NBER WORKING PAPER SERIES

# THE RETIREMENT-CONSUMPTION PUZZLE:
# NEW EVIDENCE FROM PERSONAL FINANCES

Arna Olafsson
Michaela Pagel

Working Paper 24405
http://www.nber.org/papers/w24405

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
March 2018

We are grateful for the financial financial support of the Pension Research Center (PeRCent) at Copenhagen Business School, and we thank Andrew Caplin, Rachel Kranton, Jawad Addoum, Jon Parker, Matthew Rabin, Botond Koszegi, David Laibson, Steve Zeldes, Emi Nakamura, Jon Zinman, Jennifer La'O, Emir Kamenica and seminar participants at the Federal Reserve Bank of Richmond, University of Queensland, PerCent 2017 Conference, University of Minnesota, Columbia University, and ECWFC at the WFA 2017 for a range of insightful comments. We are also indebted to August Schweitz Eriksson and Meniga for providing the Icelandic data and to Steffen Meyer for replicating our results in German bank data. We also thank Belinda Chen for outstanding research assistance. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

The Retirement-Consumption Puzzle: New Evidence from Personal Finances
Arna Olafsson and Michaela Pagel
NBER Working Paper No. 24405
March 2018
JEL No. D12,D14,E21,J26,J32

**ABSTRACT**

This paper uses a detailed panel of individual spending, income, account balances, and credit limits from a personal finance management software provider to investigate how expenditures, liquid savings, and consumer debt change around retirement. The longitudinal nature of our data allows us to estimate individual fixed-effects regressions and thereby control for all selection on time-invariant (un)observables. We provide new evidence on the retirement-consumption puzzle and on whether individuals save adequately for retirement. We find that, upon retirement, individuals reduce their spending in both work-related and leisure categories. However, we feel that it is difficult to tell conclusively whether expenses are work related or not, even with the best data. We thus look at household finances and find that individuals delever upon retirement by reducing consumer debt and increasing liquid savings. We argue that these findings are difficult to rationalize via, for example, work-related expenses. A rational agent would save before retirement because of the expected fall in income, and dissave after retirement, rather than the exact opposite

Arna Olafsson
Copenhagen Business School
Department of Finance
Solbjerg Plads 3
2000 Frederiksberg
Denmark
Denmark
ao.fi@cbs.dk

Michaela Pagel
Columbia Business School
3022 Broadway
Uris Hall
New York, NY 10027
and NBER
mpagel@columbia.edu

# 1 Introduction

A large literature analyzes changes in household consumption upon retirement. After all, household consumption is the most important part of aggregate demand and the increase in the share of the workforce that will be approaching or past retirement age in the coming years puts this topic at centerstage for both policy-makers and researchers. This paper uses new data from a personal finance management software to shed additional light on the effects of retirement on individual spending, income, and personal finances, that is, liquid savings and consumer debt.

A central implication of Modigliani's (1954) life-cycle model, the standard model for analyzing consumption-savings decisions by households, is that consumption should be smoothed across periods of predictably high and low income. Retirement is arguably among the most predictable and important income changes individuals encounter in their lives, and consumption should therefore not be affected by its onset. However, a number of empirical studies (e.g., Banks et al., 1998; Bernheim et al., 2001; Haider and Stephens, 2007; Schwerdt, 2005) find a sharp decline in consumption during the first years of retirement, a phenomenon referred to as the retirement-consumption puzzle.[1]

But other studies argue that a drop in consumption at retirement is actually not puzzling. Aguiar and Hurst (2005, 2013) and Hurst (2008) strongly question the claim that there is a decline in actual consumption utility at retirement. They argue that spending, rather than consumption, decreases on the grounds that individuals reduce their work-related expenses and overall spending through more efficient shopping and household production, as a result of changes in the opportunity cost of time after retirement.[2] So the mechanism for the drop in spending upon retirement is still debated, as is the broader question whether individuals save adequately for retirement and whether Modigliani's (1954) life-cycle model is applicable.

This paper revisits the retirement-consumption puzzle with new, accurate, and comprehensive data on spending, income, consumer debt, and liquid savings from personal finance management software. The accurate spending data, covering more than six years, offers a unique opportunity to reevaluate the puzzle. Moreover, to the best of our knowledge, this paper is the first to document changes in personal finances, that is, liquid savings and consumer debt, around retirement. The data allow us to analyze changes in individual spending, interest payments, and financial account balances upon retirement using individual fixed-effects regressions. We find

[1]The first study to document a clear decline in consumption at the onset of retirement was conducted by Banks et al. (1998), using a pseudo panel constructed from 25 years of the Family Expenditure Survey (FES) in the UK. Bernheim et al. (2001) also found a drop in consumption at retirement using longitudinal data from the Panel Study of Income Dynamics (PSID). The drop in consumption at retirement is theoretically rationalized by Pagel (2017) and Huang and Caliendo (2011), among others. Moreover, Ameriks et al. (2007) and Haider and Stephens (2007) provide evidence that the drop is expected.

[2]While some additional studies provide evidence supporting this hypothesis (see, e.g., Hurd and Rohwedder, 2003; Battistin et al., 2009), others argue against it (such as Stephens Jr and Toohey, 2017). However, all these studies are based on survey data. Analyzing the puzzle using transaction-level data from personal finance management software, as introduced by Gelman et al. (2014), is a natural next step.

evidence of reductions in both work-related and leisure spending categories. However, we note that it is difficult to tell conclusively which expenses are work related, even when we consider very fine categories. Additionally, we look at personal finances and document that individuals delever around retirement by reducing their consumer debt and increasing their liquid savings. Our findings about personal finances are very interesting because they are difficult to rationalize via, for example, theories about work-related expenses. Any rational agent who expects a fall in income at retirement will save before retirement and dissave after retirement, rather than the other way around.

Unless the reduction in work-related expenses is larger than the fall in income, agents should always save before retirement and dissave after. If the reduction in work-related expenses is larger than the fall in income, they should retire early. However, the average individual in our sample continues to work voluntarily some time after reaching the age thresholds at which disincentives to retire no longer apply. Thus, our finding that individuals increase their savings after retiring is difficult to explain by work-related expenses or any other theory that reduces consumption needs around retirement, such as by reference to the opportunity costs of time. Our findings could be explained by individuals liquidating retirement accounts or other illiquid assets, such as houses, around retirement. To address this concern, we make sure our findings are robust to controlling for income from all sources. Furthermore, we find that investment transactions and all other sources of income are unaffected by retirement status. Overall, we carefully discuss a number of theories consistent with rational planning: work-related expenses, opportunity costs of time, wealth shocks and liquidation of assets, health shocks, and intra-household bargaining. We conclude, however, that they all have difficulty explaining our findings.

We thus argue that we cannot retire the consumption puzzle just yet. After all, the retirement-consumption puzzle is about individuals not being able to plan for an expected, large, and salient reduction in income. Our finding that consumption and consumer debt drop while liquid savings increase can be explained by undersaving before retirement and adjusting consumption patterns afterward, which requires a time-inconsistent overconsumption problem such as hyperbolic discounting (as in Laibson et al., 1998) that is corrected after retirement, as we show in a fully-fledged life-cycle model. Alternatively, Pagel (2017) shows that a model of expectations-based loss aversion, as developed by Kőszegi and Rabin (2009), predicts that individuals will correct their overconsumption problem upon retiring. The intuition is the following: when income is uncertain, individuals overconsume in the present and hope for a better realization of income in the future. But when income is certain, as it is after retirement, overspending results in a sure reduction in future spending, and because the agent dislikes this sure loss, she corrects her overconsumption problem after retirement. We thus rationalize a simultaneous decrease in consumption and increase in savings upon retirement in a realistically calibrated life-cycle model.

Reassuringly, we find the same empirical pattern in two commonly used US consumption survey data sets, the Consumer Expenditure Survey (CEX) and the Survey of Consumer Finances (SCF). In the CEX data, we find that retirement results in an increase in savings (measured as income minus spending), checking account balances, and savings account balances. In the SCF data, we find that retirement results in reductions in leverage and debt and in increases in checking, savings, and call account balances. We control for cohort, age, and year effects, although one has to keep in mind that these results suffer from selection bias and measurement error. Beyond the CEX and SCF data, we thus replicate our results in individual- and transaction-level bank account data from Germany by running fixed-effects regressions. Finally, we use two more US survey data sets to replicate our results: the PSID and the HRS. Because these surveys poll households consecutively, we can also include individual fixed effects in our regressions. In all these data sets, we find that consumption and debt holdings decrease but savings and checking account balances increase along with other measures of wealth.

In this paper, we explore the retirement-consumption puzzle using a very accurate panel of individual spending and income. The data were captured in the course of business by Meniga, a provider of personal finance management software in Iceland. This data set has already proven useful for studying, among other things, the spending responses of individuals to income arrivals (Olafsson and Pagel, forthcoming) and the drivers of individuals' attention to their personal finances (Olafsson and Pagel, 2018). We are aware of only one previous study to use transaction-level data to investigate the consumption drop upon retirement: Agarwal et al. (2015) use debit and credit card spending data from Singapore. Our data set has five advantages: (1) In Iceland, consumers use electronic means of payments almost exclusively, which eliminates one limitation of the data from Singapore, where a significant fraction of expenditures in certain shops, such as fresh markets and small grocery stores, are paid with cash. (2) We observe the incomes and expenditures of individuals over a long period of time around retirement. Thus, we have sufficient power to estimate individual fixed-effects regressions, controlling for all selection on observable and unobservable time-invariant characteristics. (3) We can identify individual spending and income because all financial accounts are personal in Iceland. At the same time, we can identify individuals within a household, which allows us to control for household income. (4) We can see how individuals spend within certain categories of spending, which gives us the opportunity to test whether consumers substitute toward cheaper but more time consuming goods when they retire. In addition, our categorization is very accurate and comprehensive. (5) Because we have detailed information on all account balances, credit limits, and financial fees, we are able to document the changes in personal finances at the onset of retirement.

With respect to changes in household finances upon retirement, the only related paper we are aware of is Addoum (2016), which analyzes changes in household portfolios upon retirement using PSID data. The author shows that portfolios become less risky when male spouses retire as women gain bargaining power and are more risk averse. Moreover, our findings are related to recent work documenting that mean and median cohort wealth, for either singles or couples, can be stationary or rising for many years after retirement (Poterba et al., 2011a,b) even though the standard Modigliani's (1954) life-cycle model predicts that individuals should decumulate assets. This empirical finding has been termed the "retirement-savings puzzle" and is theoretically explained by DeNardi et al. (2010) and Laitner et al. (2017), among others.

The remainder of this paper proceeds as follows. Section 2 briefly reviews the Icelandic pension system, describes our data, and reports summary statistics. Section 3 presents our empirical approach and findings. Section 4 discusses how our findings can be theoretically rationalized. Finally, Section 5 offers some concluding remarks.

# 2 Background, data, and summary statistics

## 2.1 Background and Icelandic pension system

A long working life is more common in Iceland than in most other countries. Figure 1 compares the average effective retirement ages of men and women in Iceland, Germany, and the United States. This data is obtained from the Organisation for Economic Co-operation and Development (OECD). In our data, we label individuals above age 60 as retired when we observe pension payments above a certain limit for several months and salary income below a certain limit for several months.[3] Figure 2 displays the share of retired individuals at each age and Figure 3 displays the distribution of retirement ages. Our inferred time of retirement is consistent with the information from the OECD on effective retirement age in Iceland displayed in Figure 1.

The Icelandic pension system consists of three pillars: a tax-financed public pension (i.e., social security benefits), compulsory occupational pension funds (i.e., defined benefit/contribution plans), which are the dominant feature of the system, and voluntary private pensions with tax incentives (i.e., tax-deductible savings). The age thresholds at which individuals are no longer punished for retiring early are the following: the public pension, which is need-based, is paid from age 67 on. The occupational pension is paid from age 67 on, but it is possible to start withdrawing it as early as 65 with a reduced benefit, or as late as 70 with additional benefits. This pension is paid as an annuity and depends partly on individual contributions. The occupational pension system is very transparent, and individuals can easily acquire all the necessary information about their annuitized retirement income. Finally, private pension savings can be withdrawn from age 60 on. Appendix A contains a more detailed review of the key features of the pension system in Iceland.

[3]More specifically, individuals older than 60 are labeled as retired if (1) we see them receiving at least 1,000,000 ISK (9,770 USD) in pension payments over the sample period, (2) the pension payment in the current month is at least 30,000 ISK (293 USD), and (3) we do not see a salary payment higher than 150,000 ISK (1,466 USD) in the current month or the three months before and after.

## 2.2 Data

In this paper, we exploit new data from Iceland generated by Meniga, a financial aggregation software provider to European banks and financial institutions. Meniga was founded in 2009 and is the European market leader of white-label Personal Finance Management (PFM) and next-generation online banking solutions, reaching more than 50 million users in 20 countries. Meniga's account-aggregation platform lets users view all their accounts and credit cards from multiple banks in one place.

In January 2017, Iceland's population was 338,349 individuals, of whom 262,846 were older than 16. At that time, Meniga had 50,573 users, or about 20 percent of the population above age 16. Because their service is marketed through banks, the sample of users is fairly representative. Each day, the software automatically records all the bank and credit card transactions, including descriptions and the balances, overdrafts, and credit limits. The software also collects demographic information such as age, gender, marital status, and postal code. Figure 4 displays screenshots of the app's user interface. The first shows background characteristics that the user provides, the second shows transactions, and the third shows bank account information.

We use the entire de-identified population of active users in Iceland and the data derived from their records. The data on spending, income (including interest income from savings account balances), overdraft interest, and financial fees runs from 2011 to 2017 and the data on balances and limits spans 2014 to 2017. We restrict the sample to individuals above the age 60 who receive at least one salary transaction (before receiving their pension payments) and engage in at least one grocery store transaction per month. We perform the analysis on user-level data aggregated at a monthly level for different income sources, spending categories, and measures of household finances. Individuals in the same household can link each other, in which case we obtain information on both individual and total household spending and income. All accounts in Iceland are personal; thus, we know each individual's spending, salary and pension income, balances, and credit limits.

### Spending data

Spending is categorized, and each category is aggregated at both the individual and the household level. The panel thus provides individual- and household-level expenditure information for disaggregated categories. We consider ten fairly broad spending categories: groceries, fuel, alcohol, ready-made food, home improvement, transportation, clothing and accessories, sports and activities, and pharmacies.[4] We also have more disaggregated categories. For instance, for ready-made food, we know the type of restaurant, such as bakery, canteen, or fine dining.

[4]We can observe expenditures on alcohol that is not bought at bars and restaurants because a state-owned company, the State Alcohol and Tobacco Company, has a monopoly on the sale of alcoholic beverages in Iceland.

### Income data

When the data are extracted from the PFM system, they have already been categorized by a three-tiered approach: system, user, and community rules. The system rules are applied when codes from the transaction system clearly indicate the type of transaction being categorized. For example, when transactions in the Icelandic banking system contain the value "04" in a field named "Text key," the payer has indicated payment of salary. User rules apply when no system rules are in place but a user persistently categorizes transactions with certain text or code attributes to a specific category, so that the system automatically creates a rule that is applied to all further such transactions. If neither system rules nor user rules apply, the system detects identical categorization rules from multiple users, which allows for the generation of a community rule applying the categorization across the whole community. The PFM system has already detected first-party transactions, such as between two accounts belonging to the same household, and excluded them. Thus, multiple steps were taken to achieve an accurate categorization of transactions based on banking system codes, transaction texts, amounts, and payer profiles.

Payers identity and NACE category (The Statistical Classification of Economic Activities in the European Community)[5] are also added to each income transfer whenever possible.[6] The system sorts income into 23 categories. Regular income categories are child support, benefits, child benefits, interest income, invalidity benefits, parental leave, pension, housing benefits, rental benefits, rental income, salary, student loans, and unemployment benefits. The irregular income categories are damages, grant, other income, insurance claims, investment transactions, reimbursements, tax rebates, and travel allowances.

### Bank data

The amount of savings and overdrafts that individuals hold can be inferred from information on balances, interest income from savings accounts, and interest paid on overdrafts. An overdraft occurs when withdrawals from a current account exceed its available balance. This means that the balance is negative and the bank is providing credit to the account holder, with interest being charged at the agreed rate. Virtually all current accounts in Iceland offer a pre-agreed overdraft facility, the size of which is based on individual credit scores and histories. Customers can use this overdraft facility at any time without consulting the bank, and it can be maintained indefinitely. Although an overdraft facility may be authorized, technically the money is repayable on demand by the bank. In reality, this is a rare occurrence, as the overdrafts are profitable for the

[5] This is is the industry classification system used in the European Union.

