The Retirement-Consumption Puzzle: New Evidence on Individual Spending and Financial Structure

Arna Olafsson* and Michaela Pagel†

Copenhagen Business School   Columbia GSB, NBER, & CEPR

This version: September 2017

Abstract

In this paper, we use an accurate panel of individual spending, income, and financial account balances to learn more about expenditure and household financial structure changes 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. Upon retirement, individuals spend less on ready-made food, fuel, and clothes and more in pharmacies, which is consistent with reductions in work-related expenses and increases in health spending. However, individuals also spend less on other consumption categories, such as sports and activities and fine dining. Furthermore, we are in a unique position to document the effect of retirement on credit-card, checking, and savings account balances: we find that individuals delever by reducing consumer debt and increasing liquid savings. These findings cannot be rationalized via work-related expenses. Any rational agent would save before retirement, the expected fall in income, and dissave after retirement rather than the exact opposite.

JEL classifications: D12, D14, E21, J26, J32

*Department of Finance, Copenhagen Business School. ao.fi@cbs.dk

†Division of Economics and Finance, Columbia Business School, NBER, & CEPR. mpagel@columbia.edu

We are grateful for the financial financial support from the Pension Research Center (PeRCent) at Copenhagen Business School and thank Andrew Caplin, Rachel Kranton, Jawad Addoum, Matthew Rabin, Botond Koszegi, Steve Zeldes, Emi Nakamura, Jon Zinman, and Emir Kamenica as well as seminar participants at the Federal Reserve Bank of Richmond, University of Queensland, PerCent 2017 conference, and ECWFC at the WFA 2017 for a range of insightful comments. We are indebted to Ágúst Schweitz Eriksson and Meniga for providing the Icelandic data and Steffen Meyer for providing the German bank account data. We also thank Belinda Chen for excellent research assistance.

1 Introduction

Household spending amounts to about 60 percent of GDP in developed countries and is the most important part of aggregate demand. Demographic changes in developed countries lets populations grow older and an increasing share of the workforce will be approaching or past retirement age in the coming years. Understanding how consumers respond to the onset of their retirement is therefore essential for demand analysis. Additionally, the complexity of consumers' financial lives has increased considerably in recent years and the prevalence and consequences of bad decisions are not well understood by researchers or policy-makers. For instance, whether individuals save enough or not for retirement is still debated in the literature. For these reasons, it is important to understand how individuals going through retirement manage their personal financial structures.

A central implication of Modigliani (1954)'s life-cycle model, the standard model to analyze consumption-saving 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 that individuals encounter during their lifetime 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.[1] This phenomenon is called the retirement-consumption puzzle and the authors argue that overconsumption before retirement causes a sharp adjustment at retirement, a mechanism that is theoretically rationalized in Pagel (2017) and Huang et al. (2007). Moreover, Ameriks et al. (2007) and Hurd and Rohwedder (2003) provide evidence that the drop in consumption is expected.

The retirement-consumption puzzle and its mechanism are still debated though. Lundberg et al. (2003) argues that the drop is caused by the fact that the retirement of male spouses generates a favorable shift in the distribution of bargaining power within households. On average,

[1]The first study to document a clear decline in consumption at the onset of retirement was 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).

wives earn bargaining power and use this to exert their preferences for increasing savings since women have on average higher life expectancies than men. Moreover, a series of studies (e.g., Aguiar and Hurst, 2005; Hurst, 2008; Aguiar and Hurst, 2013) strongly question that there is a decline in actual consumption at retirement. The authors show that the overall decline is driven by consumers substituting away from market expenditures toward household production as the opportunity cost of time changes after retirement.[2] The mechanism for the drop in spending upon retirement, whether individuals save adequately, and whether the standard life-cycle model is applicable is thus still debated.

This paper revisits the retirement-consumption puzzle with new, accurate, and comprehensive data on spending and income. Moreover, to the best of our knowledge, this paper is the first to document changes in personal financial structures around retirement. Using transaction-level data from a financial aggregation software provider over more than six years, we are in a unique position to accurately analyze individual spending categories and financial account balances upon entering retirement using individual fixed-effects regressions. We find support for substantial reductions in work-related spending categories. But more interestingly, we document that individuals delever around retirement by reducing their consumer debt and increasing their liquid savings. These findings are difficult to rationalize via assumptions about work-related expenses. In fact, any rational agent, who expects a fall in income at retirement, would save before retirement and dissave after retirement rather than the other way around.

We conclude that our findings about debt and savings imply that we cannot "retire the consumption puzzle" as suggested by Hurst (2008) 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. Observing that individuals decrease their debt and increase their savings is the opposite of what a rational agent would do and thus puzzling from Modigliani (1954)'s life-cycle model perspective.

Interestingly, we find the same patterns in two commonly used US consumption survey

[2] Hurd and Rohwedder (2003) argue that this drop can be attributed to a drop in work-related expenses, more efficient purchases, and the substitution between purchased goods and home-produced ones. Other survey studies have also found evidence that support this hypothesis (see, e.g., Hurst, 2008; Battistin et al., 2009).

data sets, the CEX and SCF. In CEX data, we find that retirement results in an increase in savings, i.e., income minus spending, checking account balances, and savings account balances. In SCF data, we find that retirement results in reductions in leverage and debt as well as increases in checking, savings, and call account balances. We control for cohort, age, and year effects though one has to keep in mind that these results suffer from selection bias and measurement error. Beyond CEX and SCF data, we thus replicate our results in individual-and-transaction-level bank account data from Germany running fixed-effects regressions. Finally, we use another US survey dataset to replicate our results: the PSID. Because the PSID surveys households consecutively, we can also include individual fixed effects in our regressions. We again find that consumption drops but savings and checking account balances increase as well as overall wealth.

The results on debt and savings may suggest that individuals reconsider their spending and savings habits upon retirement. This reconsideration results in a fall in spending because individuals are correcting overconsumption and undersaving before retirement. In fact, Pagel (2017) and Kőszegi and Rabin (2009) show that a model of expectations-based loss aversion predicts that individuals have more problems with overconsumption before retirement than after retirement. The intuition is the following: when income is uncertain, individuals overconsume in the present just hoping for a better realization of income in the future. However, when income is certain, as it is after retirement, overspending results in a sure reduction in future spending. Because the agent dislikes a sure loss more than a sure gain, he or she is able to address his or her overconsumption problems.

Previous efforts to measure the response of individuals and households to the onset of retirement have been complicated by the fact that a comprehensive view of household expenditures is required. Existing data typically capture only some dimensions of spending with sufficient resolution. In this paper, we explore the existence of the retirement-consumption puzzle from a very accurate panel of individual spending and income. The data are 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 the spending responses of individuals to income arrivals (Olafsson and Pagel, 2016b) and how these vary with the financial structure of households (Olafsson and Pagel, 2016a).

We are only aware of one previous study that uses transaction-level data to investigate the documented consumption drop upon retirement. Agarwal et al. (2015) investigate the question on how consumers respond to retirement using financial transaction data from Singapore. Relative to this data, our data offers five important advantages. (1) In Iceland, consumers use electronic means of payments almost exclusively, which eliminates one limitation of the data from Singapore where a fraction of expenditures in establishments such as fresh markets and small grocery stores are paid with cash. (2) We observe income and expenditure of individuals for a long period of time around retirement. Thus, we have sufficient power to estimate individual fixed-effects regressions, controlling for all selection on observable or unobservable time-invariant characteristics. (3) We can observe both spouses within a household, which gives us a unique opportunity to investigate the importance of retirement of male and female spouses separately. But we observe all individual spending and income because all financial accounts are personal in Iceland. (4) We see how individuals spend within certain categories of spending, giving us an opportunity to test whether consumers substitute toward cheaper but more time consuming goods when they retire. Additionally, our categorization is very accurate with a negligible share of uncategorized transactions. (5) Because we have detailed information on all account balances, credit limits, and financial fees, we are able to document the changes in household financial structure at the onset of retirement. With respect to changes in household financial structure upon retirement, the only related paper we are aware of is Addoum (2016) who 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.

The findings in this paper are possibly related to recent work finding 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 (1954)'s life-cycle model predicts that individuals should decumulate assets. This empirical finding has been termed the retirement-savings puzzle and is theoretically explained in DeNardi et al. (2010) and Laitner et al. (2017) among others. Rather than focusing on behavior after retirement, this paper analyzes household balance sheet changes around the transition into retirement. To the best of our knowledge, we are the first documenting deleveraging and a rise in savings at the time of retirement.

The remainder of this paper proceeds as follows. Section 2 reviews the key features of the pension system in Iceland. Section 3 describes our data and reports descriptive statistics. Section 4 presents our findings on how consumption changes as individuals enter retirement. Section 5 rationalizes our findings via expectations-based loss aversion and the final section offers some concluding remarks.

2 Institutional setup and data

2.1 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 authorised 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.[3]

A long working life is common in Iceland, the average man retires at the age of 68.2 and the average woman at the age of 67.2, which is significantly later than in most other countries. Figure 2 displays the average effective retirement age for men and women in Iceland compared to Germany and the United States. Empirically, 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. Figure 3 displays the share of retired individuals

[3]After the financial crisis, individuals were given permission to take out private pension savings to pay down debt.

at each age and Figure 4 displays the distribution of retirement age. Our inferred time of retirement is consistent with the information on effective retirement age in Iceland.

2.2 Data and summary statistics

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 over 40 million online and mobile banking users across 18 countries. Meniga's Account Aggregation platform allows bank customers to manage all their bank accounts and credit cards across multiple banks in one place by aggregating data from various sources (internal and external). Meniga's financial feed tells the story of consumers' financial lives as they unfold in familiar social media style. Categorized transactions are mixed in with automated and custom advice, notifications, messages, merchant funded offers, and various insights and interpretations of the user's finances.

In January 2015, the Icelandic population counted 329,100 individuals – 249,094 of which were older than 18. At the same time, Meniga had 50,573 users, which is about 20 percent of the adult individuals living in Iceland. Because their service is marketed through banks, the sample of Icelandic users is fairly representative. The company allows financial institutions to offer their online customers a platform to connect all their financial accounts, including bank and credit card accounts, to see all of them in a single location. Each day, the application automatically records all the bank and credit card transactions, including descriptions as well as balances, overdraft, and credit limits. Figure 1 displays screenshots of the app's user interface. The first screenshot shows background characteristics that the user provides, the second one shows transactions, and the third one bank account information.

We use the entire de-identified population of active users in Iceland and the data derived from their records from 2011 until January 2017. We perform the analysis on aggregated user-level data for different income and spending categories. Additionally, the app collects demographic information such as age, gender, marital status, and postal code. Presumably, the user population is not perfectly representative of the Icelandic population, but it is a substantial, heterogenous fraction that includes large numbers of users of different ages, education levels, and geographic locations.

Expenditures are divided into ten expenditure categories and aggregated to generate a monthly panel. We consider households comprised of people who are observable either as single individuals or as members of collective households. Each consumption category is then aggregated to the household level. The panel thus provides household level expenditure information for disaggregated expenditure categories. This means that we can observe the budget shares for individuals living alone, and the budget shares for individuals living with a spouse, and hence the total budget shares for the household. This aspect of our data allows us to link the distribution of income within household with household expenditure shares.

