# Retirement Puzzles: New Evidence from Personal Finances

Arna Olafsson* and Michaela Pagel†

Copenhagen Business School  Columbia GSB, NBER, & CEPR

This version: January 2022

**Abstract**

Using comprehensive transaction-level panel data on personal finances, we document that individuals repay their consumer debt and save more after they retire. These findings are puzzling because standard economic theory predicts that people should save more before, rather than after, the expected decrease in income upon retirement. We consider a number of potential explanations for our findings, including a reduction in work-related expenses and an increase in medical health risks around retirement, which are the leading explanations of the so-called retirement-consumption and retirement-savings puzzles. We argue that these explanations are not fully consistent with our findings and we thereby inform the larger question of whether individuals save enough for retirement. Finally, we rationalize our findings in a model with non-standard preferences.

**Keywords: retirement, savings, consumer debt**

**JEL codes: G51, D12, D14, E21, J26, J32**

*Department of Finance, Copenhagen Business School, the Danish Finance Institute, & CEPR. ao.fi@cbs.dk

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

We are grateful for the financial support of the Pension Research Center (PeRCent) at Copenhagen Business School. We thank Steve Zeldes, Emi Nakamura, Alex Rees-Jones, David Laibson, Andrew Caplin, Doug Bernheim, Rachel Kranton, Jawad Addoum, Jon Parker, Matthew Rabin, Botond Koszegi, Chris Moser, Jon Zinman, Jennifer La'O, Emir Kamenica and seminar participants at the Brown University, NYU Sloan-Nomis Conference on Attention and Applied Economics, Federal Reserve Bank of Richmond, Frankfurt School of Finance, CEPR European Conference on Household Finance, NBER Behavioral Macro Summer Institute, AFA, Stanford Institute for Theoretical Economics (SITE) Psychology and Economics, University of Queensland, PerCent 2017 Conference, University of Minnesota, Columbia University, 8th conference of the CESifo network on Behavioral Economics, and ECWFC at the Western Finance Association 2017 for a range of insightful comments. This paper was nominated for the Distinguished CESifo Affiliate Award. We are also indebted to Meniga and their data analysts for providing and helping with the Icelandic data and to Steffen Meyer for replicating our results in German bank data. We also thank Fedra De Angelis Effrem, Andrea Marogg, and Belinda Chen for outstanding research assistance. The paper was previously titled "The Retirement-Consumption Puzzle: New Evidence from Personal Finances."

# 1 Introduction

In many developed countries, mandatory retirement contribution plans are becoming less common and voluntary savings schemes have gained importance shifting the responsibility of preparing for retirement onto individuals. This makes sound personal finances at the onset of retirement more important than ever. But many people have barely any savings and hold substantial amounts of consumer debt at the time of retirement (Skinner, 2007; Anguelov and Tamborini, 2009; Poterba et al., 2012). In this paper, we argue that understanding what happens to household balance sheets around retirement is informative about the question whether people plan properly and save enough for retirement.

We use longitudinal transaction-level data from a personal financial management software in Iceland to investigate how individuals' liquid savings and consumer debt positions change around retirement. We show that individuals are 9 percent more likely to have liquid savings and save 28 percent more, as measured by interest income, after they retire. Additionally, individuals are 10 percent less likely to overdraw their checking accounts post retirement. Such overdrafts are the predominant way of rolling over high-interest unsecured consumer debt in Iceland. New retirees also reduce their amounts of overdraft debt, as measured by interest payments, by 55 percent. We document these effects in a number of different specifications, from simple individual-level mean comparisons before versus after retirement to event study designs controlling for individual and month-by-year fixed effects as well as for several additional variables.

That individuals repay consumer debt and save more after retiring is surprising from the viewpoint of standard economic theory. If individuals expect that income decreases upon retirement, they should save more in anticipation of the decline in income rather than after. We now first describe what happens on the income side of the household balance sheet. In turn, we review the literature and argue that looking at overdraft debt and liquid savings can help us evaluate the leading explanations for two existing retirement puzzles.

In Iceland, individuals face a sizable step down in income at the time of retirement. However, the Icelandic pension system is both transparent and comprehensive: individuals can easily look up how much their annuitized pension income will be and there is no longevity risk to income, as it is indexed to the consumer price level.

People may compensate for lower retirement income by liquidating voluntary retirement accounts, investment accounts, or other illiquid assets, such as real estate; which would explain our findings. However, because we observe all pension liquidations as well as liquidations from investment accounts and any other uncategorized inflows (from real estate transactions for instance), we can show that liquidations are unaffected or decreasing around retirement for the average individual. Additionally, we can show that our results are robust to controlling for these variables in our specifications.

