The Retirement-Consumption Puzzle: New Evidence from Personal Finances

Arna Olafsson* and Michaela Pagel†

Copenhagen Business School Columbia GSB, NBER, & CEPR

This version: April 2019

Abstract

This paper uses transaction-level data on individual spending, income, account balances, and credit limits from a personal finance management software provider to investigate how expenditures, liquid savings, and consumer debt change around retirement. The longitudinal nature of our data allows us to include individual fixed effects and identify the effect of individuals transitioning into retirement. We provide new evidence on the retirement-consumption puzzle and on whether individuals save adequately for retirement. We find that, upon retirement, individuals reduce their spending in both work-related and leisure categories. However, even for the most detailed categories, we cannot tell conclusively which expenses are definitely work related or not. We thus look at household finances and find that individuals delever upon retirement by reducing consumer debt and increasing liquid savings. We argue that these findings are difficult to rationalize via, for example, work-related expenses. An agent with standard preferences would save before retirement because of the expected fall in income, and dissave after retirement, rather than the exact opposite. Additionally, we document the same patterns in commonly used US survey datasets and generate the joint observation of decreasing income and consumption but increasing savings upon retirement in a life-cycle model with non-standard preferences.

Keywords: retirement, consumption, savings, consumer debt

JEL codes: 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 of the Pension Research Center (PeRCent) at Copenhagen Business School, and we thank Andrew Caplin, Rachel Kranton, Jawad Addoum, Jon Parker, Matthew Rabin, Botond Koszegi, David Laibson, Steve Zeldes, Emi Nakamura, Jon Zinman, Jennifer La'O, Emir Kamenica and seminar participants at the Federal Reserve Bank of Richmond, Frankfurt School of Finance, CEPR European Conference on Household Finance, University of Queensland, PerCent 2017 Conference, University of Minnesota, Columbia University, 8th conference of the CESifo network on Behavioral Economics, AFA, and ECWFC at the WFA 2017 for a range of insightful comments. This paper was nominated for the Distinguished CESifo Affiliate Award. We are also indebted to Ágúst Schweitz Eriksson and Meniga for providing the Icelandic data and to Steffen Meyer for replicating our results in German bank data. We also thank Belinda Chen for outstanding research assistance.

1 Introduction

An increasing share of the workforce will be approaching or past retirement age in the coming years in all developed countries. This has put the question of how well individuals are financially prepared for their retirement at centerstage for both policy-makers and researchers. This paper uses new longitudinal data from a personal finance management software to shed additional light on the effects of retirement on individual spending, income, and personal finances, that is, liquid savings and consumer debt, and to answer the question whether individuals properly plan for retirement.

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

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

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

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

adequately for retirement and whether Modigliani's (1954) life-cycle model is applicable.

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

We find evidence of reductions in both work-related and leisure spending, for relatively broad as well as very fine categories. However, we note that it is difficult to tell conclusively which expenses are work related or not, even though we consider very fine categories and the most detailed and comprehensive spending data. Additionally, we look at personal finances and document that individuals delever around retirement by reducing their consumer debt and increasing their liquid savings.[3] Our findings about personal finances are very interesting because they are difficult to rationalize via, for example, theories about work-related expenses. Any rational agent who expects a fall in income at retirement will save before retirement and dissave after retirement, rather than the other way around.

The comprehensive Icelandic pension system mainly consists of mandatory savings in pension funds, after retirement, pension savings are paid out as an annuity. Thus, individuals face a simple step down in income at the time of retirement. Unless the reduction in work-related expenses is larger than the fall in income, agents should always save before retirement and dissave after. If the reduction in work-related expenses is larger than the fall in income, they should retire early. However, the average individual in our sample continues to work voluntarily some time after reaching the age thresholds at which disincentives to retire no longer apply. Thus, our finding that individuals increase their savings after retiring is difficult to explain by work-related expenses or any other rational theory that reduces consumption needs around retirement. Our findings could be explained by individuals liquidating retirement accounts or

[3] A reduction in consumer debt may be driven by decreases in borrowing capacity, that we can observe via credit limits. However, we find that individual borrowing capacity or liquidity increases around retirement.

other illiquid assets, such as houses, around retirement. To address this concern, we make sure our findings are robust to controlling for income from all sources; including sources of savings such as investment accounts. Furthermore, we show that investment transactions income and all other sources of income are unaffected by retirement status. Beyond work-related expenses and investment liquidations, we carefully discuss a number of other theories consistent with rational planning: opportunity costs or utility of time, health shocks, intra-household bargaining, or lumpy pension payments and inventory savings. We conclude, however, that they all have difficulty explaining our findings.

We thus argue that we cannot retire the consumption puzzle just yet. After all, the retirement-consumption puzzle is about individuals not being able to plan for an expected, large, and salient reduction in income. In turn, we ask which existing models generating a drop in consumption at retirement can explain our joint findings that consumption and income decrease but liquid savings increase. We consider two classes of models: non-standard expectations or planning behavior and non-standard preferences. We argue that the existing models of non-standard expectations and insufficient planning have a difficult time because even with a limited horizon agents would smooth consumption. Turning to non-standard preferences, we show that a model with a time-inconsistent overconsumption problem due to hyperbolic discounting (as in Laibson et al., 1998) that is corrected after retirement succeeds in explaining our joint findings. Furthermore, the same correction of time-inconsistent overconsumption is achieved in the model by Pagel (2017) of expectations-based loss aversion, as developed by Kőszegi and Rabin (2009). The model predicts that individuals will correct their overconsumption problem upon retiring because of the decrease in income uncertainty. When income is uncertain, individuals overconsume in the present and hope for a better realization of income in the future. But when income is certain, as it is after retirement, overspending results in a sure reduction in future spending, and because the agent dislikes this sure loss, she corrects her overconsumption problem after retirement. We thus rationalize a simultaneous decrease in consumption and increase in savings upon retirement in a realistically calibrated life-cycle model with two of the most-widely applied non-standard preference specifications in the literature.

Reassuringly, we find the same empirical pattern in two commonly used US consump-

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

Our findings are related to recent work documenting that mean and median cohort wealth, for either singles or couples, can be stationary or rising for many years after retirement even though the standard Modigliani's (1954) life-cycle model predicts that individuals should decumulate assets. Love et al. (2009) carefully construct a measure of wealth and track it over time beginning at age 65 documenting that it rises with age. Poterba et al. (2011a) and Poterba et al. (2011b) document that individuals do not withdraw more funds from their personal retirement accounts relative to their rate of return, which causes wealth to effectively rise during retirement. Finally, Agarwal et al. (2009) document that financial mistakes, such as suboptimal use of credit card balance transfer offers, follow a U-shaped pattern over the life-cycle, i.e., financial mistakes are increasing for older adults. In contrast to these papers, we look at a very short period of time around retirement, spanning only three years before and after on average, and document results not for overall wealth, but liquid savings and consumer debt. Looking at liquid savings and consumer debt around the time of retirement allows us to test the hypothesis that individuals are rationally planning their transition to retirement and smoothing the marginal utility of consumption properly which is informative about the retirement-consumption puzzle.[4]

[4]We do not observe overall wealth, however, because of the Icelandic pension system which provides individuals with an annuity at the time of retirement, we can treat dissavings of pensions as simply income after retirement.

The empirical finding that wealth increases rather than decrease over the course of retirement has been termed the "retirement-savings puzzle" and is theoretically explained by DeNardi et al. (2010) and Laitner et al. (2017), among others. DeNardi et al. (2010) explain the rise in wealth during retirement with longevity risk and precautionary savings due to the risk of medical expenses.[5] The out-of-pocket health expenses in Iceland are similar to the US. However, we do not find that pharmacy spending increases upon retirement which would be implied if health shocks were the main reason that individuals retire and the explanation for an increase in savings due to precautionary motives upon the start of retirement.

None of these papers specifically look at liquid savings before versus after retirement to highlight what we can learn from the patterns of liquid savings around retirement about households' abilities to plan and smooth the marginal utility of consumption and the relevance of the retirement-consumption puzzle.[6] To the best of our knowledge, we are the first to document deleveraging and a rise in savings at the time of retirement. Furthermore, if people were to save rationally – for retirement consumption or medical expenses at old age (as suggested by DeNardi et al. (2010) and Laitner et al. (2017)) and spending were to drop only because of work-related expenses – we would not observe a simultaneous decrease in consumer debt and increase in liquid savings.

We are aware of only one previous study that uses transaction-level data to investigate the consumption drop upon retirement: Agarwal et al. (2015) use debit and credit card spending data from Singapore. Our data set from Iceland has five advantages: (1) Consumers use electronic means of payments almost exclusively, which eliminates one limitation of the data from

Additionally, we observe all other liquidations of assets, and can similarly treat that as income, we thus do not need to observe overall wealth to make conclusive statements about whether the patterns of liquid savings are consistent with rational planning.

[5]The Icelandic health care system is financed by taxes, as common in the Nordic welfare state model so that the population has equal access to the health care and welfare system. Iceland does not operate its health care system based on financial need, but some disadvantaged groups, including disabled and elders, generally receive discounts on personal health expenses. Out-of-pocket payments are a source for the universal health care system, and make up 18.2 percent of total health expenditures that amount to 9 percent of GDP. For comparison, in the US, out-of-pocket medical expenditures are 11 percent of total expenditures that amount to 17.7 percent of GDP. However, individuals should be aware of these costs before retirement and should not start saving for them after retirement.

[6]With respect to changes in household finances upon retirement, the only related paper we are aware of is Addoum (2016), which analyzes changes in household portfolios upon retirement using PSID data. The author shows that portfolios become less risky when men retire as female spouses gain bargaining power and are typically more risk averse.

Singapore, where a significant fraction of expenditures in certain shops, such as fresh markets and small grocery stores, are paid with cash. (2) We observe the incomes and expenditures of individuals over a long period of time around retirement. Thus, we have sufficient power to estimate individual fixed-effects regressions, controlling for all selection on observable and unobservable time-invariant characteristics. (3) We can identify individual spending and income because all financial accounts are personal in Iceland. At the same time, we can identify individuals within a household, which allows us to control for household income. (4) We can see how individuals spend within certain categories of spending, which gives us the opportunity to test whether consumers substitute toward cheaper but more time consuming goods when they retire. In addition, our categorization is very accurate and comprehensive. (5) Because we have detailed information on all account balances, credit limits, and financial fees, we are able to document the changes in personal finances at the onset of retirement. The Icelandic data set has already proven useful for studying, among other things, the spending responses of individuals to income arrivals (Olafsson and Pagel, 2018a) and the drivers of individuals' attention to their personal finances (Olafsson and Pagel, 2018b).

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

2 Background, data, and summary statistics

2.1 Background and Icelandic pension system

A long working life is more common in Iceland than in most other countries. Figure 1 compares the average effective retirement ages of men and women in Iceland, Germany, and the United States. This data is obtained from the Organisation for Economic Co-operation and Development (OECD). In our data, we label individuals above age 60 as retired when we observe pension payments above a certain limit for several months and salary income below a certain

limit for several months.[7] Figure 2 displays the share of retired individuals at each age and Figure 3 displays the distribution of retirement ages. It can be seen that our inferred time of retirement is consistent with the information from the OECD on effective retirement age in Iceland displayed in Figure 1. Moreover, the figure shows OECD data going further back in time to illustrate that no major discontinuities happened at the start of our sample period. Before 55 no individuals are classified as retired, but individuals start slowly retiring at the age of 60.

