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INTEREST RATE AND AGE EFFECTS ON CONSUMER BEHAVIOR

Evaluating the effectiveness of interest rate policy

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Abstract

Over the last decade several central banks have chosen to follow a policy of steadily lowering interest rates in order to stimulate consumption and investment, as well as to reach inflation targets. In the scope of this central bank policy trend, in this paper, differences in investment and consumption behaviour of differently aged individuals are examined. Analysis is conducted mainly using OLS regressions on statistical data from the Fed´s (Federal Reserve) triennial Survey of Consumer Finances. Firstly, the relationship between interest rates and savings behaviour is looked into, and is found to be positive. Secondly, age effects on investment and consumption behaviour are investigated. It is found that investment and consumption behaviour differ depending on the age of the individual. The aim of this thesis is to evaluate the effectiveness of the above described central bank policy trend, and discuss the implications of the policy for a country´s economic stability.

Table of Contents

1. Introduction

During the last decade, an increasing number of central banks around the world have adopted a policy of lowering interest rates, striving to stimulate their country's economy (Cao and Illing (2015)). For example, the Swedish central bank introduced a repo rate of negative 0.10% in February 2015, and has since pushed it even deeper into negative territory (Swedish central bank (2016)). Central banks of countries like Japan, Denmark and Switzerland have adopted the same policy. The idea is to make bank deposits much less compelling, and stimulate people to search for alternative ways of allocating their wealth, such as to consumption. The resulting hike in aggregate demand is expected to lead to an increase in prices which is desirable for countries experiencing low inflation, or deflation (Swedish central bank (2011)).

In this paper we view the allocation choice as one between two things; investments and consumption, and investigate whether an individual's age could be a factor influencing it.

If the changes in interest rates induce investment and consumption behaviours that differ between people from different age groups, this is an important topic to discuss in the scope of analysing the success of the above described central bank policy trend. In Sweden, for instance, old and young people make up a growing percentage of the Swedish population due to increasing average life length (United Nations (2015)) (Statistiska Centralbyrån (2011)), and a considerable influx of young migrants in recent years (Migrationsverket (2016)) (Statistiska Centralbyrån (2015)). The effectiveness of the policy might also be influenced by the behaviour of middle aged people, the age group with the highest disposable income (Guvenen et al. 2015). If people feel that financial security, and a high enough pension income at an older age is uncertain, it might be very difficult to incentivize them to consume more (Carroll (1994)).

Our research is mainly based on repeated cross section from the Survey of Consumer of Finances that the Federal Reserve has conducted on US citizens every three years.

This paper is divided into six main sections, Introduction, Literature review/Theoretical background, Hypothesis, Data analysis, Method, Robustness/Discussion and Conclusion. In the Literature review/Theoretical background we summarize relevant research articles and theories for our research topic. We then proceed to present our hypothesis. The method

section covers our methodology. We then move on to the analysis, then discuss robustness and implications, and lastly conclude the paper.

Through our analysis we find the relationship between interest rates and savings to be positive, meaning that lowering interest rates is indeed an effective way to reduce savings. We also discover that investment and consumption behaviour is dependent on age. The age-investment relationship is clearly characterized by an inverse "u" shaped, exponential curve, where, as young people age, they invest increasing amount, and after retirement, they reduce their investments. The age-consumption relationship can be illustrated using a "u" shaped, exponential curve where as young people age, they consume decreasing amounts, but after a certain age they increase their consumption once again. We also investigate whether interactive effects of age and interest rate on consumption and investment behaviour exist. We find that such an effect exists when it comes to consumption, but can using the same method not confirm that the same applies for investment.

The fact that young and old people are so much more easily incentivized to increase their consumption than middle aged individuals, who´d rather invest, limits the effectiveness of the above described central bank policy in the long run, as well as endangers the stability of the countries´ economies, making them susceptible to financial crashes to a greater extent than before.

2. Literature review/Theoretical background

This section is divided into two parts. In part one the relationship between interest rates and savings behaviour is discussed, while in section two the focus lies on age´s effects on investment and consumption behaviour.

2.1 Interest rates and savings behaviour

The intuition behind the relationship between interest rates and saving is straightforward. If the interest rate on savings accounts rises, people are more compelled to deposit money to these, and vice versa. The intuition is supported by classical macroeconomic theory, and older research papers which also state that while the relationship between the interest rate and savings is positive, the opposite is true for the link between interest rates and investment (Maxwell J. (1980)), (Obstfeld et al. (1996)).

However, interestingly, many studies based on micro data find that the relationship between the interest rate and savings actually isn't all that clear cut. Before presenting these however, it is worth noting that each of these studies have slightly different definitions of what savings actually are, for example, some include certain types of assets (stocks, bonds etc.), and some define savings residually from income and consumption. Furthermore, they are based on different types of data from different countries. However, comparisons between them can still be drawn, because the main focus is the same, and because only a limited amount of research has been conducted on this topic.

Beznoska and Ochmann (2013) conducted an analysis, where they aim to estimate the income, price and interest rate effects on household consumption and savings. They base their analysis on official survey data on consumption of German households and estimate that the interest rate elasticity of savings is not significantly different from zero. Interest elasticity of savings can be defined as: "...the percent change in saving that results from a one-percent change in the interest rate "(Elmendorf (1996)).

They find that the effect of income on savings is, unsurprisingly much larger, and recommend policy makers to impact the disposable income of people using tax policy if they want to affect their saving behaviours, rather than changing the interest rate. However, they do find the interest elasticity of savings to be positive, and more significant amongst people who possess substantial savings. (Beznoska and Ochmann (2013)), (Giovanni (1983)) also reached a similar conclusion studying the interest elasticity of savings in developing countries.

Elmendorf (1996), who at the time he conducted his research was part of the board of the Federal Reserve, also studied the interest elasticity of savings. Elmendorf (1996) takes an indirect approach, combining several behavioural models, including the life cycle model, and models based on people who plan to leave bequests, or are target savers. In his paper he uses data from the National Income and Product Accounts (NIPAs) when he conducts his analysis (Elmendorf (1996)). He finds that interest elasticity of saving can vary, depending on the unique life situation of the given individual, as well as on which model is used. He states however, that overall, the interest elasticity of saving is unlikely to be negative, and is likely positive, which confirms the intuition that a lower interest rate will make people less willing to save. These people are then presented with the choice between investing and consuming (Elmendorf (1996)).

Some researchers have approached savings behaviour from a more behavioural point of view. Two types of contending theory types are models where the entire lifetime of an individual is considered in his/her consumption and savings decisions. Such models include the permanent income savings model that "predicts that the consumption growth rate in a country depends primarily on the interest rate " (and since consumption and savings are closely related, it can be deducted that interest rates should also have an effect on savings) (Friedman, Milton in Thaler (1990)), and the lifecycle model that is based on a hump shaped age-saving profile, where the youngest age group saves little, the middle aged group saves the most, and the oldest age group is characterized by dissaving (Benartzi and Thaler (2004)).

An opposing theory is the rule of thumb theory, which in essence differs from the other two in that it is not based on an individual's permanent income, but rather on the rules of thumb, which can for instance be to spend all of one's income, and save nothing (Thaler (1990)), (Shiller (1995)).