Income data. When the data is extracted from the PFM system it has already been categorized by a three tiered approach: system rules as well as user- and community-rules. The system rules are applied in instances where codes from the transactions systems 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 if no system rules are in place and when a user persistently categorizes transactions with certain text or code attributes to a specific category, the system will automatically create a rule which is applied to all further such instances of transactions. If neither system rules nor user rules apply, the system can sometimes detect identical categorization rules from multiple users which allows for the generation of a community rule which then applies the categorization across the whole community. It is also important to note that the PFM system has already detected 1st party transactions such as between two accounts that belong to the same household. These transactions are not included in the sample data set. Multiple additional steps were taken to further categorize transactions based on banking system codes, transaction texts, amounts and payer profile.

Payers identity as well as NACE category (The Statistical Classification of Economic Activities in the European Community)[4] are added to each income transfer whenever possible.[5] This allows us to identify individuals who have the same employer.

The system categorizes the income as described above into 23 different income 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. Irregular income categories are: damages, grant, other income, insurance claims, investment transactions, reimbursements, tax rebates, and travel allowances.

Spending data. The spending categories are groceries, fuel, alcohol,[6] ready made food, home improvement, transportation, clothing and accessories, sports and activities, and pharmacies. Expenditure shares are the portions of total expenditures (as percentages) allotted to the distinct aforementioned expenditure categories.

2.2.1 Summary statistics

Table 1 displays summary statistics of the Icelandic users, including income and spending in US dollars across four income quartiles along with some 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 and 48 percent being female. Thus, our demographic statistics are remarkably similar to the overall Icelandic population. This is reassuring because of the following concern when using app data: 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

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

[5] Payers identity can sometimes be hard or impossible to identify because of limited information in transaction data such as generic transaction texts. In specific cases where identifying the payer was not possible, a proxy id was created to enable the binding of payments from single source even though the true source id is not known. 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 was not known.

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

remarkably similar for those categories that match well.

Table 2 displays summary statistics for individuals that are eligible for retirement (have reached 60 years of age) and are either retired or not. We can see that, on average, individuals that have retired have lower income, spend less (both when looking at individual spending and household spending), hold less consumer debt, have less access to credit, and incur less bank fees and penalty payments. In the raw data, we can already see that spending and income is considerably lower for retired individuals. Moreover, consumer debt is lower and savings are larger for retired individuals.

Figure 5 summarizes the salary, pension payments, and expenditure trajectories of men and women using binned averages by age. The pattern displays 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.

3 Analysis

We start by examining the age profile of consumption for the individuals in the sample. Following Aguiar and Hurst (2013) and Agarwal et al. (2015), we obtain the age profile of consumption by regressing log of total spending on age, controlling for year and month as well as individual fixed effects. We also estimate separate regressions for log spending in ten consumption categories: groceries, ready-made food, clothing and accessories, alcohol, fuel, sports and activities, vehicles, home improvements, home security, and pharmacies. Figure 6 plots the age coefficients for log total monthly spending. The expenditure profile exhibits the familiar hump-shaped pattern profile of expenditure over the life cycle, with monthly spending peaking in the late thirties at around 60 log points higher than the level of 20-year old spending and monthly spending declining by about the same amount when the individual is in his or her late fifties.

As shown in Figure 7 we find considerable heterogeneity in life-cycle patterns of spending across different consumption categories. While spending in grocery stores/supermarkets, the largest part of household total spending (excluding expenditure commitments like housing and utilities), exhibits the hump-shaped pattern, other expenditure categories do not. For instance, ready-made food expenditure rise during the twenties and then stay more or less constant until it declines during the sixties. Moreover, alcohol expenditure is constantly rising while spending on clothes and accessories is constantly falling.

As shown in Figures 8 and 9, we also find considerable heterogeneity in life-cycle patterns of spending across types of grocery stores (categorized as either budget or expensive stores) and types of ready-made food places. Expenditures on budget supermarkets have a much greater hump than the expenditures in more expensive grocery stores. Furthermore, the share of expenditures in expensive grocery stores falls during the twenties until it reaches its bottom around the age of 30 and stays constant until it starts rising again in the early forties. Expenditures on fast food increase during the twenties and stay more or less constant until they start falling during the sixties. This is consistent with fast food being a type of work-related expense or a substitute for home production that increases as individuals enter the labor market and decrease 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 consumption unlikely to be a work-related expense or a substitute for home production, which is rather unaffected by labor market status. Taken together, these figures suggest that individuals shift toward more time consuming food expenditures as they leave the labor market upon retirement.

3.1 The effects of retirement on houshold behavior

This section presents the estimation results of how retirement influences household expenditures and financial structure. To examine the effects of the onset of retirement we run the following regression:

$$Y_{it} = \beta Retired_{it} + \mu HHInc_{it} + \phi_m + \gamma_y + \eta_i + \epsilon_{it} \tag{1}$$

where Y_{it} is the dependent variable of interest. ϕ_m is a month fixed effect, γ_y is a year fixed effect, and η_i is an individual fixed effect. Controlling for individual fixed effects allows us to compare individuals to themselves before and after retirement. $HHInc_{it}$ is the total income of individual i. $Retired_{it}$ is an indicator equal to 1 if the individual has retired at time t. The β coefficient thus measures the effect of the onset of retirement on household spending.

3.1.1 The retirement effects on individual spending

Tables 3 and 4 show the estimated effect of retirement on expenditure based on the individual fixed effects regression, Equation (1), with and without controlling for total income, respectively. Because the individual spending categories consist of many zeros, we do not log the outcome variable but instead winsorize to take care of outliers. However, results are not qualitatively or quantitatively affected if we log our outcome variables. According to these results, spending drops significantly for both men and women. Controlling for income, the drop is more than a third of the drop not controlling for income suggesting that individuals reshuffle spending not only because income drops at retirement.

In turn, we find results consistent with a reduction in work-related expenses: ready-made food and clothing expenses drop substantially and the drop is less dependent on whether or not we control for income. Grocery expenses fall as well but only because income falls (when we do not control for income). However, leisure expenses, or sports and activities also decrease substantially suggesting that households correct an overconsumption problem. Moreover, we find evidence consistent with retiring due to health problems as pharmacy spending increases for both men and women and this effect is more pronounced when we control for income.

3.1.2 The retirement effects of spending on categories of restaurants and groceries

Our results show that consumers substitute across different types of grocery stores and types of ready-made food over their life cycle. Previous studies that have relied only on spending data fail to capture some of these key expenditure patterns. The reason is that consumers in countries where card payments are not as widely accepted as in Iceland typically use different types of payment instruments across different types of establishments. For instance, cash payments are much more common in fresh markets and smaller grocery stores, establishment that older cohorts spend a larger share of their grocery spending than younger cohorts as Figure 9 shows. This would suggest that the spending of older cohorts could be underestimated in countries where the most common payment instruments include cash. These results are consistent with previous observations of Agarwal et al. (2015) using the Nielsen scanner data. However, given that almost all purchases in our data are made with non-cash payment instruments (and we can control for any possible cash withdrawals), this cannot be part of the explanation for the drop in consumption in Iceland. In fact, it suggests that the numbers on grocery 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 their overall spending is reduced.

Figure 10 shows the life-cycle profiles of: (1) restaurant spending and number of visits, (2) expenditures in different types of restaurants, such as bars or fine dining, and (3) number of trips to different types of restaurants. We can clearly see humps for all life-cycle profiles of trips and spending on all the different subcatgeories of restaurants. Moreover, we can look at the effects of retirement on these categories. We can see in Table 5 that individuals exhibit a drop in spending on all categories of restaurants, including bars and fine dining. This result is more consistent with a reduction in overconsumption around retirement rather than merely a reduction in work-related expenses.

3.1.3 The retirement effects on household financial structure

Using the same methodology, we can investigate the effects of retirement on checking and savings account balances, interest payments, overdrafts, and credit limits. The most interesting result is that individuals delever. Measuring consumer debt via interest expenses, we find a 238 krona per month reduction, which corresponds to 17.5 percent of the mean interest expenses. Thus, individuals not only decide to cut their consumption but also reduce their consumer debt considerably. This deleveraging cannot easily be rationalized by a reduction in work-related expenditure as we discuss in more detail below. Given that individuals expect a substantial reduction in income, they would always optimally save before and dissave after rather than the other way around. Instead it seems sensible to assume that individuals decide to correct their overconsumption and debt holdings and delever. Figure 11 shows the life-cycle profile of consumer debt holdings, it features a pronounced hump shape similar to consumption and income.

Tables 6 and 7 display all the estimated effect of retirement on household financial structure based on an individual fixed effects regression, Equation (1), with and without controlling for total income, respectively. We find that households not only delever but also increase their liquid savings substantially (13.2 percent from the mean) independent of whether we control for income. This again hints toward a rethinking of individuals to save more at the onset of retirement. Moreover, we find that individuals decrease their overdraft and credit limits although liquidity still increases given the concurrent reduction in consumer debt. We also find that checking account balances are somewhat reduced while savings account balances are increased. Both of these results appear to be consistent with mental accounting and self-control problems. Individuals try to constrain themselves by reducing their credit limits and moving money to savings accounts. Finally, individuals also reduce late fee payments. A potential explanation could be that individuals have more time to pay all bills in time.

Robustness

We now discuss two additional results that illustrate the robustness of our findings on changes in household financial structure upon retirement. We want to test whether our finding that individuals increase their savings upon retirement is robust to using a different definition of savings. So far we have relied on information from bank account balances. One might worry that increases in bank account balances might simply reflect that individuals are liquidating assets upon retirement even though we control for total income. Another way to address this concern is to test whether our findings are robust to using a different measure of savings, i.e., the simple difference between income and expenditures. Table 8 displays the estimated effect of retirement on savings. These results show that our findings are robust to using a different measure of savings. Moreover, we look at not only individual but also household savings to rule out that cash transfers within the household is driving our results.

As discussed above, any rational agent would save before retirement and dissave after because he expects his income to fall upon retirement. Thus, the joint pattern of a fall in income, a fall in consumption, and an increase in savings are hard to reconcile with a rational model of consumption smoothing. We thus now discuss some more specific explanations for our findings. In turn, we move on to an overconsumption, impatience, and undersaving explanation that appears parsimonious and has been shown to explain micro evidence in a number of other domains.

Can work-related expenses explain our findings?

In which situation would a sudden reduction in work-related expenses cause an increase in savings at retirement? To answer that question, we will outline five different scenarios for the income and pension profiles. (1) If the income profile is flat before retirement and the pension profile is flat and lower than income after retirement, then any patient agent would smooth consumption by accumulating liquid savings before retirement and decreasing savings after. (2) If the income profile is flat before retirement and the pension profile is lower than income after retirement but increasing, then again any patient agent would smooth consumption by borrowing at the start of retirement and decreasing debt after. (3) If the income profile is flat before retirement and the pension profile is lower than income after retirement but decreasing, then again any patient agent would smooth consumption by accumulating savings before retirement and decreasing savings after. (4) If the income profile is flat before retirement and the pension profile is just marginally lower (less than work-related expenses) than income after retirement and decreasing, then a patient agent may increase savings at the start of retirement. However, work-related expenses are not larger than the difference between pension and work income as individuals would simply retire early in that case. We can thus rule out this explanation. (5) If the income profile is flat before retirement and the pensions are larger than income after retirement, then a patient agent may accumulate debt and decrease debt at the start of retirement. However, we see that pensions are lower than work income and rule out this explanation.