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

For the purpose of interpreting our findings, we thus observe individuals who have higher and potentially uncertain salary income before retirement, and after retirement, they have lower but certain income that is provided by the annuity of their pension wealth. We can thus simply treat individuals as facing a step function in income. In turn, if they hold other pension wealth or other assets, we observe all income inflows of liquidating these assets. Thus, after retirement, individuals may or may not have other income from liquidating assets, but importantly, we observe that income and can control for it.

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

2.2 Data

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

In January 2017, the Icelandic population counted 338,349 individuals, 262,846 of which were older than 18. At the same time, Meniga had 52,545 users, which is about 20 percent of the adult individuals living in Iceland. We study 13,411 active users with complete records, i.e., for whom we observe all balances, salary arrivals, and transactions. In general, all individuals in our sample have passed an "activity test" that is designed to verify that we are capturing all of their financial picture. More specifically, our sample of Meniga users is restricted to individuals with complete records, defined by four requirements. First, we restrict our sample to individuals for whom we see bank account balances and credit lines. Second, we restrict our sample to individuals for whom we observe income arrivals (this does not only include labor market income but also, e.g., unemployment benefits, pension payments, invalidity benefits, and student loans). The third requirement is that key demographic information about the user is available (age, sex, and postal code). The final requirement is that the consumption of each user must be credible, which we ensure by requiring at least 5 food transactions in at least 23 months of a 24 months period. This activity test is designed to not exclude any subsamples of the population, such as low income or uneducated consumers, but only to exclude individuals of whom we do not observe the whole financial picture because they did not link all of their financial accounts.

Because Meniga's software and service is marketed through banks, i.e., in individuals' online banking interfaces, the sample of users is fairly representative (the internet penetration is 96 percent in Iceland). Each day, the software automatically records all the bank and credit card transactions, including descriptions and the balances, overdrafts, and credit limits. The software also collects demographic information such as age, gender, marital status, and postal

code. Figure 4 displays screenshots of the app's user interface. The first shows background characteristics that the user provides, the second shows transactions, and the third shows bank account information.

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

Categorizing transactions

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

Spending data

For spending, we obtain categorized data on all transactions based on the type of retailer and each category is aggregated at both the individual and the household level. The panel thus provides individual- and household-level expenditure information for a number of spending categories. We consider ten fairly broad categories: groceries, fuel, alcohol, ready-made food, home improvement, transportation, clothing and accessories, sports and activities, and pharmacies.[8] We also have more disaggregated categories. For instance, for ready-made food, we know the type of restaurant, such as bakery, canteen, or fine dining. We only consider discretionary spending, such as on groceries and clothing, and not recurring spending on rents, utilities, or phone bills.

Income data

We generally call income all incoming transactions or inflows. Thus, when individuals are retired and receive their annuitized pension payments, such income is effectively dissaving. Furthermore, when individuals sell investment assets, we observe investment income, and other sale transactions are contained in an unclassified incoming transaction category or other income. As an overview, the system sorts income into 23 categories. Regular income categories are child support, benefits, child benefits, interest income, invalidity benefits, parental leave, pension, housing benefits, rental benefits, rental income, salary, student loans, and unemployment benefits. The irregular income categories are damages, grant, other income, insurance claims, investment transactions, reimbursements, tax rebates, and travel allowances.

Payers identity and NACE category (The Statistical Classification of Economic Activities in the European Community)[9] are also added to each income transaction whenever possible.[10]

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

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

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

Bank data

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

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

2.3 Summary statistics

Table 1 displays summary statistics of the user population, including income and spending in US dollars and demographic statistics. We can see that the average user is 41 years old and 49 percent of users are female. For comparison, Statistics Iceland reports the average age in the population to be 37 years, with 48 percent being female. Thus, our demographic statistics are very similar to those of the overall population and not statistically significantly different. When using app data, there is a concern that the user population, which may tend to be young, well-situated, male, and tech-savvy is not representative of the overall population. However, our demographic statistics are very similar to those of the overall population alleviating us of this concern. The representative national household expenditure survey conducted by Statistics Iceland also reports income and spending statistics. In the table, parentheses indicate when

spending categories did not match perfectly with the data. We can see that the income and spending figures are very similar for those categories that match well and are not statistically significantly different from the means in the Statistics Iceland numbers. Our sample is fairly representative because individuals are offered to sign up for the software automatically by the bank when they access their accounts online and the internet penetration is 97 percent in Iceland. Moreover, even if individuals never use the software, the moment that they sign up once, we obtain their data.

Furthermore, Figure 2 displays the share of retired individuals at each age and Figure 3 displays the distribution of retirement ages. Our inferred time of retirement is consistent with the information from the OECD on effective retirement age in Iceland displayed in Figure 1. Thus, in terms of retirement choices, our data appears to match the Icelandic population as a whole. Statistics Iceland also reports the fraction of retired individuals by age group. These numbers match our data in Figure 1 very well. For ages 60 to 64, only 0.1 percent of individuals eligible for retirement receive pension benefits while for ages 65 to 66 it is 36.9 percent and for ages 67 to 69 it is 86.6 percent.

Table 2 displays summary statistics for individuals who are eligible for retirement, i.e., have reached age 60, whether or not they are retired. We can see in the raw data that on average retired individuals have lower incomes, spend less (in both individual spending and household spending), have more savings, hold less consumer debt, have more access to credit (liquidity), and incur fewer bank fees and penalty payments.[11]

Figure 5 summarizes the salary, pension-payment, and expenditure trajectories of men and women using binned averages by age. The figure shows how salary payments decrease and pension payments increase between the ages of 60 and 70. Labor income and spending are both hump-shaped over the life cycle. Note that, Table 2 and Figure 5 display not all spending but only discretionary spending, i.e., spending in categories such as groceries and clothes, leaving out recurring spending such as rent payments and utilities bills.

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

3 Analyses

3.1 Life-cycle profiles of spending and income

We start our analysis by investigating whether we can replicate the familiar hump-shaped profile of spending over the life cycle in our data. Following Aguiar and Hurst (2013) and Agarwal et al. (2015), we obtain the age profile of consumption by regressing log total discretionary spending on a full set of age dummies, controlling for month-by-year and individual fixed effects. We also estimate separate regressions for log spending in our ten broad consumption categories. Figure 6 plots the age dummy coefficients for log total monthly discretionary spending. The omitted age dummy is age 20. The figures thus plot the estimated age coefficient from the regression of spending relative to the coefficient for age 20. The expenditure profiles do indeed exhibit the conventional hump-shaped patterns, in which spending peaks in the late thirties, at a bit less than 40 log points higher than the level for twenty year olds, and spending declines by about the same amount from the individual's late fifties until retirement age.

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

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

We also find different patterns among more refined ready-made food categories. Expendi-

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

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

3.2 The effects of retirement on spending and personal finances

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

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

where C_{it} is the dependent variable of interest and Y_{it} is income of individual i at time t. ϕ_{my} is a month-by-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. $Retired_{it}$ is an indicator equal to 1 if individual i has retired at time t and the $\widehat{\beta}$ coefficient thus measures the effect of retirement on the outcome variable under consideration.

Clearly, retirement status is endogenous. Individuals may be induced to retire by the pension benefits thresholds discussed in Section 2.1. But as Figure 2 shows, there are no discontinuities in the fraction of individuals retiring at the retirement age thresholds of 60, 65, 67, and 70. Thus, in our data, the decision to retire appears to be voluntary after individuals reach the benefits thresholds. We thus cannot argue that the retirement coefficient $\widehat{\beta}$ has a causal interpretation. That said, as we will discuss at length in Section 4, the fact that the retirement decision is voluntary helps us to rule out a number of theoretical explanations for our findings that are

based on rational planning. Thus, the interpretation of the endogenous effect of retirement, i.e., the coefficient $\widehat{\beta}$, is much more informative and meaningful.

The estimated effect of the fall in income at retirement is approximately 22 percent. This number is in line with estimates from the US reported in Ameriks and Zeldes (2004) among others.

Spending by category

Table 3 shows the estimated effect of retirement on spending based on the individual fixed effects model, Equation (1), with and without controlling for total income.[12] We can control either for individual income or for total household income when individuals link each other. These results show that spending drops significantly upon retirement. When we control for income, the drop is about as large as the reduction without controlling for income, which suggests that individuals change their spending habits not only because income drops at retirement. To control for income in these regressions is thus informative about why individuals cut their consumption.

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

Nevertheless, we feel that the results on spending in such broad categories do not paint a conclusive picture of whether or not work-related expenses explain the retirement-consumption puzzle. We thus turn to a finer categorization and examine spending on food more closely. We choose to analyze spending on food in more detail because food expenses have received the most attention in the retirement-consumption literature (for instance, Aguiar and Hurst, 2005,

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

among many others).

Spending by grocery store and type of restaurant

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

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

Moreover, we can look at the effects of retirement on these categories. From Table 4 we see that individuals exhibit a drop in spending for all categories of restaurants, including bars and fine dining. This result is more consistent with a reduction in overconsumption around retirement than with a reduction in work-related expenses. Unfortunately, we can only analyze overall spending, i.e., quantities times prices, and do not know whether senior discounts

for instance majorly affect prices while quantities stay the same. That said, for a number of consumption categories, such as groceries or fine dining, senior discounts or other price discrimination are not present.

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

Personal finances

Using the same estimation approach, we can investigate the effects of retirement on bank account balances, overdrafts, credit limits, and bank fees. Table 5 displays the estimated effects of retirement on household finances based on the individual fixed effects model, Equation (1), with and without controlling for total income. One of the most interesting results is that individuals delever. When we measure consumer debt via interest expenses, we find a 11.1 percent reduction (22.5% after controlling for income). Thus, individuals not only cut their consumption, but they also reduce their consumer debt considerably. This deleveraging cannot easily be rationalized by a reduction in work-related expenditures, as we discuss in detail below. When rational agents expect a substantial reduction in income, they will optimally save before and dissave after retirement. But our findings indicate that they save more after retirement rather than before.

As an alternative, it seems sensible to suggest that individuals decide to correct their overconsumption and debt holdings after retirement by deleveraging. Figure 8 shows the life-cycle profile of interest payments on consumer debt holdings. Consumer debt features a pronounced hump similar to those of consumption and income. Obviously, if consumer debt were to smooth the marginal utility of consumption and income over the life cycle, it would be U-shaped, not

hump-shaped.

We find that households not only delever but also increase their liquid savings (measured by interest income on bank account balances) substantially by 6.1 percent. This again hints at individuals rethinking their financial plans at the onset of retirement. Figure 9 displays the life-cycle profile of interest income from savings accounts and shows a clear increase around the time of retirement. Moreover, we find that individuals increase their current account balances and decrease their overdraft holdings and credit card balances. Finally, individuals also reduce total and late fee payments. We can also look at credit limits and overall liquidity, or borrowing capacity, but do not find significant results here. Thus, it does not appear to be the case that banks restrict individual borrowing capacity. Furthermore, we can estimate the effect of retirement on net savings, as measured by income minus total discretionary spending. Again, we estimate a positive effect confirming the source of the increase in savings and reduction in consumer debt.[13]

We find similar results whether or not we control for income. Controlling for all income is of utmost importance for the interpretation of our results, as we will discuss in Section 4. After all, it could be that individuals simply liquidate assets after entering retirement to repay their consumer debt.