[6] Payer identity can be hard or impossible to identify because of limited information in transaction data, such as generic transaction texts. In specific cases where the payer could not be identified, a proxy id was created to enable the binding of payments from single sources even though the true source id is unknown. In some cases, no attempts could be made to bind transactions by origin via a proxy id. Some payments without actual payer identity may have a proxy id, but never a NACE category, as the real id of the payer is unknown. All such transactions are categorized as other income.

bank and expensive for the customer.

In addition, we have information on three types of financial penalties: late-payment interest, non-sufficient-funds fees, and late fees. Credit card companies charge late-payment interest daily from the date a payment is due and payable to the date it is paid in full. Non-sufficient-funds fees occur when the overdraft limit is exceeded in a consumer's current account. In the event of attempted debit card transactions, the bank charges the account with these fees. Finally, late fees are fees assessed for paying bills after their due dates.

## 2.3 Summary statistics

Table 1 displays summary statistics of the user population, including income and spending in US dollars and demographic statistics. We can see that the average user is 41 years old and 49 percent of users are female. For comparison, Statistics Iceland reports the average age in the population to be 37 years, with 49.5 percent being female. Thus, our demographic statistics are very similar to those of the overall population. This is reassuring because of the concern when using app data that the user population may be young, well-situated, male, and tech-savvy relative to the overall population. The representative national household expenditure survey conducted by Statistics Iceland also reports income and spending statistics. In the table, parentheses indicate when spending categories did not match perfectly with the data. We can see that the income and spending figures are very similar for those categories that match well. Our sample is fairly representative because individuals are offered to sign up for the software automatically by the bank when they access their accounts online and the internet penetration is 97% in Iceland.

Table 2 displays summary statistics for individuals who are eligible for retirement, i.e., have reached age 60, whether or not they are retired. We can see in the raw data that on average retired individuals have lower incomes, spend less (in both individual spending and household spending), have more savings, hold less consumer debt, have more access to credit (liquidity), and incur fewer bank fees and penalty payments.[7]

Figure 5 summarizes the salary, pension-payment, and expenditure trajectories of men and women using binned averages by age. The figure shows how salary payments decrease and pension payments increase between the ages of 60 and 70. Labor income and spending are both hump-shaped over the life cycle.

[7] Liquidity is defined as access to credit and thus current account balance plus savings account balance plus overdraft limits plus credit card limits minus overdrafts and credit card balances.

# 3 Analyses

## 3.1 Life-cycle profiles of spending and income

We start our analysis by investigating whether we can replicate the familiar hump-shaped profile of spending over the life cycle in our data. Following Aguiar and Hurst (2013) and Agarwal et al. (2015), we obtain the age profile of consumption by regressing log total spending on age, controlling for month-by-year and individual fixed effects. We also estimate separate regressions for log spending in our ten broad consumption categories. Figure 6 plots the age coefficients for log total monthly spending. The expenditure profiles do indeed exhibit the conventional hump-shaped patterns, in which spending peaks in the late thirties, at a bit less than 40 log points higher than the level for twenty year olds, and spending declines by about the same amount from the individual's late fifties until retirement age.

Aguiar and Hurst (2013), Agarwal et al. (2015), and Figure 6 document considerable heterogeneity in life-cycle patterns of spending across different consumption categories. Spending in grocery stores and supermarkets is the largest part of household total spending (excluding expenditure commitments like housing and utilities) and it does exhibit the hump-shaped pattern, but other spending categories do not. For instance, ready-made food expenditures rise in the individual's twenties and then stay more or less constant until declining in the sixties. Alcohol expenditure is constantly rising, while spending on clothes and accessories is constantly falling.

As shown in Figure 6, we also find considerable heterogeneity in the life-cycle patterns of spending in more refined categories. For instance, grocery stores are categorized as either budget or expensive stores. Spending in budget supermarkets exhibits a much greater hump than spending in more expensive grocery stores. Furthermore, the share of expenditures in expensive grocery stores falls during the twenties, reaches its bottom around age 30, and stays constant until the early forties, when it starts rising again.

We also find different patterns among more refined ready-made food categories. Expenditures on fast food increase in the individual's twenties and stay more or less constant until they start falling during the sixties. This is consistent with fast food being a work-related expense or a substitute for home production that increases as individuals enter the labor market and decreases as they retire. The same applies to casual dining. Expenditure on fine dining, on the other hand, increases gradually and then stays pretty much constant. This pattern appears reasonable for a kind of expense that is unlikely to be a work related or a substitute for home production and thus to be relatively unaffected by labor-market status.

Taken together, these figures suggest that individuals shift toward more time-consuming food expenditures as they retire from the labor market, which is perfectly consistent with the findings in the literature (e.g., Aguiar and Hurst, 2013).

## 3.2 The effects of retirement on spending and personal finances

To examine the effects of retirement on spending and personal finances we run the following regression:

$$\log(C_{it}) = \widehat{\alpha} + \widehat{\beta} Retired_{it} + \widehat{\gamma}\log(Y_{it}) + \phi_{my} + \eta_i + \epsilon_{it} \quad (1)$$

where $C_{it}$ is the dependent variable of interest and $Y_{it}$ is income of individual $i$ at time $t$. $\phi_{my}$ is a month-by-year fixed effect, and $\eta_i$ is an individual fixed effect. Controlling for individual fixed effects allows us to compare individuals to themselves before and after retirement. $Retired_{it}$ is an indicator equal to 1 if individual $i$ has retired at time $t$ and the $\widehat{\beta}$ coefficient thus measures the effect of retirement on the outcome variable under consideration.

### Spending by category

Table 3 shows the estimated effect of retirement on spending based on the individual fixed effects model, Equation (1), with and without controlling for total income.[8] We can control either for individual income or for total household income when individuals link each other. These results show that spending drops significantly upon retirement. When we control for income, the drop is about 70% of the reduction without controlling for income, which suggests that individuals change their spending habits not only because income drops at retirement.

In turn, we find results consistent with a reduction in work-related expenses: spending on fuel, ready-made food, and clothing drops substantially. Grocery spending falls as well, which might be attributed to more efficient shopping and home production, as individuals have more time at their disposal after retirement. However, leisure-related expenses (for instance, sports and activities) also decrease substantially, suggesting that individuals are correcting an over-consumption problem. Other spending that can hardly be attributed to work, such as alcohol bought in stores and pharmacy spending, also falls upon retirement.

Nevertheless, we feel that the results on spending in such broad categories do not paint a conclusive picture of whether or not work-related expenses explain the retirement-consumption puzzle. We thus turn to a finer categorization and, following the literature, examine spending on food more closely.

### Spending by grocery store and type of restaurant

In the previous section, we showed that consumers substitute across different types of grocery stores and of ready-made food places over their life cycles. We know the type of grocery store (budget or expensive) and the types of restaurant (such as bakery or fine dining). We can

[8] Because individual spending categories include many zeros, we replace the log of all values between zero and one Icelandic krona with zero to avoid losing these observations. Our estimates are not qualitatively or quantitatively affected by winsorizing to address outliers instead of taking the log of the outcome variables. Moreover, our results are not affected by controlling for winsorized income as opposed to log income.

also distinguish between individual trips and overall daily spending. Previous studies, even those using transaction-level data, may have failed to capture some patterns. The reason is that consumers in countries where card payments are not as widely accepted as in Iceland typically use different payment instruments in different types of stores. For instance, cash payments are much more common in fresh markets and smaller grocery stores and, as Figure 6 shows, older cohorts exhaust a larger share of their grocery spending in such stores. This would suggest that the spending of older cohorts is underestimated in countries where cash is among the most common payment instruments. These results are consistent with findings by Agarwal et al. (2015) using the shopping scanner data. However, given that almost all purchases in Iceland are made with non-cash instruments (and we can control for cash withdrawals), this cannot be part of the explanation for the drop in consumption at retirement in Iceland. In fact, it suggests that the numbers on groceries and ready-made food shown in Table 3 underestimate the reduction in the amount of grocery spending as consumers spend a larger share in more expensive supermarkets at later ages but still reduce their overall spending.

Figure 7 shows the life-cycle profiles of (1) restaurant spending and visits, (2) expenditure in different types of restaurants, such as bars or fine dining, and (3) visits to different types of restaurants. We can clearly see humps for all the life-cycle profiles of both spending and trips and for all the categories of restaurants.

Moreover, we can look at the effects of retirement on these categories. We can see in Table 4 that individuals exhibit a drop in spending for all categories of restaurants, including bars and fine dining. This result is more consistent with a reduction in overconsumption around retirement than with a reduction in work-related expenses.

Nevertheless, we again feel that the results on spending, even with the most accurate and comprehensive data and a very fine categorization, do not paint a conclusive picture of whether or not work-related expenses, home production, and efficient shopping explain the retirement-consumption puzzle. After all, one could easily construct a theory of how fine dining or other activities are work related and thus bound to fall around retirement without affecting consumption utility and without concluding that individuals do not save properly for retirement. Overall, we thus conclude that whether a puzzle exists cannot be decided conclusively even with the most comprehensive and accurate spending data.

### Personal finances

Using the same estimation approach, we can investigate the effects of retirement on bank account balances, overdrafts, credit limits, and bank fees. Table 5 displays the estimated effects of retirement on household finances based on the individual fixed effects model, Equation (1), with and without controlling for total income. The most interesting result is that individuals delever. When we measure consumer debt via interest expenses, we find a 13.2% reduction. Thus, individuals not only cut their consumption, but they also reduce their consumer debt considerably. This deleveraging cannot easily be rationalized by a reduction in work-related expenditures, as we discuss in detail below. When rational agents expect a substantial reduction in income, they will optimally save before and dissave after retirement rather than the other way around. So instead, it seems sensible to suggest that individuals decide to correct their over-consumption and debt holdings by delevering. Figure 8 shows the life-cycle profile of interest payments on consumer debt holdings. Consumer debt features a pronounced hump similar to those of consumption and income. Obviously, if consumer debt were to smooth consumption and income over the life cycle, it would be U-shaped, not hump-shaped.

We find that households not only delever, they also increase their liquid savings (measured by interest income on bank account balances) substantially, between 5.5% and 12.1% depending on whether income is controlled for. This again hints at individuals rethinking their financial plans at the onset of retirement. Figure 9 displays the life-cycle profile of interest income from savings accounts and shows a clear increase around the time of retirement. Moreover, we find that individuals increase their current account balances and decrease their overdraft holdings and credit card balances. Finally, individuals also reduce total and late fee payments.

## 3.3 Replicating the analysis in other data sets

In this section, we show that we can replicate our results in commonly used survey data sets from the US and in another individual- and transaction-level data set from Germany. It is reassuring that we can document the same results in survey consumption data most commonly used in the literature, the Consumer Expenditure Survey (CEX) and the Survey of Consumer Finances (SCF). However, these data sets suffer from selection bias and measurement error, so to bolster the credibility of our findings we replicate our analysis using additional data sets from the US as well as Germany where we can employ individual fixed effects and conclude that our results are not specific to Iceland.

### CEX data

We use data from the CEX for 1980 to 2002. Following Aguiar and Hurst (2013), we use the NBER extraction files by John Sabelhaus and Ed Harris of the Congressional Budget Office. The data set links four quarterly interviews for each respondent household and collapses all the spending, income, and wealth categories into a consistent set of categories covering all the years. The CEX is conducted by the Bureau of Labor Statistics and surveys a large sample of the US population to collect data on consumption expenditures, demographics, income, and assets. Following Harris and Sebelhaus (2000) suggest, consumption expenditures include food, tobacco, alcohol, amusement, clothing, personal care, housing, house operations (such as furniture and house supplies), personal business, transportation (such as autos and gas), recreational activities (such as books and sports), and charity expenditures. Alternatively, we could consider non-durable or discretionary consumption only. Income consists of wages, business income, farm income, rents, dividends, interest, pension, social security, supplemental security, unemployment benefits, worker's compensation, public assistance, food stamps, and scholarships.

We regress savings, measured simply as income minus overall consumption, on a full set of age, year, and cohort fixed effects. In addition to the retirement and age effects of interest, the data are contaminated by potential time and cohort effects, which constitutes an identification problem, as time minus age equals cohort. In the portfolio-choice literature, it is standard practice to solve the identification problem by acknowledging age and time effects (as tradable and non-tradable wealth varies with age, and contemporaneous stock market happenings are likely to affect participation and shares) while omitting cohort effects (Campbell and Viceira, 2002). By contrast, in the consumption literature it is standard to omit time effects but acknowledge cohort effects (Gourinchas and Parker, 2002). By including the full set of fixed effects, we identify the regression simply by an arbitrary trend assumption (we find the same results when omitting the year fixed effects while including the region's unemployment rate, following Gourinchas and Parker (2002)). Instead of age dummies, we can use a polynomial in age to the fifth power, and we can control for family size and number of earners in the same way. In addition to measuring savings as income minus consumption, we use checking and savings account balances as outcome variables.

Table 7 shows the regression results for savings (measured as income minus consumption), checking account balances, and savings account balances. The effect of retirement is positive, significant, and economically large in all specifications. But, given that we cannot control for household fixed effects, this result may be driven by selection: richer households are retiring earlier. However, all the results hold even when we control for income.

**SCF data**

The SCF is a statistical survey of income, balance sheets, pensions, and other demographic characteristics of families in the United States, sponsored by the Federal Reserve Board in cooperation with the Treasury Department. We use the data from six waves from 1992 to 2007. However, as in the case of the CEX data, the SCF does not survey households consecutively and we can therefore not employ household fixed effects. As before, we estimate the effect of retirement jointly controlling for age, time, and cohort fixed effects and identify the model with a random assumption about its trend. We control for family size in the same manner as for the CEX data.

Table 8 shows the regression results for leverage, debt, and savings account balances. The effect of retirement is negative, significant, and economically meaningful for the SCF measures of leverage and debt both when controlling for income or not. For savings account balances, the effect of retirement is positive, significant, and large once we control for income. We also find very similar results for related variables, such as overdraft debt, credit card, checking, current, and call account balances.[9]

The results of both the CEX and SCF data are prone to an obvious selection bias. Clearly, individuals with large savings and little consumer debt may choose to retire earlier. Therefore, we also replicate our results in data sets that allow us to control for individual fixed effects and thus for all selection on time-invariant observable or unobservable characteristics. In such specifications, we only identify an effect off of households transitioning into retirement.

### German bank account data

We replicate our results in a data set that includes information on income, spending, and checking, credit, and portfolio accounts from a German bank covering approximately 5,000 individuals who transitioned into retirement in the period from 1998 to 2010. The results can be found in Table 9. We find that savings (measured as income minus consumption) increases when individuals retire, and we see increases in current account balances and portfolio values and decreases in credit account balances.

### PSID data

We also use the Panel Study of Income Dynamics (PSID) data from 1968 to 2015. The PSID is a nationally representative survey of households in the United States conducted by the University of Michigan. It was administered annually from 1968 to 1997 and then biennially post 1997. Furthermore, it included questions that relate to specific consumption and savings measures post 1997. Following the literature, we use the consumption and savings data post 1997 (Li et al., 2010) and consumption is measured as expenditure on food, housing, transportation, education, childcare, and healthcare. Because the PSID surveys households consecutively, we can also include individual fixed effects in our regressions. The results of the PSID analysis are consistent with our other results. The coefficients on consumption are negative and significant, indicating that individuals consume less after retirement. Moreover, retired individuals increase their balances in savings and checking accounts, which corroborates our previous findings. Finally, individuals also hold less debt, and their overall wealth increases with and without accounting for equity.[10] These results can be found in Table 10.

### HRS data

Finally, we replicate our results using the Health and Retirement survey (HRS) conducted by the University of Michigan. This survey asks individuals and their spouses who are over 50

[9] A call deposit account is a bank account for investment funds that provides instant access to funds and interest accrual.

[10] Because about one-third of the wealth observations in the PSID data are negative, we winsorize the wealth variables rather than logging them. If we log the variables, the results are qualitatively similar but only marginally significant.

years old about their health, employment, quality of life, and wealth. It was conducted biennially from 1992 to 2014. In 2001, the HRS sent a consumption-and-activities mail survey (CAMS) to a subsample of the initial HRS population, and it has tracked consumption for these households biennially ever since. The RAND Center for the Study of Aging provides clean versions of each wave of HRS data, which we merged with the CAMS data set to extract information on individuals' consumption and wealth. We construct the savings variable as the sum of the values of CDs, government savings bonds, checking, savings, and money market accounts, stocks, mutual funds, investment trusts, bonds, bond funds, and all other savings. The results of the HRS analysis are consistent with our previous results. When they retire, individuals consume less but increase their savings, IRA assets, and overall wealth. The results can be found in Table 11.