More systematically, we can think about the following calculations. If income decreases then savings decrease or debt increases. However, if work-related expenses decrease, then savings increase or debt decreases. Moreover, if the agent is very impatient then the consumption path may be steeply decreasing, which, in any period, causes savings to increase or debt to decrease. Therefore, to explain our findings, the decrease in work-related expenses plus a decrease in spending in the period before to after retirement (which can be assumed to be zero for monthly to annual horizons if individuals are reasonably patient) has to 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 we find in Icelandic or US data upon retirement. Furthermore, individuals would simply retire early in that case. Additionally, we could look at individuals with a very large drop in income to reject that theory. But that is not even necessary as the theory does not square with a known comparative static: when the drop in income is larger we see a larger drop in consumption so the reason here cannot be simply work-related expenses or impatience.

This argument is illustrated in Figure **??**. In a rational model, if an agent expects a fall in income and expenditure then savings will always increase so 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. However, in that case, the agent gains on net by retiring early. Thus, it is very hard to explain in any rational model, the joint observation of increasing savings after retirement and the fact that individuals who are eligible do not retire immediately.

Can labor-leisure substitution explain our findings?

Retirement comes with an increase in time that may be spent on leisure or used for home production. While it is unclear whether additional leisure time results in an increase or decrease of the marginal utility of consumption, it can be reasonably assumed that home production increases the value of purchases as argued by Aguiar and Hurst (2005). However, in principle, a negative substitutability between leisure and consumption as well as home production can simply be reinterpreted as a reduction in work-related expenses and thus the above arguments directly apply to rule out labor-leisure substitutabilities as an explanation. If expenses drop by more than income, because of labor-leisure substitutabilities or other reasons, individuals could gain in life-time resources by retiring early.

Can health shocks explain our findings?

Individuals may choose to retire in response to an adverse health shock. While it is again unclear whether health results in an increase or decrease of the marginal utility of consumption, it can be reasonably assumed that an adverse health shock also implies an adverse wealth shock which should thus decrease and not increase savings. In fact, any negative shocks have trouble to explain our findings of an increase in savings and a reduction in debt holdings. Positive wealth shocks may explain our findings, but as outlined above, we can control for all income. It could be that the health shock makes spending less enjoyable which then increases savings by reducing consumption and, at the same time, would explain why individuals retire. However, we do not find large increases in pharmacy spending upon retiring, only 6 percent in the regression not controlling for income, and we therefore think that health shocks are not the reason to retire for the average individual in our sample.

Can reduction in housing costs explain our findings?

Individuals may sell their house upon retirement or stopping to pay their mortgage and then retire. However, we observe other income that include housing transactions and we only use discretionary spending, not housing spending, in our income minus consumption robustness check.

Looking at household financial structure changes in CEX and SCF data

We use data from the Consumer Expenditure Survey (CEX) for 1980 to 2002. Following Aguiar and Hurst (2013) we use the NBER extraction files by John Sabelhaus and Ed Harris, both of the

Congressional Budget Office. The data set links the four quarterly interviews for each respondent household and collapses all the spending, income, and wealth categories into a consistent set of categories across all years under consideration. 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. As Harris and Sebelhaus (2000) suggest, consumption expenditures consist of food, tobacco, alcohol, amusement, clothing, personal care, housing, house operations (such as furniture and housesupplies), personal business, transportation such as autos and gas, recreational activities such as books and recreational sports, and charity expenditures. Alternately, 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, foodstamps, and scholarships. The data is deflated to 1984 dollars. We only consider non-student households that meet the BLS complete income reporter requirement and complete all four quarterly interviews. Furthermore, we only consider households older than 25 years and younger than 78 (the average life expectancy in the US according to the UN list).

In turn, we regress savings, as simply defined by 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 is 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 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). In contrast, in the consumption literature, it is standard to omit time effects but acknowledge cohort effects (Gourinchas and Parker, 2002). We decide to identify the regression simply by an arbitrary trend assumption, by including the full set of fixed effects. This does not make a difference to the results as we find the same 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 manner. Instead of income minus consumption, we can use checking and savings account balances as the regression outcome variable.

Table 9 shows the regression results for savings, income minus consumption, checking account balances, and savings account balances, respectively. It can be seen that the retirement dummy is positive, significant, and economically large in all specifications. That said, given that we cannot control for household fixed effects, this result may be driven by selection: richer households are retiring more early. However, when we control for income, all coefficients except one are as significant. Thus, it is interesting to find the same observations in consumption data commonly used in the literature.

The Survey of Consumer Finances (SCF) data is a statistical survey of incomes, 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. The SCF was conducted in six survey waves from 1992 to 2007 but did not survey households consecutively. We again estimate a pooled OLS model, where we jointly control for age, time, and cohort effects and identify the model with a random assumption about its trend. We employ the same age restrictions and control for family size in the same manner as for the CEX data.

Table 10 shows the regression results for leverage, debt, and savings account balances, respectively. It can be seen that the retirement dummy is negative, significant, and economically large for leverage and debt whether or not we control for income. For savings account balances, the effect of retirement is positive, significant, and large once we control for income. Additionally, we find very similar results for overdraft debt, credit card balances, checking, current, and call account balances. Again, it is interesting to find the same observations in household finances data commonly used in the literature.

Replicating the results on household financial structure changes in other individual-level datasets

While interesting, the results in CEX and SCF data cannot be taken at face value as they suffer from obvious selection problems. Therefore, we replicate our results in another individual-and-transaction-level dataset from a different country: Germany. We have access to a dataset covering all checking, savings, credit, and portfolio accounts from a German bank covering approximately 5000 individuals who transition into retirement in the period from 1998 to 2010. The results can be found in Table 11. As can be seen, consumption drops, but savings, income minus consumption, increases when individuals transition into retirement. Additionally, we see increases in portfolio values and decreases in credit account balances. We thus conclude that our results are not specific to Iceland.

Finally, we use the Panel Study of Income Dynamics (PSID) data from 1968-2015. The PSID is a nationally representative survey of households in the United States conducted by the University of Michigan. From 1968-1997, the PSID was administered annually, the PSID switched to a biennial survey format post 1997. We follow Addoum (0) and extract consumption data from years prior to 1997 and household finance data post 1997. Moreover, we follow the literature and use household food expenditures, the sum of food consumed at home and away, as a proxy for consumption. Because the PSID surveys households consecutively, we can also include individual fixed effects in our regressions. The results from 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 more value in stocks and their overall wealth increases with and without accounting for equity. The results can be found in Table 12.

4 Potential theoretical explanations

Overall, the financial structure results suggest that we should not "retire the consumption puzzle" as suggested by Hurst (2008) just yet. Any rational agent would save before retirement, given that he or she expects a fall in income, and dissave after but we observe that individuals do the exact opposite: they dissave before and save after retirement. Furthermore, as argued above, work-related expenses or substitutabilities between labor, leisure, and consumption are not obvious explanations for our findings.

A possible theoretical explanation could be the following: a freeing up of cognitive resources allows individuals to reconsider savings and consumption plans at the start of 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 (as potentially suggested by the work on cognitive resources and decision-making as in Mullainathan et al. (2007) though not confirmed by Carvalho et al. (2016)). An alternative theoretical explanation for undersaving before retirement is quasi-hyperbolic discounting preferences as in Laibson et al. (1998) and Laibson et al. (2007). However, to rationalize an incrase in savings after retirement, one would have to assume that the hyperbolic discount factor changes when the individual transitions into retirement. While this appears plausible, it feels a bit reverse-engineered. Finally, Pagel (2017) showed that consumption drops at retirement because expectations-based loss aversion predicts different degrees of present bias depending on the amount of income uncertainty, which is arguably lower after retirement. In this model, individuals indeed reverse their overconsumption and thus may increase their savings after retirement.

Expectations-based reference-dependent preferences, as developed in Kőszegi and Rabin (2009) and applied in a life-cycle model by Pagel (2017), predict a drop in consumption at retirement. During retirement, income uncertainty is absent in a standard life-cycle model–which ends time-inconsistent overconsumption. The agent stops overconsuming because he allocates certain retirement income instead of uncertain labor income. Certainty implies that overconsumption today will yield a sure loss in future consumption, and this sure loss would hurt more than today's overconsumption would give pleasure (because the agent is loss averse). Thus, the agent suddenly controls his time-inconsistent desire to overconsume and his consumption drops at retirement. This result is robust to assuming small uncertainty, such as inflation or pension risk, and discrete uncertainty, such as health shocks.

The Kőszegi and Rabin (2009) preferences in a life-cycle model consisting of T periods are defined as follows. 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

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

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 consumption utility in period t. The other terms in Equation (2) depend on consumption and beliefs. The second term in Equation (2), $n(C_t, F_{C_t}^{t-1})$, 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 contemporaneous consumption C_t relative to his previous beliefs $F_{C_t}^{t-1}$

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

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 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

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

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 $\gamma = 1$, the preferences 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.

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 if the agent's prospective news discount factor is high enough. The basic intuition is that, when the agent decides to increase 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 to not increase 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 $\frac{1+\gamma\eta\lambda}{1+\eta} < 1$. Thus, during retirement, the implications of the agent's prospective news discount factor γ are simple: it must be sufficiently high to keep the news-utility agent on the standard agent's track.

After the beginning of retirement, the agent is less inclined to overconsume than before. The basic intuition for overconsumption in the periods 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, $\gamma < 1$. 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 versus being somewhere in the gain domain in the future. In contrast, during retirement, the agent associates a certain loss in future consumption with an increase in present consumption–that is, he trades off a current gain with 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 1 ($\gamma = 1$), contemporaneous and prospective marginal news utility cancel. However, iff $\gamma < 1$, the agent reduces the weight on future utility relative to present utility by a factor $\frac{1+\gamma\eta\lambda}{1+\eta\lambda} < \frac{1+\gamma\eta}{1+\eta} < 1$. During retirement, the news-utility agent follows the standard agent's consumption path (if the prospective news discount factor γ 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 that reduces the weight on future utility is necessarily lower in the period just before retirement than during retirement–implying that consumption drops at the beginning of retirement. The drop in consumption 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.

The assumption of no uncertainty during retirement is made in all standard life-cycle consumption models, as these are abstracted from portfolio choice; thus, the drop in consumption at retirement is 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 risk); potentially large discrete income uncertainty (for instance, health shocks); and mortality risk.[7]

In the following we assess whether the model's quantitative predictions match the empirical evidence. To demonstrate that all predictions hold in model environments that are commonly assumed in the life-cycle consumption literature, we present the numerical implications of a power-utility model, that is, $u(C) = \frac{C^{1-\theta}}{1-\theta}$ with θ being the coefficient of constant relative risk aversion.[8]

[7]The drop in consumption is due to the fact that the agent overconsumes before retirement, but consumes efficiently after retirement. If income uncertainty is very small, the agent can credibly plan a flat consumption level, independent of the realization of his income shocks as the benefits of smoothing consumption perfectly are too small relative to the costs of experiencing news utility. In such a small-uncertainty situation, the agent can stick to a flat consumption level that induces less overconsumption after retirement than before retirement, such that consumption drops. Moreover, discrete uncertainty after retirement induces less overconsumption than before retirement for the same reason that no uncertainty causes less overconsumption. If uncertainty is discrete, overconsumption is associated with a discrete gain in present consumption and a discrete loss in future consumption. Because the discrete loss hurts more than the discrete gain, the agent may credibly plan a consumption level that induces less overconsumption than the baseline continuous-outcome equilibrium. Finally, mortality risk does not affect the result, as the agent would not experience news utility relative to being dead. Additionally, the drop in consumption is robust to uncertainty becoming small in the period just before retirement, even if the agent then chooses a flat consumption function.