3.3 Replicating the analysis in other data sets

In this section, we show that we can replicate our results in commonly used survey data sets from the US and in another individual- and transaction-level data set from Germany. It is reassuring that we can document the same results in survey consumption data most commonly used in the literature, the Consumer Expenditure Survey (CEX) and the Survey of Consumer Finances (SCF). However, these data sets suffer from selection bias and measurement error, so to bolster the credibility of our findings we replicate our analysis using additional data sets from the US as well as Germany where we can employ individual fixed effects and conclude

[13]The coefficients of the effect of retirement on income, spending, and income minus spending do not add up perfectly because of the individual and time controls as well as the fact that we measure spending at the household level but income at the individual level. Our results are not materially affected by using spending at the individual level though as only a fraction of individuals have linked other household members.

that our results are not specific to Iceland.[14]

CEX data

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

We regress savings, measured simply as log income minus log overall consumption, on a full set of age, year, and cohort fixed effects. In addition to the retirement and age effects of interest, the data are contaminated by potential time and cohort effects, which constitutes an identification problem, as time minus age equals cohort. In the portfolio-choice literature, it is

[14]Consumption surveys such as the CEX and SCF use paper or phone interviews to ask stylized questions on spending and financial standing in consumption good categories over a particular recall period or households are asked to keep track of recurrent expenditures, such as groceries, for a short period of time in a diary. Measurement error arises because survey respondents may have difficulties in recalling past purchases and have little incentive to answer the questions accurately. For instance, respondents may not understand the wording of the questions, may behave differently in practice, or may simply forget some past purchase transactions, or may strategically underreport consumption to avoid more detailed follow-up questions (Parker and Souleles, 2017). Moreover, such measurement error or noise in the data generated by surveys that simply ask about past purchases can increase with the length of the recall period (de Nicola and Giné, 2014). Additionally, surveys can produce data with systematic biases if respondents have justification bias, concerns about surveyors sharing the information, or stigma about their consumption habits (Karlan and Zinman, 2008). A large existing literature has documented basic problems with survey-based measures of consumption (see e.g., Pistaferri, 2015).

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

Table 7 shows the regression results for savings (measured as income minus consumption), checking account balances, and savings account balances. The effect of retirement is positive, significant, and economically large in all specifications. Very much in line with the Icelandic results, net savings increase by approximately 20

SCF data

The SCF is a statistical survey of income, balance sheets, pensions, and other demographic characteristics of families in the United States, sponsored by the Federal Reserve Board in cooperation with the Treasury Department. We use the data from six waves from 1992 to 2007. However, as in the case of the CEX data, the SCF does not survey households consecutively and we can therefore not employ household fixed effects. As before, we estimate the effect of retirement jointly controlling for age, time, and cohort fixed effects and identify the model with a random assumption about its trend. We control for family size in the same manner as in the CEX data. Retirement status is also defined as a binary variable in the SCF and we also have information on balances in savings accounts. Income is again using all inflows whether from labor, pensions, or businesses. Furthermore, we consider all debt, i.e., the sum of consumer, education, and mortgage debt, and leverage, debt divided by total household assets, such as

account balances, stocks, bonds, funds, and durables (for instance, cars and houses). Again, we log all outcome variables.

Table 8 shows the regression results for leverage, debt, and savings account balances. The effect of retirement is negative, significant, and economically meaningful for the SCF measures of leverage and debt whether or not income controls are included. For savings account balances, the effect of retirement is positive, significant, and large once we control for income. Very much in line with the Icelandic results, debt decreases by approximately 20

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

German bank account data

We replicate our results in a data set that includes information on income, spending, and checking, credit, and portfolio accounts from a German bank covering approximately 5,000 individuals who transitioned into retirement in the period from 1998 to 2010.[15] Retirement status is identified by looking for federal pension payment indicators in the transaction descriptions. Furthermore, we define income as the sum of all incoming transactions and spending as the sum of all outflows out of the checking accounts ensuring that we exclude all transactions between accounts. The results can be found in Table 9. We find that savings (measured as income minus consumption) increases when individuals retire, and we see increases in current account balances and portfolio values and decreases in credit account balances. Again, we log all outcome variables and obtain coefficients of percent increases that are in line with the Icelandic results.

[15]This transaction-level dataset has been obtained from a German online bank that has a brokerage arm but also a full-service retail banking arm. Beyond checking, savings, settlement, and credit account transactions, the dataset contains information on all portfolio trades and holdings.

PSID data

We also use the Panel Study of Income Dynamics (PSID) data from 1968 to 2015. The PSID is a nationally representative survey of households in the United States conducted by the University of Michigan. It was administered annually from 1968 to 1997 and then biennially post 1997. Furthermore, it included questions that relate to specific consumption and savings measures post 1997. Following the literature, we use the consumption and savings data post 1997 (Li et al., 2010) and consumption is measured as expenditure on food, housing, transportation, education, childcare, and healthcare. As before, we define income as the sum of household taxable income, unemployment income, unexpected income (income from insurance settlements, inheritances), and retirement income (income from retirement pay, pensions, or annuities). Because the PSID surveys households consecutively, we can also include individual fixed effects in our regressions. The results of the PSID analysis are consistent with our other results. The coefficients on consumption are negative and significant, indicating that individuals consume less after retirement. Moreover, retired individuals increase their balances in savings and checking accounts, which corroborates our previous findings. Finally, individuals also hold less debt, and their overall wealth increases with and without accounting for equity. We log all outcome variables except wealth.[16] These results can be found in Table 10.

HRS data

Finally, we replicate our results using the Health and Retirement survey (HRS) conducted by the University of Michigan. This survey asks individuals and their spouses who are over 50 years old about their health, employment, quality of life, and wealth. It was conducted biennially from 1992 to 2014. In 2001, the HRS sent a consumption-and-activities mail survey (CAMS) to a subsample of the initial HRS population, and it has tracked consumption for these households biennially ever since. The RAND Center for the Study of Aging provides clean versions of each wave of HRS data, which we merged with the CAMS data set to extract information on individuals' consumption and savings. We again use all household discretionary

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

spending categories and total household income measuring all inflows. We construct the savings variable as the sum of the values of CDs, government savings bonds, checking, savings, and money market accounts, stocks, mutual funds, investment trusts, bonds, bond funds, and all other savings. The results of the HRS analysis are consistent with our previous results. When they retire, individuals consume less but increase their savings, IRA assets, and overall wealth. Again, we log all outcome variables. The results can be found in Table 11.

When we run the same regressions but without household fixed effects in the three datasets, we obtain much larger coefficients, i.e., we obtain more negative coefficients for spending and larger positive one for our measures of liquid savings and wealth. This tells us that the selection effects likely to be present in CEX and SCF data overstate the consumption drop and savings increase and how important the individual fixed effects are in the analysis. That is likely why the coefficient estimates of the CEX and SCF are in some instances larger than those of the German data set, the PSID, or the HRS. For those datasets, we obtain coefficients perfectly in line with the Icelandic results. Spending decreases by 10 to 20

4 Potential theoretical explanations of our findings

We loosely categorize potential theoretical explanations for our findings as follows: We first consider explanations that are in one way or another based on rational planning for retirement and do not feature an obvious irrational component, such as limitations to planning or cognition, or behavioral component, such as non-standard preferences or beliefs. We then move on to explanations that have an irrational or behavioral component. In turn, we single out two widely-applied and highly-cited preference theories that are likely candidates to explain our findings: present bias that is corrected at retirement and expectations-based loss aversion. We then consider a fully-fledged life-cycle model and show that it generates a simultaneous drop in consumption at retirement and increase in savings by running our empirical specification in the simulated consumption data.

4.1 Explanations based on rational planning

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

Work-related expenses

In what situation would a sudden reduction in work-related expenses upon retirement cause an increase in savings? To answer that question, we outline five scenarios for individuals' income and pension profiles. (1) A flat income profile before retirement and a lower, flat pension profile after retirement. Any patient agent in this situation would smooth consumption by accumulating liquid savings before retirement and decreasing savings after. (2) A flat income profile before retirement and a lower but increasing pension profile after retirement. In this case, a patient agent would again smooth consumption by saving before retirement and potentially by increasing debt at the start of retirement but decreasing debt thereafter. (3) A flat income profile before retirement and a lower, decreasing pension profile after retirement. Again, any patient agent would smooth consumption by accumulating savings before retirement and decreasing savings after. (4) A flat income profile before retirement and a pension profile that is just marginally lower than income (by less than work-related expenses) after retirement, and decreasing. In this scenario, a patient agent might increase savings at the start of retirement. However, we observe a substantial reduction in income at the start of retirement and the pension profile is increasing after retirement, as can be seen in Figure 5. Therefore, this fourth possibility appears unlikely. (5) A flat income profile before retirement and a pension profile that is higher than income after retirement. A patient agent in this case might accumulate debt

and then decrease it at the start of retirement. However, we see that pensions are lower than labor income in Figure 5, and we can thus rule out this scenario. Furthermore, work-related expenses cannot be larger than the difference between pension and labor income, as individuals would simply retire early in that case.[17] But the average individual retires after the retirement threshold. Overall, we thus feel that work-related expenses are unlikely to explain our finding that savings increase after retirement.

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

Our argument is illustrated in Figure 10. In a rational model, if an agent expects a fall in income and expenditure then savings will increase as long as the fall in expenditure is smaller than the fall in income. If the fall in expenditure is larger than the fall in income, then savings will increase. In that case, however, the agent gains on net by retiring early. It is thus very hard to explain, in any rational model, the joint observation that savings increase after retirement

[17] Only if the additional monthly pension benefits for an additional month of work exceed the savings from retiring, individuals should work longer. However that is true only near the benefits thresholds. However, we do not see individuals retiring at the thresholds.

and individuals who are eligible do not retire immediately.

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

Opportunity costs of time

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

Wealth shocks, liquidation of assets, and returns of savings versus borrowing

Banks et al. (1998) and Bernheim et al. (2001) argue that the drop in consumption is brought about by the systematic arrival of adverse information. In this case, however, the drop in consumption would always be accompanied by a decrease rather than an increase in savings, as retirement comes with a negative wealth shock. The same is true for the model by Blau (2008)

who argues that uncertainty about one's retirement date can generate a drop in consumption at retirement. In the author's model, either individuals retire as planned and smooth their consumption, or retirement is triggered by a negative wealth shock that also causes a drop in consumption. In principle, however, to generate an increase in savings, one needs a positive wealth shock.

A positive wealth shock may be brought about by selling one's house or liquidating other assets upon retirement. However, our findings are robust to controlling for all income which includes other income (other income contains, e.g., housing transactions and uncategorized investment transactions). Furthermore, we can more directly address the concern that housing transactions and liquidation of assets are driving our results by estimating the effect of retirement on investment income and uncategorized income. Investment transactions can be identified because of the NACE categorization, and income that cannot be classified is listed as "uncategorized" income and could be due, for example, to the sale of real estate. We therefore estimate the effect of retirement on these two income categories, and the results can be found in Table 6. The fact that we do not find an effect on investment related income and a negative effect on uncategorized income should relieve concerns about liquidation of assets or housing transactions explaining why individuals increase their savings and delever upon retirement. We also ensure that our results are not affected when we control for individual as opposed to total household income.