# 4 Potential theoretical explanations of our findings

We loosely categorize potential theoretical explanations for our findings as follows: We first consider explanations that are in one way or another based on rational planning for retirement and do not feature an obvious irrational component, such as limitations to planning or cognition, or behavioral component, such as non-standard preferences or beliefs. We then move on to explanations that have an irrational or behavioral component. In turn, we discuss a fully-fledged life-cycle model that features non-standard preferences, either present bias that is corrected at retirement or expectations-based loss aversion, and generates a drop in consumption at retirement and an increase in savings simultaneously.

## 4.1 Explanations based on rational planning

Overall, our results on liquid savings and consumer debt suggest that we should not yet retire the consumption puzzle. Any rational agent will save before retirement, given that she expects a fall in income, and dissave after. However, we observe that individuals do the opposite: they dissave before and save after retirement. Thus, the joint observations of a fall in income, a fall in consumption, a decrease in consumer debt, and an increase in savings are hard to reconcile with a rational model of consumption smoothing. We next discuss some more specific potential explanations, but we conclude that work-related expenses, opportunity costs of time, wealth shocks and liquidation of assets, health shocks, and intra-household bargaining all have difficulty explaining our findings.

**Work-related expenses**

In what situation would a sudden reduction in work-related expenses upon retirement cause an increase in savings? To answer that question, we outline five scenarios for individuals' income and pension profiles. (1) A flat income profile before retirement and a lower, flat pension profile after retirement. Any patient agent in this situation would smooth consumption by accumulating liquid savings before retirement and decreasing savings after. (2) A flat income profile before retirement and a lower but increasing pension profile after retirement. In this case, a patient agent would again smooth consumption by saving before retirement and potentially by increasing debt at the start of retirement but decreasing debt thereafter. (3) A flat income profile before retirement and a lower, decreasing pension profile after retirement. Again, any patient agent would smooth consumption by accumulating savings before retirement and decreasing savings after. (4) A flat income profile before retirement and a pension profile that is just marginally lower than income (by less than work-related expenses) after retirement, and decreasing. In this scenario, a patient agent might increase savings at the start of retirement. However, we observe a substantial reduction in income at the start of retirement. Furthermore, the pension profile is increasing after retirement, as can be seen in Figure 5. (5) A flat income profile before retirement and a pension profile that is higher than income after retirement. A patient agent in this case might accumulate debt and then decrease it at the start of retirement. However, we see that pensions are lower than labor income in Figure 5, and we can thus rule out this scenario. Furthermore, work-related expenses cannot be larger than the difference between pension and labor income, as individuals would simply retire early in that case.

More systematically, we can think about the following calculations. If income decreases, then savings must decrease or debt must increase, other things being equal. However, if work-related expenses decrease, then savings must increase or debt must decrease. Moreover, if the agent is very impatient then the consumption path may be steeply decreasing, which in any period will cause savings to increase or debt to decrease. Therefore, to explain our findings, the decrease in work-related expenses plus the decrease in spending from the period before retirement to after (the latter decrease can be assumed to be zero for monthly to annual horizons if individuals are reasonably patient) must exceed the drop in income at retirement. While this is a theoretical possibility, work-related expenses are unlikely to be as large as the drop in income upon retirement that we find in Icelandic and US data. Furthermore, as we have already mentioned, individuals would simply retire early in such a case. We could also look at individuals with very large drops in income to reject that theory. Moreover, the theory does not square with a known comparative static (see Bernheim et al., 2001, among others): when the drop in income is larger, we also see a larger drop in consumption, so the reason here cannot be work-related expenses being too large or households being too impatient.

Our argument is illustrated in Figure 10. In a rational model, if an agent expects a fall in income and expenditure then savings will increase as long as the fall in expenditure is smaller than the fall in income. If the fall in expenditure is larger than the fall in income, then savings will increase. In that case, however, the agent gains on net by retiring early. It is thus very hard to explain, in any rational model, the joint observation that savings increase after retirement and individuals who are eligible do not retire immediately.

As Figure 2 shows, there are no discontinuities in the fraction of individuals retiring at the retirement age thresholds of 60, 65, 67, and 70. A mass of individuals retires at 60, but this is a mechanical effect, as we start defining individuals as retired from age 60. Since we restrict the analysis to individuals over 60 and include individual fixed effects, we do not identify our effects off of this mass. Furthermore, there is no discontinuous increase at age 65 or 67; if anything, the mass is larger at ages 64 and 69. Finally, there is no discontinuous increase from age 69 to 70. Overall, the spikes are fairly different for men and women, suggesting a lot of heterogeneity, but across the whole population the distribution looks fairly normal. We thus conclude that individuals do not immediately retire at the benefits thresholds. On average, individuals appear to retire voluntarily at least a couple months after the age thresholds and sometimes years after.

#### Opportunity costs of time

Retirement puts additional time at the individual's disposal that can be spent on leisure, used to find bargains and otherwise shop less expensively, or used for home production. While it is unclear whether additional leisure time results in an increase or a decrease of the marginal utility of consumption, it can be reasonably assumed that home production increases the value of expenditures, as argued by Aguiar and Hurst (2005). In principle, however, more time spent on home production can simply be reinterpreted as a reduction in work-related expenses, and then the above arguments apply directly and cast doubt on this explanation. If expenses drop by more than income, whether due to additional disposable time or for other reasons, individuals could gain in life-time resources by retiring early.

#### Wealth shocks and liquidation of assets

Banks et al. (1998) and Bernheim et al. (2001) argue that the drop in consumption is brought about by the systematic arrival of adverse information. In this case, however, the drop in consumption would always be accompanied by a decrease rather than an increase in savings, as retirement comes with a negative wealth shock. The same is true for the model by Blau (2008) who argues that uncertainty about one's retirement date can generate a drop in consumption at retirement. In the author's model, either individuals retire as planned and smooth their consumption, or retirement is triggered by a negative wealth shock that also causes a drop in consumption. In principle, however, to generate an increase in savings, one needs a positive wealth shock.

A positive wealth shock may be brought about by selling one's house or other assets upon retirement. However, our findings are robust to controlling for all income which includes other income (other income contains, e.g., housing transactions and uncategorized investment transactions). Furthermore, we can more directly address the concern that housing transactions and liquidation of assets are driving our results by estimating the effect of retirement on investment income and uncategorized income. Investment transactions can be identified because of the

NACE categorization, and income that cannot be classified is listed as "uncategorized" income and could be due, for example, to the sale of real estate. We therefore estimate the effect of retirement on these two income categories, and the results can be found in Table 6. The fact that we do not find an effect on investment related income and a negative effect on uncategorized income should relieve concerns about liquidation of assets or housing transactions explaining why individuals increase their savings and delever upon retirement. We also ensure that our results are not affected when we control for individual as opposed to total household income.

Another concern related to housing is that individuals wait to retire until they have paid off their mortgages, in which case their increase in savings and decrease in consumer debt is only a consequence of the reduced debt burden after making the final mortgage payment. However, we do not see a sharp decline in mortgage debt by individuals who have reached the official retirement age, as can be seen in Figure 11. A large fraction of mortgage debt is paid off before individuals reach age 60, and the remainder declines smoothly as individuals reach average retirement age.

### Health shocks

Individuals may choose to retire in response to an adverse health shock. While it is again unclear whether health results in an increase or a decrease in the marginal utility of consumption, it can reasonably be assumed that an adverse health shock implies an adverse wealth shock, which should decrease and not increase savings. As we discussed, any negative shocks will have trouble explaining our findings of an increase in savings and a reduction in debt holdings. It could be that a health shock makes spending less enjoyable or increases a precautionary savings motive, which then increases savings by reducing consumption and, at the same time, explains why the individual retires. However, we find that pharmacy spending falls upon retirement and is about 7.3% lower afterward, which strongly suggests that health shocks are not the reason the average individual in our sample retires (when individuals buy medical supplies, they do so in pharmacies and must make a copayment).

### Intra-household bargaining

Lundberg et al. (2003), among others, argues that the drop in consumption is caused by the fact that the retirement of male spouses generates a shift in the distribution of bargaining power within households. On average, wives gain bargaining power and use this to exert their preferences for increased savings, because women have on average higher life expectancies than men. Furthermore, Addoum (2016) and Olafsson and Thörnqvist (2018) provide evidence of intra-household bargaining affecting household portfolio choice.

Our findings on spending, liquid savings, and consumer debt are broadly consistent with this mechanism. However, we find very similar results for both men and women when we split the sample by gender, which seems inconsistent with household bargaining being first-order important. Olafsson and Pagel (2016) shed further light on how spending and debt holdings at the household level are influenced by differences in preferences over spending and consumer debt displayed by the members of the household.

## 4.2 Explanations based on insufficient planning and overconsumption

### Insufficient planning

One possible theoretical explanation is the following: the freeing up of cognitive resources allows individuals to reconsider their savings and consumption plans upon retirement. However, that theory would not predict a systematic reduction in debt and increase in savings unless insufficient time for planning always results in overconsumption. Haider and Stephens (2007) and Ameriks et al. (2007) argue that insufficient planning and overconsumption are the reason for the drop in consumption, and such a systematic effect is suggested by work on cognitive resources and decision making, as in Mullainathan et al. (2007), although their findings are not confirmed by Carvalho et al. (2016). In fact, we observe reductions in total financial fees paid as well as late fees paid. Thus, individuals may be better at planning, but they also have more time to pay all their bills on schedule.

The insufficient-planning life-cycle models, such as those of Huang and Caliendo (2011) and Caliendo and Aadland (2007), generate a drop in consumption at retirement but not a simultaneous increase in savings. For instance, the model in Huang and Caliendo (2011) generates a drop in consumption at retirement because individuals consume all their income and never save. Thus, the moment income drops, consumption must drop. Clearly, however, savings would not increase in this case: if individuals consume their entire income when it is high, they will also do so when it is low. The same is true for the models by Reis (2006) and by Campbell and Mankiw (1989). With respect to poverty and cognitive resources, a widely-applied model does not exist at this point, which makes writing down a corresponding theory feel reverse-engineered.

### Overconsumption and present bias

An alternative theoretical explanation for undersaving before retirement is quasi-hyperbolic discounting preferences, as in Laibson et al. (1998) and Laibson et al. (2007). Hyperbolic discounting preferences cannot generate a drop in consumption at retirement per se because the agent is equally impatient before and after retirement and can smooth consumption perfectly. If a liquidity constraint would bind, a fall in income might cause a fall in consumption. In such a situation, however, we have to assume that individuals hit their liquidity constraints before and after retirement, but empirically, we see individuals having substantial liquidity. Furthermore, the same critique applies as for the insufficient-planning models, if individuals hit their liquidity constraint, their savings are zero before retirement. If income falls at retirement, their savings should be zero as well.

To rationalize a drop in consumption and an increase in savings after retirement, one needs to assume that the hyperbolic discount factor changes when the individual retires. Although this appears plausible, it again feels somewhat reverse-engineered. Nevertheless, in the following section, we theoretically analyze how far a change in the exponential or hyperbolic discount factor, and thus in the agent's degree of present bias, can generate a drop in consumption at the same time as an increase in savings at retirement in a fully-fledged life-cycle model that is calibrated realistically in line with the literature.

**Expectations-based loss aversion**

As we will show, a theoretical explanation for our findings requires a different degree of present bias before and after retirement. Kőszegi and Rabin (2009) and Pagel (2017) show that expectations-based reference-dependent preferences predict that the degree of present bias depends on the level of income uncertainty, which is arguably lower after retirement. In this model, individuals reduce their overconsumption after the start of retirement and thus may simultaneously decrease their consumption and increase their savings.

Expectations-based loss aversion, as developed by Kőszegi and Rabin (2009) and applied in a life-cycle model by Pagel (2017), predicts a drop in consumption at retirement. The intuition is that expectations-based reference dependence introduces an overconsumption problem when income is uncertain. After retirement, however, income uncertainty is absent in a standard life-cycle model, which ends time-inconsistent overconsumption. The agent stops overconsuming because he is allocating certain retirement income instead of uncertain labor income. Certainty means that overconsumption today yields a sure loss in future consumption, and this loss would hurt more than today's overconsumption would give pleasure, as the agent is loss averse. Thus, the agent suddenly begins controlling his time-inconsistent desire to overconsume, and his consumption drops at retirement. The assumption of no uncertainty during retirement is made in all standard life-cycle consumption models, as these are abstracted from portfolio choice. The drop in consumption at retirement is thus a necessary artifact of news-utility preferences in the standard environment. However, the drop is robust to three alternative assumptions: small income uncertainty during retirement (for instance, inflation and pension risk), potentially large discrete income uncertainty (for instance, health shocks), and mortality risk (refer to Pagel, 2017, for a more detailed discussion). This change in the agent's degree of present bias may cause a simultaneous increase in savings, which we now examine in a fully-fledged life-cycle model.

We consider Kőszegi and Rabin (2009) preferences in a discrete-time life-cycle model with periods indexed by $t \in 1, ..., T$. The preferences reduce to standard preferences (Carroll, 1997) or hyperbolic-discounting preferences (Laibson et al., 1998) for certain parameter combinations. We also discuss temptation-disutility preferences (Gul and Pesendorfer, 2004) as another alternative. In period $t$, the utility function consists of consumption utility, contemporaneous news utility about current consumption $C_t$, and prospective news utility about the entire stream of future consumption $\{C_{t+\tau}\}_{\tau=1}^{T}$. Thus, lifetime utility in each period $t \in 0, ..., T$ is

$$E_t[\sum_{\tau=0}^{T-t} \beta^\tau U_{t+\tau}] = u(C_t) + n(C_t, F_{C_t}^{t-1}) + \gamma \sum_{\tau=1}^{T-t} \beta^\tau \boldsymbol{n}(F_{C_{t+\tau}}^{t,t-1}) + E_t[\sum_{\tau=1}^{T-t} \beta^\tau U_{t+\tau}], \quad (2)$$

where $\beta \in [0, 1)$ is an exponential discount factor. The first term on the right-hand side of Equation (2), $u(C_t)$, corresponds to the consumption utility in period $t$. The other terms depend on consumption and beliefs. The second term, $n(C_t, F_{C_t}^{t-1})$, corresponds to news utility over contemporaneous consumption; here, the agent compares his present consumption $C_t$ with his beliefs $F_{C_t}^{t-1}$. The agent's beliefs, $F_{C_t}^{t-1}$, correspond to the conditional distribution of consumption in period $t$, given the information available in period $t-1$. Thus, the agent experiences news utility over "news" about contemporaneous consumption by evaluating his current consumption $C_t$ relative to his previous beliefs $F_{C_t}^{t-1}$

$$n(C_t, F_{C_t}^{t-1}) = \eta \int_{-\infty}^{C_t} (u(C_t) - u(c)) dF_{C_t}^{t-1}(c) + \eta\lambda \int_{C_t}^{\infty} (u(C_t) - u(c)) dF_{C_t}^{t-1}(c). \quad (3)$$

The parameter $\eta > 0$ thus weights the news-utility component relative to the consumption-utility component, and the coefficient of loss aversion $\lambda > 1$ implies that losses outweigh gains. The third term in Equation (2), $\gamma \sum_{\tau=1}^{T-t} \beta^\tau \boldsymbol{n}(F_{C_{t+\tau}}^{t,t-1})$, corresponds to the news utility experienced in period $t$ over the entire stream of future consumption. Prospective news utility about period $t+\tau$ consumption depends on $F_{C_{t+\tau}}^{t-1}$, the beliefs with which the agent entered the period, and on $F_{C_{t+\tau}}^{t}$, the agent's updated beliefs about consumption in period $t+\tau$. The agent experiences news utility over news about future consumption by evaluating his updated beliefs about future consumption $F_{C_{t+\tau}}^{t}$ relative to his previous beliefs $F_{C_{t+\tau}}^{t-1}$ as follows

$$\boldsymbol{n}(F_{C_{t+\tau}}^{t,t-1}) = \int_{-\infty}^{\infty} (\eta \int_{-\infty}^{c} (u(c) - u(r)) + \eta\lambda \int_{c}^{\infty} (u(c) - u(r))) dF_{C_{t+\tau}}^{t,t-1}(c, r). \quad (4)$$

As can be seen in Equation (2), the agent discounts exponentially prospective news utility by $\beta \in [0, 1]$. Moreover, he discounts prospective news utility relative to contemporaneous news utility by a factor $\gamma \in [0, 1]$. Thus, he puts a weight $\gamma\beta^\tau < 1$ on prospective news utility regarding consumption in period $t+\tau$. For certain parameter combinations, the Kőszegi and Rabin (2009) preferences reduce to well-known specifications. For $\eta = 0$ or $\lambda = 1$ and $\gamma = 1$, they reduce to standard preferences (Carroll, 2001; Gourinchas and Parker, 2002; Deaton, 1991). For $\eta > 0$, $\lambda = 1$, and $\gamma < 1$, the preferences correspond to hyperbolic-discounting preferences, with the hyperbolic-discount factor given by $\frac{1+\gamma\eta}{1+\eta}$ (Angeletos et al., 2001; O'Donoghue and Rabin, 1999). More specifically, the hyperbolic agent's lifetime utility is $u(C_t^b) + bE_t[\sum_{\tau=1}^{T-t} \beta^\tau u(C_{t+\tau}^b)]$ where $b \in [0,1]$ is the hyperbolic-discount factor.