[8]The model cannot be solved analytically, but it can be solved by numerical backward induction (Gourinchas

We follow Carroll (1997) and Gourinchas 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 labor 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 $p = 0.01$. G_t implies a hump-shaped income profile and is estimated from CEX data but we set it to be a flat line initially to highlight the different predictions of the different models. For the preference parameters, we use the same calibration as in Pagel (2017). In addition to the standard and news-utility agents, we show results for quasi-hyperbolic preferences, as in Laibson et al. (2012), internal, multiplicative habit-formation preferences, as assumed in Michaelides (2002), and temptation-disutility preferences, as developed by Gul and Pesendorfer (2004) and assumed in Bucciol (2012). For the habit-formation agent, we follow Michaelides (2002) and choose a habit-forming parameter $h = 0.45$. The tempted agent's additional preference parameter $\tau = 0.1$ is chosen following the estimate of Bucciol (2012).

Figure 13 contrasts the five agents' consumption paths with the empirical consumption and income profiles. We show only part of the habit-formation agent's consumption profile because he engages in extremely high wealth accumulation, owing to his high effective risk aversion, confirming the findings of Michaelides (2002). Hyperbolic-discounting preferences push the consumption profile upward at the beginning and downward at the end of life. Temptation disutility causes severe overconsumption at the beginning of life, which then reduces when consumption opportunities are depleted. Standard, hyperbolic-discounting, news-utility, and

and Parker, 2002; Carroll, 2001, among others). The numerical solution is illustrated in greater detail in Appendix A.

temptation-disutility preferences all generate a hump-shaped consumption profile. The consumption path of the standard and hyperbolic agents is increasing at the beginning of life because power utility makes them unwilling to borrow; however, these agents are also sufficiently impatient, such that consumption eventually decreases. Because power utility eliminates the possibility of negative or zero consumption and because of the small possibility of zero income in all future periods, the agents will never find it optimal to borrow.

Moreover, Figure 13 shows a drop in consumption at retirement, period $T-R$, for both the news-utility consumption profile and the CEX consumption data. Thus, we conclude that the news-utility agent's lifetime consumption profile looks very similar to the average consumption profile from CEX data. Let us now demonstrate the drop in a regression using simulated data. We simulate 200 consumption and income data points and run the regression

$$\Delta log(C_{T-R}) = \alpha + \beta \Delta log(Y_{T-R}) + \varepsilon_{T-R}.$$

We thus look at the change in consumption at the onset of retirement, controlling for the change in income. The intercept α will then determine the drop in consumption at retirement. Moreover, we will run the same regression but with savings growth, $\Delta log(X_{T-R} - C_{T-R})$, on the left-hand side. The results are shown in Table 14. In the news-utility model, we obtain a regression intercept $\alpha \approx -0.11$ while the intercepts of all other agents are basically zero. Hyperbolic discounting preferences are not able to generate a drop in consumption at retirement 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 may cause a fall in consumption. However, in such a situation, we would have to assume that individuals hit their liquidity constraint before and after retirement. Empirically, we see individuals having substantial liquidity though.

Moreover, for the news-utility agent the intercept for savings is positive and significant while it is negative for the other agents. Clearly, the news-utility agent will also decumulate his savings after retirement. However, there is another force, the change in his effective discount factor, that increases savings at retirement via the fall in consumption. This force can temporarily increase his savings upon retirement.

In turn, we can introduce work-related expenses into the model. We simply assume that consumption is 10 percent higher before retirement because of work-related expenses. We then run the regressions measuring the drop in consumption at retirement that now trivially indicate such a drop. However, the results for savings growth are unchanged and thus consistute another test that any model of spending around retirement should be able to rationalize.

5 Conclusion

We document expenditure across different consumption categories and household financial structure responses to retirement using a large proprietary data set on consumer financial accounts. Exploiting the fact that we observe pension payments in our data set, we show that the overall decline in spending post-retirement is in part attributable to work-related expenses. Individuals spend less on ready-made food and clothes when they retire, which is consistent with a reduction in work-related expenses. However, we also observe reductions in leisure goods suggesting the presence of an overconsumption problem before retirement and an adjustment after. Finally, we are the first to document individual financial structure changes at the onset of retirement. We find that individuals reduce consumer debt positions substantially and increase liquid savings. The findings about debt and savings imply that we cannot ”retire the consumption puzzle” as suggested by Hurst (2008) just yet. After all, the retirement-consumption puzzle is about individuals not being able to plan for an expected reduction in income. Any rational plan for a reduction in income would feature saving before and dissaving after retirement. Observing that individuals decrease their debt and increase their savings is thus the opposite of what any rational agent would do.

References

Addoum, Jawad M., "Household Portfolio Choice and Retirement," *The Review of Economics and Statistics*, 0, *0* (ja), null.

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, 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.

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.

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

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.

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, Frank N Caliendo et al., "Rationalizing Seven Consumption $ Saving Puzzles in a Unified Framework," Technical Report, Vanderbilt University Department of Economics 2007.

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.

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.

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.

Michaelides, A., "Buffer Stock Saving and Habit Formation," *LSE and CEPR Working Paper*, 2002.

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 Liquid Hand-to-Mouth: Evidence from a Personal Finance Management Software," Technical Report 2016.

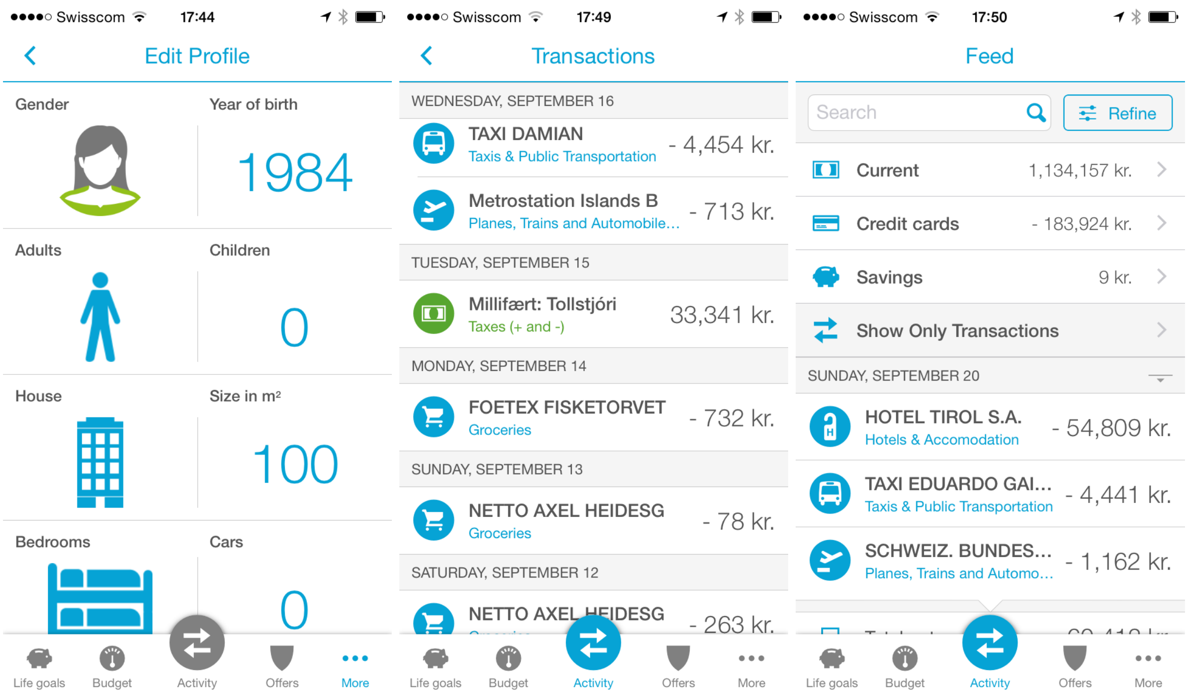
Pagel, Michaela, "Expectations-Based Reference-Dependent Life-Cycle Consumption," *Review of Economic Studies*, 2017.

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.

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

Figure 1: The financial aggregation app: screenshots



Notes: This figure shows the Meniga app.

Table 1: Summary Statistics

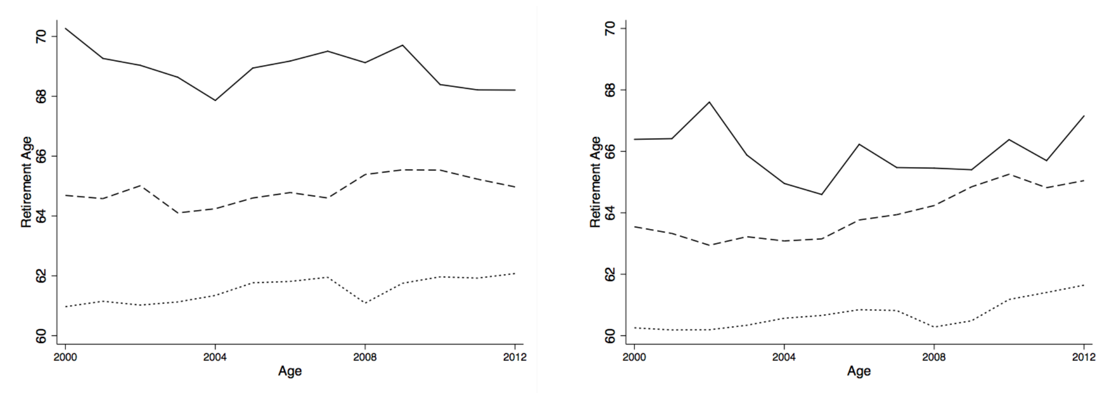
	Mean	Standard Deviation	Statistics Iceland
Monthly regular income	3,547	3,717	3,768
Monthly salary	3,157	3,494	2,867
Monthly spending:			
Total	1,535	1,429	
Groceries	546	454	572
Fuel	276	302	(419)
Alcohol	72	141	99
Ready Made Food	198	202	(294)
Home Improvement	175	543	(267)
Transportations	68	817	77
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
Eligible 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