It can be deducted, that a positive link between interest rate and savings is not uniformly accepted, however, disproof is not sufficient either. Much of this controversy probably has to do with how savings are defined, and the lack of detailed micro data for several countries. In our analysis, we define saving solely as money deposited to savings accounts and checking accounts (see definition above and in data section), and do not include assets as a form of saving. The reason for this is that we are interested in allocation choice between investment into equity and consumption, of money withdrawn from bank accounts as a result of decreasing interest rates. Put differently, we view money deposited into savings and checking accounts as one form of saving. This form of saving is highly sensitive to interest rate changes, which cause it to be reallocated into either investment or consumption.

2.2 Age effects on investment and consumption behaviour

Literature addressing investment and consumption behaviour is extensive. Much of it is in one way or another related to choices based on risk, age, and discounting models.

Grable (2000) studied risk aversion between age groups where he found evidence that as people age they tend to have a lower acceptance of risk. In other words, they are less willing to engage in activities involving higher risk. Such activities could for example involve investing into stocks, a much riskier thing to do than eating a three course dinner in a nice restaurant.

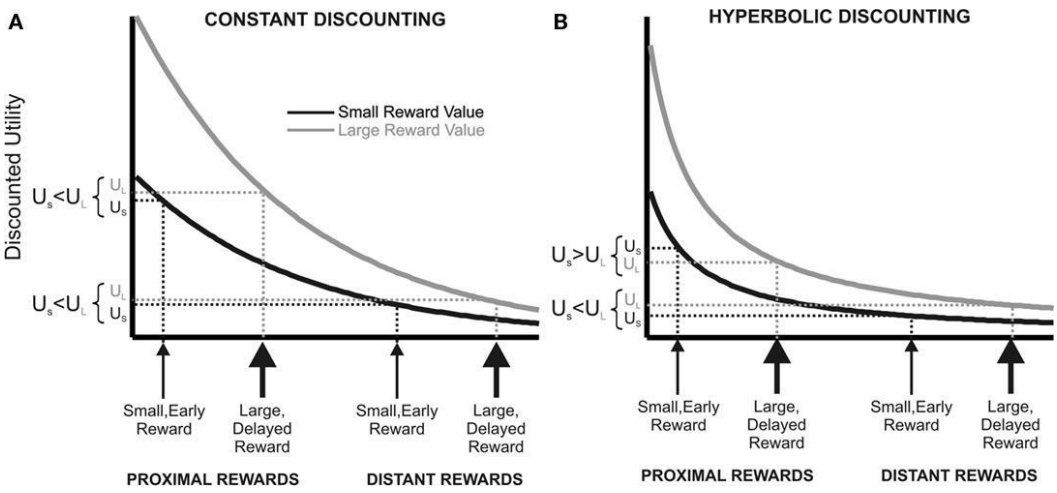
Harbaugh et al. (2002) also investigates risk aversion between different age groups. He bases his research on the prospect theory, and finds that 70% of children would take a gamble for a potential reward, whereas only 43% of older adults would. He concludes that younger individuals are more risk loving than older individuals.

The studies above all point towards that risk averseness, and consumption and investment behaviour of an individual depends on what phase of his/her life the given individual is in. This concept, is best explained by the life cycle model which is discussed in Benartzi and Thaler's (2004) study. The life-cycle model describes that consumption smoothes out over a lifetime, in other words, when their income is at its highest, people tend to save or invest money for consumption at a later stage in life when income is not as high anymore, for instance after retirement. The theory is based on the assumption that we have a rational plan that gives us the possibility to have a stable level of consumption during our lifetime. (Benartzi and Thaler (2004)) It could be said, that the life cycle model explains a way of behaviour where we refrain from consumption now, to reward ourselves at a later stage. The incentives to refrain from consumption today in order to be able to consume more in the future are probably bigger when an individual is mid-aged, than during the last few years of one's life.

Hyperbolic discounting is also a highly relevant concept when discussing age effects on investment and consumption behaviour, and is brought up by Laibson (1998) in a study about consumers' intertemporal consumption decisions. Laibson (1998) questions that an exponential discounting structure where the discount rate for future rewards is constant over time is realistic. He instead suggests a hyperbolic discounting structure where the discount rate gets smaller and smaller as the length of time the individual has to wait for a reward in the future increases. As seen in the graph below, when it comes to hyperbolic discounting, the utility for a reward falls substantially for a shorter period, and less for a longer one. Essentially, hyperbolic discounting claims that people are impulsive, and prefer a small reward now, over a much larger reward later in time (Thaler (1991)).

Laibson (1998) also discusses how hyperbolic discounting varies over a life cycle. He looks at how the marginal propensity to consume differs based on which phase of his/her life a person is in. Laibson (1998) states that the probability of having a high marginal propensity to consume is higher for young people who expect to have a higher income in the future, and

who therefore have a low discount factor. By contrast it is lower for people who expect to have decreasing income paths and therefore have a high discount rate.



(Kalenscher and Van Wingerden (2011))

Ameriks and Zeldes (2004) look into how household finances vary with ages. They express that most papers which have investigated this relationship find it to be described by a hump shape. (Some of the papers mention that this relationship could be due to people following the advice of financial planners). Ameriks and Zeldes (2004) conduct their analysis using pooled cross-sectional data from the Surveys of Consumer Finances, and panel data from TIAA-CREF (financial services organization). They too, find that a hump shape best describes the relationship, where younger individuals and older individuals have smaller shares of their financial wealth in financial assets than the middle aged. However, they want to attribute the variation in equity shares less to age, and more to the date of birth of the individuals (cohort effects). They also believe that equity share in financial assets depends on trends, such as for example the amount and quality of financial information available to households.

Using the life cycle model as base, Gomes and Michaelides (2005) find that young people will consume more than save, as they expect to have a higher income in the future, and because their debt to income ratio is quite high. They also conclude that young people invest so little into financial assets, because the fixed cost of doing so exceeds the possible gains. In contrast, older people possess a larger financial wealth, and therefore have more incentives to invest.

3. Hypothesis

In this section we present our hypothesis, which can be divided into two main parts or stages.

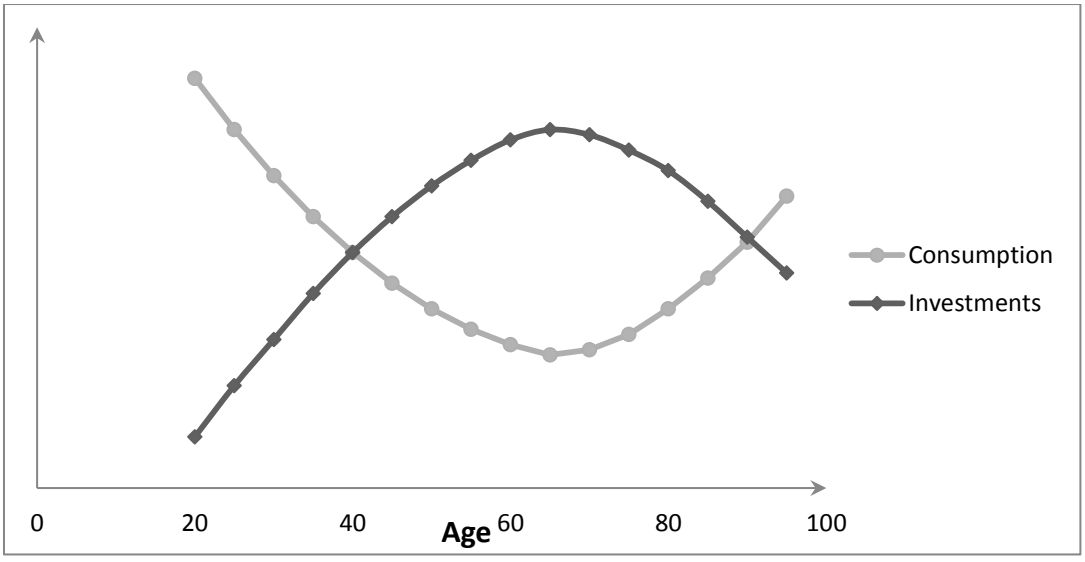
3.1 Interest rate effects on savings behaviour (part one)

In regards to interest rate effects on savings behaviour, we hypothesize, in line with Elmendorf (1996) the relationship to be positive. When central banks lower interest rates, we expect people to decrease their money kept on savings and checking accounts because of the lowered yield, and reallocate them to investment or consumption.