In the following, we describe the news-utility agent's consumption and time-inconsistency problems before and after retirement following Kőszegi and Rabin (2009) and Pagel (2017). Suppose that in periods $t \in \{T-R, ..., T\}$, the agent earns income without uncertainty. If uncertainty is absent, the personal equilibrium of the news-utility agent corresponds to the standard agent's equilibrium if the discount factor on prospective versus contemporaneous news utility is weakly larger than the inverse of the coefficient of loss aversion $\gamma \geq \frac{1}{\lambda}$. If $\gamma < \frac{1}{\lambda}$, then the monotone-personal equilibrium of the news-utility agent corresponds to a hyperbolic-discounting agent's monotone-personal equilibrium, with the hyperbolic-discount factor given by $\frac{1+\gamma\eta\lambda}{1+\eta}$.

The news-utility agent is likely to follow the standard agent's path if uncertainty is absent and the agent's prospective news discount factor is high enough. The basic intuition is that when the agent decides to increase his present consumption, he also considers a certain loss in future consumption, which is very painful. Thus, unless the agent discounts prospective news utility significantly, he decides not to increase his present consumption. More formally, suppose that the agent allocates his deterministic cash-on-hand between present consumption $C_{T-1}$ and future consumption $C_T$. Under rational expectations, he cannot fool himself, hence he cannot experience actual news utility in equilibrium in a deterministic model. Accordingly, his expected utility maximization problem corresponds to the standard agent's maximization problem (determined by setting present and future marginal consumption utilities equal, with the discount factor and interest rate). Suppose that the agent's beliefs about consumption in both periods correspond to this equilibrium path. Taking his beliefs as given, the agent deviates if the gain from consuming more exceeds the discounted loss from consuming less in the future; that is,

$$u'(C_{T-1})(1+\eta) > \beta(1+r)u'(C_T)(1+\gamma\eta\lambda).$$

Thus, he follows the standard agent's path iff the discount factor on prospective versus contemporaneous news utility is weakly larger than the inverse of the coefficient of loss aversion, $\gamma \geq \frac{1}{\lambda}$. In this case, the pain associated with a certain loss in future consumption is larger than the pleasure gained from present consumption. However, if $\gamma < \frac{1}{\lambda}$, the agent deviates and must choose a consumption path that just meets the consistency constraint, thereby behaving as a hyperbolic-discounting agent, with a hyperbolic discount factor of $\frac{1+\gamma\eta\lambda}{1+\eta} < 1$. Thus, during retirement, the implications of the agent's prospective news discount factor $\gamma$ are simple: it must be high enough to keep the news-utility agent on the standard agent's track.

After retirement, the agent is less inclined to overconsume. The basic intuition for overconsumption before retirement is that the agent consumes house money–that is, labor income that he was not certain to receive. Such uncertain income wants to be consumed before his expectations catch up iff the prospective news discount factor is less than one, i.e., $\gamma < 1$. In the period just before retirement, the agent finds the loss in future consumption merely as painful as a slightly less favorable realization of his labor income, $Y_{T-1} \sim F_Y$; that is, the agent trades off being somewhere in the gain domain today against being somewhere in the gain domain in the future. By contrast, after retirement the agent associates a certain loss in future consumption with an increase in present consumption–that is, he trades off a current gain against a sure loss in the future. For example, suppose the agent's retirement period is period $T$ only. The agent's first-order condition in period $T-1$, absent uncertainty in period $T$, is given by

$$u'(C_{T-1})(1+\eta(\lambda-(\lambda-1)F_Y(Y_{T-1}))) = \beta(1+r)u'(C_T)(1+\gamma\eta(\lambda-(\lambda-1)F_Y(Y_{T-1}))). \quad (5)$$

In Equation (5), it can be seen that, iff the prospective news discount factor equals one, i.e., $\gamma = 1$, contemporaneous and prospective marginal news utility cancel each other out. However, iff $\gamma < 1$, the agent reduces the weight on future utility relative to present utility by a factor of $\frac{1+\gamma\eta\lambda}{1+\eta\lambda} < \frac{1+\gamma\eta}{1+\eta} < 1$. After retirement, the news-utility agent follows the standard agent's consumption path if the prospective news discount factor $\gamma$ is sufficiently high, and otherwise follows a hyperbolic agent's consumption path with discount factor $b = \frac{1+\gamma\eta\lambda}{1+\eta}$. Because $min\{\frac{1+\gamma\eta\lambda}{1+\eta}, 1\} > \frac{1+\gamma\eta}{1+\eta}$ iff $\gamma < 1$, the agent's factor for reducing the weight on future utility is necessarily lower in the period just before retirement than afterward–implying that consumption drops at retirement. This drop is thus brought about by a change in the agent's effective time-inconsistency problem, which is necessary for observing a drop in consumption at the same time as an increase in savings.

In the following, we assess whether the model's quantitative predictions about the drop in consumption at retirement match the empirical evidence. We also assess whether the model can generate a simultaneous increase in savings. In addition to the standard and news-utility agents, we show results for quasi-hyperbolic preferences, as in Laibson et al. (2012), and temptation-disutility preferences, as developed by Gul and Pesendorfer (2004) and assumed in Bucciol (2012). For the standard, hyperbolic, and tempted agents, we assume that the effective discount factor changes to generate a drop in consumption at retirement and possibly a simultaneous increase in savings. For hyperbolic-discounting preferences, we assume that the agent is subject to present bias before retirement but not after; that is, his hyperbolic discount factor is less than one before retirement but equal to one after. For the temptation-disutility preferences, we also assume that the agent experiences temptation disutility only before retirement, not after. In addition, we assume for comparison that the standard agent's exponential discount factor increases to one after retirement, so that he becomes more patient as well.

We choose the model environment in line with the life-cycle consumption literature and present the numerical results of a power-utility model; that is, $u(C) = \frac{C^{1-\theta}}{1-\theta}$, with $\theta$ being the coefficient of constant relative risk aversion.[11] We follow Carroll (1997) and Gourinchas

[11]The model cannot be solved analytically, but it can be solved by numerical backward induction (see Gourinchas and Parker, 2002; Carroll, 2001, among others). The numerical solution is illustrated in greater detail in Appendix B.

and Parker (2002), who specify income $Y_t$ as log-normal and characterized by deterministic permanent income growth $G_t$, permanent shocks $N_t^P$, and transitory shocks $N_t^T$, which allow for a low probability $p$ of unemployment or illness

$$Y_t = P_t N_t^T = P_{t-1} G_t N_t^P N_t^T$$

$$N_t^T = \left\{ \begin{array}{cc} e^{s_t^T} & \text{with probability } 1-p \text{ and } s_t^T \sim N(\mu_T, \sigma_T^2) \\ 0 & \text{with probability } p \end{array} \right\} \; N_t^P = e^{s_t^P} \; s_t^P \sim N(\mu_P, \sigma_P^2).$$

Labor income is stochastic up until period $T - R$, when the agent enters retirement and his income is deterministic. The life-cycle literature suggests fairly tight ranges for the parameters of the log-normal income process, which are approximately $\mu_T = \mu_P = 0$, $\sigma_T = \sigma_P = 0.1$, and $p = 0.01$. The deterministic profile $G_t$ is estimated from the CEX data.[12] The agent has access to a simple savings account that pays net interest $r = 0.01$. For the preference parameters, we use calibrations that are standard in the literature, as displayed in Table 12 and discussed by Pagel (2017) among others.

Figure 12 contrasts the four agents' consumption paths with the empirical consumption and income profiles from the CEX data. Hyperbolic-discounting preferences push the consumption profile upward at the beginning and downward at the end of life. Temptation disutility also causes overconsumption at the beginning of life, which decreases when consumption opportunities are depleted. Standard, hyperbolic-discounting, news-utility, and temptation-disutility preferences all generate a hump-shaped consumption profile in line with the evidence (refer to Ameriks and Zeldes, 2004, for instance). Moreover, Figure 12 shows a large drop in consumption at retirement, period $T - R$, for the news-utility and hyperbolic agents' consumption profiles as well as the CEX consumption data. The tempted agent's profile features a very small drop, and the standard agent's profile only features a kink. Thus, one needs a change in the degree of present bias or time inconsistency, not only the discount rate, to generate a sizable drop in consumption at retirement (temptation-disutility preferences are time-consistent preferences, as are standard preferences). Note, however, that for the standard, hyperbolic, and temptation-disutility agents, the change in consumption around retirement is only brought about by the preference parameters and thus the effective discount rate changing. If the preference parameters were constant, the standard, hyperbolic, and temptation-disutility agents would smooth consumption around retirement and only the news-utility agent's consumption profile would feature a drop at retirement.

Let us now demonstrate the drop in a regression using simulated data. For 200 agents, indexed by $i$, we simulate four years of consumption and income data points, indexed by $t$,

[12]Following Gourinchas and Parker (2002), we choose 25 as the beginning of working life and then $\hat{Ret} = 11$ years of retirement and $\hat{T} = 78$ in accordance with the average retirement age in the US according to the OECD and the average life expectancy in the US according to the UN.

around the retirement date and run the regression

$$\log(C_{it}) = \widehat{\alpha} + \widehat{\beta} Retired_{it} + \widehat{\gamma} \log(Y_{it}) + \varepsilon_{it}.$$

We thus run exactly the equivalent regression in our simulated data as in our empirical analysis. We look at logged consumption as the outcome variable, control for income, and consider the coefficient of a retirement dummy $Retired_{it}$. The coefficient $\widehat{\beta}$ will then determine the percentage drop in consumption at retirement. To theoretically illustrate our statistical power, we intentionally choose a much lower quantity for the number of simulated agents. Moreover, we run the same regression but with savings, $log(X_{it} - C_{it})$, on the left-hand side. The results are shown in Table 13. In the news-utility and hyperbolic-discounting models, we obtain a negative and significant drop in consumption, while the standard and tempted agents' coefficients are basically zero. The news-utility agent's drop in consumption is larger than the hyperbolic agent's, even though the preference parameters generating the degree of present bias, $\gamma$ and $b$, are equal before retirement, and both agents become perfectly time-consistent after retirement, as $b$ is equal to one after retirement and $\gamma > \frac{1}{\lambda}$.

Moreover, for the news-utility and hyperbolic agents the coefficient for savings is positive and significant, but it is negative for the other agents. Clearly, the news-utility and hyperbolic agents will also decumulate their savings after retirement. However, there is another force, the change in the degree of present bias, that can temporarily increase their savings upon retirement. For the news-utility agent, the fall in consumption is large enough to generate a temporary increase in savings roughly in line with what we see empirically. For the hyperbolic agent, we can also observe an increase in savings, although it is somewhat smaller. The savings coefficient of the hyperbolic agent is thus closer to those of the standard and tempted agents.

In turn, we can introduce work-related expenses into the model. We simply assume that consumption is ten percent higher before retirement because of work-related expenses. We then run the regressions measuring the drop in consumption at retirement, which now trivially indicate a ten percent larger drop for all agents. However, the results for savings growth are unchanged and thus constitute another phenomenon that any model of spending around retirement should be able to rationalize. The results for savings growth are unchanged because we can simply treat work-related expenses as a reduction in income. A somewhat lower income profile before retirement will not cause an increase in savings after retirement, as long as income before retirement is higher than income after.

# 5 Conclusion

We document how spending, liquid savings, and consumer debt change in response to retirement using a large proprietary data set on income, spending, account balances, and credit limits. We show that the overall decline in spending post retirement is only partially attributable to work-related expenses. In addition to lower spending on ready-made food and clothes (which is consistent with a reduction in work-related expenses), we also observe reductions in leisure goods, suggesting the presence of an overconsumption problem before retirement and an adjustment after. Nevertheless, we note that even the most accurate and comprehensive spending data cannot conclusively decide whether spending alone or actual consumption utility drops at retirement. Thus, whether or not the drop in consumption is puzzling and more broadly whether or not individuals save adequately for retirement, is a difficult question to answer using spending data alone.

We thus analyze changes in liquid savings and consumer debt around retirement, and we find that individuals reduce consumer debt substantially and increase liquid savings. The findings about debt and savings are very difficult to reconcile in a rational model and thus imply that we cannot ”retire the consumption puzzle” just yet. After all, the retirement-consumption puzzle says that individuals do not plan rationally for an expected reduction in income at retirement. However, any rational plan for a reduction in income would involve saving before and dissaving after retirement. Our empirical findings that individuals decrease their consumer debt and increase their liquid savings is thus the opposite of what a rational agent would do.

# References


**Addoum, Jawad M**, "Household portfolio choice and retirement," *Review of Economics and Statistics*, 2016, (0).

**Agarwal, Sumit, Jessica Pan, and Wenlan Qian**, "The Composition Effect of Consumption around Retirement: Evidence from Singapore," *American Economic Review Papers & Proceedings*, 2015, *105* (5), 426–431.

**Aguiar, Mark and Erik Hurst**, "Consumption vs Expenditure," *Journal of Political Economy*, October 2005, *113* (5), 919–948.

_ **and** _ , "Deconstructing Life Cycle Expenditure," *Journal of Political Economy*, 2013, *121* (3), 437–492.

**Ameriks, J. and S. Zeldes**, "How do Household Portfolio Shares vary with Age?," *Working Paper Columbia Business School*, 2004.

**Ameriks, John, Andrew Caplin, and John Leahy**, "Retirement Consumption: Insights from a Survey," *The Review of Economics and Statistics*, May 2007, *89* (2), 265–274.

**Angeletos, G. M., D. Laibson, A. Repetto, and S. Weinberg**, "The Hyperbolic Consumption Model: Calibration, Simulation, and Empirical Evaluation," *Journal of Economic Perspectives*, 2001, *15* (3), 47.

**Banks, James, Richard Blundell, and Sarah Tanner**, "Is There a Retirement-Savings Puzzle?," *The American Economic Review*, 1998, *88* (4), 769–788.

**Battistin, Erich, Agar Brugiavini, Enrico Rettore, and Guglielmo Weber**, "The Retirement Consumption Puzzle: Evidence from a Regression Discontinuity Approach," *American Economic Review*, 2009, *99* (5), 2209–26.

**Bernheim, B. Douglas, Jonathan Skinner, and Steven Weinberg**, "What Accounts for the Variation in Retirement Wealth among U.S. Households?," *American Economic Review*, September 2001, *91* (4), 832–857.

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

**Brumberg, Richard and Franco Modigliani**, "Utility Analysis and the Consumption Function: An Interpretation of Cross-Section Data," in Kenneth Kurihara, ed., *Post-Keynesian Economics*, New Brunswick, NJ: Rutgers University Press, 1954, pp. 388–436.

**Bucciol, A.**, "Measuring Self-Control Problems: A Structural Estimation," *Journal of the European Economic Association*, 2012.

**Caliendo, Frank and David Aadland**, "Short-term planning and the life-cycle consumption puzzle," *Journal of Economic Dynamics and Control*, 2007, *31* (4), 1392–1415.

**Campbell, John Y and Luis M Viceira**, *Strategic asset allocation: portfolio choice for long-term investors*, Oxford University Press, USA, 2002.

_ **and N Gregory Mankiw**, "Consumption, income, and interest rates: Reinterpreting the time series evidence," *NBER macroeconomics annual*, 1989, *4*, 185–216.