Instead, spending drops by more than income upon retirement, which is why we see an

increase in liquid savings and a decrease in consumer debt. Potential reasons are a drop in work-related expenses, increase in home production, or a decrease in the opportunity cost of time. But if people know in advance that they can save more after retiring, they should retire as early as possible — unless the additional pension benefit from working longer exceeds the additional savings they accumulate when retiring. After age 67, the additional benefits in pension payments from working for one more month are small: approximately 0.5 percent or 10 USD per month in additional pension income.[1] These increases in pension income are much smaller than the savings from retiring, which equal monthly reductions in overdrafts of approximately 102 USD and monthly increases in liquid savings balances of approximately 210 USD. Therefore, individuals should retire as early as possible as they can save more by doing so. However, we find that individuals continue to work for many months and sometimes years beyond reaching the retirement eligibility age.[2] We conclude that our findings can not be fully explained by work-related expenses or any other theory that reduces consumption needs around retirement but require a reason for why individuals still wait to retire.

Another potential explanation for our findings is that health shocks cause individuals to simultaneously retire and increase their need for precautionary savings. For three reasons, however, we argue that health shocks and increased medical expense risk cannot fully explain our findings. First, Iceland is a Nordic welfare state. As mentioned, the pension income is not subject to income risks due to either longevity or price. Moreover, the health care system is comprehensive and individuals do not face large medical expense risks of the type that many US households face. Out-of-pocket expenses, even for small items such as copays for medical supplies, are capped. Second, we do not observe increases in pharmacy spending at retirement. Because copayments are mandatory in Iceland up to the cap, pharmacy spending is a proxy for health status. Thus, we argue that the average individual does not seem to retire because of health shocks and such shocks would not simultaneously increase medical expenditure risk.[3] Third, if individuals rationally expect an increase in medical expenses after retirement, then they would logically save more before retirement rather than after.

Our findings thus indicate that individual consumption falls by more than expected as a

[1] In Iceland, the retirement system is designed so that an individual with the average life expectancy after the age of 67 is (actuarially) indifferent between retiring and working an extra year, i.e., the additional benefits paid out from working longer equal the contemporaneously forgone pension payments.

[2] We consider two alternative definitions of retirement. The first one depends only on the presence of pension payments whereas the second one also includes the absence labor income. For the latter definition of retirement, we observe a drop in income that is larger and comparable to the US drop in income. For both definitions of retirement, we observe the same results: individuals decrease consumer debt and increase savings but continue to work well beyond the age of 67 (after which the additional pension benefits are small) and until 70 (for the former definition of retirement) or 71 (for the latter definition of retirement).

[3] The Icelandic health care system is financed by taxes, which is common in the Nordic welfare state model and implies 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 elderly individuals, generally receive discounts on personal health expenses. Out-of-pocket payments are a source of funding for the universal health care system and amount to 9 percent of GDP. In comparison, in the US, out-of-pocket medical expenditures amount to 17.7 percent of GDP. Furthermore, in Iceland, there is no risk of personal costs for large health expenses because they are capped. See https://en.wikipedia.org/wiki/Healthcare_in_Iceland.

result of work-related expenses or the opportunity costs of time, or that individuals do not fully anticipate the increases in medical expense risk they face after retirement (as in Heimer et al., 2019). Additionally, we discuss a number of other potential explanations; for instance, reductions in consumer debt may be driven by decreases in borrowing capacity that we can observe through credit limits. However, we do not find that individual borrowing capacity or liquidity decreases around retirement. Furthermore, we discuss labor-leisure substitution, intra-household bargaining, consumption insurance, lump-sum pension payments, and inventory savings. We conclude, however, that these theories all have difficulty explaining our findings.

Our analysis is based on Icelandic data due to their unusually high quality. However, we show that we obtain similar findings using data from other sources: survey data from the US and bank account data from Germany. We first look at the most commonly used US consumption survey data sets, the Consumer Expenditure Survey (CEX) and the Survey of Consumer Finances (SCF). 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. 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 also replicate our results in another set of individual- and transaction-level bank account data from Germany employing fixed-effects regressions. Finally, we use two more US survey data sets to replicate our results: the University of Michigan's Panel Study of Income Dynamics (PSID) and the Health and Retirement Study (HRS). Because these surveys poll the same households a number of times, we can also include household fixed effects in our regressions. In all of these data sets, we find that consumption and debt holdings decrease upon the onset of retirement, but savings and checking account balances increase as do other measures of wealth.

To our knowledge, no existing studies empirically investigate the relationship between retirement, consumer debt, and liquid savings. A few studies look at how other positions on households' balance sheets are affected by retirement. First, Addoum (2016) shows that household portfolios become less risky when men retire using PSID data. Second, Agarwal et al. (2009) documents 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. Third, Agarwal et al. (2015) show that credit card spending declines while debit card spending increases upon retirement, which may be indicative of a change in consumer debt. Fourth, Carlin et al. (2019) discuss generational differences in managing personal finances.