3.2 Age´s effect on the choice between consumption and investment (part two)

We also predict that age is the significant factor affecting the investment and consumption behaviours of private individuals. Taking the research we presented in the Literature Review/Theoretical background as aid (Benartzi and Thaler's (2004)), (Laibson (1998), (Gomes and Michaelides (2005)) we would like to propose that the relationships between age and investment, and age and consumption behaviour can both be represented by hump shaped curves. Certain age spans/periods, usually come with different circumstances for an individual. As individuals move from one phase in their lives, to the next, a number of things change, and because of that, so does their behaviour.

Chart 1: *Age-consumption and age-investment relationships*



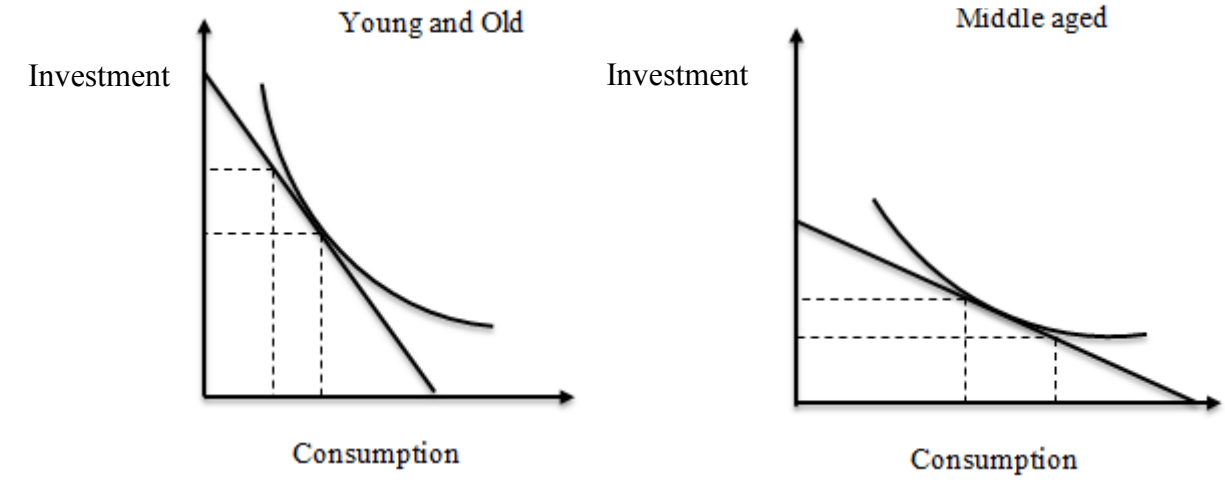
We predict, as seen in Chart 1 that at a young age, people are more inclined to consume, rather than invest. They have low income, and so they refrain from investing because the fixed cost of doing so is relatively high, but because they expect rising income paths, they spend most of their income on consumption. They have a high propensity to consume.

As people age however, they'll usually experience a rise in income, as well as knowledge and experience. They'll at this stage be more inclined to invest a larger part of their income into financial assets for several reasons. Firstly, because they now have a higher income, they'll only need to spend a smaller part of it on consumption, and the fixed costs of investing are not any more relatively high for them. Secondly, because they now have more knowledge and experience, they'll be less wary of investing. And thirdly, because they expect falling income paths for the future. We predict that investment will peak between 60 and 70.

Furthermore, we propose, that when people will start reaching higher ages, they'll once again consume a larger, and invest a smaller part of their income. Once again, this depends on several reasons. In accordance with the life cycle model, they'll now consume more, instead of refraining from consumption like they did in earlier stages of their lives. Because they know they have a limited time left to live, they'll gain more utility from short term rewards. On top of that, they are also more risk averse, and will therefore invest less.

When drawing the comparison between the investment and consumption behaviours of these three age groups, it can be fitting to illustrate the choice between investing and consuming with indifference curves.

Chart 2: *Behavioural indifference curves for different age groups*



Above, in Chart 2 we have graphed how these indifference curves might look. Essentially, in this case the choice lies not between two goods but between consumption and investment. Younger and old people are willing to give up more units of investments for an increase on consumption than people at the peak of their careers. We can see that young and old people have a higher MRS (marginal rate of substitution) than people at the peak of their careers.

4. Data sample and summary statistics

4.1 Variable definitions

Table 1: Variable names and definitions

Variable	***Description***
Age	The numerical age of the household head
Age	Age*Age
Interest rate	The Federal Fund´s effective rate at the given year
Stocks	Value of owned stocks
Food consumption	Annualized spending on eating out
Equity	Value of owned equity
Networth	Assets minus debts
Time	Time variable
Income	Yearly income (includes all types of income such as investment and wage income. See Fed codebook 2013b)
Education	Education in years of household head
Hhsex	Sex of household head
Kids	Number of kids in the household
Married	Marital status of the household´s head
Labour force	Labour force participation
Savings	Total value of savings and checking accounts
CPI	Consumer price index. Variable names with "cpi" in them indicate that the variable has been CPI adjusted
Agecl	Age categories where: 1:<35, 2:35-44, 3:45-54, 4:55-64, 5:65-74, 6:>74
Have equity	Dummy variable: Respondent owns equity=1 does not own equity=0

4.2 Summary statistics

Table 2: Summary descriptive statistics

Variable	***Scale***	***Mean***	***Std.Dev.***	***Min***	***Max***
Age	Years	50.66	0.08	17	95
Age^2	Years	2829.04	8.48	289	9025
Interest rate	Numerical	3.29	0.01	0.11	9.21
Stocks	Numerical	738906.90	5108689	0	1.46e+08
Foodaway	Numerical	1993.71	5184.56	0	221965.6
Equity	Numerical	1310858	7038434	0	1.47e+08
Time	Numerical	5.47	2.57	1	9
Income	Numerical	626352.80	4061014	0	2.56e+08
Education	Numerical	13.79	2.89	-1	17
Hhsex	1-2 Dummy	1.22	0.41	1	2
Kids	Numerical	0.86	1.18	0	10
Married	1-2 Dummy	1.35	0.48	1	2
Labour force	0-1 Dummy	0.77	.42	0	1
Savings	Numerical	61884.81	660629.50	0	4.33e+07
CPI	Numerical	79.22	14.84	53.23	100
Agecl	Numerical	3.13	1.54	1	6
Have equity	Dummy	0.57	.49	0	1

Above are the summary statistics for the variables we have used. A little bit of explanation might be needed. It can be spotted that some values are expressed as x e+y. This is the same as x*10^y. Also, Education has a minimum value of -1 when the respondent has no education.