**Carroll, C.**, "Theoretical Foundations of Buffer Stock Saving," *Working Paper Johns Hopkins University*, 2001.

**Carroll, C. D.**, "Buffer Stock Saving and the Life Cycle/Permanent Income Hypothesis," *Quarterly Journal of Economics*, 1997, *CXII*, 1–56.

**Carvalho, Leandro S., Stephan Meier, and Stephanie W. Wang**, "Poverty and Economic Decision-Making: Evidence from Changes in Financial Resources at Payday," *American Economic Review*, February 2016, *106* (2), 260–84.

**Deaton, A.**, "Saving and Liquidity Constraints," *Econometrica*, 1991, *59*, 1221–1248.

**DeNardi, Mariacristina, Eric French, and John Bailey Jones**, "Why Do the Elderly Save?

The Role of Medical Expenses," *Journal of Political Economy*, 2010, *118*, 39–75.

**Gelman, Michael, Shachar Kariv, Matthew D. Shapiro, Dan Silverman, and Steven Tadelis**, "Harnessing naturally occurring data to measure the response of spending to income," *Science*, 2014, *345* (6193), 212–215.

**Gourinchas, Pierre-Olivier and Jonathan A. Parker**, "Consumption Over the Life Cycle," *Econometrica*, January 2002, *70* (1), 47–89.

**Gul, F. and W. Pesendorfer**, "Self-Control and the Theory of Consumption," *Econometrica*, 2004, *72* (4), 119–158.

**Haider, Steven J. and Melvin Stephens**, "Is There a Retirement-Consumption Puzzle? Evidence Using Subjective Retirement Expectations," *The Review of Economics and Statistics*, May 2007, *89* (2), 247–264.

**Harris, Ed and John Sebelhaus**, "Consumer Expenditure Survey," *Congressional Budget Office*, 2000.

**Huang, Kevin XD and Frank Caliendo**, "Rationalizing multiple consumption-saving puzzles in a unified framework," *Frontiers of Economics in China*, 2011, *6* (3), 359.

**Hurd, Michael and Susann Rohwedder**, "The Retirement-Consumption Puzzle: Anticipated and Actual Declines in Spending at Retirement," NBER Working Papers 9586, National Bureau of Economic Research, Inc March 2003.

**Hurst, Erik**, "Understanding Consumption in Retirement: Recent Developments," in John Ameriks and Olivia Mitchell, eds., *Recalibrating Retirement Spending and Saving*, Oxford University Press, September 2008, chapter Understanding Consumption in Retirement: Recent Developments.

**Jr, Melvin Stephens and Desmond Toohey**, "Changes in Measured Food Intake at Retirement: Implications for the Retirement-Consumption Puzzle," 2017.

**Kőszegi, Botond and Matthew Rabin**, "Reference-Dependent Consumption Plans," *American Economic Review*, June 2009, *99* (3), 909–36.

**Laibson, D., A. Repetto, and J. Tobacman**, "Self-Control and Saving for Retirement," *Brookings Papers on Economic Activity*, 1998, *1*, 91–196.

**_ , _ , and _** , "Estimating Discount Functions with Consumption Choices over the Lifecycle," *American Economic Review*, 2012.

**Laibson, David, Andrea Repetto, and Jeremy Tobacman**, "Estimating discount functions with consumption choices over the lifecycle," Technical Report, National Bureau of Economic Research 2007.

**Laitner, John, Dan Silverman, and Dmitriy Stolyarov**, "The Role of Annuitized Wealth in Post-Retirement Behavior," 2017.

**Li, Geng, Robert F Schoeni, Sheldon Danziger, and Kerwin Kofi Charles**, "New Expenditure Data in the PSID: Comparisons with the CE," *Monthly Labor Review*, 2010, *133* (2), 29–39.

**Lundberg, Shelly, Richard Startz, and Steven Stillman**, "The Retirement-Consumption Puzzle: A Marital Bargaining Approach," *Journal of Public Economics*, 2003, *87* (5-6), 1199 – 1218.

**Mullainathan, Sendhil, Bindu Ananth, and Dean Karlan**, "Microentrepreneurs and Their Money: Three Anomalies," Technical Report, Working Paper, Financial Access Initiative 2007.

**O'Donoghue, T. and M. Rabin**, "Doing it Now or Later," *American Economic Review*, 1999, *89* (1), 103–124.

**Olafsson, Arna and Michaela Pagel**, "Family Finances: Intra-Household Bargaining, Spending, and Capital Structure," Technical Report 2016.

— **and** — , “The Ostrich in Us: Selective Attention to Financial Accounts, Income, Spending, and Liquidity,” Technical Report 2018.

— **and** — , “The Liquid Hand-to-Mouth: Evidence from a Personal Finance Management Software,” *The Review of Financial Studies*, forthcoming.

— **and Tomas Thörnqvist**, “Bargaining over risk: The impact of decision power on household portfolios,” Technical Report 2018.

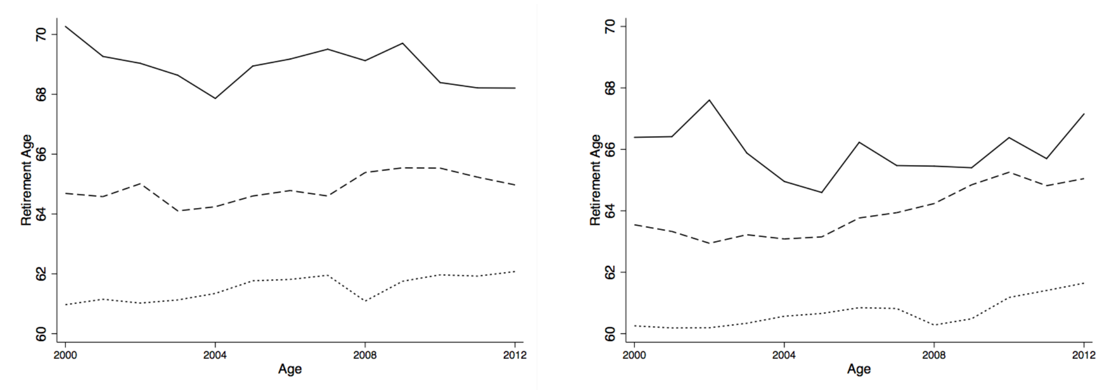
**Pagel, Michaela**, “Expectations-Based Reference-Dependent Life-Cycle Consumption,” *Review of Economic Studies*, 2017.

**Poterba, James, Steven Venti, and David Wise**, “The Composition and Draw-Down of Wealth in Retirement,” *Journal of Economic Perspectives*, 2011, *25*, 95–117.

— **,** — **, and** — , “Family Status Transitions, Latent Health, and the Post-Retirement Evolution of Assets,” *In David A. Wise (ed.), Explorations in the Economics of Aging. Chicago: The University of Chicago Press*, 2011.

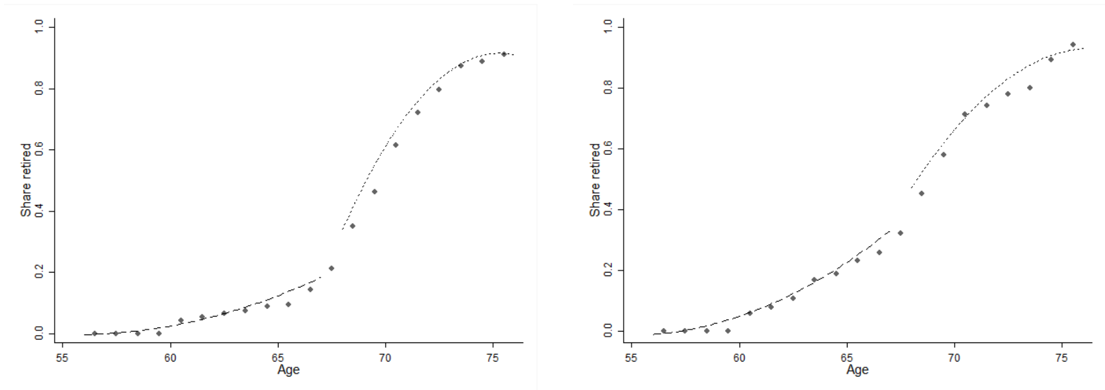
**Reis, Ricardo**, “Inattentive consumers,” *Journal of monetary Economics*, 2006, *53* (8), 1761–1800.

**Schwerdt, Guido**, “Why does consumption fall at retirement? Evidence from Germany,” *Economics Letters*, 2005, *89* (3), 300 – 305.




Men Women

Figure 1: Average effective retirement age for men and women in Iceland (solid line) compared to Germany (dotted line) and the United States (dashed line)




Men Women

Figure 2: Share retired by age

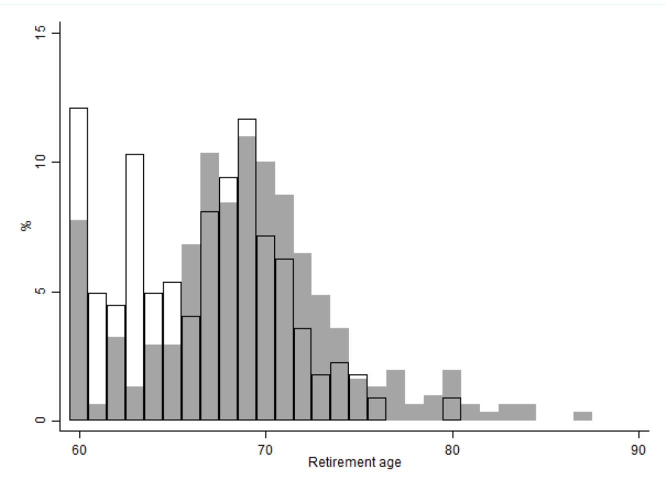



Figure 3: Distribution of retirement age: women (white bars) and men (gray bars)

Table 1: Summary statistics

| | Mean | Standard Deviation | Statistics Iceland |
|---|---|---|---|
| Monthly regular income | 3,547 | 3,717 | 3,768 |
| Monthly salary | 3,157 | 3,494 | 2,867 |
| Monthly spending: | | | |
| Total | 1,535 | 1,429 | |
| Groceries | 546 | 454 | 572 |
| Fuel | 276 | 302 | (419) |
| Alcohol | 72 | 141 | 99 |
| ready-made food | 198 | 202 | (294) |
| Home Improvement | 175 | 543 | (267) |
| Transportations | 68 | 817 | 77 |
| Clothing & accessories | 102 | 211 | 112 |
| Sports & activities | 51 | 173 | (42) |
| Pharmacies | 47 | 72 | 49 |
| Age | 40.6 | 11.5 | 37.2 |
| Female | 0.49 | 0.50 | 0.48 |
| Eligibible for retirement | 0.087 | 0.282 | 0.194 |
| Retired | 0.039 | 0.194 | |

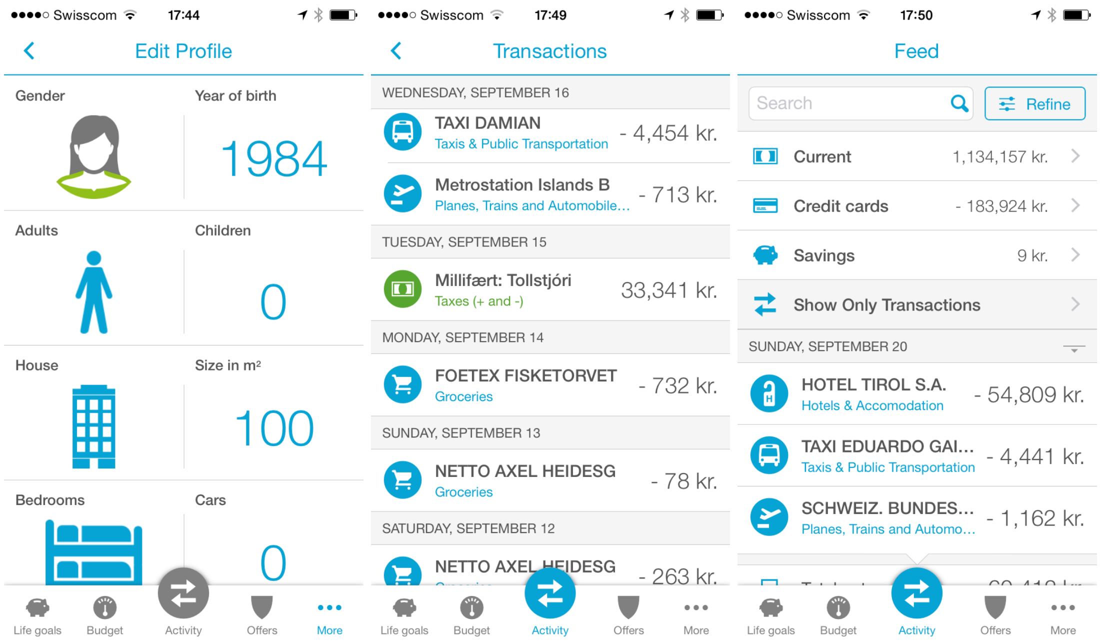
Note: All numbers are in US dollars. Parentheses indicate that data categories do not match perfectly.

Table 2: Summary statistics

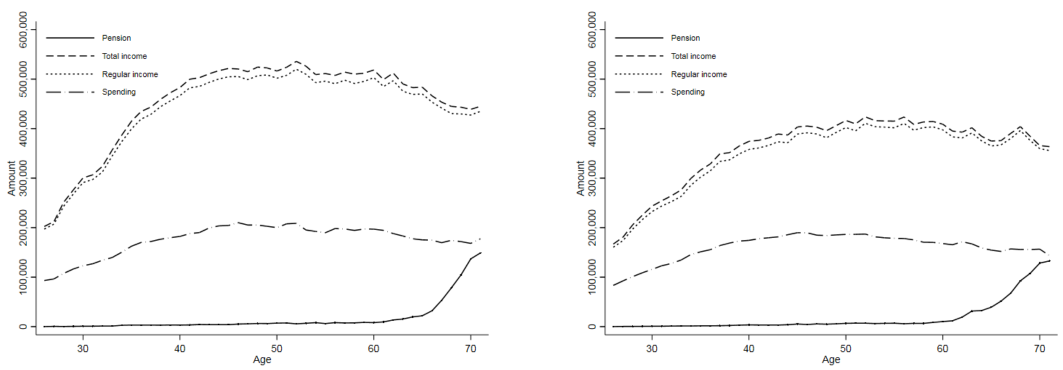
| | Eligible but not retired | | Retired | |
|---|---|---|---|---|
| | Mean | St.dev. | Mean | St.dev. |
| ***Demographics:*** | | | | |
| Age | 64.2 | 3.6 | 71.2 | 5.8 |
| Female | 0.41 | 0.49 | 0.41 | 0.49 |
| ***Monthly income:*** | | | | |
| Total | 4,580 | 3,973 | 3,403 | 2,563 |
| Regular | 4,462 | 3,856 | 3,293 | 2,426 |
| Irregular | 89 | 391 | 79 | 374 |
| Salary | 4,066 | 3,706 | 708.695 | 2,084 |
| Total hh | 4,865 | 4,263 | 3,727 | 2,947 |
| ***Personal finances:*** | | | | |
| Total bank fees | 49 | 98 | 37 | 85 |
| Late fees | 18 | 79 | 14 | 44 |
| Overdraft interest | 52 | 81 | 43 | 89 |
| Overdraft amount | 970 | 4,326 | 852 | 4,196 |
| Savings account balance | 6,259 | 73,649 | 8,720 | 27,868 |
| Interest income | 248 | 2,217 | 337 | 1,306 |
| Current account balance | 2,184 | 13,033 | 2,079 | 9,173 |
| Overdraft limit | 2,024 | 5,578 | 2,281 | 6,128 |
| Credit card balance | -1,051 | 6,339 | -1,221 | 14,435 |
| Credit card card limit | 3,872 | 9,640 | 4,504 | 15,944 |
| Liquidity | 11,581 | 71,056 | 13,967 | 30,179 |
| ***Daily spending:*** | | | | |
| ***Individual:*** | | | | |
| Total | 56.7 | 38.3 | 53.4 | 31.3 |
| Groceries | 16.4 | 12.4 | 16.6 | 10.4 |
| Fuel | 7.9 | 7.5 | 6.5 | 6.2 |
| Alcohol | 2.8 | 4.4 | 2.6 | 4.3 |
| Ready-made food | 4.1 | 4.9 | 3.4 | 4.0 |
| Home improvements | 6.2 | 11.6 | 5.5 | 10.4 |
| Home security | 0.3 | 0.8 | 0.3 | 0.8 |
| Transportation | 2.7 | 5.7 | 2.2 | 5.2 |
| Clothing & accessories | 3.5 | 6.3 | 2.7 | 5.1 |
| Sports & activities | 0.3 | 1.3 | 0.2 | 1.1 |
| Pharmacies | 2.0 | 2.5 | 2.4 | 2.6 |
| ***Household:*** | | | | |
| Total | 60.3 | 41.8 | 57.6 | 35.8 |
| Groceries | 17.4 | 12.9 | 17.7 | 11.0 |
| Fuel | 8.2 | 7.7 | 7.0 | 6.4 |
| Alcohol | 2.9 | 4.6 | 2.9 | 4.6 |
| Ready-made food | 4.4 | 5.2 | 3.7 | 4.4 |
| Home improvements | 6.7 | 12.4 | 6.0 | 11.3 |
| Home security | 0.3 | 0.8 | 0.3 | 0.8 |
| Transportation | 2.9 | 6.2 | 2.5 | 5.6 |
| Clothing & accessories | 3.7 | 6.7 | 3.0 | 5.5 |
| Sports & activities | 0.4 | 1.4 | 0.3 | 1.3 |
| Pharmacies | 2.1 | 2.6 | 2.6 | 2.7 |

Note: All numbers are in US dollars.

