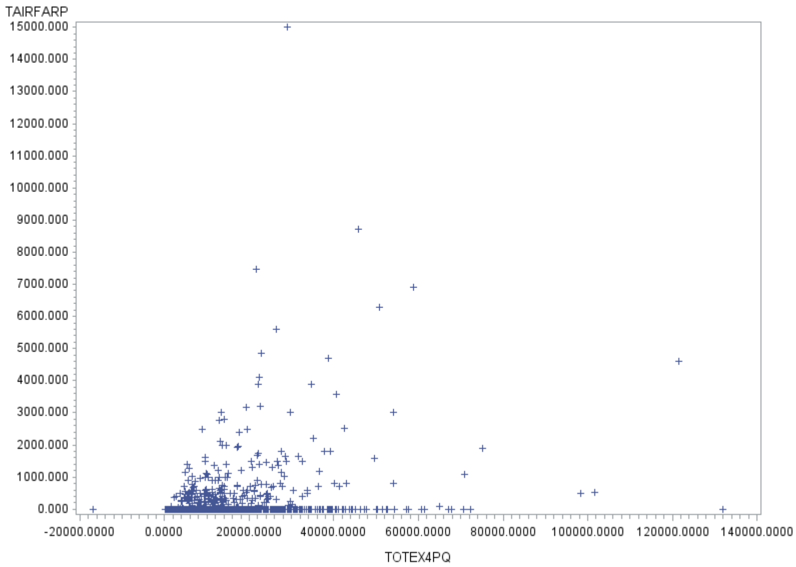
NOTE. Data come from the 2014 Consumer Expenditure Survey by The Bureau of Labor Statistics.

7.2 Investigation of OLS assumptions

7.2.1 Outliers

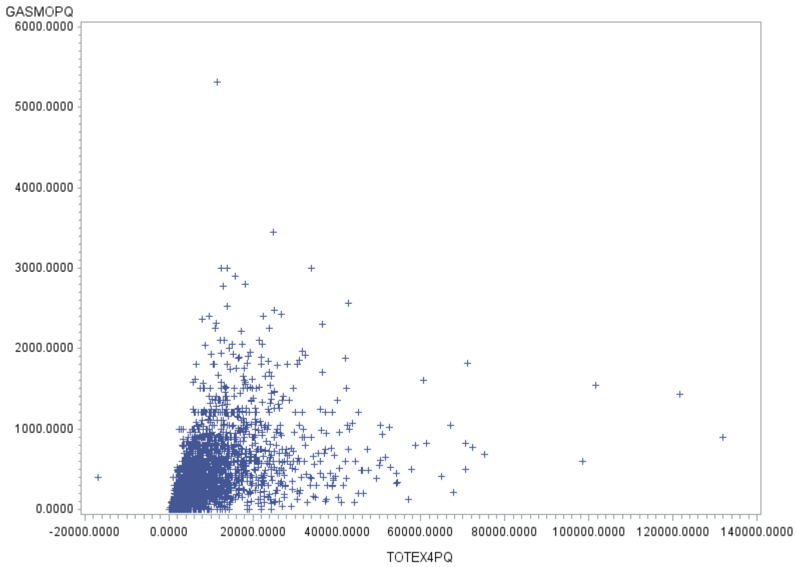
One of the OLS-assumptions is that large outliers are unlikely (Stock and Watson, 2015, pp. 245-246) and to investigate this, two scatter plots are presented below in figure1 and 2 where the variables of interest, gasoline and airfare expenditure, is plotted against total expenditure. As can be seen in the figures, there are in both cases one outlier that poses a potential problem as the expenditure on airfare and gasoline are much higher compared to total expenditure than the rest of the sample. Apart from these, the data points look acceptable. In order to investigate how much these outliers disrupt the results, the models were estimated when leaving these data points out. The results of these estimations are found in table 10 where it can be seen that the results are only altered slightly when the outlier is removed, making them even stronger. Due to this and the fact that it is good to avoid tampering with the data if possible, the outliers are left in the original model estimation.