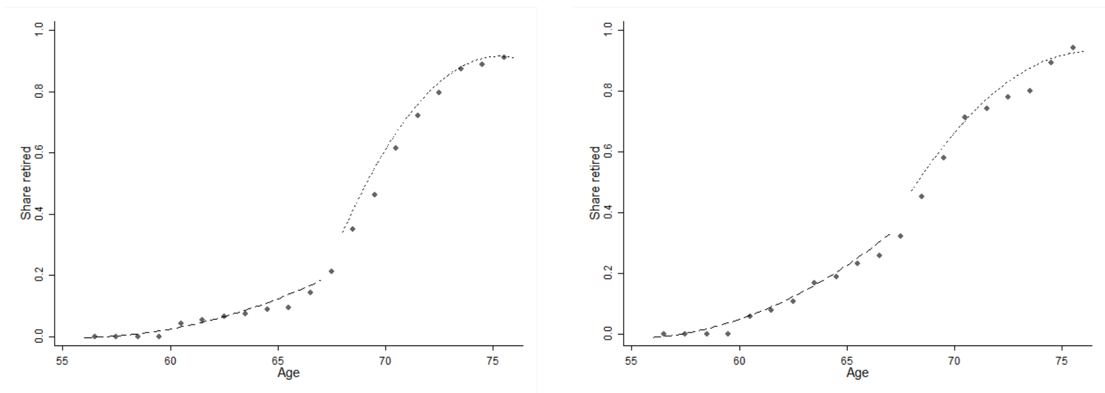
	Eligible but not retired		Retired	
	Mean	St.dev.	Mean	St.dev.
Demographics:				
Age	64.2	3.6	71.4	6.4
Female	0.41	0.49	0.41	0.49
Monthly income:				
Total	4,580	3,973	3,399	2,560
Regular	4,462	3,856	3,289	242,316
Irregular	8.9	39.1	7.9	37.3
Salary	4,066	3,706	717	2,084
Total hh	4,865	4,263	3,721	2,943
Individual finances:				
Total bank fees	20.4	36.0	14.0	30.4
Late fees	3.6	9.1	2.6	7.5
Overdraft interest	14.8	2.8	9.8	2,3
Savings account balance	6,098	14,411	9,400	17,333
Current account balance	2,974	5,834	2,484	4,952
Overdraft limit	3,351	4,923	2,708	4,233
Credit card balance	2,043	1,867	1,683	1,587
Credit card card limit	7,655	6,472	6,755	5,476
Liquidity	19,079	21,150	20,951	22,853
Cash	9,741	18,143	12,633	20,571
Overdraft	1,924	4,375	1,325	3,606
Daily spending:				
Individual:				
Total	56.9	38.8	53.6	31.6
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	5.8	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	60.6	42.3	57.8	36.2
Groceries	17.4	12.9	17.7	11.0
Fuel	8.3	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	11.2
Home security	0.3	0.8	0.3	0.8
Transportation	2.9	6.2	2.5	5.6
Clothing & accessories	3.8	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.



Men Women

Figure 2: Average effective retirement age for men and women in Iceland compared to Germany and the United States



Men Women

Figure 3: Share retired by age

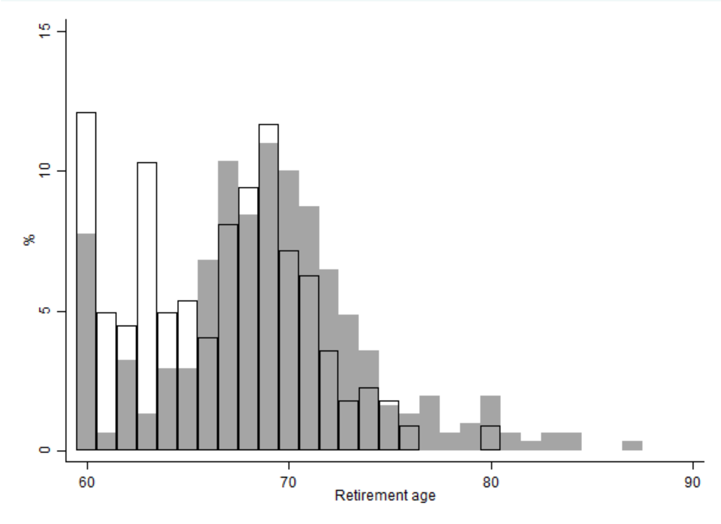
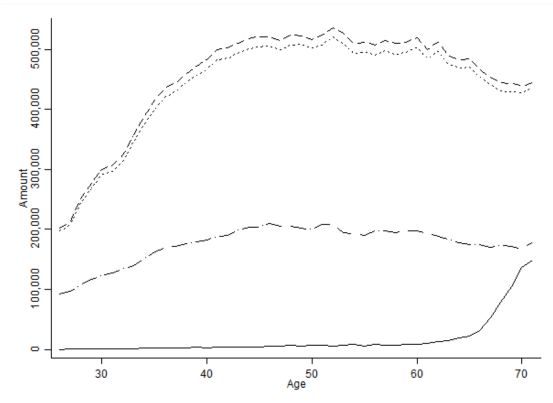
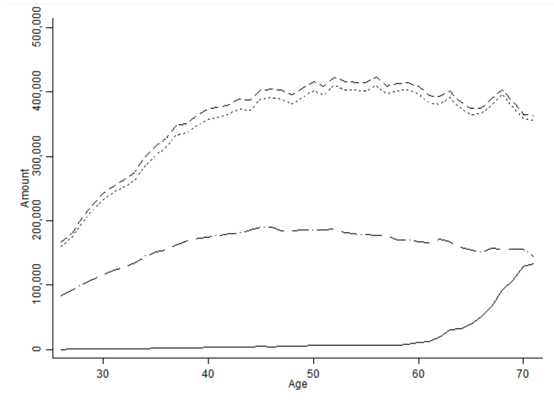


Figure 4: Distribution of retirement age: women (white bars) and men (gray bars)



Men



Women

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

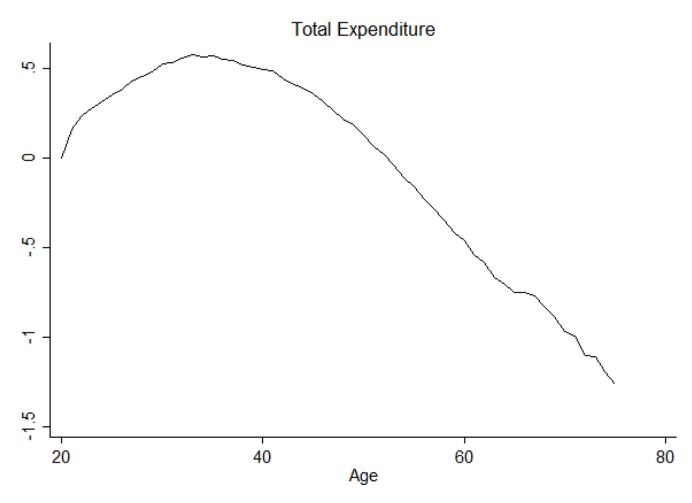


Figure 6: Total spending

This figure plots the log total monthly spending for each age relative to individuals at age 20. The figure controls for month fixed effects, year fixed effects, and individual fixed effects.

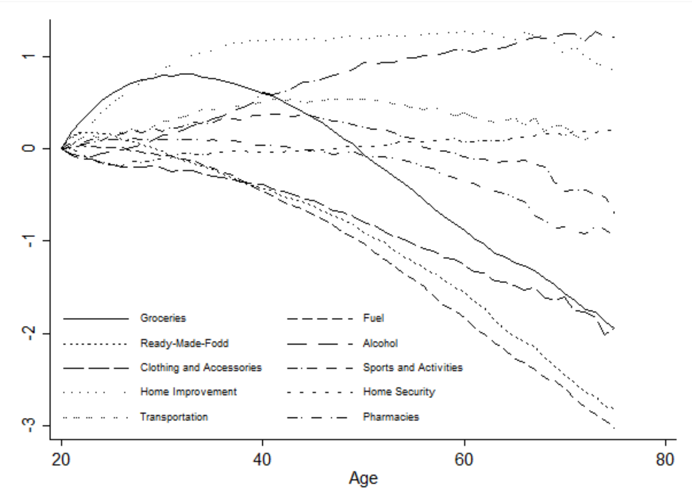


Figure 7: Spending by category

This figure plots the log total monthly spending on different consumption categories for each age relative to individuals at age 20.The figure controls for month fixed effects, year fixed effects, and individual fixed effects.

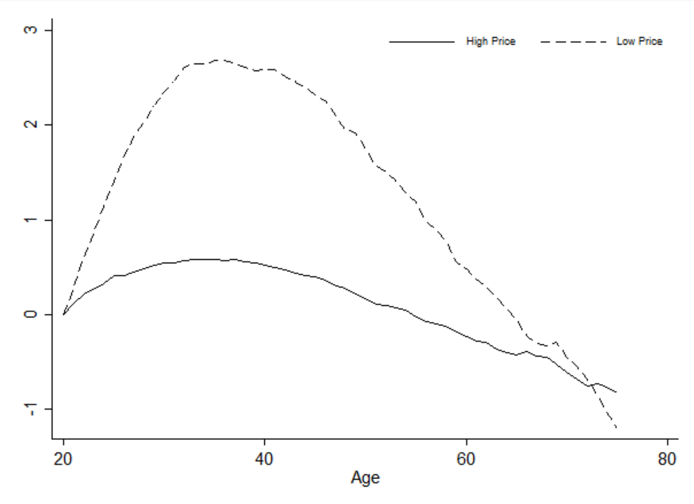


Figure 8: Grocery spending by price category

This figure plots the log total monthly spending in budget and expensive grocery stores for each age relative to individuals at age 20.The figure controls for month fixed effects, year fixed effects, and individual fixed effects.

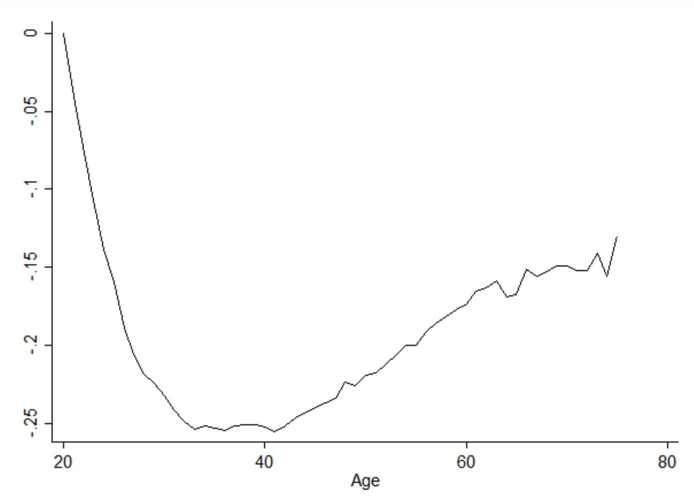


Figure 9: Share of expensive groceries

This figure plots the share of expenditures in grocery stores/supermarkets that are spent in expensive stores relative to individuals at age 20.The figure controls for month fixed effects, year fixed effects, and individual fixed effects.