5. Data construction and Methodology

5.1 Data sample

In this paper we have used Triennial consumer finances data collected by the Federal Reserve between the years 1989 and 2013. The data was collected from different respondents each year and can therefore be called repeated cross sectional data (Federal Reserve (2013b)). The sample combines 41 527 observations that give us a stable ground to base our analysis on. The respondents in the data were between 17 and 95 years old, a fitting range for us to test our hypothesis. Early in our analysis we discovered that some of the relationships and values in our data seemed exaggerated which made us look for possible outliers.

5.2 Interest rate effects on savings

The first relationship we wished to examine is the one between interest rate and savings. In looking at the data, we found that some respondents had extremely high and low amounts of money saved and/or invested. These respondents carried quite little weight in the data set, meaning that they were not very representative of the American population (Federal Reserve (2013a)). We therefore proceeded in dropping the observations for the variable financial assets that were in the upper and lower 0.3rd percentiles. 125 observations with values larger than approximately 158 million dollars were dropped. As a result, the regressions conducted were more suiting for our research objective, which was to examine how the "average" American´s behaviour varies, and not how the 1% reacts.

Because the USA has during the past three to four decades had an upward trending inflation rate, there was a need to inflation adjust some of the data used, otherwise, many of the relationships measured could have been distorted. For example, the value of equity holdings in 2013 would be overestimated, and the value of holdings in 1989 underestimated. This is because in relative terms, x amount of USD in 1989 had much bigger purchasing power than the same amount in 2013. Inflation adjustment was performed using CPI (consumer price index). (See appendix for CPI calculations and results (Bureau of Labor Statistics (2015))

Furthermore, as the analysis was conducted on repeated cross sectional data, it was necessary to include a time variable to rid the results of time trends (Moffitt (1993)), (Roberts and Whited (2012)). This variable simply just increases in value by one for each survey

completed. For example, for results from 1989 it is 1, and for results from 1992 it takes the value of 2. By including this variable in our regressions, we can assure that societal trends do not cause bias in the other independent variables included.

Also, to assure a normal distribution (Wooldridge (2015)), our independent variable, savings was logged. (See appendix for details on the process).

Lastly, although the effect of age on savings behaviour in itself is not something this paper discusses, age is a key variable throughout, both when looking at age effects, and combined age-interest rate effects on investment and consumption behaviour. Given this, the variables age and age^2 were also included into the regression.
It was now possible to estimate the following regression:

Results recorded in table 1:

$$savings = \beta_0 + \beta_1 interest\ rate_t + \beta_2 time_t + \beta_3 age_i + \beta_4 age^2{}_i + \varepsilon_{t,i}$$

As seen in the literature, there is no widespread agreement on whether the relationship between interest rate and savings is positive, zero or negative. (See literature review). We hypothesize it is positive, at least when savings is defined as money kept on savings and checking accounts. Hence, we expect β_1 to be positive.
Furthermore, although our hypothesis does not cover age effects on savings specifically, it can be reasonable to assume that a hump shaped relationship exists, where young people and old people save little, and middle aged individuals save the most (Benartzi and Thaler (2004)). We therefore expect β_3 to be positive, and β_4 to be negative.

Next, in order to decrease the chances for an omitted variable bias of occurring, we ran the same regression, this time however, with six control variables included. The control variables are represented as a combined vector by $\boldsymbol{\beta_x C_x}$. The control variables capture the sex, education level, labour force participation, marital status, number of kids, and yearly income of the respondents. Doing this is important, because if a variable that actually belongs in the true model is omitted, the coefficients in the model will be biased, as they correlate with the excluded variable(s) (Woolridge (2015)). For instance, when investigating the relationship between percentage of income spent on food away from home and age, it can be argued that the age coefficients are biased if the income variable is not included into the regression. Put

differently, because age and income are correlated, age will capture the income effect, and might then have either a smaller or larger coefficient than realistic.

We therefore proceed to run the following regression with all the controls included, where C represents all the controls:

Results recorded in table 1:

$$savings = \beta_0 + \beta_1 interest\ rate_t + \beta_2 time_t + \beta_3 age_i + \beta_4 age^2{}_i + \boldsymbol{\beta}_{\boldsymbol{x_{t,i}}} \boldsymbol{C}_{\boldsymbol{x_{t,i}}} + \varepsilon_{t,i}$$

We expect both interest rate and age to remain significant. However, we predict β_3 and β_4 to take smaller values, as they now will not capture the effects of the control variables on savings behaviour.

5.3 Age effects on investment behaviour

In this section we describe the methods used to investigate age effects on investment behaviour. This is an interesting and important relationship to investigate given the above confirmed positive correlation between interest rates and savings behaviour, and the fact that interest rates have in a large number of countries around the world steadily fallen during the last decade (Cao and Illing (2015)).

Our hypothesis estimates a hump shaped relationship, which can be explained by the life cycle theory, where it is theorized that consumption is smoothed out over a lifetime (Benartzi and Thaler (2004)). Based on the logic of the theory, young people who expect rising income curves consume much, and invest little. As they age, and their income curves start to peak, they´ll consume less, and invest more with the future in mind. After retirement however, they will be inclined to consume more (in relation to income), and invest less (Grable (2000)), (Benartzi and Thaler (2004)). Such behaviour can as explained in our literature review also be explained by attitudes towards risk. Gruber (2000) states in his work that older people are more risk averse. This could be one of the reasons for why older individuals invest less of their wealth into equities, a high risk behaviour compared to consumption.

To test our hypothesis we set up the following regression:

Results recorded in table 2:

$$\%equity = \beta_0 + \beta_1 time_t + \beta_2 age_i + \beta_3 age^2{}_i + \varepsilon_{t,i}$$

As it can be observed, most of the variables here are already familiar, with the exception of %Equity. %Equity represents the value of the equity investments the respondents possess, in relation to how much they save. The variable was created by dividing the variables equity and savings. The ratio was used to better be able to show how people change their investment behaviour in relation to how much they save, after all, our hypothesis concerns how individuals allocate their savings money when the interest rate falls. The ratio was then logged. (see section 5.3 and appendix). In line with our hypothesis, we expect β_2 to be positive and β_3 to be negative in order for the inverse u shape to exist.

Next, the same regression is run with all the control variables included:

Results recorded in table 2:

$$\%equity = \beta_0 + \beta_1 time_t + \beta_2 age_i + \beta_3 age^2{}_i + \boldsymbol{\beta}_{\boldsymbol{x_{t,i}}} \boldsymbol{C}_{\boldsymbol{x_{t,i}}} + \varepsilon_{t,i}$$

We expect age to remain significant. However, we predict β_2 and β_3 to take smaller values, as they now will not capture the effects of the control variables on investment behaviour.

The relationship is also illustrated in a graphical way, in charts 1 and 2. The charts are based on mean estimations of the variables %Equity (chart 1) and Haveequity (chart 2) (dummy for having or not having equity ownership), divided into age categories. In other words, they show equity ownership in relation to savings for each age category, and the percentage of respondents in the given age category, that own equities at all.

One advantage with the mean estimations using a dummy variable is that a few outlying observations cannot affect the outcome as much as if we compared numerical values. For example, if a respondent has a hundred million dollars in equities, when using numerical values, the mean estimation for the age group would be unrealistically high, as the given observation probably doesn't carry as much weight, and isn't very representative of the

American population. On the contrary, when using a dummy variable, the observation is simply recorded as a 1, which doesn´t then greatly affect the representativeness of the results. Both charts are predicted to illustrate the inverse u relationship between equity investment and age.