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

A final alternative explanation considers not the quantity of savings but its price. It could be that retired individuals face higher interest rates on savings and on overdrafts and thus increase their savings after retirement and decrease their overdrafts. The overdraft interest rates

in Iceland, however, are pre-agreed upon and do not change with the status of retirement. Furthermore, we have no evidence that retired individuals would suddenly face higher returns to savings, and, again in that case, they should decide to retire early.

Health shocks

Individuals may choose to retire in response to an adverse health shock. While it is again unclear whether health results in an increase or a decrease in the marginal utility of consumption, it can reasonably be assumed that an adverse health shock implies an adverse wealth shock, which should decrease and not increase savings. As we discussed, any negative shocks will have trouble explaining our findings of an increase in savings and a reduction in debt holdings. It could be that a health shock makes spending less enjoyable or increases a precautionary savings motive, which then increases savings by reducing consumption and, at the same time, explains why the individual retires. However, we find that pharmacy spending falls upon retirement and is about 8.6 percent lower afterward, which strongly suggests that health shocks are not the reason the average individual in our sample retires (when individuals buy medical supplies, they do so in pharmacies and must make a copayment). Pharmacy spending drops because individuals also buy household goods, such as cleaning supplies and make-up, in pharmacies. DeNardi et al. (2010) explain the increase in savings after retirement with the risk of health expenses. However, such a motive should be present before and after retirement given that health shocks are not the reason individuals retire in our sample.

In a bit more detail, the fact that we see a fall in pharmacy spending rules out health shocks as an explanation for retiring because co-payments are only waved or reduced after people reach a certain level of expenditure on medicine. Therefore, for people who were at or above the threshold before retirement, we would expect no change but for people below we would expect an increase up to the eligibility level in case health shocks were to explain that people retire. However, the documented drop in healthcare expenditure does show that this cannot be the case.

Intra-household bargaining

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

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

Inventory considerations and lumpy pension withdrawal

If individuals were to withdraw their pension payments less frequently after retirement then they received their labor income before retirement, then they should keep a larger inventory of balances in their checking and savings accounts. The occupational pension as well as the means-tested pension is paid out in a monthly fashion, as the labor income of the vast majority of working individuals. Furthermore, in principle, voluntary pensions can be withdrawn in any fashion and there are no transaction costs associated with that, however, in practice we do not observe lumpy withdrawals. In fact, the standard deviation in income payments is less after retirement than before retirement. Moreover, as mentioned, we can control for all income payments and that does not affect our estimated coefficients.

Dissaving in total assets

Even though liquid savings increase and consumer debt decreases at the transition to retirement, individuals in Iceland may decumulate their total assets because they receive their pension annuities. To the extent that individuals liquidate any other assets, as discussed, we would

observe and can control for these. The pension system in Iceland and the implied step function in income thus allows us to draw conclusions from looking at liquid savings and consumer debt as to whether individuals plan optimally for the onset of retirement, which sheds light on the retirement-consumption puzzle.

4.2 Explanations based on insufficient planning and overconsumption

The existing literature rationalizing the drop in consumption at retirement can be loosely classified into two types of models: first there are models based on non-standard expecations and insufficient planning and second there are models of non-standard preferences that generate an overconsumption problem before retirement. We now discuss in how far the two types of models may be able to also generate an increase in savings at retirement.

Insufficient planning

One possible theoretical explanation is the following: fixed or endogenous attention costs or the freeing up of cognitive resources allows individuals to reconsider their savings and consumption plans upon retirement. However, that theory would not predict a systematic reduction in debt and increase in savings unless insufficient attention or time for planning always results in overconsumption. Haider and Stephens (2007) and Ameriks et al. (2007) argue that insufficient planning and overconsumption are the reason for the drop in consumption, and such a systematic effect is suggested by work on cognitive resources and decision making, as in Mullainathan et al. (2007), although their findings are not confirmed by Carvalho et al. (2016). We observe reductions in total financial fees paid as well as late fees paid. Thus, individuals may be better at planning, but they also have more time to pay all their bills on schedule. Unfortunately, a widely-applied model of poverty and cognitive resources does not exist at this point, which makes writing down a corresponding theory feel reverse-engineered. Additionally, the limited-attention models, as in Gabaix (2016) and Sims (2003) predict that individuals plan late for retirement resulting in a sharper reduction in consumption at retirement, however, to the extent individuals pay attention to retirement eventually, savings should not increase. Combining these models with systematic arrival of health shocks that increase precautionary savings, for

instance, seems reasonable but again reverse-engineered.

The insufficient-planning life-cycle models, such as those of Huang and Caliendo (2011) and Caliendo and Aadland (2007), may generate a drop in consumption at retirement if liquidity constraints are binding but not a simultaneous increase in savings. For instance, the model in Huang and Caliendo (2011) generates a drop in consumption at retirement because individuals consume all their income and never save. Thus, the moment income drops, consumption must drop as a liquidity constraint binds. However, empirically we see individuals having substantial liquidity. Furthermore, if individuals hit their liquidity constraint, their savings are zero before retirement. If income falls at retirement, their savings will be zero after retirement as well. Clearly, however, savings would not increase in this case: if individuals consume their entire income when it is high, they will also do so when it is low. The same is true for the models by Reis (2006) and by Campbell and Mankiw (1989).

We thus feel that the insufficient planning models cannot generate an increase in savings on top of a drop in consumption at retirement without heavy tweaking and move on to non-standard preferences generating overconsumption problems.

Overconsumption and present bias

There exists widespread evidence for individuals having overconsumption problems (refer to Do, 2011, for a literature survey). The most highly-cited and widely-applied models of over-consumption are based on quasi-hyperbolic discounting preferences, as in Laibson et al. (1998) and Laibson et al. (2007). Hyperbolic discounting preferences cannot generate a drop in consumption at retirement per se because the agent is equally impatient before and after retirement and can smooth consumption. As in the insufficient planning models, if a liquidity constraint would bind, a fall in income might cause a fall in consumption. In such a situation, however, we have to assume that individuals hit their liquidity constraints before and after retirement, but empirically, we see individuals having substantial liquidity. Furthermore, if individuals hit their liquidity constraint, their savings are zero before retirement. If income falls at retirement, their savings should be zero after retirement as well and not increase.

To rationalize a drop in consumption and an increase in savings after retirement within the

hyperbolic-discounting framework, one needs to assume that the hyperbolic discount factor changes when the individual retires. Although this appears plausible, it again feels somewhat reverse-engineered. Nevertheless, in the following section, we theoretically analyze how far a change in the exponential or hyperbolic discount factor, and thus in the agent's degree of present bias, can generate a drop in consumption at the same time as an increase in savings at retirement in a fully-fledged life-cycle model that is calibrated realistically in line with the literature. Furthermore, we analyze a model that is the only existing one, to the best of our knowledge that generates a fall in consumption and an increase in savings at retirement simultaneously (Pagel, 2017) because the effective discount factor changes at retirement.

Expectations-based loss aversion

As we will show, a theoretical explanation for our findings requires a different degree of present bias before and after retirement. Kőszegi and Rabin (2009) and Pagel (2017) show that expectations-based reference-dependent preferences predict that the degree of present bias depends on the level of income uncertainty, which is arguably lower after retirement. In this model, individuals reduce their overconsumption after the start of retirement and thus may simultaneously decrease their consumption and increase their savings. Furthermore, the preferences in Kőszegi and Rabin (2009) have been widely applied and the papers Kőszegi and Rabin (2006, 2007, 2009) are the most highly-cited models of beliefs-based preferences (Olafsson and Pagel, 2018b), which makes it worthwhile to see in how far their predictive power extends to this "out-of-sample" test.

Expectations-based loss aversion, as developed by Kőszegi and Rabin (2009) and applied in a life-cycle model by Pagel (2017), predicts a drop in consumption at retirement. In the following, we describe the intuition for this result closely following the exposition in Pagel (2017) to then test our novel empirical prediction. The intuition is that expectations-based reference dependence introduces an overconsumption problem when income is uncertain. After retirement, however, income uncertainty is absent in a standard life-cycle model, which ends time-inconsistent overconsumption. The agent stops overconsuming because he is allocating certain retirement income instead of uncertain labor income. Certainty means that overcon-

sumption today yields a sure loss in future consumption, and this loss would hurt more than today's overconsumption would give pleasure, as the agent is loss averse. Thus, the agent suddenly begins controlling his time-inconsistent desire to overconsume, and his consumption drops at retirement.

4.2.1 A quantitative exploration of the different preference-based explanations in a life-cycle model

We consider a discrete-time life-cycle model with periods indexed by $t \in 1, ..., T$. The agent has standard preferences (Carroll, 1997), hyperbolic-discounting preferences (Laibson et al., 1998), temptation-disutility preferences (Gul and Pesendorfer, 2004), or reference-dependent Kőszegi and Rabin (2009) preferences. Each preference specification can be represented by Kőszegi and Rabin (2009) preferences for certain parameter combinations. 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

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

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

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

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

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

As can be seen in Equation (2), the agent discounts exponentially prospective news utility by $\beta \in [0, 1]$. Moreover, he discounts prospective news utility relative to contemporaneous news utility by a factor $\gamma \in [0, 1]$. Thus, he puts a weight $\gamma\beta^\tau < 1$ on prospective news utility regarding consumption in period $t+\tau$. For certain parameter combinations, the Kőszegi and Rabin (2009) preferences reduce to the alternative preference specifications. For $\eta = 0$ or $\lambda = 1$ and $\gamma = 1$, they reduce to standard preferences (Carroll, 2001; Gourinchas and Parker, 2002; Deaton, 1991). For $\eta > 0$, $\lambda = 1$, and $\gamma < 1$, the preferences correspond to hyperbolic-discounting preferences, with the hyperbolic-discount factor given by $\frac{1+\gamma\eta}{1+\eta}$ (Angeletos et al., 2001; O'Donoghue and Rabin, 1999). More specifically, the hyperbolic agent's lifetime utility is $u(C_t^b) + bE_t[\sum_{\tau=1}^{T-t} \beta^\tau u(C_{t+\tau}^b)]$ where $b \in [0, 1]$ is the hyperbolic-discount factor. In addition, we show results for temptation-disutility preferences, as developed by Gul and Pesendorfer (2004) and assumed in Bucciol (2012).

In the following, we describe the news-utility agent's consumption and time-inconsistency problems before and after retirement following Kőszegi and Rabin (2009) and Pagel (2017).

Suppose that in periods $t \in \{T-R, ..., T\}$, the agent earns income without uncertainty. If uncertainty is absent, the news-utility agent behaves like the standard agent 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 news-utility agent behaves like the hyperbolic-discounting agent, with the hyperbolic-discount factor given by $\frac{1+\gamma\eta\lambda}{1+\eta}$.