Table 3: Effects of retirement on household expenditures

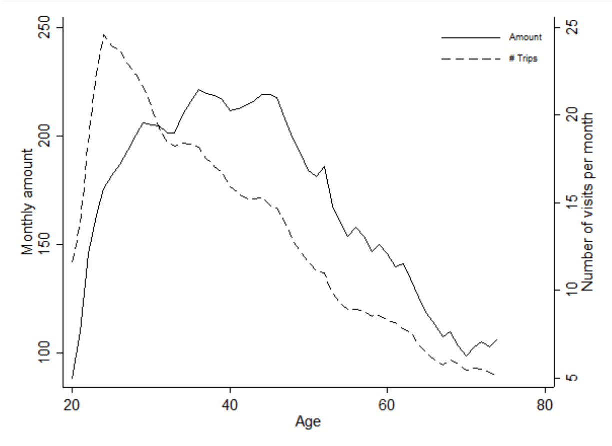
	Total expenditure	Grocery	Fuel	Alcohol	Ready-made -food	Home improvement	Home Security	Transportation	Clothing and Accessories	Sports and Activities	Pharmacies
All individuals:											
Retired	-164.2***	-1.0	-29.0***	7.3**	-152.0***	25.4*	4.5***	-12.6*	-52.3***	-11.7***	20.1***
	(40.7)	(12.3)	(7.2)	(3.5)	(6.5)	(13.7)	(0.4)	(6.5)	(8.9)	(1.7)	(2.3)
Δ from mean	-2.7%	-0.1%	-3.6%	2.5%	-35.8%	3.9%	13.5%	-4.5%	-14.6%	-33.7%	9.0%
R-sqr	0.216	0.193	0.065	0.059	0.173	0.042	0.013	0.031	0.06	0.012	0.038
#obs	886,512	886,512	886,512	886,512	886,512	886,512	886,512	886,512	886,512	886,512	886,512
#individuals	12,143	12,143	12,143	12,143	12,143	12,143	12,143	12,143	12,143	12,143	12,143
Women:											
Retired	-152.4**	14.6	-47.8***	10.4**	-130.9***	26.1	-3.1***	-4.1	-58.3***	-8.4***	17.0***
	(60.2)	(19.6)	(9.8)	(4.7)	(9.2)	(19.8)	(0.6)	(8.8)	(14.5)	(2.6)	(3.8)
Δ from mean	-2.7%	0.8%	-7.9%	4.8%	-32.6%	4.3%	-11.9%	-2.1%	-13.0%	-27.9%	7.0%
R-sqr	0.231	0.205	0.06	0.051	0.181	0.047	0.011	0.029	0.069	0.014	0.045
#obs	425,371	425,371	425,371	425,371	425,371	425,371	425,371	425,371	425,371	425,371	425,371
#individuals	5,826	5,826	5,826	5,826	5,826	5,826	5,826	5,826	5,826	5,826	5,826
Men:											
Retired	-177.8***	-5.5	-18.1*	2.4	-172.2***	22.6	9.8***	-21.0**	-41.9***	-13.8***	23.9***
	(55.4)	(15.7)	(10.4)	(5.0)	(9.2)	(19.0)	(0.6)	(9.4)	(11.1)	(2.3)	(2.8)
Δ from mean	-2.8%	-0.3%	-1.9%	0.7%	-39.0%	3.3%	25.5%	-6.2%	-14.2%	-36.3%	11.3%
R-sqr	0.204	0.185	0.07	0.066	0.169	0.038	0.015	0.033	0.052	0.011	0.032
#obs	461,141	461,141	461,141	461,141	461,141	461,141	461,141	461,141	461,141	461,141	461,141
#individuals	6,317	6,317	6,317	6,317	6,317	6,317	6,317	6,317	6,317	6,317	6,317
Individual FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Month FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Total HH income	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Note: [a] This table shows regression results for winsorized household spending categories using individual and calendar fixed effects as well as a dummy for retirement. All specifications control for total household income. Standard errors are clustered at the individual level. [b] Significance levels: * $p<0.1$ ** $p<0.05$ *** $p< 0.01$
[c] All numbers are in US dollars.

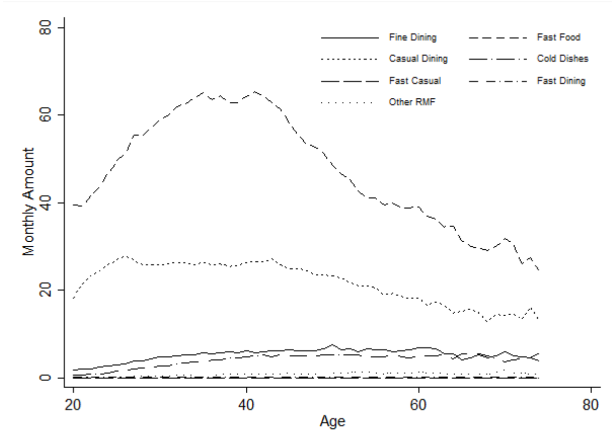
Table 4: Effects of retirement on household expenditures

	Total expenditure	Grocery	Fuel	Alcohol	Ready-Made -Food	Home Improvement	Home Security	Transportation	Clothing and Accessories	Sports and Activities	Pharmacies
All individuals:											
Retired	-445.2***	-65.4***	-62.3***	-1.8	-180.1***	-10.7	3.9***	-26.9***	-77.5***	-13.6***	14.6***
	(42.0)	(12.6)	(7.3)	(3.5)	(6.6)	(13.8)	(0.4)	(6.5)	(8.9)	(1.7)	(2.3)
Δ from mean	-7.4%	-3.7%	-7.8%	-0.6%	-42.4%	-1.6%	11.7%	-9.6%	-21.7%	-39.1%	6.5%
R-sqr	0.166	0.164	0.039	0.05	0.153	0.033	0.01	0.025	0.05	0.011	0.031
#obs	886,512	886,512	886,512	886,512	886,512	886,512	886,512	886,512	886,512	886,512	886,512
#individuals	12,143	12,143	12,143	12,143	12,143	12,143	12,143	12,143	12,143	12,143	12,143
Women:											
Retired	-407.0***	-50.1**	-73.6***	3	-155.4***	-6.6	-3.6***	-14.6*	-85.4***	-10.3***	11.1***
	(62.2)	(20.0)	(9.9)	(4.8)	(9.3)	(19.9)	(0.6)	(8.8)	(14.6)	(2.6)	(3.9)
Δ from mean	-7.2%	-2.7%	-12.2%	1.4%	-38.7%	-1.1%	-13.8%	-7.3%	-19.1%	-34.3%	4.6%
R-sqr	0.178	0.171	0.035	0.042	0.158	0.037	0.008	0.023	0.057	0.012	0.036
#obs	425,371	425,371	425,371	425,371	425,371	425,371	425,371	425,371	425,371	425,371	425,371
#individuals	5,826	5,826	5,826	5,826	5,826	5,826	5,826	5,826	5,826	5,826	5,826
Men:											
Retired	-475.3***	-68.1***	-57.3***	-7.9	-202.6***	-15.7	9.0***	-38.3***	-64.8***	-15.6***	18.8***
	(57.0)	(16.0)	(10.5)	(5.0)	(9.3)	(19.1)	(0.6)	(9.5)	(11.1)	(2.3)	(2.8)
Δ from mean	-7.6%	-4.0%	-6.2%	-2.3%	-45.9%	-2.3%	23.4%	-11.4%	-21.9%	-41.0%	8.9%
R-sqr	0.157	0.158	0.043	0.058	0.151	0.03	0.011	0.027	0.044	0.01	0.026
#obs	461,141	461,141	461,141	461,141	461,141	461,141	461,141	461,141	461,141	461,141	461,141
#individuals	6,317	6,317	6,317	6,317	6,317	6,317	6,317	6,317	6,317	6,317	6,317
Individual FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Month FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Total HH income											

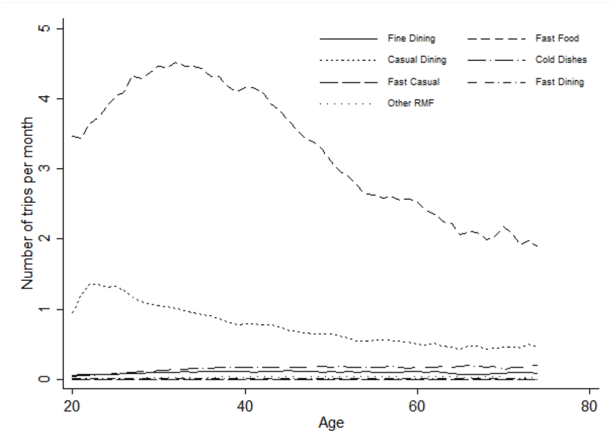
Note: [a] This table shows regression results for winsorized household spending categories using individual and calendar fixed effects as well as a dummy for retirement. Standard errors are clustered at the individual level. [b] Significance levels: * $p<0.1$ ** $p<0.05$ *** $p<0.01$ [c] All numbers are in US dollars.



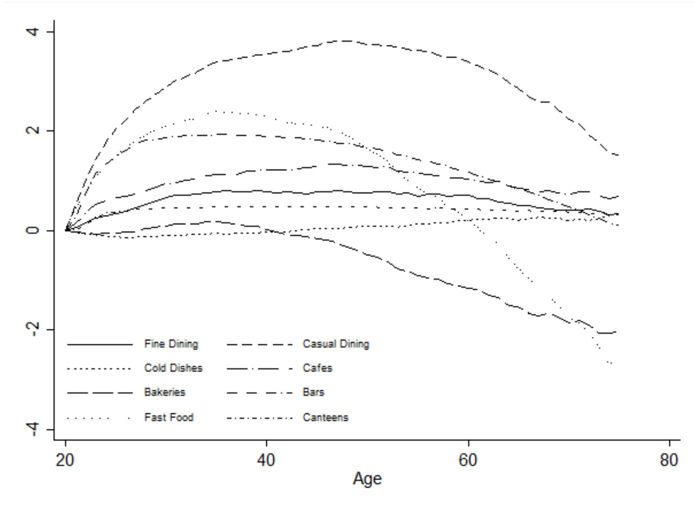
Restaurant spending (solid) and visits (broken)



Restaurant expenditure by category per month



Restaurant trips by category per month



Expenditure by type of restaurant

Figure 10: Life-cycle profiles of restaurant trips and grocery store visits

Table 5: Effects of retirement on household restaurant spending

	Total	Casual dining	Cold dishes	Cafes	Bakeries	Bars	Fast food	Fine dining	Canteens
Spending:									
Retired	-53.27***	-21.25***	-0.27	-1.99 ***	-1.41***	-6.22***	-30.02***	-1.79***	-0.34***
	(2.10)	(1.12)	(0.22)	(0.47)	(0.48)	(0.51)	(1.44)	(0.62)	(0.05)
Δ from mean	-25.5%	-31.2%	-5.3%	-10.1%	-5.8%	-45.1%	-28.5%	-10.6%	-52.1%
Number of visits:									
Retired	-3.42***	-0.65***	0.01	-0.11***	0.07***	-0.24 ***	-1.14 ***	-0.03***	-0.06 ***
	(0.25)	(0.04)	(0.01)	(0.03)	(0.03)	(0.03)	(0.09)	(0.01)	(0.01)
Δ from mean	-20.1%	-25.7%	5.5%	-8.4%	4.3%	-40.3%	-19.0%	-10.6%	-78.3%
Individual FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Month FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Total HH income	✓	✓	✓	✓	✓	✓	✓	✓	✓
R-sqr - amount	0.195	0.088	0.015	0.038	0.057	0.022	0.103	0.016	0.011
R-sqr - trips	0.07	0.051	0.01	0.019	0.039	0.014	0.054	0.015	0.007
#obs.	900,090	900,090	900,090	900,090	900,090	900,090	900,090	900,090	900,090

Note: [a] This table shows regression results for spending on different restaurant categories. Standard errors are clustered at the individual level. All specifications control for total household income. [b] Significance levels: * p<0.1 ** p<0.05 *** p< 0.01 [c] All numbers are in US dollars.