Figure 4: The financial aggregation app: screenshots

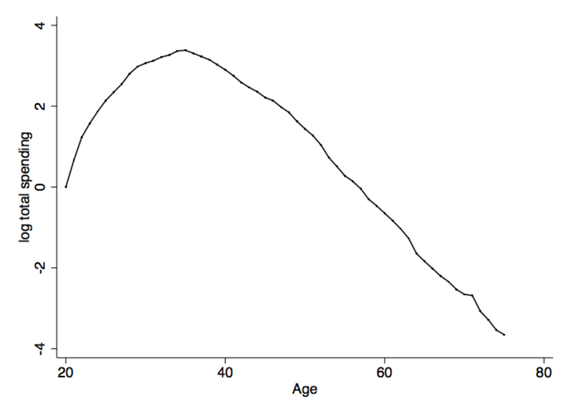



Notes: This figure shows the Meniga app interfaces.

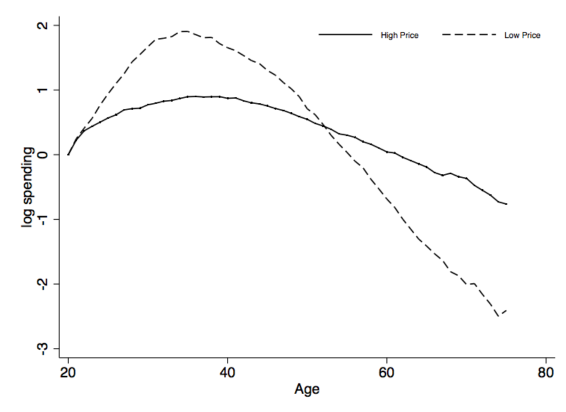



Men Women

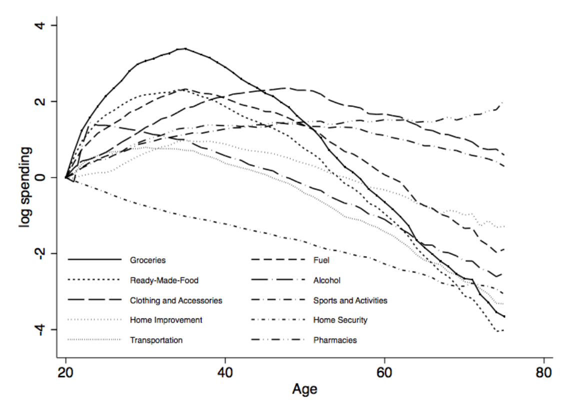
Figure 5: Total and labor income, expenditure, and pension payments over age




Total spending




Grocery spending by price category (total monthly spending in budget and expensive grocery stores)




Spending by category


Share of expensive groceries (the share of expenditures in grocery stores/supermarkets that are spent in expensive stores)

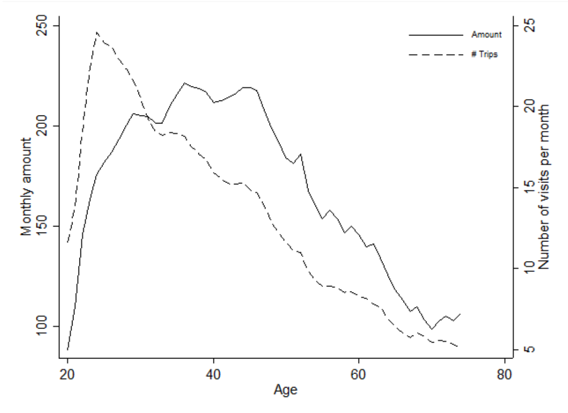
Figure 6: Life-cycle profiles of expenditures

The figures plot the estimated age coefficient from the regression of the outcome variables relative to the coefficient for age 20. The regressions include month-by-year fixed effects and individual fixed effects.

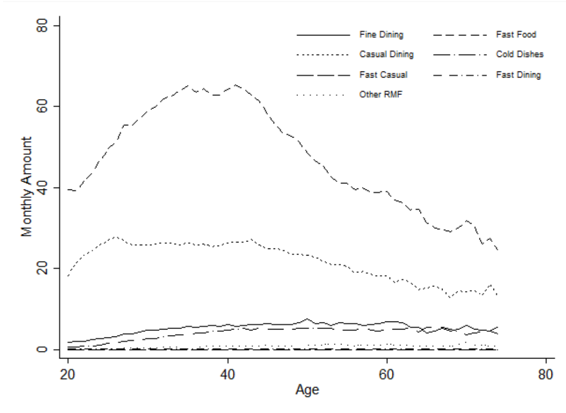
Table 3: Effects of retirement on spending by category

| | Total expenditure | Grocery | Fuel | Alcohol | Ready-made -food | Home improvement | Home security | Transportation | Clothing and accessories | Sports and activities | Pharmacies |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Without controlling for income:* | | | | | | | | | | | |
| Retired | -0.136*** | -0.121*** | -0.230*** | -0.142*** | -0.145*** | -0.056 | -0.046*** | -0.239*** | -0.164*** | -0.137*** | -0.073** |
| | (0.010) | (0.019) | (0.025) | (0.033) | (0.02) | (0.037) | (0.012) | (0.036) | (0.040) | (0.025) | (0.032) |
| $R$-sqr | 0.079 | 0.046 | 0.013 | 0.027 | 0.05 | 0.056 | 0.003 | 0.038 | 0.035 | 0.005 | 0.008 |
| *Controlling for income:* | | | | | | | | | | | |
| Retired | -0.093*** | -0.077*** | -0.176*** | -0.097*** | -0.099*** | 0.017 | -0.038*** | -0.177*** | -0.098** | -0.119*** | -0.036 |
| | (0.010) | (0.018) | (0.025) | (0.033) | (0.020) | (0.037) | (0.012) | (0.036) | (0.040) | (0.025) | (0.032) |
| $R$-sqr | 0.095 | 0.051 | 0.017 | 0.029 | 0.055 | 0.059 | 0.003 | 0.041 | 0.038 | 0.006 | 0.01 |
| #obs | 781,263 | 781,263 | 781,263 | 781,263 | 781,263 | 781,263 | 781,263 | 781,263 | 781,263 | 781,263 | 781,263 |
| #individuals | 12,143 | 12,143 | 12,143 | 12,143 | 12,143 | 12,143 | 12,143 | 12,143 | 12,143 | 12,143 | 12,143 |
| Individual FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Month-by-year FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

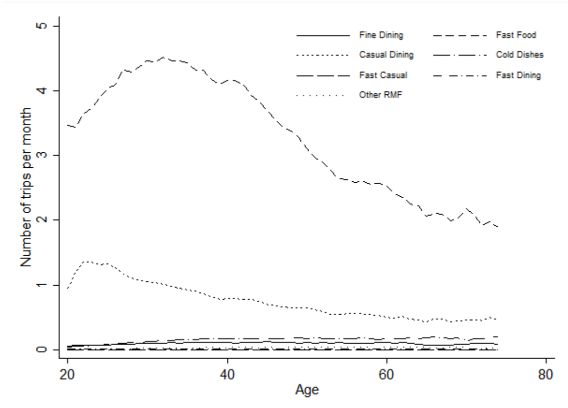
Note: [a] This table shows regression results for log spending by different categories using individual and calendar fixed effects as well as a dummy for retirement with and without controlling for total income. Standard errors are clustered at the individual level. [b] Significance levels: * $p<0.1$ ** $p<0.05$ *** $p<0.01$
[c] All coefficients represent percentage changes.



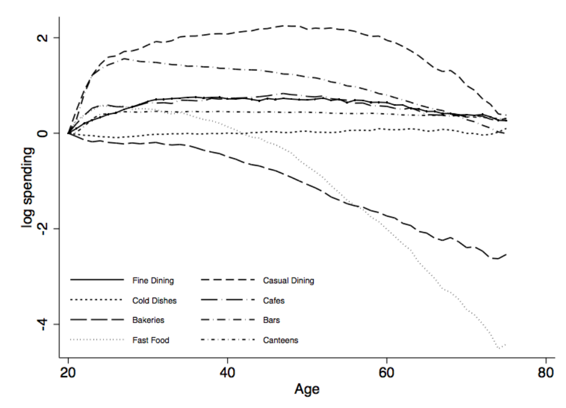

Restaurant spending (solid) and visits (broken)




Restaurant expenditure by category per month




Restaurant trips by category per month




Expenditure by type of restaurant

Figure 7: Life-cycle profiles of restaurant trips and grocery store visits

Table 4: Effects of retirement on restaurant spending and visits

| | Total | Casual dining | Cold dishes | Cafes | Bakeries | Bars | Fast food | Fine dining | Canteens |
|---|---|---|---|---|---|---|---|---|---|
| *Spending:* | | | | | | | | | |
| *Without controlling for income:* | | | | | | | | | |
| Retired | -0.234*** | -0.441*** | 0.007 | -0.071*** | -0.003 | -0.247*** | -0.394*** | -0.073*** | -0.048*** |
| | (0.021) | (0.024) | (0.014) | (0.020) | (0.020 ) | (0.017) | (0.022) | (0.020 ) | (0.007) |
| $R$-sqr | 0.233 | 0.113 | 0.012 | 0.046 | 0.07 | 0.027 | 0.156 | 0.017 | 0.012 |
| *Controlling for income:* | | | | | | | | | |
| Retired | -0.136*** | -0.382*** | 0.014 | -0.043** | 0.028 | -0.238*** | -0.319*** | -0.049** | -0.050*** |
| | (0.02 | (0.023) | (0.014) | (0.02 0) | (0.020) | (0.018) | (0.021) | (0.020) | (0.007) |
| $R$-sqr | 0.278 | 0.134 | 0.015 | 0.055 | 0.084 | 0.031 | 0.186 | 0.022 | 0.012 |
| *Number of visits:* | | | | | | | | | |
| *Without controlling for income:* | | | | | | | | | |
| Retired | -3.768*** | -0.623*** | -0.001 | -0.116*** | 0.027 | -0.190*** | -1.237*** | -0.026*** | -0.058*** |
| | (0.241) | (0.042) | (0.004) | (0.029) | (0.030) | (0.023) | (0.088) | (0.007) | (0.011) |
| $R$-sqr | 0.056 | 0.033 | 0.002 | 0.01 | 0.022 | 0.009 | 0.039 | 0.004 | 0.007 |
| *Controlling for income:* | | | | | | | | | |
| Retired | -3.448*** | -0.588*** | 0.001 | -0.100*** | 0.052* | -0.189*** | -1.113*** | -0.022*** | -0.062*** |
| | (0.245) | (0.042) | (0.004) | (0.03 0) | (0.031) | (0.024) | (0.090) | (0.007) | (0.011) |
| $R$-sqr | 0.067 | 0.038 | 0.003 | 0.012 | 0.027 | 0.009 | 0.047 | 0.005 | 0.007 |
| Individual FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Month-by-year FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| #obs. | 900,090 | 900,090 | 900,090 | 900,090 | 900,090 | 900,090 | 900,090 | 900,090 | 900,090 |
| #individuals | 14,287 | 14,287 | 14,287 | 14,287 | 14,287 | 14,287 | 14,287 | 14,287 | 14,287 |

Note: [a] This table shows regression results for the log spending on different restaurant categories and on the number of visits to different types of restaurants with and without controlling for total income. Standard errors are clustered at the individual level. [b] Significance levels: * p<0.1 ** p<0.05 *** p< 0.01
[c] All coefficients represent percentage changes.

Table 5: Effects of retirement on personal finances

| | Total fees | Late fees | Overdraft interest | Interest income | Current acct balance | Overdraft amount | Credit card balance | Credit card limit | Liquidity |
|---|---|---|---|---|---|---|---|---|---|
| *Without controlling for income:* | | | | | | | | | |
| Retired | -0.208*** | -0.144*** | -0.132*** | 0.054** | 0.162* | -0.100** | -0.116** | -0.047 | 0.010 |
| | (0.037) | (0.035) | (0.034) | (0.022) | (0.093) | (0.045) | (0.057) | (0.050) | (0.033) |
| $R$-sqr | 0.058 | 0.028 | 0.035 | 0.059 | 0.024 | 0.001 | 0.010 | 0.019 | 0.060 |
| *Controlling for income:* | | | | | | | | | |
| Retired | -0.035 | -0.022 | -0.028 | 0.121*** | 0.238** | -0.099** | -0.103* | -0.036 | 0.035 |
| | (0.037) | (0.035) | (0.033) | (0.056) | (0.022) | (0.088) | (0.057) | (0.050) | (0.033) |
| $R$-sqr | 0.078 | 0.041 | 0.045 | 0.051 | 0.026 | 0.001 | 0.010 | 0.019 | 0.061 |
| #obs | 885,189 | 885,189 | 885,189 | 885,189 | 331,668 | 331,668 | 331,668 | 331,668 | 331,668 |
| #individuals | 12,143 | 12,143 | 12,143 | 12,143 | 12,143 | 12,143 | 12,143 | 12,143 | 12,143 |
| Individual FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Month-by-year FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

Note: [a] This table shows regression results for log interest payments, balances, and limits using individual and month-by-year fixed effects as well as a dummy for retirement with and without controlling for total income. Standard errors are clustered at the individual level. [b] Significance levels: * $p<0.1$ ** $p<0.05$ *** $p< 0.01$ [c] All coefficients represent percentage changes.

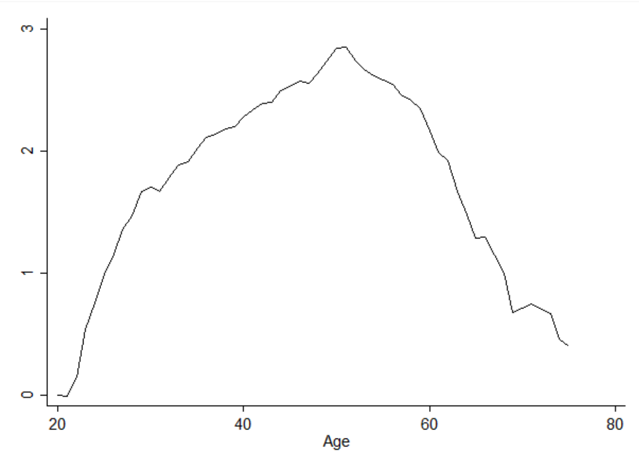



Figure 8: Consumer debt

This figure plots the estimated age coefficient from the regression of log total monthly overdraft interest payments on age dummies relative to the coefficient for age 20. The regressions include month fixed effects, year fixed effects, and individual fixed effects.

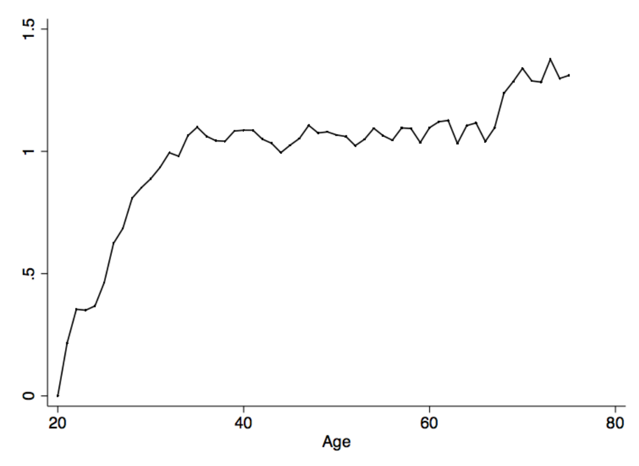



Figure 9: Interest income

This figure plots the estimated age coefficient from the regression of log total monthly interest income from bank account balances on age dummies relative to the coefficient for age 20. The regressions include month-by-year and individual fixed effects.