5.4 Age effects on consumption behaviour

In this section it is described how age effects on consumption behaviour were looked at. Once again, we hypothesize a hump shaped relationship built upon the principles of the life-cycle hypothesis and risk behaviour. (see section 5.2). This time however, the relationship is predicted to take the form of a "u" shape, where young people spend considerable amount of resources on consumption, middle aged people spend the least, and after retirement, people start spending their savings money on consumption (Friedman (1957)).

We start by estimating the following regression:

Results recorded in table 3:

$$\%food\ consumption = \beta_0 + \beta_1 time_t + \beta_2 age_i + \beta_3 age^2{}_i + \varepsilon_{t,i}$$

Most of the variables are familiar; the dependent variable however is new. %Food consumption measures how much people spend on eating out per year, in relation to their yearly income. It was created by dividing the variable food consumption by the variable income, and was then logged. (See section 5.3 and appendix)

The variable %food consumption gives us a decent measure for consumption behaviour, however, it is far from ideal. It was chosen because the data set used lacks variables measuring consumption as a whole, which is why food consumption was used as a next best alternative. It was divided by income to avoid distorted results. After all, some respondents in the data set have very high incomes, and spend extreme amounts of money on eating out. Because of that, the ratio with income gives us a more realistic image of how consumption behaviours for differently aged people look like.

We hypothesize that the relationship takes a "u" shape, we predict β_2 to be negative, and β_3 to be positive.
Next, the same regression is run with all the control variables included:

Results recorded in table 3:

$$\%food\ consumption = \beta_0 + \beta_1 time_t + \beta_2 age_i + \beta_3 age^2{}_i + \boldsymbol{\beta}_{\boldsymbol{x_{t,i}}} \boldsymbol{C}_{\boldsymbol{x_{t,i}}} + \varepsilon_{t,i}$$

We expect age to remain significant. However, we predict β_2 and β_3 to take smaller values, as they now will not capture the effects of the control variables on investment behaviour.

The relationship is also illustrated in a graphical way, in chart 3, where the mean percentage of income spent on eating out separated according to age groups. Here as well, we expect to see a "u" shaped relationship between the age categories and food consumption.

5.5 Interactive interest rate and age effects

As mentioned previously, this paper investigates the implications of lowering interest rates in two stages. In the first stage, the effect of interest rate changes on savings is looked at. In the second stage, age´s effect on the allocation choice between investment and consumption is investigated. After performing in depth analysis on both stages separately, we attempt to tie them together, to better understand the interactive effect of interest rate and age on consumption and investment behaviour.

To capture the interactive effect, two new variables are generated, rateage and rateage^2, given by interest rate times age, and interest rate times age^2 respectively.

The following two regressions are run:

Results recorded in table 4:

$$\%equity = \beta_0 + \beta_1 time_t + \beta_2 age_i + \beta_3 age^2{}_i + \beta_4 rateage_{t,i} + \beta_5 rateage2_{t,i} + \beta_6 interest\ rate_t + \boldsymbol{\beta}_{\boldsymbol{x_{t,i}}} \boldsymbol{C}_{\boldsymbol{x_{t,i}}} + \varepsilon_{t,i}$$

$$\%food\ consumption = \beta_0 + \beta_1 time_t + \beta_2 age_i + \beta_3 age^2{}_i + \beta_4 rateage_{t,i} + \beta_5 rateage2_{t,i} + \beta_5 interest\ rate_t + \boldsymbol{\beta}_{\boldsymbol{x_{t,i}}} \boldsymbol{C}_{\boldsymbol{x_{t,i}}} + \varepsilon_{t,i}$$

Regression one is aimed at capturing the interactive effects on equity ownership. Regression two is aimed at finding interactive effects on food consumption.

According to our hypothesis, which connects the interest rate effect on savings, and the reallocation of savings money to consumption or investments, the effects of rateage and rateage^2 should be significant in all cases. Hence, we expect the β_2 and β_3 coefficients to turn out significant in both outputs.

6. Empirical results/Discussion

6.1 Interest rate effects on savings

Table 1

Savings	***(1)***	***(2)***
Interest rate	0.021***	0.017***
	(0.007)	(0.006)
Time	-0.067***	-0.077***
	(0.007)	(0.007)
Age	0.128***	0.041***
	(0.004)	(0.004)
Age^2	-0.001***	0.00001
	(0.000)	(0.00001)
Educ		0.273***
		(0.004)
Hhsex		-0.628***
		(0.036)
Income		6.30e-08***
		(9.51e-09)
Kids		-0.007
		(0.009)
Married		-0.570***
		(0.032)
lf		0.582***
		(0.034)
Intercept	5.104***	4.169***
	(0.111)	(0.126)
Observations	36 222	36 222
R-squared	0.085	0.297

* = 10 % significance level, ** = 5 % significance level, *** = 1 % significance level. Standard errors are listed in the parenthesis. (1) Regression without controls. (2) Regression with controls

(It is important to note that all the regression outputs provided in this paper contain rounded values! If you wish to attain exact values, kindly contact the authors.)

Table 1 above records interest rate effects on savings. Column (1) shows the results of the regression without, and column (2), with the controls.

As predicted, the relationship between interest rates and savings turns out to be positive and significant at the 99% level for both regressions. When the controls are included, its beta

coefficient decreases by a little. It can be observed, that a 1 unit increase in interest rate incentivizes people to increase their savings by 1.7%. Of course, the opposite holds as well; a 1 percent decrease in interest rate will lead people to decrease their savings by 1.7%.

In accordance with existing research on the topic (see Benartzi and Thaler 2004 in literature review), in regression one, there is indeed an inverse "u" shaped relationship between age and savings where the coefficient for age is positive, and negative for age^2. However, not only do these coefficients lose much of their effect in regression (2), age^2 also becomes positive, and so the hump shape cannot any more be confirmed. Furthermore, as expected, the time coefficient turns out to be negative. Lastly, the control variables all turn out to be significant, and many of them, such as education and labour force participation have considerable effects on money saved. In summary, the relationship between interest rates and savings turns out to be positive, and our hypothesis can be confirmed.

6.2Behavioral differences between age groups

Age effects on investment behaviour

Table 2

%Equity	***(1)***	***(2)***
Age	0.164***	0.136***
	(0.006)	(0.007)
Age^2	-0.001***	-0.001***
	(0.000)	(0.000)
Time	-0.018***	-0.022***
	(0.006)	(0.006)
Educ		0.178***
		(0.007)
Hhsex		-0.256***
		(0.061)
Income		3.87e-08***
		(7.80e-09)
Kids		-0.008
		(0.014)
Married		-0.081
		(0.051)
Labor Force		0.044
		(0.053)
Intercept	2.872***	-4.462***
	(0.167)	(0.203)
Observations	21 972	21 972
R-squared	0.076	0.117

* = 10 % significance level, ** = 5 % significance level, *** = 1 % significance level. Standard errors are listed in the parenthesis. (1) Regression without controls. (2) Regression with controls

Table 2 above depicts age effects on equity investment. As hypothesized, the age coefficients turn out to be significant at the 99% level. Also age retains a positive, and age^2 a negative value in line with the inverse "u" hypothesis.

In regression (2) with all the controls included, this still holds, although the age variable loses some of its effect. From the age coefficients it can be deducted that as young people age, they do indeed invest more and more into equities. It can be calculated that 30 year olds increase their equity ownership (in relation to savings) by 8% as they age a year, and keep piling up their investments up until around 74-75 years of age, where investments peak. After that age,

people start decreasing their equity ownership. For example, people aged 80 decrease their equity ownership by 1% as they become one year older.
Many of the controls are significant as well. For example it can be observed, that higher educated respondents invest more into equities than people with fewer years of education.