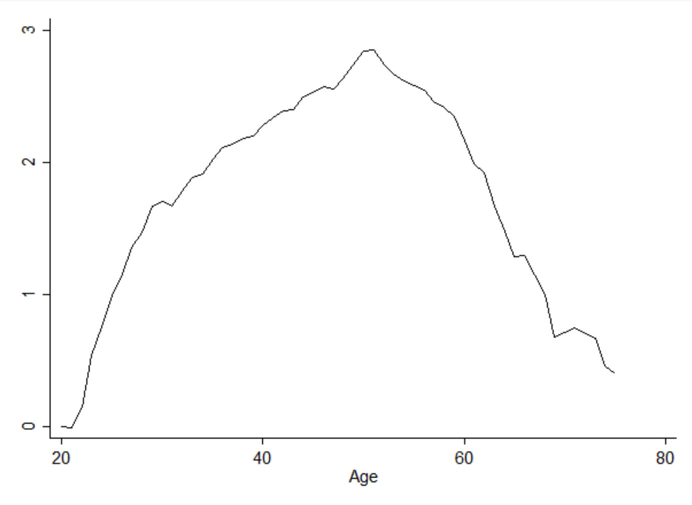


Figure 11: Consumer debt

This figure plots the log total monthly overdraft interest payments for each age relative to individuals at age 20.The figure controls for month fixed effects, year fixed effects, and individual fixed effects.

Table 6: Effects of retirement on household finances

	Late fees	Overdraft interest	Savings	Current Account balance	Overdraft limit	Credit card balance	Credit card limit	Liquidity	Cash
All individuals:									
Retired	-0.27***	-2.05***	793.03***	-153.87**	-155.72***	-144.00***	22.94	837.15***	497.36***
	(0.10)	(0.20)	(108.27)	(75.28)	(56.86)	(21.65)	(42.33)	(179.14)	(156.49)
Δ from mean	-9.3%	-17.5%	13.2%	-6.3%	-5.7%	-8.6%	0.4%	5.0%	5.5%
R-sqr	0.022	0.035	0.006	0.01	0.007	0.012	0.028	0.021	0.011
#obs	886,512	886,512	331,818	331,818	331,818	331,818	331,818	331,818	331,818
#individuals	12,143	12,143	12,143	12,143	12,143	12,143	12,143	12,143	12,143
Women:									
Retired	0.05	-2.36***	825.73***	-161.56	-179.66**	-107.41***	-24.70	277.50	3855.48*
	(0.15)	(0.28)	(154.95)	(101.72)	(79.49)	(31.69)	(58.39)	(247.83)	(216.66)
Δ from mean	1.9%	-21.7%	16.2%	-8.1%	-7.6%	-7.0%	-0.4%	1.9%	5.1%
R-sqr	0.024	0.039	0.006	0.009	0.007	0.012	0.024	0.02	0.011
#obs	425,371	425,371	161,356	161,356	161,356	161,356	161,356	161,356	161,356
#individuals	5,826	5,826	5,826	5,826	5,826	5,826	5,826	5,826	5,826
Men:									
Retired	-0.49***	-1.82***	763.53***	-160.06	-136.71*	-171.33***	52.73	1239.02***	564.08**
	(0.13)	0.27	(151.30)	(109.38)	(80.82)	(29.73)	(60.69)	(256.39)	(223.90)
Δ from mean	-15.9%	-14.8%	11.4%	-5.8%	-4.5%	-9.6%	0.8%	6.6%	5.5%
R-sqr	0.021	0.032	0.006	0.012	0.007	0.012	0.031	0.023	0.013
#obs	461,141	461,141	170,462	170,462	170,462	170,462	170,462	170,462	170,462
#individuals	6,317	6,317	6,317	6,317	6,317	6,317	6,317	6,317	6,317
Individual FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Month FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Total HH income	✓	✓	✓	✓	✓	✓	✓	✓	✓

Note: [a] This table shows regression results for winsorized household interest payments, balances, and limits using individual and calendar fixed effects as well as a dummy for retirement. All specifications control for total household income. Standard errors are clustered at the individual level. [b] Significance levels: * $p<0.1$ ** $p<0.05$ *** $p<0.01$ [c] All numbers are in US dollars.

Table 7: Effects of retirement on household finances

	Late fees	Overdraft interest	Savings	Current Account balance	Overdraft limit	Credit Card balance	Credit Card limit	Liquidity	Cash
All individuals:									
Retired	-0.48***	-2.40***	720.70***	-240.09***	-164.41***	-149.77***	13.72	644.03***	327.87**
	(0.10)	0.20	(108.28)	(75.37)	(56.83)	(21.65)	(42.31)	(179.34)	(156.67)
Δ from mean	-16.7%	-20.5%	12.0%	-9.8%	-6.0%	-8.9%	0.2%	3.8%	3.6%
R-sqr	0.016	0.031	0.005	0.007	0.007	0.012	0.028	0.018	0.008
#obs	886,512	886,512	331,818	331,818	331,818	331,818	331,818	331,818	331,818
#individuals	12,143	12,143	12,143	12,143	12,143	12,143	12,143	12,143	12,143
Women:									
Retired	-0.15	-2.69***	763.75***	-235.13**	-190.48**	-111.91***	-34.24	109.98	242.95
	(0.15)	(0.29)	(155.02)	(101.92)	(79.46)	(31.68)	(58.39)	(248.25)	(217.00)
Δ from mean	-5.6%	-24.7%	15.0%	-11.7%	-8.1%	-7.3%	-0.6%	0.8%	3.2%
R-sqr	0.017	0.034	0.005	0.005	0.007	0.012	0.024	0.016	0.007
#obs	425,371	425,371	161,356	161,356	161,356	161,356	161,356	161,356	161,356
#individuals	5,826	5,826	5,826	5,826	5,826	5,826	5,826	5,826	5,826
Men:									
Retired	-0.71***	-2.19***	684.40***	-254.48**	-142.77*	-178.07***	44.38	1029.98***	376.17*
	(0.13)	(0.27)	(151.28)	(109.48)	(80.77)	(29.71)	(60.65)	(256.57)	(224.08)
Δ from mean	-23.1%	-17.8%	10.2%	-9.2%	-4.7%	-10.0%	0.7%	5.5%	3.7%
R-sqr	0.015	0.028	0.005	0.009	0.007	0.012	0.031	0.020	0.010
#obs	461,141	461,141	170,462	170,462	170,462	170,462	170,462	170,462	170,462
#individuals	6,317	6,317	6,317	6,317	6,317	6,317	6,317	6,317	6,317
Individual FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Month FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Total HH income									

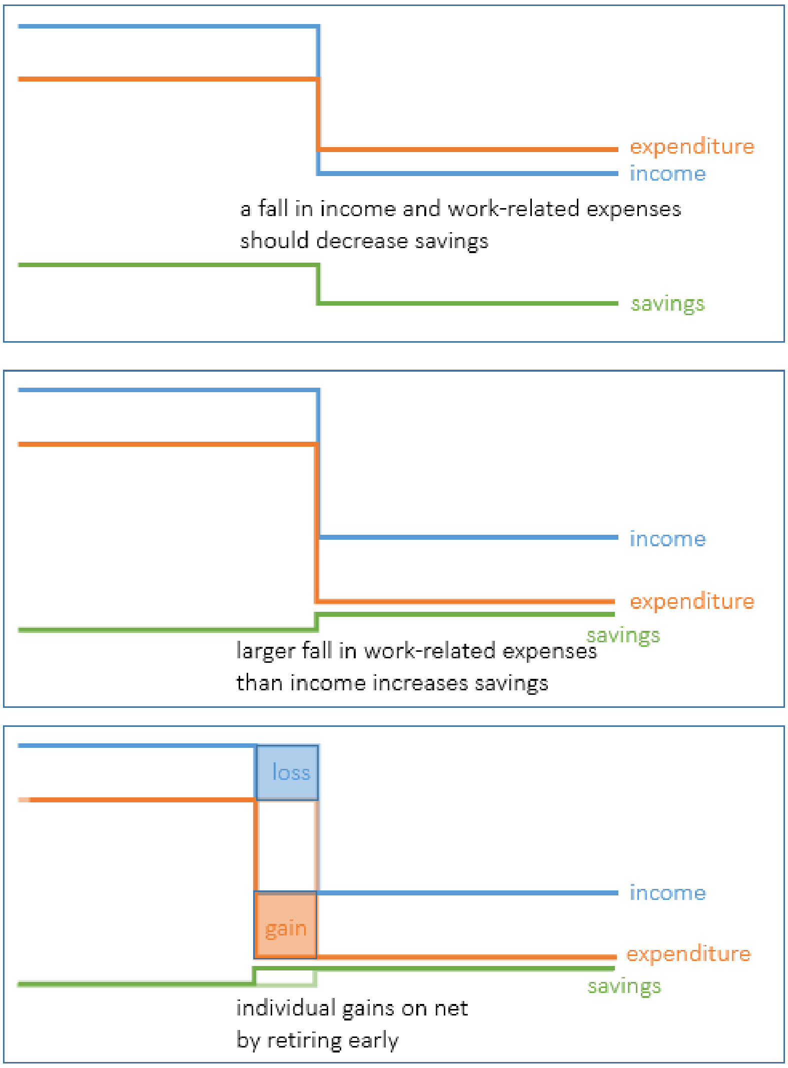
Note: [a] This table shows regression results for winsorized household interest payments, balances, and limits using individual and calendar fixed effects as well as a dummy for retirement. Standard errors are clustered at the individual level. [b] Significance levels: * p<0.1 ** p<0.05 *** p< 0.01 [c] All numbers are in US dollars.

Table 8: Effects of retirement on savings, i.e., income minus spending

	Individual savings	Individual savings	Household savings	Household savings
All individuals:				
Retired	82.64***	100.93***	128.33***	143.79***
	(10.48)	(11.52)	(11.44)	(12.74)
Δ from mean	3.2%	3.9%	4.7%	5.2%
R-sqr	0.919	0.902	0.922	0.903
#obs	730,721	730,721	739,508	739,508
#individuals	12,144	12,144	12,144	12,144
Women:				
Retired	71.32***	77.35***	117.85***	120.44***
	(15.28)	(16.72)	(16.90)	(18.78)
Δ from mean	3.2%	3.5%	4.9%	5.0%
R-sqr	0.912	0.895	0.917	0.897
#obs	351,549	351,549	356,377	356,377
#individuals	5,827	5,827	5,827	5,827
Men:				
Retired	91.34***	118.36***	137.39***	161.88***
	(14.42)	(15.90)	(15.60)	(17.38)
Δ from mean	3.1%	4.0%	4.9%	5.7%
R-sqr	0.924	0.907	0.925	0.907
#obs	379,172	379,172	383,131	383,131
#individuals	6,317	6,317	6,317	6,317
Individual FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓
Month FE	✓	✓	✓	✓
Total HH income	✓		✓	
Regular HH income		✓		✓
Irregular HH income		✓		✓

Note: [a] This table shows regression results for winsorized individual and household savings, i.e., income minus spending. Standard errors are clustered at the individual level. [b] Significance levels: * p<0.1 ** p<0.05 *** p< 0.01 [c] All numbers are in US dollars.

Figure 12: 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 he or she retires early.

Table 9: Effects of retirement on savings, i.e., income minus consumption, checking, and savings account balances in CEX data

	Log income minus consumption	Log income minus consumption	Log of current account	Log of current account	Log of savings account	Log of 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

te: [a] This table shows regression results for household savings, i.e., 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 [c] All coefficients represent percentage changes.

Table 10: Effects of retirement on leverage, debt, current and savings account balances in SCF data

	Leverage	Leverage	Log of debt	Log of debt	Log of current account	Log of current account	Log of savings account	Log of savings account
Retired	-0.293**	-0.349***	-0.674***	-0.211***	0.00551	0.329***	0.0762	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 household savings, i.e., 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 [c] All coefficients represent percentage changes.