Table 6: Effects of retirement on investment transactions and uncategorized income

| | Investment transactions | Uncategorized income | Investment transactions | Uncategorized income |
|---|---|---|---|---|
| Retired | -0.010 | -0.071*** | -0.014 | -0.079*** |
| | (0.009) | (0.012) | (0.009) | (0.012) |
| $R$-sqr | 0.0232 | 0.0211 | 0.0247 | 0.0235 |
| #obs | 885,189 | 885,189 | 885,189 | 885,189 |
| #individuals | 12,144 | 12,144 | 12,144 | 12,144 |
| Individual FE | ✓ | ✓ | ✓ | ✓ |
| Month-by-year FE | ✓ | ✓ | ✓ | ✓ |
| Total HH income | | | ✓ | ✓ |

Note: [a] This table shows regression results for log investment related income and uncategorized income. Standard errors are clustered at the individual level. [b] Significance levels: * p<0.1 ** p<0.05 *** p< 0.01 [c] All coefficients represent percentage changes.

Table 7: Effects of retirement on savings (measured as income minus consumption), checking, and savings account balances in CEX data

| | Income minus consumption | Income minus consumption | Current account | Current account | Savings account | Savings account |
|---|---|---|---|---|---|---|
| Retired | 0.203*** | 0.0960*** | 1.024*** | 0.957*** | 1.488*** | 1.391*** |
| | (6.84) | (3.64) | (8.80) | (8.18) | (8.60) | (8.06) |
| Unemployment rate | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| # earners | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| # family | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Cohort FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Year FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Age FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Total HH income | | ✓ | | ✓ | | ✓ |
| #obs | 36,505 | 36,505 | 26,046 | 25,813 | 21,408 | 21,248 |

Note: [a] This table shows regression results for household savings (measured as income minus spending), checking and savings account balances. Standard errors are robust to heteroskedasticity.
[b] Significance levels: * p<0.1 ** p<0.05 *** p< 0.01

Table 8: Effects of retirement on leverage, debt, current and savings account balances in SCF data

| | Leverage | | Debt | | Current account | | Savings account | |
|---|---|---|---|---|---|---|---|---|
| Retired | -0.293** | -0.349*** | -0.674*** | -0.211*** | 0.006 | 0.329*** | 0.076 | 0.407*** |
| | (-3.02) | (-3.38) | (-15.81) | (-5.31) | (0.15) | (9.02) | (1.44) | (8.02) |
| # family | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Cohort FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Year FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Age FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Total HH income | | ✓ | | ✓ | | ✓ | | ✓ |
| #obs | 128,805 | 128,085 | 99,249 | 98,734 | 119,110 | 118,461 | 58,612 | 58,422 |

Note: [a] This table shows regression results for leverage, debt, checking and savings account balances. Standard errors are robust to heteroskedasticity. [b] Significance levels: * p<0.1 ** p<0.05 *** p< 0.01

Table 9: Effects of retirement on income minus spending, current account balances, portfolio, and credit account balances in German bank data

| | Income minus spending | | Current account | | Value of portfolio | | Credit account balance | |
|---|---|---|---|---|---|---|---|---|
| Retired | 0.145** | 0.149*** | 0.311*** | 0.0781 | 0.358*** | 0.327*** | -0.152 | -0.153 |
| | (3.20) | (7.20) | (6.42) | (1.81) | (7.44) | (5.86) | (-1.82) | (-1.83) |
| Indiv FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Year FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Month FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Total HH income | | ✓ | | ✓ | | ✓ | | ✓ |
| #obs | 1,407,347 | 1,407,347 | 1,407,347 | 1,407,347 | 250,664 | 250,664 | 158,173 | 158,173 |

Note: [a] This table shows regression results for log household savings (measured as income minus spending), current account balances, portfolio, and credit account balances. Standard errors are clustered at the individual level. [b] Significance levels: * p<0.1 ** p<0.05 *** p< 0.01

Table 10: Effects of retirement on spending, checking and savings account balances, amount of debt, and wealth in PSID data

| | Spending | | Savings | | Debt | | Wealth | |
|---|---|---|---|---|---|---|---|---|
| Retired | -0.146*** | -0.0958*** | 0.00342 | 0.143** | -0.310** | -0.334** | 17875.9** | 24945.9*** |
| | (-9.28) | (-6.33) | (0.07) | (2.81) | (-2.98) | (-3.11) | (3.06) | (4.18) |
| Indiv FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Year FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Total HH income | | ✓ | | ✓ | | ✓ | | ✓ |
| #obs | 68,895 | 68,240 | 68,895 | 68,240 | 44,442 | 43,989 | 68,895 | 68,240 |

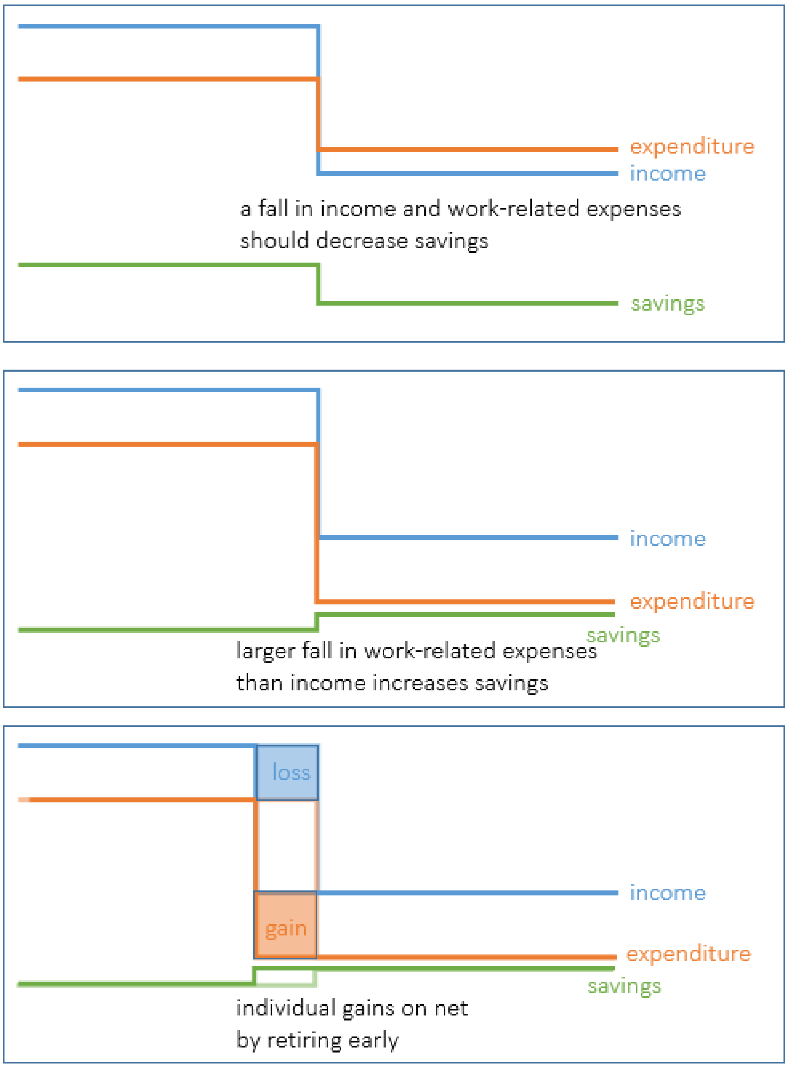
Note: [a] This table shows regression results for log household spending, checking and savings account balances, amount of debt, and wealth (winsorized not logged due to many negative observations). Standard errors are clustered at the individual level. [b] Significance levels: * p<0.1 ** p<0.05 *** p< 0.01

Table 11: Effects of retirement on spending, savings, amount of IRA assets, and wealth in HRS data

| | Spending | | Savings | | IRA assets | | Financial wealth | |
|---|---|---|---|---|---|---|---|---|
| Retired | -0.240*** | -0.229*** | 0.0814 | 0.234*** | 0.271*** | 0.295*** | 0.106 | 0.235*** |
| | (-2.82) | (-2.70) | (1.10) | (3.17) | (3.79) | (4.03) | (1.45) | (3.25) |
| Indiv FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Year FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Total HH income | | ✓ | | ✓ | | ✓ | | ✓ |
| #obs | 1,184 | 1,184 | 9,455 | 9,455 | 9,455 | 9,455 | 9,455 | 9,455 |

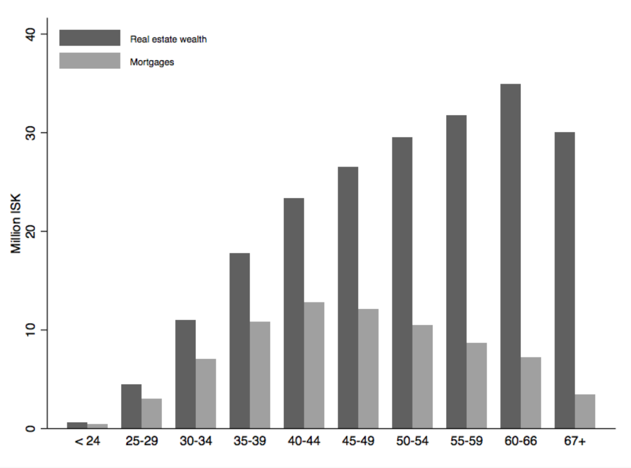
Note: [a] This table shows regression results for log household spending, savings, amount of IRA assets, and wealth. Standard errors are clustered at the individual level.
[b] Significance levels: * p<0.1 ** p<0.05 *** p< 0.01

Figure 10: Illustration of the argument




This figure illustrates why a rational model has difficulty explaining our two findings that 1) individual savings increase after retirement and 2) eligible individuals do not retire immediately. A fall in income and work-related expenses (or any other theory that would decrease consumption such as a health shock) will only increase savings if work-related expenses (or the fall in consumption more generally) are larger than the fall in income. However, in that case, the individual gains on net in life-time resources if she retires early.

Figure 11: Housing wealth and mortgage debt over age




This figure plots the amount of mortgage debt and housing wealth (source: Statistics Iceland) over age.

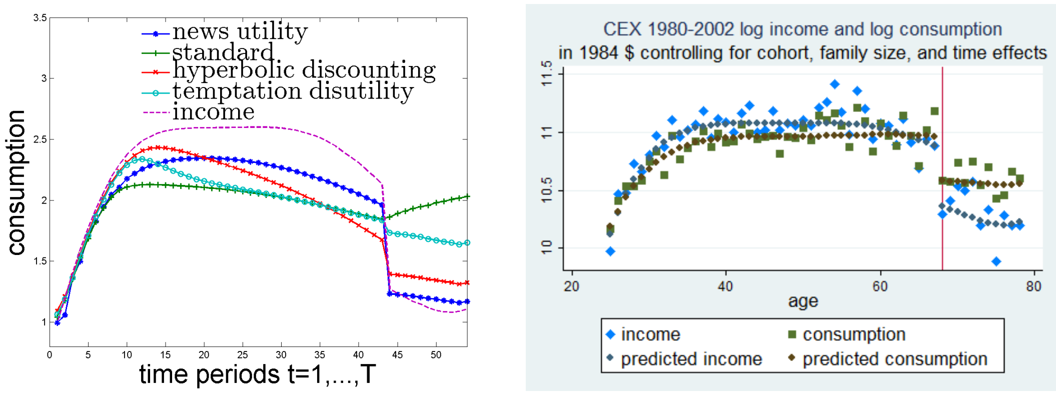
Table 12: Environmental and preference parameters

| parameter | $\mu_P$ | $\sigma_P$ | $\mu_T$ | $\sigma_T$ | $p$ | $G_t$ | $r$ | $P_0$ | $\frac{A_0}{P_0}$ | $R$ | $T$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| value | 0 | 0.1 | 0 | 0.1 | 0.01 | $\widehat{G_t}$ | 0.01 | 1 | 0.0096 | 11 | 78 |

| parameter | $\beta$ | $\theta$ | $\eta$ | $\lambda$ | $\gamma$ | $b$ | $\tau$ |
|---|---|---|---|---|---|---|---|
| value | 0.97 | 2 | 1 | 2 | 0.7 | 0.7 | 0.1 |

This table displays all calibrated parameters.

Figure 12: Life-cycle profiles and CEX consumption and income data




This figure contrasts the five agents' consumption paths with the average CEX consumption and income data. The parameter values are $\mu_T = \mu_P = 0$, $\sigma_T = \sigma_P = 0.1$, $p = 0.01$, , $r = 0.01$, and $G_t$ is estimated from the CEX data. The preference parameters are $\beta = 0.97$, $\theta = 2$, $\eta = 1$, $\lambda = 2$, $\gamma = 0.7$, the hyperbolic discounting parameter is $b = 0.7$, and the temptation-disutility parameter is $\tau = 0.1$. The standard agent's exponential discounting parameter $\beta$ is 1 after retirement, the hyperbolic discounting parameter is 1 after retirement, and the temptation-disutility parameter is 0. The unit of consumption and income is the log of 1984 dollars controlling for cohort, family size, and time effects.

Table 13: Effects of retirement on spending and savings in simulated data

| | Standard agent | News-utility agent | Hyperbolic agent | Tempted agent |
|---|---|---|---|---|
| *Consumption regressions:* | | | | |
| Retired | 0.06*** | -0.38*** | -0.14*** | -0.004*** |
| | (22.67) | (-94.40) | (-44.76) | (-1.42) |
| Total HH income | ✓ | ✓ | ✓ | ✓ |
| #obs | 8,00 | 8,00 | 8,00 | 8,00 |
| *Savings regressions:* | | | | |
| Retired | -0.006*** | 0.052*** | 0.016*** | -0.0004*** |
| | (-21.93) | (86.56) | (44.61) | (-1.37) |
| Total HH income | ✓ | ✓ | ✓ | ✓ |
| #obs | 8,00 | 8,00 | 8,00 | 8,00 |

Note: [a] The table displays the regression results for 200 agents and their simulated data points for four years around the retirement date. The displayed regression coefficients represent the percentage fall or increase in consumption and savings due to retirement. The corresponding t-statistics are displayed in parentheses.
[b] Significance levels: * p<0.1 ** p<0.05 *** p< 0.01

# A The Icelandic pension system

The Icelandic pension system consists of three pillars: a tax-financed public pension (social security benefits), compulsory occupational pension funds which are the dominant feature of the system, and voluntary private pensions with tax incentives.

**Pillar one - public pensions.** The social security system in Iceland was founded in 1936 with the main purpose of ensuring the livelihood of those unable to work because of old age or disability. The system provides old age, disability, sickness, maternity, and survivors pensions. The old age pension is paid from the age of 67. The public pension is paid as a basic pension and supplementary additions to single or low income people. The basic pension is low or roughly 10 percent of the average earnings of unskilled workers and is means-tested by a 30 percent reduction rate after a certain income threshold. The main transfers are, however, paid through the supplementary pension which is also means-tested with a 45 percent reduction rate. The maximum pension per year for an individual without any supplementary income is almost the same as the minimum wage level. The public pension system in Iceland is fully financed by taxes. The main financing source is the social security tax which is earmarked to the social security system. The social security tax rate is currently 5.79 percent and the tax base is total salaries. The social security tax is paid by the employers.

**Pillar two - occupational pensions.** Occupational pensions are the cornerstone of the Icelandic pension system. The compulsory employer and employee-financed pension system provides benefits amounting to 50-60 percent of full time earnings during employment. The contribution rate must be at least 11 percent with the employer paying 7 percent and the employee 4%. Premiums are fully deductible for tax purposes. The accumulated pension rights in the occupational pension funds are generally indexed to the consumer price index. The contribution can be divided into two parts. The first part goes towards acquiring pension rights which (for a 40 years period of contributions) should give a lifelong pension amounting to at least 56 percent of wages at the end of the contribution period. The second part can go towards acquiring additional pension rights, including defined contribution schemes with individual accounts. The main rule is that members can begin to withdraw old-age pensions at the age of 67. It is, however, possible to start withdrawing pension as early as 65, but then with a reduced benefit, or as late as 70 with additional benefits.