To see this, 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). Taking his beliefs as given, the agent deviates if the gain from consuming more exceeds the discounted loss from consuming less in the future; that is,

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

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

After retirement, the agent is less inclined to overconsume. The basic intuition for overconsumption before retirement is that the agent consumes house money–that is, labor income that he was not certain to receive. Such uncertain income wants to be consumed before his expectations catch up iff the prospective news discount factor is less than one, i.e., $\gamma < 1$. In the period just before retirement, the agent finds the loss in future consumption merely as painful as a slightly less favorable realization of his labor income, $Y_{T-1} \sim F_Y$; that is, the agent trades off being somewhere in the gain domain today against being somewhere in the gain domain in the

future. By contrast, after retirement the agent associates a certain loss in future consumption with an increase in present consumption–that is, he trades off a current gain against a sure loss in the future. For example, suppose the agent's retirement period is period T only. The agent's first-order condition in period $T-1$, absent uncertainty in period T, is given by

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

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

We now move on to a fully-fledged life-cycle model to assess whether the model's quantitative predictions about the drop in consumption at retirement roughly match the empirical evidence. We also assess whether the model can generate a simultaneous increase in savings. For the standard, hyperbolic, and tempted agents, we assume that the effective discount factor changes to generate a drop in consumption at retirement and possibly a simultaneous increase in savings. For hyperbolic-discounting preferences, we assume that the agent is subject to present bias before retirement but not after; that is, his hyperbolic discount factor is less than one before retirement but equal to one after. For the temptation-disutility preferences, we also assume that the agent experiences temptation disutility only before retirement, not after. In addition, we assume for comparison that the standard agent's exponential discount factor increases to one after retirement, so that he becomes more patient as well.

We choose the model environment in line with the life-cycle consumption literature and

present the numerical results of a power-utility model; that is, $u(C) = \frac{C^{1-\theta}}{1-\theta}$, with θ being the coefficient of constant relative risk aversion.[18] 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 income is deterministic. The life-cycle literature suggests fairly tight ranges for the parameters of the log-normal income process, which are approximately $\mu_T = \mu_P = 0$, $\sigma_T = \sigma_P = 0.1$, and $p = 0.01$. The deterministic profile G_t is estimated from the CEX data.[19] The agent has access to a simple savings account that pays net interest $r = 0.01$. For the preference parameters, we use calibrations that are standard in the literature, as displayed in Table 12 and discussed by Pagel (2017) among others.

Figure 12 contrasts the four agents' consumption paths with the empirical consumption and income profiles from the CEX data. Hyperbolic-discounting preferences push the consumption profile upward at the beginning and downward at the end of life. Temptation disutility also causes overconsumption at the beginning of life, which decreases when consumption opportunities are depleted. Standard, hyperbolic-discounting, news-utility, and temptation-disutility preferences all generate a hump-shaped consumption profile in line with the evidence (refer to Ameriks and Zeldes, 2004, for instance). Moreover, Figure 12 shows a large drop in consumption at retirement, period $T - R$, for the news-utility and hyperbolic agents' consumption profiles as well as the CEX consumption data. The tempted agent's profile features a very small

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

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

drop, and the standard agent's profile only features a kink. Thus, one needs a change in the degree of present bias or time inconsistency, not only the discount rate, to generate a sizable drop in consumption at retirement (temptation-disutility preferences are time-consistent preferences, as are standard preferences). Note, however, that for the standard, hyperbolic, and temptation-disutility agents, the change in consumption around retirement is only brought about by the preference parameters and thus the effective discount rate changing. If the preference parameters were constant, the standard, hyperbolic, and temptation-disutility agents would smooth consumption around retirement and only the news-utility agent's consumption profile would feature a drop at retirement.

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

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

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

Moreover, for the news-utility and hyperbolic agents the coefficient for savings is positive and significant, but it is negative for the other agents. Clearly, the news-utility and hyperbolic agents will also decumulate their savings after retirement. However, there is another force, the

change in the degree of present bias, that can temporarily increase their savings upon retirement. For the news-utility agent, the fall in consumption is large enough to generate a temporary increase in savings roughly in line with what we see empirically. For the hyperbolic agent, we can also observe an increase in savings, although it is somewhat smaller. The savings coefficient of the hyperbolic agent is thus closer to those of the standard and tempted agents.

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

We now briefly discuss three possible extension of this simple life-cycle framework, neither of which, however, would materially change our restults. First, we can introduce threshold for the incentives to retire and an endogenous retirement decision. In either case, however, at the time of retirement (whether endogenously choosen or exogenously induced), the hyperbolic agent's discount factor increases, and the reference-dependent agent's reduces his or her income uncertainty, both causing an increase in savings as the agents stop overconsuming time-inconsistently at the time of retirement. Second, we can assume illiquid savings and credit card borrowing. In a model with illiquid savings both the hyperbolic and reference-dependent agents would use credit card borrowing as a form of negative liquid savings. In turn, at the time of retirement, liquid savings would increase and the agents would borrow less. Third, we could assume income uncertainty even after retirement. The change in the hyperbolic agent's discount factor would not be affected and the reduction of the time-inconsistency problem for the reference-dependent agent is robust to three alternative assumptions: small income uncertainty during retirement (for instance, inflation and pension risk), potentially large discrete income uncertainty (for instance, health shocks), and mortality risk. In summary, what is necessary for

the model to generate the joint finding of falling income and consumption but increasing liquid savings (or decresing borrowing) is that the agent's degree of present bias changes at the time of retirement.

5 Conclusion

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

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

Our findings are related to recent work documenting that mean and median cohort wealth, for either singles or couples, can be stationary or rising for many years after retirement even though the standard Modigliani's (1954) life-cycle model predicts that individuals should decumulate assets (Love et al., 2009; Poterba et al., 2011a,b). This empirical finding has been

termed the ”retirement-savings puzzle” and is theoretically explained by DeNardi et al. (2010) and Laitner et al. (2017), among others, via medical expense risks or labor-leisure substitution. However, we confirm in our data that medical expenses do not increase upon retirement ruling out this explanation. Moreover, none of these papers specifically compare overall liquid savings and consumer debt in a short period before versus after retirement to highlight what we can learn from the patterns about household's ability to plan and smooth consumption and the relevance of the retirement-consumption puzzle. If people were to save rationally for retirement (and consider the magnitude and risks of expected medical expenses as well as their additional spare time) and consumption falls only due to work-related expenses – we would not observe a simultaneous decrease in consumer debt and increase in liquid savings.

References

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

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

_ **, John C Driscoll, Xavier Gabaix, and David Laibson**, "The age of reason: Financial decisions over the life cycle and implications for regulation," *Brookings Papers on Economic Activity*, 2009, *2009* (2), 51–117.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Carvalho, Leandro S., Stephan Meier, and Stephanie W. Wang, "Poverty and Economic Decision-Making: Evidence from Changes in Financial Resources at Payday," *American*

Economic Review, February 2016, *106* (2), 260–84.

de Nicola, Francesca and Xavier Giné, "How Accurate are Recall Data? Evidence from Coastal India," *Journal of Development Economics*, 2014, *106* (0), 52 – 65.

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.

Do, What Behavioral Economics Tries To, "Behavioral economics: Past, present, future," *Advances in behavioral economics*, 2011, p. 1.

Gabaix, Xavier, "Behavioral macroeconomics via sparse dynamic programming," Technical Report, National Bureau of Economic Research 2016.

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

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

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

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

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

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

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

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

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

Karlan, Dean and Jonathan Zinman, "Lying about Borrowing," *Journal of the European Economic Association*, 2008, *6* (2/3), pp. 510–521.

Kőszegi, Botond and Matthew Rabin, "A model of reference-dependent preferences," *The Quarterly Journal of Economics*, 2006, *121* (4), 1133–1165.

_ **and** _ , "Reference-dependent risk attitudes," *American Economic Review*, 2007, *97* (4), 1047–1073.

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

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

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

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

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

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

Love, David A., Michael G. Palumbo, and Paul A. Smith, "The trajectory of wealth in retirement," *Journal of Public Economics*, 2009, *93* (1), 191 – 208.

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

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

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

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

_ and _ , "The Liquid Hand-to-Mouth: Evidence from a Personal Finance Management Software," *The Review of Financial Studies*, 2018.

_ and _ , "The Ostrich in Us: Selective Attention to Financial Accounts, Income, Spending, and Liquidity," Technical Report 2018.

_ and Tomas Thörnqvist, "Bargaining over risk: The impact of decision power on household portfolios," Technical Report 2018.

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

Parker, Jonathan A and Nicholas S Souleles, "Reported Preference vs. Revealed Preference: Evidence from the propensity to spend tax rebates," 2017.

Pistaferri, Luigi, "Household Consumption: Research Questions, Measurement Issues, and Data Collection Strategies," *Journal of Economic and Social Measurement*, 2015, *40* (1-4), 123–149.

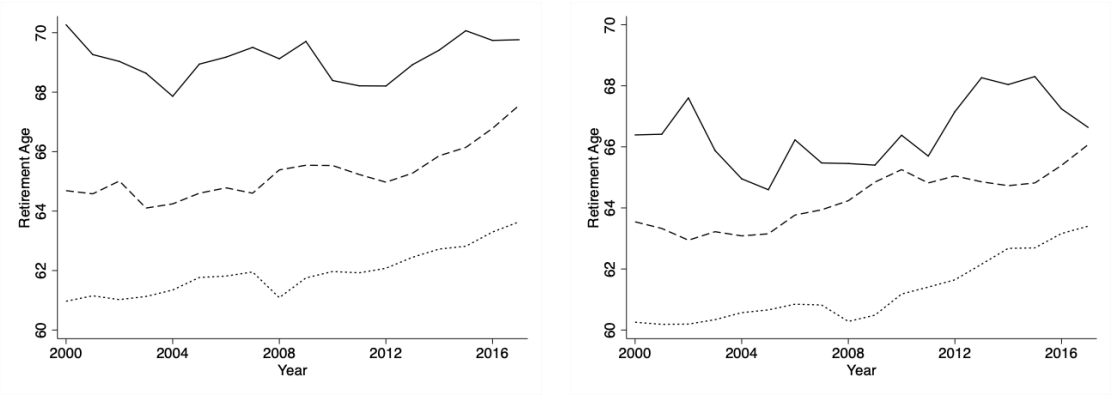
Poterba, James, Steven Venti, and David Wise, "The Composition and Draw-Down of Wealth in Retirement," *Journal of Economic Perspectives*, 2011, *25*, 95–117.

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

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

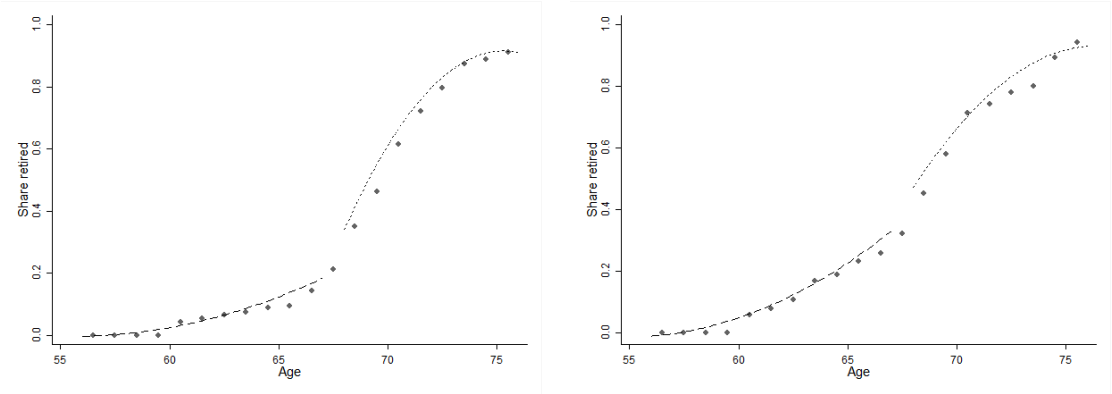
Schwerdt, Guido, "Why does consumption fall at retirement? Evidence from Germany," *Economics Letters*, 2005, *89* (3), 300 – 305.