Table 11: Effects of retirement on spending, savings, portfolio, and credit accounts in German bank account data

	Spending	Spending	Income minus spending	Income minus spending	Value of portfolio	Value of portfolio	Credit account balance	Credit account balance
Retired	-470.8***	-249.3***	892.8***	295.5***	7810.1***	7766.9***	-7565.0*	-7526.4*
	(-10.87)	(-10.64)	(9.92)	(10.83)	(7.28)	(7.24)	(-2.32)	(-2.33)
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 winsorized household spending, savings, i.e., income minus spending, 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 [c] All numbers are in Euros.

Table 12: Effects of retirement on spending, checking and savings account balances, value of stocks, and weal
without equity in PSID data

	Spending	Spending	Account balances	Account balances	Value of stocks	Value of stocks	Wealth without equity	Wealth without equity
Retired	-1,736.8***	-1,162.5***	7,861.7**	13,660.8***	38,831.5***	50,421.9***	90,430.8***	144,671.4**
	(-19.88)	(-10.61)	(3.29)	(5.11)	(4.20)	(4.33)	(3.47)	(4.96)
Indiv FE	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓
Total HH income		✓		✓		✓		✓
#obs	138,145	138,143	85,637	85,635	85,637	85,635	85,637	85,635

Note: [a] This table shows regression results for winsorized household spending, checking and savings account balances, value o
stocks, and wealth without equity. Standard errors are clustered at the individual level. [b] Significance levels: * p<0.1 ** p<0.0
*** p< 0.01 [c] All numbers are in US dollars.

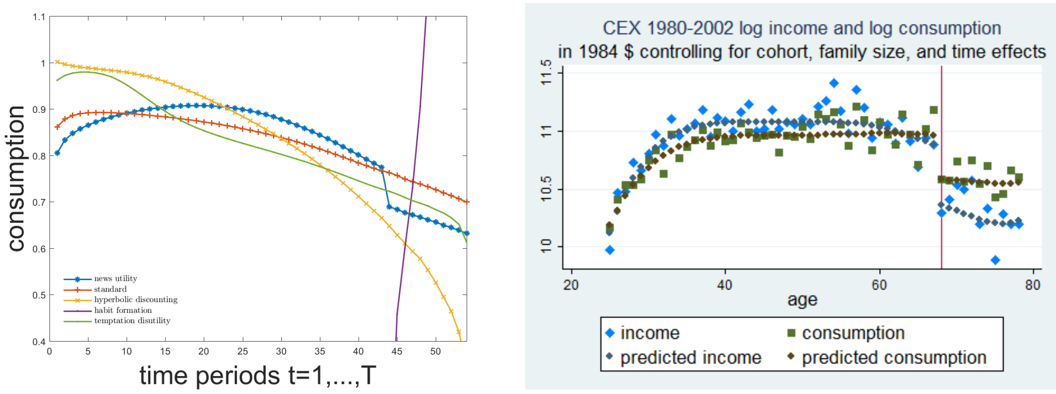
Table 13: Environmental and preference parameters

parameter	μ_P	σ_P	μ_T	σ_T	p	G_t	r	P_0	$\frac{A_0}{P_0}$	R	T
value	0	0.1	$-\frac{p}{1-p}$	0.1	0.01	1	1%	1	0.0096	10	60

parameter	β	θ	η	λ	γ	b	h	τ
value	0.97	2	1	3	0.7	0.7	0.45	0.1

This table displays all calibrated parameters.

Figure 13: 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 $\mu_T = \mu_P = 0$, $\sigma_T = \sigma_P = 0.1$, $p = 0.01$, and $G_t = 1$ for all t. The preference parameters are $\beta = 0.97$, $r = 1\%$, $\theta = 2$, $\eta = 1$, $\lambda = 3$, $\gamma = 0.7$, the hyperbolic discounting parameter is 0.7, the habit-forming parameter is $h = 0.45$, and the temptation-disutility parameter is $\tau = 0.1$. The unit of consumption and income is the log of 1984 dollars controlling for cohort, family size, and time effects.

Table 14: Retirement-consumption puzzle regression results

Model	news-utility		standard		hyperbolic		habit		tempted	
	α	β	α^s	β^s	α^b	β^b	α^h	β^h	α^{td}	β^{td}
coefficient consumption	-0.109	-0.012	-0.002	0.0005	-0.022	-0.001	0.0001	0.001	-0.007	-0.001
t-statistic	-140.9	-1.578	-23.88	0.558	-198.4	-0.711	10.82	0.633	-65.33	-0.973
coefficient savings	0.001	0.007	-0.001	0.0069	-0.014	0.0073	-0.001	0.002	-0.002	0.007
t-statistic	3.327	2.894	-3.670	2.819	-3.670	2.819	-3.238	2.276	-6.781	2.824

The table displays the regression results of 200 simulated data points. The coefficient α captures the percentage fall (increase) in consumption (savings) at retirement

A Derivation of the theoretical framework

A.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

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

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

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 η, 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 $\gamma\beta R E_{T-1}[u'(C_T)]\eta(\lambda - (\lambda-1)F^{T-2}_{A_{T-1}}(A_{T-1}))$. 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 σ_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

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

Again, we can normalize maximization problem by $P_{T-i}^{1-\theta}$ 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

$$u'(c_{T-i}) = \frac{\Psi_{T-i}^{'} + \gamma \Phi_{T-i}^{'} \eta(\lambda - (\lambda - 1) F_{c_{T-i}}^{T-i-1}(c_{T-i}))}{1 + \eta(\lambda - (\lambda - 1) F_{a_{T-i}}^{T-i-1}(a_{T-i}))}$$

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}, $F_{a_{T-i}}^{T-i-1}(a_{T-i})$, and $F_{c_{T-i}}^{T-i-1}(c_{T-i})$. 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 $G_{T-i} e^{s_{T-i}^{P}}$; thus, we cannot fully normalize the problem but have to find the right consumption grid for each value of $G_{T-i} e^{s_{T-i}^{P}}$ rather than just one. The first-order condition can be slightly modified as follows

$$u'(G_{T-i} e^{s_{T-i}^{P}} c_{T-i}) = \frac{(G_{T-i} e^{s_{T-i}^{P}})^{-\theta} \Psi_{T-i}^{'} + \gamma (G_{T-i} e^{s_{T-i}^{P}})^{-\theta} \Phi_{T-i}^{'} \eta(\lambda - (\lambda - 1) F_{c_{T-i}}^{T-i-1}(c_{T-i}))}{1 + \eta(\lambda - (\lambda - 1) F_{a_{T-i}}^{T-i-1}(a_{T-i}))}$$

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_t^P, because we multiply both sides of the first-order conditions with $(G_{T-i} e^{s_{T-i}^{P}})^{-\theta}$. Thus, the agent's consumption utility continuation value is

$$\Phi_{T-i-1}^{'} = \beta R E_{T-i-1}[\frac{\partial c_{T-i}}{\partial x_{T-i}} (G_{T-i} e^{S_{T-i}^{P}})^{-\theta} u'(c_{T-i}) + (1 - \frac{\partial c_{T-i}}{\partial x_{T-i}})(G_{T-i} e^{S_{T-i}^{P}})^{-\theta} \Phi_{T-i}^{'}].$$

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

$$P_{T-i-1}^{-\theta} \Psi_{T-i-1}^{'} = \beta R E_{T-i-1}[\frac{dC_{T-i}}{dX_{T-i}} u'(C_{T-i}) + \eta(\lambda - 1) \int\limits_{C_{T-i} < C_{T-i}^{T-i-1}} (\frac{dC_{T-i}}{dX_{T-i}} u'(C_{T-i}) - x) dF_{\frac{dC_{T-i}}{dX_{T-i}} u'(C_{T-i})}^{T-i-1}(x)$$

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

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

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

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

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

A.2 The hyperbolic-discounting model

We consider an agent with hyperbolic-discounting preferences with the hyperbolic-discounting parameter denoted by γ. 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 $P_{T-i}^{1-\theta}$ 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

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

A.3 The habit-formation model

Consider an agent with internal, multiplicative habit formation preferences $u(C_t,H_t)=\frac{(\frac{C_t}{H_t^h})^{1-\theta}}{1-\theta}$ with $H_t=H_{t-1}+\vartheta(C_{t-1}-H_{t-1})$ and $\vartheta\in[0,1]$ (Michaelides, 2002). Assume $\vartheta=1$ such that $H_t=C_{t-1}$. For illustration, in the second-to-last period his maximization problem is

$$u(C_{T-1},H_{T-1})+\beta E_{T-1}[u(R(X_{T-1}-C_{T-1})+Y_T,H_T)]$$

$$= \frac{(\frac{C_{T-1}}{H^h_{T-1}})^{1-\theta}}{1-\theta} + \beta E_{T-1}[\frac{1}{1-\theta}(\frac{R(X_{T-1}-C_{T-1})+Y_T}{H^h_T})^{1-\theta}]$$

which can be normalized by $P_{T-1}^{(1-\theta)(1-h)}$ (then $C_{T-1} = P_{T-1}c_{T-1}$ for instance), and the maximization problem becomes

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

which results in the following first-order condition

$$c_{T-1}^{-\theta} = h_{T-1}^{-\theta h+h}\beta E_{T-1}[(G_T e^{s^P_T})^{-h-\theta(1-h)}(h_T)^{-h}(R+h\frac{c_T}{h_T})(\frac{c_T}{h^h_T})^{-\theta}] = h_{T-1}^{-\theta h+h}\Phi'_{T-1}$$

with Φ'_{T-1} being a function of savings $x_{T-1} - c_{T-1}$ and habit h_T. The first-order condition can be solved robustly by iterating on a grid of savings a_{T-1} with $c^*_{T-1} = (h_{T-1}^{-\theta h+h}\Phi'_{T-1})^{\frac{1}{-\theta}}$ $= (h_{T-1}^{-\theta h+h}f^{\Phi'}(a_{T-1}, h_T))^{\frac{1}{-\theta}}$ and $h_T = c^*_{T-1}\frac{1}{G_T e^{s^P_T}}$ until a fixed point of consumption and habit has been found. The normalized habit-forming agent's first-order condition in any period $T-i$ is given by

$$c_{T-i}^{-\theta} = h_{T-i}^{-\theta h+h}\Phi'_{T-i} = h_{T-i}^{-\theta h+h}\beta E_{T-i}[(G_{T-i+1}e^{S^P_{T-i+1}})^{-h-\theta(1-h)}h_{T-i+1}^{-h}(R\frac{dc_{T-i+1}}{dx_{T-i+1}}+h\frac{c_{T-i+1}}{h_{T-i+1}})(\frac{c_{T-i+1}}{h^h_{T-i+1}})^{-\theta}$$

$$+(1-\frac{dc_{T-i+1}}{dx_{T-i+1}})R(G_{T-i+1}e^{S^P_{T-i+1}})^{-h-\theta(1-h)}\Phi'_{T-i+2}].$$

A.4 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

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

which results in the following first-order condition

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

with Φ'_{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

$$c_{T-i}^{-\theta} = \frac{1}{1+\lambda^{td}}\beta E_{T-i}[(G_{T-i+1} e^{s_{T-i+1}^P})^{-\theta} R \frac{dc_{T-i+1}}{dx_{T-i+1}} u'(c_{T-i+1})]$$

$$+(1 - \frac{dc_{T-i+1}}{dx_{T-i+1}})(G_{T-i+1} e^{S_{T-i+1}^P})^{-\theta} \Phi'_{T-1}].$$