**Pillar Three - voluntary individual pension savings.** Employees can deduct from their taxable income a contribution to authorized individual pension schemes. Currently, the maximum taxable deduction by the employee is 4 percent. In addition, all employers have agreed in wage settlements to contribute 2 percent to those voluntary pension savings if the employee matched the amount with at least the same percentage. The total contribution can therefore be 6 percent. The voluntary pension savings cannot be distributed until the age of 60.[13]

[13] After the financial crisis, individuals were given permission to take out private pension savings to pay down debt. We observe all such one-time withdrawals but exclude individuals younger than 60 in all analyses.

# B Derivation of the theoretical framework

## B.1 The news-utility model

Before starting with the fully-fledged problem, we outline the second-to-last period for the case of power utility. In the second-to-last period the agent allocates his cash-on-hand $X_{T-1}$ between contemporaneous consumption $C_{T-1}$ and future consumption $C_T$, knowing that in the last period he will consume whatever he saved in addition to last period's income shock $C_T = X_T = (X_{T-1}-C_{T-1})R+Y_T$. According to the monotone-personal equilibrium solution concept, in period $T-1$ the agent takes the beliefs about contemporaneous and future consumption he entered the period with $\{F^{T-2}_{C_{T-1}}, F^{T-2}_{C_T}\}$ as given and maximizes

$$u(C_{T-1}) + n(C_{T-1}, F^{T-2}_{C_{T-1}}) + \gamma\beta\boldsymbol{n}(F^{T-1,T-2}_{C_T}) + \beta E_{T-1}[u(C_T) + n(C_T, F^{T-1}_{C_T})]$$

which can be rewritten as

$$u(C_{T-1})+\eta\int_{-\infty}^{C_{T-1}}(u(C_{T-1})-u(c))dF^{T-2}_{C_{T-1}}(c)+\eta\lambda\int_{C_{T-1}}^{\infty}(u(C_{T-1})-u(c))dF^{T-2}_{C_{T-1}}(c)$$

$$+\gamma\beta\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}(u(c)-u(r))dF^{T-1,T-2}_{C_T}(c,r)+\beta E_{T-1}[u(C_T)+\eta(\lambda-1)\int_{C_T}^{\infty}(u(C_T)-u(c))dF^{T-1}_{C_T}(c)].$$

To gain intuition for the model's predictions, we explain the derivation of the first-order condition

$$u'(C_{T-1})(1+\eta(\lambda-(\lambda-1)F^{T-2}_{C_{T-1}}(C_{T-1}))) = \gamma\beta RE_{T-1}[u'(C_T)]\eta(\lambda-(\lambda-1)F^{T-2}_{A_{T-1}}(A_{T-1}))$$

$$+\beta RE_{T-1}[u'(C_T) + \eta(\lambda-1)\int_{C_T}^{\infty}(u'(C_T)-u'(c))dF^{T-1}_{C_T}(c)].$$

The first two terms in the first-order condition represent marginal consumption utility and news utility over contemporaneous consumption in period $T-1$. As the agent takes his beliefs $\{F^{T-2}_{C_{T-1}}, F^{T-2}_{C_T}\}$ as given in the optimization, we apply Leibniz's rule for differentiation under the integral sign. This results in marginal news utility being the sum of states that would have promised less consumption $F^{T-2}_{C_{T-1}}(C_{T-1})$, weighted by $\eta$, or more consumption $1-F^{T-2}_{C_{T-1}}(C_{T-1})$, weighted by $\eta\lambda$,

$$\frac{\partial n(C_{T-1}, F^{T-2}_{C_{T-1}})}{\partial C_{T-1}} = u'(C_{T-1})\eta(\lambda-(\lambda-1)F^{T-2}_{C_{T-1}}(C_{T-1})).$$

Note that, if contemporaneous consumption is increasing in the realization of cash-on-hand then we can simplify $F^{T-2}_{C_{T-1}}(C_{T-1}) = F^{T-2}_{X_{T-1}}(X_{T-1})$. Returning to the maximization problem the third term represents prospective news utility over future consumption $C_T$ experienced in $T-1$. As before, marginal news utility is given by the weighted sum of states $\gamma\beta RE_{T-1}[u'(C_T)]\eta(\lambda-(\lambda-1)F^{T-2}_{A_{T-1}}(A_{T-1}))$. Note that $F^{T-2}_{C_T}(c)$ is defined as the probability $Pr(C_T < c|I_{T-2})$ and

$$Pr(C_T < c|I_{T-2}) = Pr(A_{T-1}R+Y_T < c|I_{T-2}) = Pr(A_{T-1} < \frac{c-Y_T}{R}|I_{T-2}).$$

Thus, if savings and therefore future consumption are increasing in the realization of cash-on-hand, then we can simplify $F^{T-2}_{A_{T-1}}(A_{T-1}) = F^{T-2}_{X_{T-1}}(X_{T-1})$.

The last term in the maximization problem represents consumption and news utility over future consumption $C_T$ in the last period $T$, i.e., the first derivative of the agent's continuation value with respect to consumption or the marginal value of savings. Expected marginal news utility $\eta(\lambda-1)\int_{C_T}^{\infty}(u'(C_T)-u'(c))dF^{T-1}_{C_T}(c)$ is positive for any concave utility function such that

$$\Psi'_{T-1} = \beta R E_{T-1}[u'(C_T)+\eta(\lambda-1)\int_{C_T}^{\infty}(u'(C_T)-u'(c))dF^{T-1}_{C_T}(c)] > \beta R E_{T-1}[u'(C_T)] = \Phi'_{T-1}.$$

As expected marginal news disutility is positive, increasing in $\sigma_Y$, absent if $\sigma_Y = 0$, and increases the marginal value of savings, we say that news-utility introduces an "additional precautionary-savings motive." The first-order condition can now be rewritten as

$$u'(C_{T-1}) = \frac{\Psi'_{T-1} + \gamma\Phi'_{T-1}\eta(\lambda-(\lambda-1)F^{T-2}_{X_{T-1}}(X_{T-1}))}{1+\eta(\lambda-(\lambda-1)F^{T-2}_{X_{T-1}}(X_{T-1}))}.$$

Beyond the additional precautionary-savings motive $\Psi'_{T-1} > \Phi'_{T-1}$ implies that an increase in $F^{T-2}_{X_{T-1}}(X_{T-1})$ decreases

$$\frac{\frac{\Psi'_{T-1}}{\Phi'_{T-1}} + \gamma\eta(\lambda-(\lambda-1)F^{T-2}_{X_{T-1}}(X_{T-1}))}{1+\eta(\lambda-(\lambda-1)F^{T-2}_{X_{T-1}}(X_{T-1}))},$$

i.e., the terms in the first-order condition vary with the income realization $X_{T-1}$ so that consumption is excessively smooth and sensitive.

The news-utility agent's maximization problem in any period $T-i$ is given by

$$u(C_{T-i}) + n(C_{T-i}, F^{T-i-1}_{C_{T-i}}) + \gamma\sum_{\tau=1}^{i}\beta^{\tau}\boldsymbol{n}(F^{T-i,T-i-1}_{C_{T-i+\tau}}) + \sum_{\tau=1}^{i}\beta^{\tau}E_{T-i}[U(C_{T-i+\tau})].$$

Again, we can normalize maximization problem by $P^{1-\theta}_{T-i}$ as all terms are proportional to consumption utility $u(\cdot)$. In normalized terms, the news-utility agent's first-order condition in any period $T-i$ is given by

$$u'(c_{T-i}) = \frac{\Psi'_{T-i} + \gamma\Phi'_{T-i}\eta(\lambda-(\lambda-1)F^{T-i-1}_{c_{T-i}}(c_{T-i}))}{1+\eta(\lambda-(\lambda-1)F^{T-i-1}_{a_{T-i}}(a_{T-i}))}$$

We solve for each optimal value of $c^*_{T-i}$ for a grid of savings $a_{T-i}$, as $\Psi'_{T-i}$ and $\Phi'_{T-i}$ are functions of $a_{T-i}$ until we find a fixed point of $c^*_{T-i}$, $a_{T-i}$, $F^{T-i-1}_{a_{T-i}}(a_{T-i})$, and $F^{T-i-1}_{c_{T-i}}(c_{T-i})$. We can infer the latter two from the observation that each $c_{T-i}+a_{T-i} = x_{T-i}$ has a certain probability given the value of savings $a_{T-i-1}$ we are currently iterating on. However, this probability varies with the realization of permanent income $G_{T-i}e^{s^P_{T-i}}$; thus, we cannot fully normalize the problem but have to find the right consumption grid for each value of $G_{T-i}e^{s^P_{T-i}}$ rather than just one. The first-order condition can be slightly modified as follows

$$u'(G_{T-i}e^{s^P_{T-i}}c_{T-i}) = \frac{(G_{T-i}e^{s^P_{T-i}})^{-\theta}\Psi'_{T-i} + \gamma(G_{T-i}e^{s^P_{T-i}})^{-\theta}\Phi'_{T-i}\eta(\lambda-(\lambda-1)F^{T-i-1}_{c_{T-i}}(c_{T-i}))}{1+\eta(\lambda-(\lambda-1)F^{T-i-1}_{a_{T-i}}(a_{T-i}))}$$

to find each corresponding grid value. Note that, the resulting two-dimensional grid for $c_{T-i}$ will be the normalized grid for each realization of $s^T_t$ and $s^P_t$, because we multiply both sides of the first-order conditions with $(G_{T-i}e^{s^P_{T-i}})^{-\theta}$. Thus, the agent's consumption utility continuation value is

$$\Phi'_{T-i-1} = \beta RE_{T-i-1}[\frac{\partial c_{T-i}}{\partial x_{T-i}}(G_{T-i}e^{S^P_{T-i}})^{-\theta}u'(c_{T-i}) + (1-\frac{\partial c_{T-i}}{\partial x_{T-i}})(G_{T-i}e^{S^P_{T-i}})^{-\theta}\Phi'_{T-i}].$$

The agent's news-utility continuation value is given by

$$P^{-\theta}_{T-i-1}\Psi'_{T-i-1} = \beta RE_{T-i-1}[\frac{dC_{T-i}}{dX_{T-i}}u'(C_{T-i})$$

$$+\eta(\lambda-1)\int\limits_{C_{T-i}<C^{T-i-1}_{T-i}}(\frac{dC_{T-i}}{dX_{T-i}}u'(C_{T-i})-x)dF^{T-i-1}_{\frac{dC_{T-i}}{dX_{T-i}}u'(C_{T-i})}(x)$$

$$+\gamma\eta(\lambda-1)\int\limits_{A_{T-i}<A^{T-i-1}_{T-i}}(\frac{dA_{T-i}}{dX_{T-i}}P^{-\theta}_{T-i}\Phi'_{T-i}-x)dF^{T-i-1}_{\frac{dA_{T-i}}{dX_{T-i}}P^{-\theta}_{T-i}\Phi'_{T-i}}(x)+(1-\frac{dC_{T-i}}{dX_{T-i}})P^{-\theta}_{T-i}\Psi'_{T-i}]$$

(here, $\int\limits_{C_{T-i}<C^{T-i-1}_{T-i}}$ means the integral over the loss domain) or in normalized terms

$$\Psi'_{T-i-1} = \beta RE_{T-i-1}[\frac{dc_{T-i}}{dx_{T-i}}u'(c_{T-i})(G_{T-i}e^{s^P_{T-i}})^{-\theta}$$

$$+\eta(\lambda-1)\int\limits_{C_{T-i}<C^{T-i-1}_{T-i}}(\frac{dc_{T-i}}{dx_{T-i}}u'(c_{T-i})(G_{T-i}e^{S^P_{T-i}})^{-\theta}-x)dF^{T-i-1}_{\frac{dc_{T-i}}{dx_{T-i}}u'(c_{T-i})(G_{T-i}e^{S^P_{T-i}})^{-\theta}}(x)$$

$$+\gamma\eta(\lambda-1)\int\limits_{A_{T-i}<A^{T-i-1}_{T-i}}(\frac{da_{T-i}}{dx_{T-i}}\Phi'_{T-i}(G_{T-i}e^{S^P_{T-i}})^{-\theta}-x)dF^{T-i-1}_{\frac{da_{T-i}}{dx_{T-i}}\Phi'_{T-i}(G_{T-i}e^{S^P_{T-i}})^{-\theta}}(x)+(1-\frac{dc_{T-i}}{dx_{T-i}})(G_{T-i}e^{S^P_{T-i}})^{-\theta}\Psi'_{T-i}]$$

## B.2 The hyperbolic-discounting model

We consider an agent with hyperbolic-discounting preferences with the hyperbolic-discounting parameter denoted by $\gamma$. The agent's maximization problem in any period $T-i$ is

$$max\{u(C_{T-i}) + \gamma\sum_{\tau=1}^{i}\beta^\tau E_{T-i}[u(C_{T-i+\tau})]\}.$$

We can normalize the maximization problem by $P^{1-\theta}_{T-i}$ as for the standard agent. In turn, we can solve the model by numerical backward induction (as Laibson et al. (2012)) and the first-order condition is

$$u'(c_{T-i}) = \gamma\Phi'_{T-i} = \gamma\beta R E_{T-i}[\frac{\partial c_{T-i+\tau}}{\partial x_{T-i+1}}(G_{T-i+1}e^{s^P_{T-i+1}})^{-\theta}u'(c_{T-i+1})+(1-\frac{\partial c_{T-i+1}}{\partial x_{T-i+1}})(G_{T-i+1}e^{s^P_{T-i+1}})^{-\theta}\Phi'_{T-i+1}].$$

## B.3 The temptation-disutility model

Consider an agent with temptation-disutility preferences as developed by Gul and Pesendorfer (2004) following the specification of Bucciol (2012). The "tempted" agent's lifetime utility is given by

$$u(C_t) - \lambda^{td}(u(\tilde{C}_t) - u(C_t)) + E_t[\sum_{\tau=1}^{T-t}\beta^\tau(u(C_{t+\tau}) - \lambda^{td}(u(\tilde{C}_{t+\tau}) - u(C_{t+\tau})))]$$

with $\tilde{C}_t$ being the most tempting alternative consumption level and $\lambda^{td} \in [0, \infty)$. Note that, in a life-cycle model context the most tempting alternative is to consume the entire cash-on-hand. However, not more as borrowing could be infinitely painful with power utility and a chance of zero income in all future periods. For illustration, in the second-to-last period the agent's maximization problem is

$$u(C_{T-1}) - \lambda^{td}(u(X_{T-1}) - u(C_{T-1})) + \beta E_{T-1}[u(R(X_{T-1} - C_{T-1}) + Y_T)]$$

which can be normalized by $P_{T-1}^{(1-\theta)}$ (then $C_T = P_T c_T$ for instance) and the maximization problem becomes

$$(P_{T-1})^{1-\theta}(u(c_{T-1})-\lambda^{td}(u(x_{T-1})-u(c_{T-1})))+(P_{T-1})^{1-\theta}\beta E_{T-1}[(G_T e^{s^P_T})^{1-\theta}u(\frac{R}{G_T e^{s^P_T}}(x_{T-1}-c_{T-1})+y_T)]$$

which results in the following first-order condition

$$u'(c_{T-1}) = \frac{1}{1+\lambda^{td}}\beta E_{T-1}[(G_T e^{s^P_T})^{-\theta}Ru'(\frac{R}{G_T e^{s^P_T}}(x_{T-1} - c_{T-1}) + y_T)]$$

with $\Phi'_{T-1}$ being a function of savings $x_{T-1} - c_{T-1}$. The first-order condition can be solved very robustly by iterating on a grid of savings $a_{T-1}$ assuming $c^*_{T-1} = (\Phi'_{T-1})^{-\frac{1}{\theta}} = (f^{\Phi'}(a_{T-1}))^{-\frac{1}{\theta}}$. The normalized agent's first-order condition in any period $T-i$ is given by

$$c_{T-i}^{-\theta} = \frac{1}{1+\lambda^{td}}\beta E_{T-i}[(G_{T-i+1}e^{s^P_{T-i+1}})^{-\theta}R\frac{dc_{T-i+1}}{dx_{T-i+1}}u'(c_{T-i+1})]$$
$$+(1-\frac{dc_{T-i+1}}{dx_{T-i+1}})(G_{T-i+1}e^{S^P_{T-i+1}})^{-\theta}\Phi'_{T-1}].$$