Figure 1: Scatter plot of airfare expenditure (tairfarp) against total expenditure (totex4pq)



Data come from the 2014 Consumer Expenditure Survey by The Bureau of Labor Statistics.

Figure 2: Scatter plot of gasoline expenditure (gasmopq) against total expenditure (totex4pq)



Data come from the 2014 Consumer Expenditure Survey by The Bureau of Labor Statistics.

Table 10: Estimations without the two potential outliers, only coefficient of interest included with p-value

Dependent variable	R_i-coefficent (p-value)
Total/airfare	-46.38 (0.0501)
Total/gasoline	0.41 (0.8344)
Airfare	50.84 (0.0083)
Gasoline	-38.88 (0.0084)

NOTE. Data come from the 2014 Consumer Expenditure Survey by The Bureau of Labor Statistics.

7.2.2 Tests for multicollinearity

Another assumption in OLS is that there should be no perfect multicollinearity (Stock and Watson 2015 pp. 246-247). In Tables 11, 12, 13 and 14 below variance inflation diagnostics are shown for each of the four model estimations. Variance inflation (VIF) is used to investigate the level of multicollinearity and a VIF higher than 10 is said to cause problems in the regression. As can be seen, no VIF is even close to 10 in the four main models that have been estimated. Hence, multicollinearity is unlikely to be a problem in any of the regressions.

Table 11: Variance inflation for primary model where total/airfare expenditure is dependent variable

Variables	Variance Inflation
Intercept	0
Retired (R_i)	1.0002
Quarter 2	1.1547
Quarter 3	1.1548

NOTE. Data come from the 2014 Consumer Expenditure Survey by The Bureau of Labor Statistics.

Table 12: Variance inflation for primary model where total/gasoline expenditure is dependent variable

Variables	Variance Inflation
Intercept	0
Retired (R_i)	1.0025
Quarter 4	1.0006
Family size	1.0023

NOTE. Data come from the 2014 Consumer Expenditure Survey by The Bureau of Labor Statistics.

Table 13: Variance inflation for secondary model where airfare is dependent variable

Variables	Variance Inflation
Intercept	0
Retired (R_i)	1.3287
Total expenditure	1.1155
Quarter 1	1.4984
Quarter 2	1.5004
Quarter 3	1.4990
Age	1.3311
Family size	1.0646
North-East	1.0783
West	1.0704
Sex	1.0285
High education	1.0744

NOTE. Data come from the 2014 Consumer Expenditure Survey by The Bureau of Labor Statistics.

Table 14: Variance inflation for secondary model where gasoline is dependent variable

Variables	Variance Inflation
Intercept	0
Retired (R_i)	1.3287
Total expenditure	1.1155
Quarter 1	1.4984
Quarter 2	1.5000
Quarter 3	1.4990
Age	1.3311
Family size	1.0646
North-East	1.0783
West	1.0704
Sex	1.0285
High education	1.0744

NOTE. Data come from the 2014 Consumer Expenditure Survey by The Bureau of Labor Statistics.

8 References

Aall, C., Klepp, I. G., Engeset, A. B., Skuland, S. E., Stoa, E., 2011. Leisure and sustainable development in Norway: part of the solution and the problem. Leisure Studies 30 (4), 453–476.

Aguiar, M., Hurst, E., 2005. Consumption versus Expenditure. Journal of Political Economy 113 (5), 919–948.

Aguiar, M., Hurst, E., 2007. Life-Cycle Prices and Production. American Economic Review 97 (5), 1533–1559.

Aguila, E., Attanasio, O., Meghir, C., 2008. Changes in Consumption at Retirement. Tech. rep., RAND Corporation Publications Department, Working Papers: 621.

Banks, J., Blundell, R., Tanner, S., 1998. Is There a Retirement-Savings Puzzle? American Economic Review 88 (4), 769–788.

Becker, G. S., 1965. A Theory of the Allocation of Time. The Economic Journal 75 (299), 493–517.

Bernheim, B. D., Skinner, J., Weinberg, S., 2001. What Accounts for the Variation in Retirement Wealth among U.S. Households? American Economic Review 91 (4), 832–857.