In Chart 3 below, this relationship is illustrated graphically, where respondents are divided into age categories. The inverse "u shape" is apparent, young people invest quite little into equities. As they age, they gradually invest more. However, once they enter the oldest age category, they decrease their equity ownership.

Chart 3: *Mean estimations of equity investments in relation to savings in different age categories*

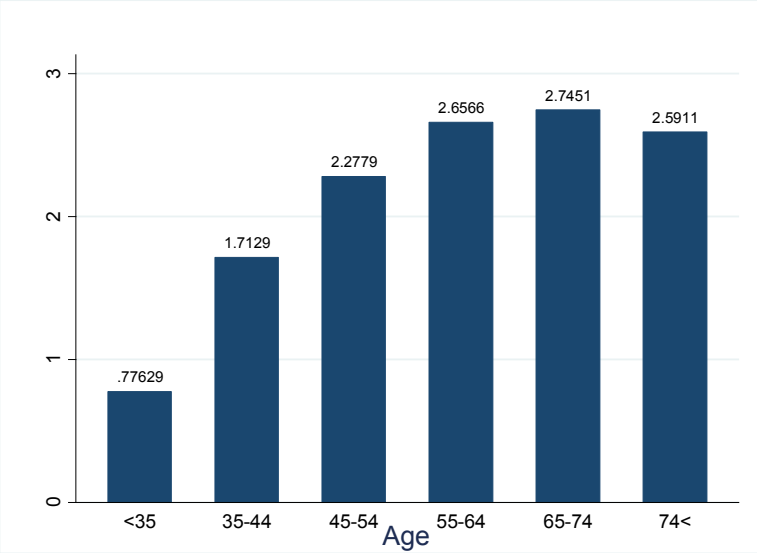
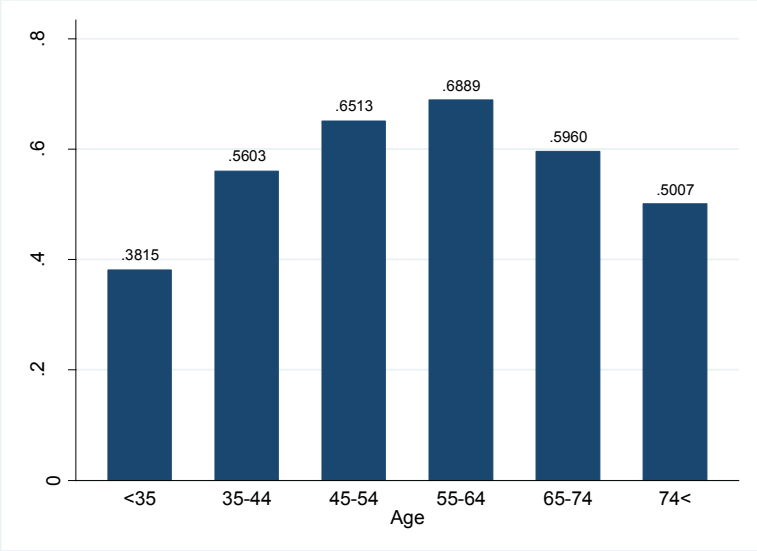


Chart 4 below is aimed to illustrate the same relationship, except this time using a dummy for equity ownership. (see section 5.2). Once again, the inverse "u" shape is clear. It can be read that 38% of people aged under 35, 69% of people aged between 55-64, 60 % of people aged between 65-74 and 50% of people aged over 74 have equity investments.

Chart 4: *Mean estimations of equity ownership in different age groups*



Paucis verbis (in a few words), our hypothesis on an inverse "u" shaped relationship between age and investments can be confirmed. As people age, they do indeed invest increasing amounts of money, but after retirement, they gradually decrease how much they invest. Furthermore, it can also be said that a smaller percentage of young, and old people invest into equities at all than middle aged people.

Age effects on consumption behaviour

Table 3

%Food consumption	*(1)*	*(2)*
Age	-0.00247***	-0. 00197***
	(0.000)	(0.000)
Age^2	-0.00002***	0. 000014***
	(0.000)	(0.000)
Time	-0.00677***	-0. 00678***
	(0.000)	(0.000)
Educ		-0. 00075***
		(0.000)
Hhsex		-0. 01061***
		(0.002)
Income		-4.71e-10***
		(0.000)
Kids		-0. 00206***
		(0.000)
Married		- 01416***
		(0.002)
lf		- 00147
		(0.001)
Intercept	0.05281***	-0.04953***
	(0.006)	(0.006)
Observations	41 098	41 098
R-squared	0.056	0.063

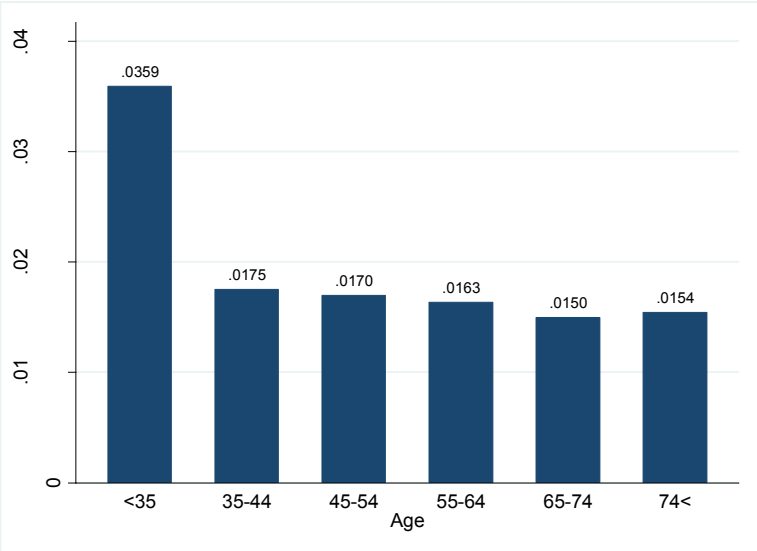
* = 10 % significance level, ** = 5 % significance level, *** = 1 % significance level. Standard errors are listed in the parenthesis. (1) Regression without controls. (2) Regression with controls

Table 3 above records age effects on consumption behaviour. In regression (1), without the controls, the hypothesized "u" shaped relationship between age and consumption cannot be confirmed. The coefficient of age does as predicted take a negative value, implying that as people get older they spend a smaller portion of their income on consumption, however, the coefficient for age^2 also takes a negative value, meaning that even after retirement, respondents spend decreasing amounts on consumption. However, when including all the controls, the age^2coefficient takes a positive value, confirming our hypothesis. Therefore, it was most likely biased in the first regression (and is now less biased). It can be calculated that 30 year olds decrease their food consumption (in relation to income) by 0.11% as they age a year, and keep consuming less up until around 69 years of age, where consumption is at its lowest. After that age, respondents start consuming more. For example, people aged 80 increase their food consumption by 0.032% as they become one year older.

Here as well, many of the controls have significant effects on money spent eating out. For instance, people with kids spend less, which is understandable, as they probably consume more of their meals at home, rather than at a restaurant.

Chart 5 below illustrates the relationship graphically, where consumption in relation to income is shown for different age categories. The hump "u" shaped curve here is not all that apparent. The youngest and oldest respondent do indeed spend more on eating out than people in the other age groups, but the relationship definitely isn't as smooth as predicted.