Sims, Christopher A, "Implications of rational inattention," *Journal of monetary Economics*, 2003, *50* (3), 665–690.



Men Women

Figure 1: Average retirement age by year for Iceland, Germany, and the US
For men and women in Iceland (solid line) compared to Germany (dotted line) and the United States (dashed line). Source: OECD.



Men Women

Figure 2: Share of individuals in Iceland that are retired by individual age
Raw data using the inferred retirement date as described in Section 2.1.

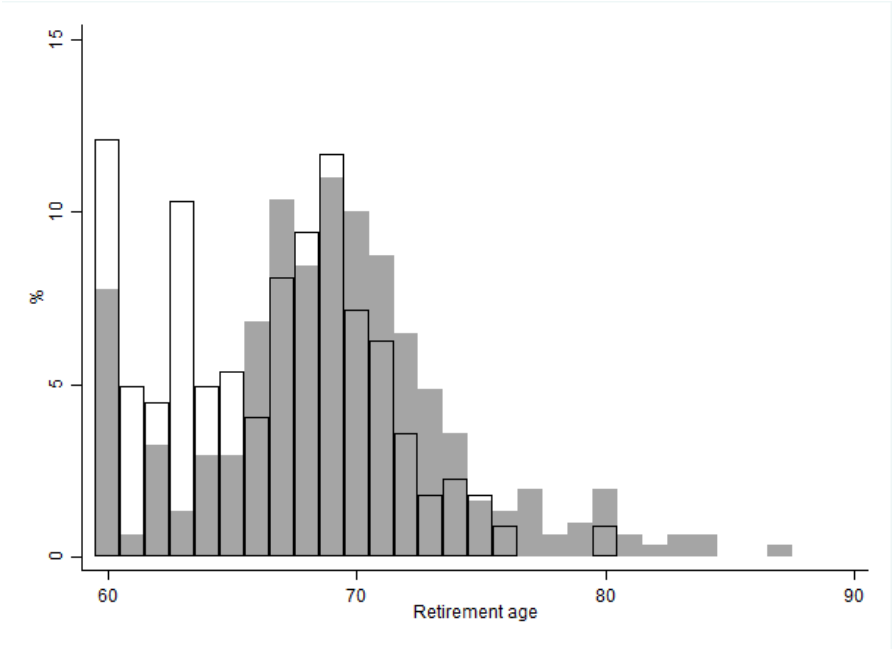


Figure 3: Distribution of retirement age in Iceland
Raw data for women (white bars) and men (gray bars) using the inferred retirement date as described in Section 2.1.

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 discretionary	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	0.124

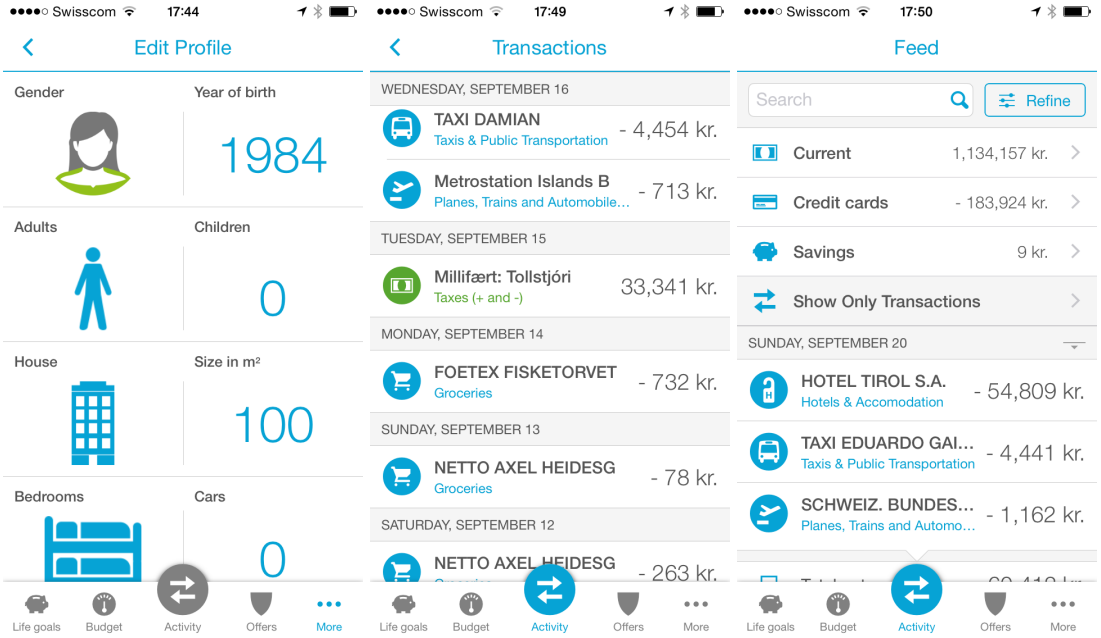
Note: All numbers are in US dollars. Parentheses indicate that data categories do not match perfectly.

Table 2: Summary statistics

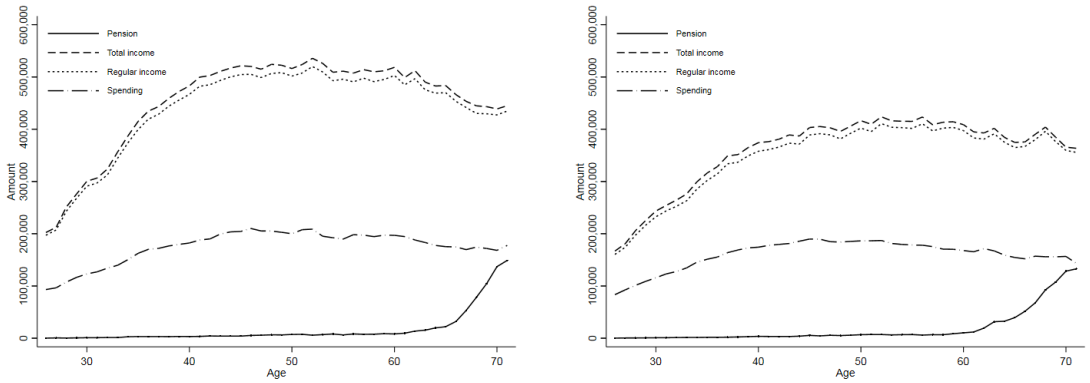
	Eligible but not retired		Retired	
	Mean	St.dev.	Mean	St.dev.
Demographics:				
Age	64.2	3.6	71.2	5.8
Female	0.41	0.49	0.41	0.49
Monthly income:				
Total	4,580	3,973	3,403	2,563
Regular	4,462	3,856	3,293	2,426
Irregular	89	391	79	374
Salary	4,066	3,706	717	2,084
Total hh	4,865	4,263	3,727	2,947
Personal finances:				
Total bank fees	49	98	37	85
Late fees	18	79	14	44
Overdraft interest	52	81	43	89
Overdraft amount	970	4,326	852	4,196
Savings account balance	6,259	73,649	8,720	27,868
Interest income	248	2,217	337	1,306
Current account balance	2,184	13,033	2,079	9,173
Overdraft limit	2,024	5,578	2,281	6,128
Credit card balance	-1,051	6,339	-1,221	14,435
Credit card card limit	3,872	9,640	4,504	15,944
Liquidity	11,581	71,056	13,967	30,179
Monthly spending:				
Total discretionary	1,729	1,168	1,629	955
Groceries	500	378	506	317
Fuel	241	229	198	189
Alcohol	85	134	79	131
Ready-made food	125	149	104	122
Home improvements	189	354	168	317
Home security	9	24	9	24
Transportation	82	174	67	159
Clothing & accessories	107	192	82	156
Sports & activities	9	40	6	34
Pharmacies	61	76	73	79

Note: All numbers are in US dollars.

Figure 4: The financial aggregation app: screenshots

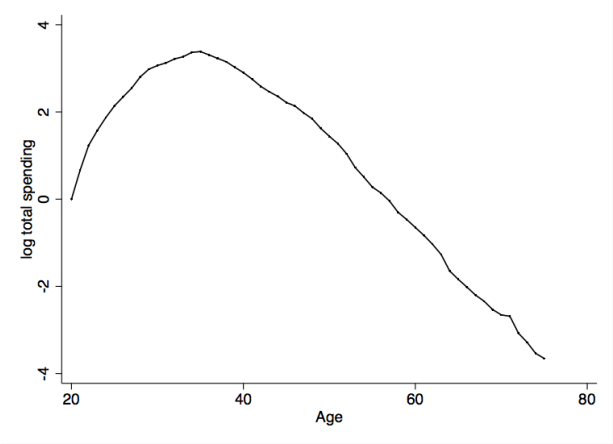


Notes: This figure shows the Meniga app interfaces.

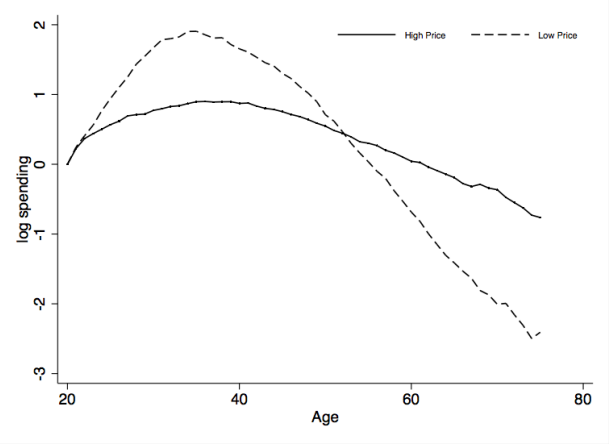


Men Women

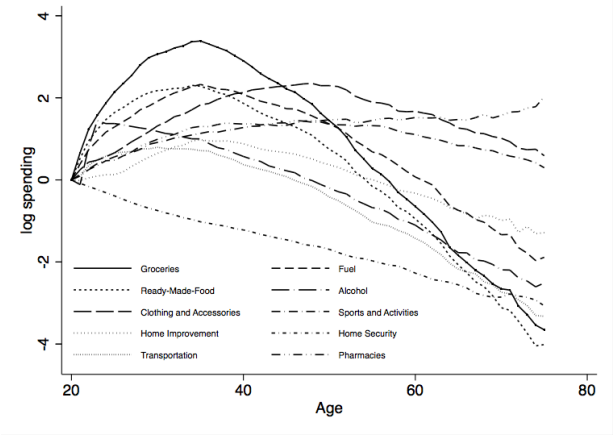
Figure 5: Total and labor income, discretionary expenditure, and pension payments over age



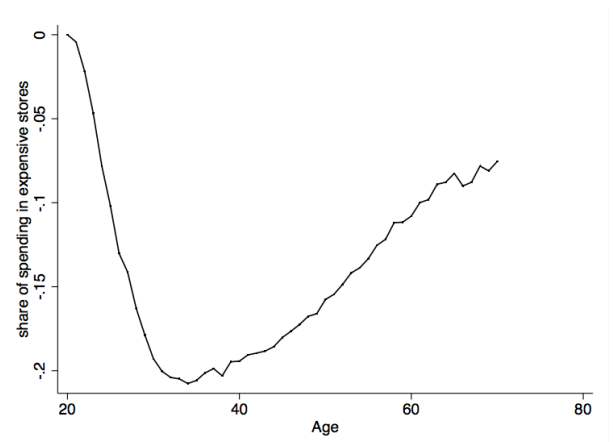
Total discretionary spending



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



Spending by category



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

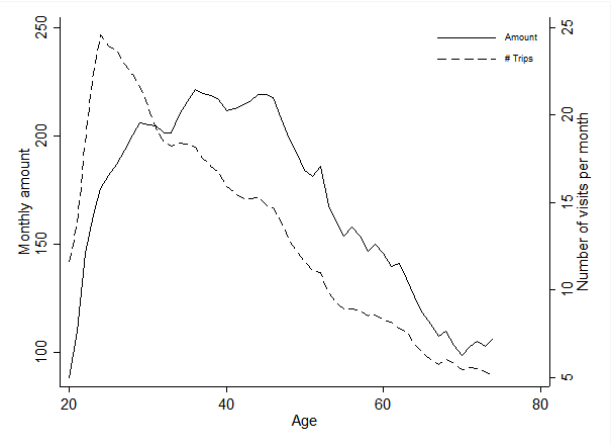
Figure 6: Life-cycle profiles of expenditures

The figures plot the estimated coefficients from a regression of the outcome variable on a full set of age dummies, with age 20 being the omitted dummy. The regressions include month-by-year fixed effects and individual fixed effects.