Blau, D. M., Jan. 2008. Retirement and consumption in a life cycle model. Journal of Labor Economics 26 (1), 35–71.

Brencic, V., Young, D., Sep. 2009. Time-saving innovations, time allocation, and energy use: Evidence from Canadian households. Ecological Economics 68 (11), 2859–2867.

Caliendo, M., Kopeinig, S., 2008. Some practical guidance for the implementation of propensity score matching. Journal of economic surveys 22 (1), 31–72.

Deaton, A., Muellbauer, J., 1980. An Almost Ideal Demand System. The American Economic Review 70 (3), 312–326.

Druckman, A., Buck, I., Hayward, B., Jackson, T., Dec. 2012. Time, gender and carbon: A study of the carbon implications of British adults' use of time. Ecological Economics 84, 153–163.

European Environment Agency (EEA), September 2015. Final energy consumption intensity. Accessed the latest on 2016-06-14.
URL `http://www.eea.europa.eu/data-and-maps/indicators/final-energy-consumption-intensity-4`

Fisher, J. D., Johnson, D. S., Marchand, J., Smeeding, T. M., Torrey, B. B., Jun. 2008. The retirement consumption conundrum: Evidence from a consumption survey. Economics Letters 99 (3), 482–485.

Friedman, M., 1957. A theory of the consumption function. Vol. 63. Princeton University Press, Princeton.

Heckman, J. J., 10 1976. The common structure of statistical models of truncation, sample selection and limited dependent variables and a simple estimator for such models. Annals of Economic and Social Measurement 5 (4), 475–492.

Hurd, M., Rohwedder, S., 2003. The retirement-consumption puzzle: Anticipated and actual declines in spending at retirement. Tech. rep., National Bureau of Economic Research.

International Energy Agency, November 2015. Key world energy statistics 2015. Tech. rep., Internatinal Energy Agency, IEA, France.

Jalas, M., Juntunen, J. K., May 2015. Energy intensive lifestyles: Time use, the activity patterns of consumers, and related energy demands in Finland. Ecological Economics 113, 51–59.

Luengo-Prado, M. J., Sevilla, A., Jun. 2013. Time to Cook: Expenditure at Retirement in Spain*. The Economic Journal 123 (569), 764–789.

Miniaci, R., Monfardini, C., Weber, G., 2010. How Does Consumption Change upon Retirement? Empirical Economics 38 (2), 257–280.

Modigliani, F., Brumberg, R., 1954. Utility analysis and the consumption function: An interpretation of cross-section data. K.K. Kurihara ed., Post Keynesian Economics, Rutgers University Press, New Brunswick, pp. 388-436.

Nässen, J., Larsson, J., Aug. 2015. Would shorter working time reduce greenhouse gas emissions? An analysis of time use and consumption in Swedish households. Environment and Planning C-Government and Policy 33 (4), 726–745.

OECD, 2015. Ageing and employment policies - statistics on average effective age of retirement. Accessed the latest online 2016-06-14.
URL www.oecd.org/els/emp/ageingandemploymentpolicies-statisticsonaverageeffectiveageofretirement.htm

Riffkin, R., 2014. Average U.S. Retirement Age Rises to 62. Accessed the latest on 2016-06-14.
URL http://www.gallup.com/poll/168707/average-retirement-age-rises.aspx

Stock, J. H., Watson, M. W., 2015. Introduction to Econometrics. Person Educated Limited, Edingburgh Gate Harlow Essex CM20 2JE England.

The Bureau of Labor Statistics, 2015. The consumer expenditure survey, 2014 public-use microdata, the interview survey. Data accessed online the last time 2016-05-20.
URL http://www.bls.gov/cex/

Tobin, J., 01 1958. Estimation of relationships for limited dependent variables. Econometrica 26, 24–36.

Zellner, A., 1962. An efficient method of estimating seemingly unrelated regressions and tests for aggregation bias. Journal of the American statistical Association 57 (298), 348–368.