Chart 5: *Mean estimations of fraction of income spent on food consumption split along different age categories*



In sum, the hump shaped relationship between age and consumption can be confirmed, however, it is far from as apparent and clear as the age-investment relation. This may, partly be due to the fact that our consumption variable only included money spent on eating out. (see robustness section)

Interactive interest rate and age effect

Table 4

%Equity	***(1)***	***%food consumption***	***(2)***
Age	0.149***		-0.004***
	(0.010)		(0.001)
Age^2	-0.010***		0.00003***
	(0.000)		(0.000)
Time	0.024**		0.006**
	(0.010)		(0.000)
Rateage	+0.004		0.001***
	(0.003)		(0.000)
$Rateage^2$	0.00001		-5.97e-06***
	(0.000)		(0.000)
Interest rate	0.179***		-0.002***
	(0.066)		(0.000)
Educ	0.178***		-0.001***
	(0.007)		(0.000)
Hhsex	-0.258***		-0.011***
	(0.061)		(0.002)
Income	3.83e-08***		-4.58e-10***
	(0.000)		(0.000)
Kids	-0.008		-0.002***
	(0.015)		(0.000)
Married	-0.076		-0.014***
	(0.051)		(0.002)
lf	0.042		-0.001
	(0.053)		(0.002)
Intercept	-5.311***		0.124***
	(0.300)		(0.013)
Observations	21 972		41 098
R-squared	0.119		0.071

* = 10 % significance level, ** = 5 % significance level, *** = 1 % significance level. Standard errors are listed in the parenthesis. (1) Regression with %Equity as dependent (2) Regression with %food consumption as dependent.

Table 4 above shows interactive interest rate-age effects on investment and consumption. In regression (1), the interactive effect on equity investment is measured, whereas in regression (2) the interactive effect on food consumption is looked at.

It can be observed, that in regression (2), the interactive variables turn out to be significant. It can therefore be confirmed, that our two stages hypothesis holds when it comes to food

consumption. In other words, as an effect of interest rate shifts, people change their savings behaviour, and age is indeed an important factor in determining how much money they allocate to consumption and investments.

In regression (1), the interactive variables are insignificant. We cannot therefore confirm the interactive effect on equity investments through this analysis. However, the effect can potentially still be there, it just isn´t picked up by the variables. When the variables age and investment are interacted, and run in regressions with equity investment, several quadratic relationships are involved. A positive coefficient can be given either through the multiplication of two positive, or two negative values. Hence, it may be due to the complicated quadratic structure of the regressions run that the variables do not turn out to be all that significant.

In conclusion, the interactive age-interest effect can be confirmed for food consumption, but using the same method the same type of effect cannot be confirmed for equity investments.

7. Robustness and Discussion

7.1 Robustness

As seen in the literature review, some researchers, such as Ameriks and Zeldes (2004) attribute changes in investment behaviours to cohort effects, and time trends, rather than age. Through our analysis, we have taken care of possible time effects by including the time variable in the regressions. We now proceed to briefly examine possible cohort effects.

Two variables were created, agetime and age^{2}time, by multiplying age and time and age^{2}and time. Next, we ran the following regression:

Results recorded in table 5:

$$\%equity = \beta_0 + \beta_1 time + \beta_2 age + +\beta_3 age^2 + \beta_4 agetime + \beta_4 \text{age}^2 time + \beta_x C_x + \varepsilon$$

The variables agetime and age^{2}time can be used to capture cohort effects. If they turn out to be significant, and the regular age variables lose their significance, it can be deducted that changes in equity investment can indeed be attributed to not only age, but also cohort effects.

The results were recorded in table 5 below. As it can be observed, the effects of the cohort variables two cohort variables turn out to be significant on a 90% level and 95% level respectively. It can therefore be confirmed that cohort effects on investment behaviour do indeed exist. At the same time however age and age^2 remain significant on a 99% level, and their beta coefficients do not change in value by a significant amount. We can therefore conclude that cohort effects do indeed exist, but it cannot be claimed that changes in investment behaviour can be attributed to cohort effects and time trends, and not age.

Table 5

%Equity	***(1)***
Age	0.101***
	(0.017)
Age^2	-0.001***
	(0.000)
Time	-0.226***
	(0.068)
Agetime	0.006**
	(0.003)
Age^2time	-0.00005*
	(0.000)
Educ	0.177***
	(0.007)
Hhsex	-0.257***
	(0.061)
Income	3.86e-08***
	(0.000)
Kids	-0.008
	(0.015)
Married	-0.079
	(0.051)
lf	0.039
	(0.053)
Intercept	-3.319***
	(0.435)
Observations	21 972
R-squared	0.118

* = 10 % significance level, ** = 5 % significance level, *** = 1 % significance level. Standard errors are listed in the parenthesis. (1) Regression without controls.

Another thing worth commenting are the issues that arose around our analysis on age effects on consumption behaviour. As already mentioned above (see section 5.3), money spent on food when eating out was the best measure for consumption in the data set used. Without doubt, such a variable has its limitations, as it only includes one quite limited form of

consumption. It is entirely possible that age´s effects on money spent on trips abroad, casino visits, or the purchase of home appliances look slightly different from its effect on money spent eating out. Hence, money spent on eating out is not a perfect representation of people´s overall consumption. It would have been much more ideal if a variable which combines several forms of consumptions could have been used. Also, had this been the case, comparisons between the magnitude of age effects on investments and consumption would be much easier to perform. This cannot be done when our consumption variable includes just one type of consumption. For further research on this topic, it would be highly recommended to find/construct and use such a variable.

It should also be noted that the respondents asked were all heads of household. The main problem with this is a disproportional representation of women. The Hhsex dummy variable has a mean of 1.22 where 1=man and 2=woman, which means that more men are household heads than women. At the same time, women make out almost half of the total US population (United States Census Bureau (2011)). Hence, we can conclude that the investment and consumption behaviours of men are overrepresented in our analysis. To ensure a fair representation of women, new types of data sets would need to be constructed, where not only household heads, but all members in family are asked about their financial situation.

To further test our hypothesis on investment behaviour, we also ran a regression with the variable %stocks (which was also logged) as dependent, and the same variables as in table 2 (2), and found the age effects to be significant, and their beta coefficients to have the same sign as in table 2, strengthening our hypothesis further. (see appendix)

Finally, the applicableness of our analysis to other countries than the US, where the data comes from can be discussed. Without doubt, sensitivity to interest rate changes and the investment and consumption behaviours of individuals varies a little bit from country to country. However, the results still carry strong predictive powers for countries other than the US as well, especially highly developed, first world economies that are in today´s world deeply interconnected, and where consumers behave in similar ways (International Monetary Fund (2013)).

7.2 Discussion

Given the results of our analysis, it is well worth discussing what implications they may have for central banks. As already discussed in the introduction, several central banks are adopting a policy of constantly lowering interest rates, to stimulate consumption and investment in order to reach their inflation targets. With the help of our analysis, we can confirm that this policy is to some extent effective, as when interest rates drop, people decrease their savings and are forced to allocate that money to either consumption or investment.

Our analysis has also shown that young and old people are the easiest to incentivize to consumption, while middle aged individuals are harder; they´d rather invest. Many countries in the western world have a growing percentage of their populations in the oldest age categories (Gerland et al. (2014)) in combination with an inflow of young migrants (Eurostat (2016)), (Department of Homeland Security (US) (2014)), (Statistiska Cenralbyrån (2016)). It can therefore be stated, that people in the youngest and oldest age categories make out increasing portions of the populations, at least in a short term perspective. Continuing to lower interest rates in such a situation might lead to decreased effectiveness, and may as well give rise to possible dangers.