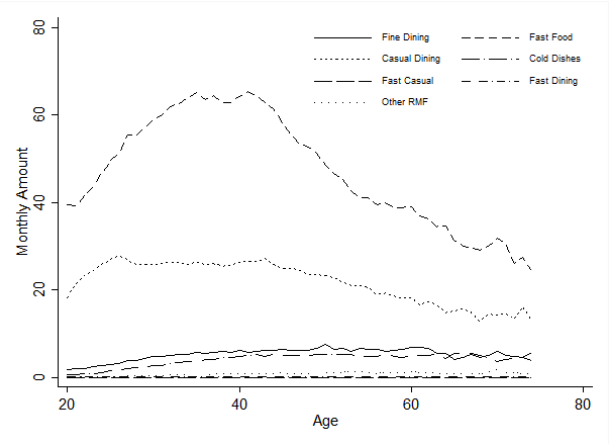
Table 3: Effects of retirement on spending by category

	Total expenditure	Grocery	Fuel	Alcohol	Ready-made -food	Home improvement	Home security	Transportation	Clothing and accessories	Sports and activities	Pharmacies
Without controlling for income:											
Retired	-0.138***	-0.136***	-0.255***	-0.165***	-0.158***	-0.072*	-0.054***	-0.279***	-0.187***	-0.160***	-0.086**
	(0.010)	(0.020)	(0.028)	(0.037)	(0.023)	(0.041)	(0.014)	(0.041)	(0.045)	(0.028)	(0.036)
R-sqr	0.100	0.051	0.015	0.028	0.054	0.057	0.003	0.041	0.036	0.006	0.010
Controlling for income:											
Retired	-0.147***	-0.152***	-0.271***	-0.175***	-0.171***	-0.088**	-0.055***	-0.293***	-0.202***	-0.165***	-0.098***
	(0.009)	(0.020)	(0.028)	(0.037)	(0.023)	(0.041)	(0.014)	(0.041)	(0.045)	(0.028)	(0.036)
R-sqr	0.117	0.061	0.021	0.029	0.060	0.059	0.004	0.043	0.038	0.007	0.012
#obs	777,283	777,283	777,283	777,283	777,283	777,283	777,283	777,283	777,283	777,283	777,283
#individuals	12,143	12,143	12,143	12,143	12,143	12,143	12,143	12,143	12,143	12,143	12,143
Individual FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Month-by-year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

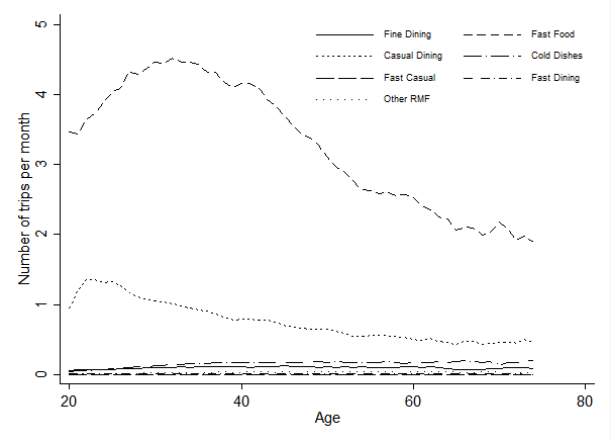
Note: [a] This table shows regression results of retirement on log spending by category using individual fixed effects and a dummy for retirement, with and without controlling for total income. All specifications control for month and year fixed effects, and their interactions. Standard errors are clustered at the individual level and displayed in parentheses. [b] Significance levels: * p<0.1 ** p<0.05 *** p< 0.01 [c] All coefficients represent percentage changes.



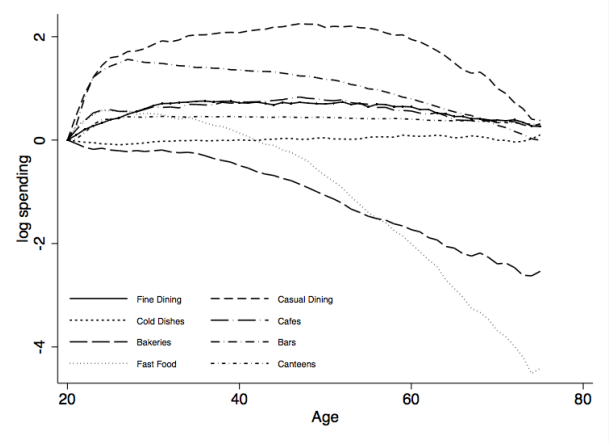
Restaurant spending (solid) and visits (broken)



Restaurant expenditure by category per month



Restaurant trips by category per month



Expenditure by type of restaurant

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

Table 4: Effects of retirement on restaurant spending and visits

	Total	Casual dining	Cold dishes	Cafes	Bakeries	Bars	Fast food	Fine dining	Canteens
Spending:									
Without controlling for income:									
Retired	-0.232***	-0.425***	0.006	-0.068***	-0.004	-0.236***	-0.384***	-0.068***	-0.045***
	(0.020)	(0.023)	(0.013)	(0.019)	(0.019)	(0.017)	(0.021)	(0.019)	(0.006)
R-sqr	0.235	0.114	0.013	0.047	0.072	0.028	0.158	0.017	0.015
Controlling for income:									
Retired	-0.450***	-0.571***	-0.016	-0.146***	-0.099***	-0.288***	-0.563***	-0.116***	-0.049***
	(0.018)	(0.022)	(0.013)	(0.019)	(0.019)	(0.017)	(0.020)	(0.020)	(0.006)
R-sqr	0.413	0.178	0.016	0.071	0.106	0.041	0.274	0.026	0.016
Number of visits:									
Without controlling for income:									
Retired	-3.748***	-0.621***	-0.001	-0.115***	0.029	-0.190***	-1.232***	-0.026***	-0.058***
	(0.241)	(0.042)	(0.004)	(0.029)	(0.030)	(0.023)	(0.088)	(0.007)	(0.011)
R-sqr	0.059	0.034	0.002	0.010	0.023	0.009	0.041	0.004	0.009
Controlling for income:									
Retired	-4.934***	-0.756***	-0.004	-0.182***	-0.054*	-0.227***	-1.624***	-0.034***	-0.061***
	(0.241)	(0.042)	(0.004)	(0.030)	(0.031)	(0.024)	(0.089)	(0.007)	(0.011)
R-sqr	0.092	0.049	0.003	0.017	0.033	0.012	0.071	0.006	0.009
Individual FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Month-by-year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
#obs.	1,042,951	1,042,951	1,042,951	1,042,951	1,042,951	1,042,951	1,042,951	1,042,951	1,042,951
#individuals	14,287	14,287	14,287	14,287	14,287	14,287	14,287	14,287	14,287

Note: [a] This table shows regression results of retirement on log of spending in different types of restaurants and on the number of visits to different types of restaurants, using individual fixed effects, with and without controlling for total income. All specifications control for month and year fixed effects, and their interactions. Standard errors are clustered at the individual level and displayed in parentheses. [b] Significance levels: * p<0.1 ** p<0.05 *** p< 0.01 [c] All coefficients represent percentage changes.

Table 5: Effects of retirement on personal finances

	Total fees	Late fees	Overdraft interest	Interest income	Current acct balance	Overdraft amount	Credit card balance	Credit card limit	Liquidity	Income minus consumption
Without controlling for income:										
Retired	-0.191***	-0.164***	-0.111***	0.061***	0.156*	-0.376***	-0.087	-0.013	0.021	0.267**
	(0.036)	(0.035)	(0.033)	(0.022)	(0.090)	(0.086)	(0.054)	(0.048)	(0.032)	(0.1179)
R-sqr	0.060	0.030	0.036	0.506	0.024	0.020	0.010	0.019	0.058	0.063
Controlling for income:										
Retired	-0.369***	-0.278***	-0.225***	0.003	0.147	-0.378***	-0.090*	-0.015	0.016	
	(0.035)	(0.034)	(0.032)	(0.022)	(0.090)	(0.086)	(0.054)	(0.048)	(0.032)	
R-sqr	0.129	0.061	0.071	0.516	0.024	0.020	0.010	0.019	0.059	
#obs	885,189	885,189	885,189	885,189	331,668	331,668	331,668	331,668	331,668	885,114
#individuals	12,143	12,143	12,143	12,143	12,143	12,143	12,143	12,143	12,143	12,143
Individual FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Month-by-year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Note: [a] This table shows regression results of the effect of retirement on log interest payments, balances, and limits, using individual fixed effects, with and without controlling for total income. All specifications control for month and year fixed effects, and their interactions. Standard errors are clustered at the individual level and displayed in parentheses. [b] Significance levels: * p<0.1 ** p<0.05 *** p< 0.01 [c] All coefficients represent percentage changes.

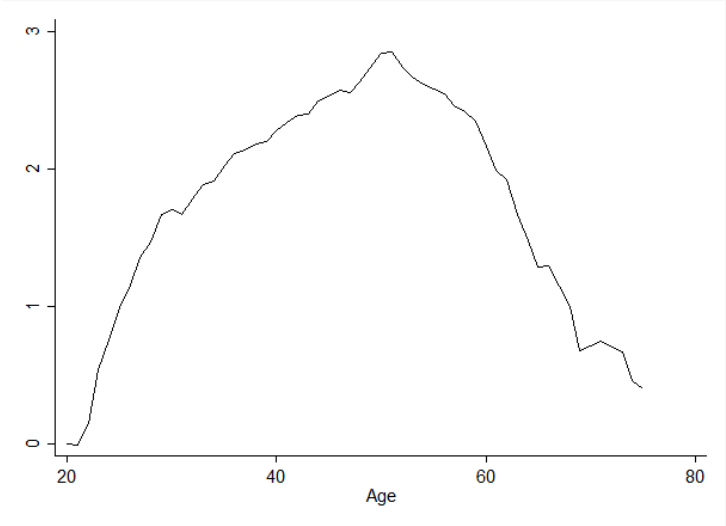


Figure 8: Consumer debt

This figure plots the estimated coefficients from a regression of log total monthly overdraft interest payments on a full set of age dummies, with age 20 being the omitted age dummy. The regressions include month-by-year fixed effects, and individual fixed effects.