Let´s look at the implications for the different age categories. As interest rates fall, the young and the old will consume increasing portions of their incomes. This might help central banks edge close to their inflation goals. However, because people in the youngest and oldest age categories have lower disposable incomes (Guvenen et al. 2015) compared to middle aged individuals, to finance their increased consumption, they´ll indebt themselves deeply (International Monetary Fund (2014)). For instance, in Sweden, the loan to value ratio has increased greatly over the last 20 years (Statistiska Centralbyrån (2013)). A high indebtedness amongst people with lower disposable incomes greatly decreases the stability and strength of the given country´s economy. Interest rates can´t continue to fall forever. When the time comes for them to start rising again, these people will have huge issues with paying off their loans, given that they on top of a low disposable income also have very few equity investments that could be sold off to finance loans.

Our analysis has also proven, that middle aged individuals will change their consumption behaviours the least when interest rates are lowered. This is quite problematic given that they have the highest disposable income (Guvenen et al. 2015), and the greatest power in driving prices up if they were to consume more. Instead, they seem to be incentivized to take more

risks, and invest into equities. Such behaviour does not only decrease the effectiveness of central bank policy in driving up inflation, but leads to an increased fragileness of the country´s economy. If a crash were to occur, people in the age categories with the highest disposable income would be hurt direly because they have large portions of their wealth invested into risky assets which usually plunge in value when such an event occurs.

All in all, it can be stated that given the current demographic situation of many countries in the western world, central bank policy of constantly driving down interest rates is not all that effective, and on top of that leads to fragile economies, more susceptible to economic crises.

8. Conclusion

In this paper it was investigated how changes in interest rate affect savings behaviour, and how money is allocated to consumption or investments differently, depending on age. This was an important topic to discuss given that many central banks around the world have in recent years adopted a policy of constantly lowering interest rates in order to stimulate their country´s economies, and reach inflation targets.

Our findings were mostly in line with our hypothesis. We found the relationship between interest rates and saving to be positive, which means that if central banks lower interest rates, people do indeed reduce, and reallocate their savings money to consumption or investment.

How much people spend on investment and consumption does indeed differ depending on age. The age-investment relationship is very clearly characterized by an inverse “u” shaped, exponential curve, where, as young people age, they invest increasing amount, and after retirement, they reduce their investments. The relationship between age and consumption is characterized by a “u” shaped exponential curve, although not as clear as in the age-investment relationship. As young people age, they limit their consumption, after retirement however, consumption starts increasing once again.

Our findings lead us to conclude, that when young and old people are much more easily incentivized to increase their consumption than middle aged people, who´d rather invest, the effectiveness of the central bank policy to drop interest rates in order to achieve inflation targets is limited. On top of that, the facts that young and old people, who have relatively low

disposable incomes compared to middle aged individuals consume such large chunks of their income, and that middle aged individuals invest more into risky assets, pose a danger to these countries‘ economies, making them more susceptible to financial crashes.

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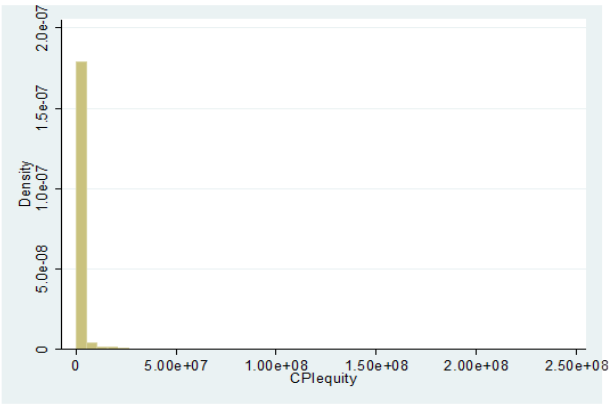
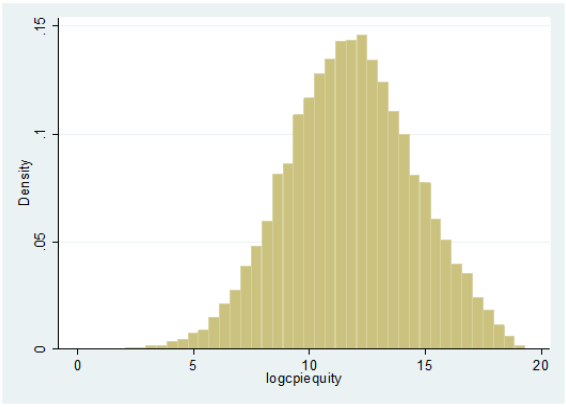
Appendix

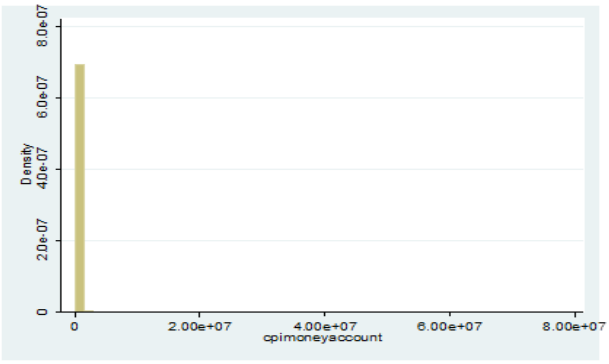
Logged variables

Equity

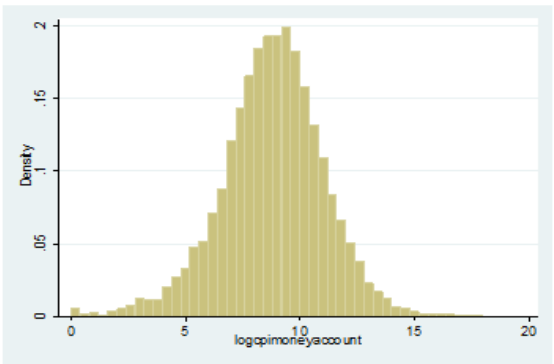


Log Equity





CPImoneymarket



LogCPImoneymarket

Inflation adjustment

If we for instance have an observation from 1992 with a person that has 1.000.000 in savings we will recalculate this as following: (1000000/60.23)*100=1 660 302. This gives us a hint of what the money would be worth in 2013. If we do this calculation on an observation from 2013 the value would be the same as before the calculation since we divide by 100 and then multiply by 100.

Year	***CPI***
2013	100
2010	93.6
2007	89
2004	81.09
2001	76.02
1998	69.97
1995	65.42
1992	60.23
1989	53.23

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Running stocks with the same variables

%Stocks	(1)	(2)
Age	0.111***	0.085***
	(0.010)	(0.011)
Age^2	-0.001***	-0.0004***
	(0.000)	(0.000)
Time	-0.057***	-0.075***
	(0.009)	(0.010)
Educ		0.188***
		(0.012)
Hhsex		-0.371***
		(0.107)
Income		4.06e-08***
		(9.54e-09)
Kids		-0.032
		(0.024)
Married		0.094
		(0.085)
lf		-0.071
		(0.078)
Intercept	-2.219***	-3.995***
	(0.275)	(0.357)
Observations	10 768	10 768
R-squared	0.065	0.099

* = 10 % significance level, ** = 5 % significance level, *** = 1 % significance level. Standard errors are listed in the parenthesis. (1) Regression without controls. (2) Regression with controls