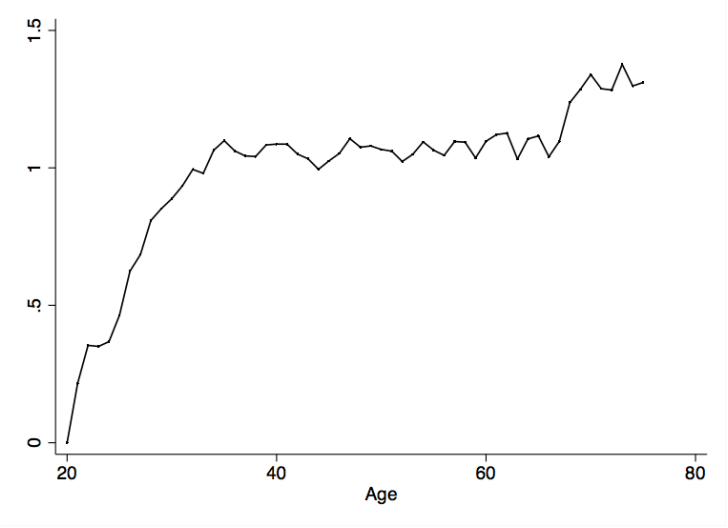


Figure 9: Interest income

This figure plots the estimated coefficients from a regression of log total monthly interest income from bank account balances on a full set of age dummies, with age 20 being the omitted age dummy. The regressions include month-by-year and individual fixed effects.

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

	Investment transactions	Uncategorized income	Investment transactions	Uncategorized income
Retired	-0.010	-0.069***	-0.014	-0.077***
	(0.009)	(0.012)	(0.009)	(0.012)
R-sqr	0.024	0.024	0.025	0.025
#obs	885,189	885,189	885,189	885,189
#individuals	12,144	12,144	12,144	12,144
Individual FE	✓	✓	✓	✓
Month-by-year FE	✓	✓	✓	✓
Total HH income			✓	✓

Note: [a] This table shows regression results of the effect of retirement on log investment related income and uncategorized income. All specifications control for month and year fixed effects, and their interactions. Standard errors are clustered at the individual level and displayed in parentheses. [b] Significance levels: * p<0.1 ** p<0.05 *** p< 0.01
[c] All coefficients represent percentage changes.

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

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

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

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

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

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

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

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

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

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

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

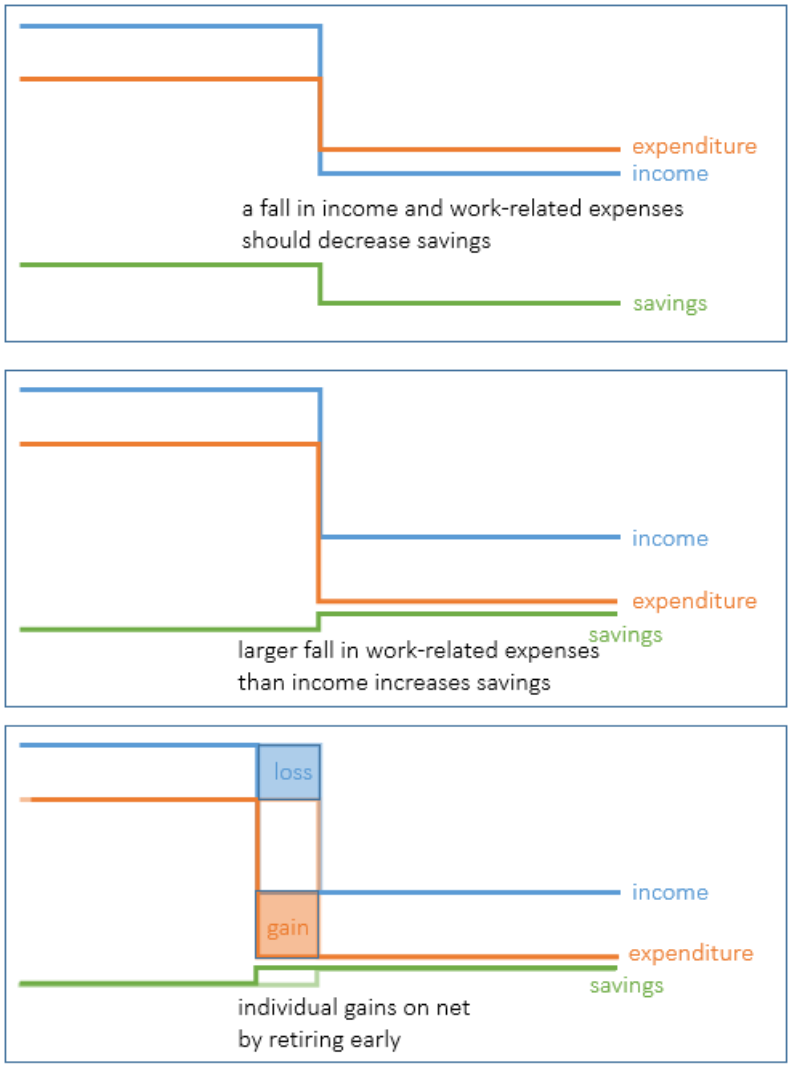
Note: [a] This table shows regression results for log household spending, checking and savings account balances, amount of debt, and wealth (winsorized not logged due to many negative observations). Standard errors are clustered at the individual level. t-statistics are displayed in parentheses. [b]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

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

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

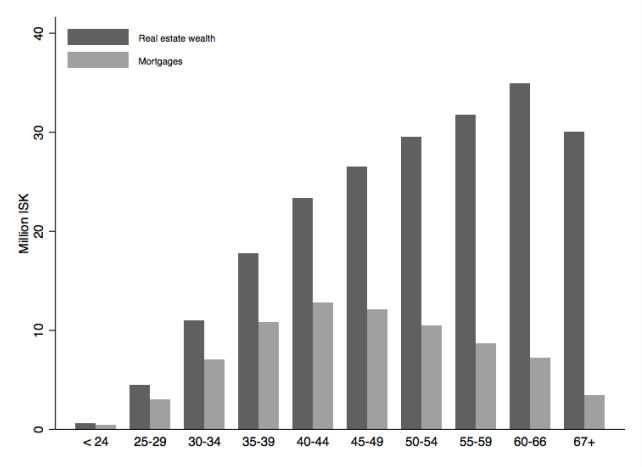
Note: [a] This table shows regression results for log household spending, savings, amount of IRA assets, and wealth. Standard errors are clustered at the individual level. t-statistics are displayed in parentheses. [b] Significance levels: * p<0.1 ** p<0.05 *** p< 0.01

Figure 10: Illustration of the argument



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

Figure 11: Housing wealth and mortgage debt over age



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

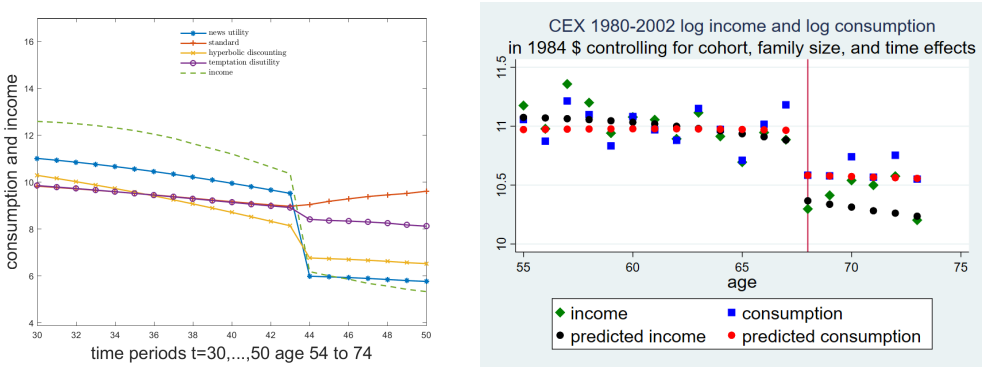
Table 12: Environmental and preference parameters

parameter	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	0	0.1	0.01	$\widehat{G_t}$	0.01	1	0.0096	11	78

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

This table displays all calibrated parameters.

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



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

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

	Standard agent	News-utility agent	Hyperbolic agent	Tempted agent
Consumption regressions:				
Retired	0.06***	-0.38***	-0.14***	-0.004***
	(22.67)	(-94.40)	(-44.76)	(-1.42)
Total HH income	✓	✓	✓	✓
#obs	800	800	800	800
Savings regressions:				
Retired	-0.006***	0.052***	0.016***	-0.0004***
	(-21.93)	(86.56)	(44.61)	(-1.37)
Total HH income	✓	✓	✓	✓
#obs	800	800	800	800

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

A The Icelandic pension system

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

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

Pillar two - occupational pensions. Occupational pensions are the cornerstone of the Icelandic pension system. The occupational pension system, making occupational pension funds available to the general public, was established in 1969 by agreement between the social partners. In 1974 it was made mandatory by law for all wage and salary earners. 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 percent. 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 payments as early as 65, but then with a reduced benefit, or as late as 70 with additional benefits. In general, the benefit rule in the new public sector scheme and in the private sector is neutral towards the choice of early or late retirement.[20]

Pillar Three - voluntary individual pension savings. Employees can deduct from their taxable income a contribution to authorized individual pension schemes. Currently, the maximum taxable deduction by the employee is 4 percent. In addition, all employ-

[20]The question whether it is beneficial to postpone benefit withdrawal until after 67 therefore depends on how long individuals expect to live and the individual should be indifferent if she expects to live until she reaches the average life expectancy. Based on calculations from the Icelandic Pension Funds Association ($https://www.lifeyrismal.is/static/files/old/Sveigjanleg_starfslok.pdf$), early withdrawal pays off if individuals pass the age of 84 and late withdrawal pays off if individuals pass the age of 94. Individuals would therefore have to expect to live at least until the age of 94 if they were to benefit from postponing to withdraw their benefits.

ers 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.[21]

B Derivation of the theoretical framework

B.1 The news-utility model

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

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

which can be rewritten as

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

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

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

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

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

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 $\eta\lambda$,

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

[21] After the financial crisis, individuals were given permission to take out private pension savings to pay down debt. We observe all such one-time withdrawals but exclude individuals younger than 60 in all analyses. This also implies that any lingering effects of the financial crisis, even if they affect older people differently from younger people, are captured by the inclusion of time fixed effects.

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

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

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

condition in any period $T-i$ is given by

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

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

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

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

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

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

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

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

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

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

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

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

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

B.2 The hyperbolic-discounting model

We consider an agent with hyperbolic-discounting preferences with the hyperbolic-discounting parameter denoted by 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

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

$$+(1-\frac{\partial c_{T-i+1}}{\partial x_{T-i+1}})(G_{T-i+1}e^{s^P_{T-i+1}})^{-\theta}\Phi'_{T-i+1}].$$

B.3 The temptation-disutility model

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

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

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

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

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

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

which results in the following first-order condition

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

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

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