There exists a large literature on two "retirement puzzles:" (1) the empirical observations that spending drops upon retirement, i.e., the "retirement-consumption" puzzle, and (2) the observation that wealth rises after retirement, i.e., the "retirement-savings" puzzle. We argue

that our results are informative about these puzzles as well as about their leading explanations.

The retirement-consumption puzzle considers a central implication of standard life-cycle models of household consumption and savings: that the marginal utility of consumption should be smoothed across periods of predictably high and low income. However, a number of empirical studies (e.g., Banks et al., 1998; Bernheim et al., 2001; Schwerdt, 2005; Haider and Stephens, 2007; Fe, 2019) find a sharp decline in consumption during the first years of retirement.[4] The leading explanation for this puzzle is provided by Aguiar and Hurst (2005, 2013) and Hurst (2008); they argue that spending, rather than consumption, decreases on the grounds that individuals reduce their work-related expenses and overall spending through household production.[5]

As discussed above, our findings about personal finances suggest that work-related expenses cannot be the only explanation for the increase in savings and reduction in consumer debt we observe after retirement. When we look at spending instead, we find evidence of reductions in expenses that are plausibly work-related but are also in leisure categories. Our analysis of spending categories thus supports our findings based on personal finances that constitute a new test for the premise that work-related expenses are the leading explanation for the retirement-consumption puzzle.

The retirement-savings puzzle considers the prediction of the standard life cycle model that individuals should decumulate assets over the course of retirement. Recent literature documents that mean and median cohort wealth, for either singles or couples, remains constant or rises for many years after retirement (Love et al., 2009; Poterba et al., 2011a,b; Kieren and Weber, 2019).[6] The leading explanations for this puzzle are longevity and medical expense risks, as theorized by DeNardi et al. (2010) and Laitner et al. (2018), and empirically analyzed by Jones et al. (2018) and Ameriks et al. (2016). The Icelandic pension system is designed so that individuals decumulate their pension wealth after retirement through their annuitized pension payments. Given that the average monthly pension payments are larger than the additional savings from retiring, individuals decumulate their wealth after retiring in our setting. However, we can still view our results on how liquid savings and consumer debt changes around retirement as a new test for the leading explanation of the findings in this literature. That said, as discussed, we argue that medical expense and longevity risk cannot be the only explanation

[4]Following Davies (1981) and Hamermesh (1984), Banks et al. (1998) document a decline in consumption at retirement using a pseudo panel from the Family Expenditure Survey (FES) in the UK. Bernheim et al. (2001) confirm this finding using longitudinal data from the Panel Study of Income Dynamics (PSID). The drop in consumption at retirement is theoretically rationalized by Laitner and Silverman (2005), 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.

[5]While some additional studies provide evidence supporting this explanation (see, e.g., Hurd and Rohwedder, 2003; Battistin et al., 2009), others argue against it (such as Stephens Jr and Toohey, 2018).

[6]Love et al. (2009) construct a measure of wealth beginning at age 65 and document that it rises with age. Poterba et al. (2011a,b) show 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. Guo et al. (2020) shows however that individuals tend to claim social security benefits early.

for our findings.

We evaluate which models that generate a drop in consumption upon retirement can explain our joint findings that consumption and income decrease but liquid savings increase. Two "model ingredients" are necessary to explain our results. First, the model must offer an explanation for why spending falls by more than income at retirement, e.g., because of work-related expenses. Second, the model must offer an explanation for why it is not optimal for the agent to retire early if he or she can save by doing so. Potential explanations are that agents derive utility from working, that they are surprised by medical expense risks, or that their marginal utility of consumption is affected by labor or health status in an unexpected way. To our knowledge, however, the existing life-cycle models based on rational preferences offer only the first, but not the second, ingredient. In terms of more behavioral approaches, we consider two classes of models: non-standard planning behavior and non-standard preferences.

Even with a limited planning horizon, agents would begin to smooth consumption once they are close to retirement. We thus need an additional change in information processing or planning behavior at the time of retirement. To model where that is coming from, we turn to non-standard preferences. We first consider the most widely-applied model with a time-inconsistent overconsumption problem due to hyperbolic discounting (as in Laibson et al., 1998). This model does not predict a fall in consumption and an increase in savings upon retirement per se. However, if we assume that the agent corrects his or her time-inconsistency problem and stops overconsuming after retirement, then the model succeeds in explaining our joint findings. This assumed change in the agent's discount factor could be brought about by a change in information-processing capacity, more ability to plan, or any other change to his or her limited rationality (Bordalo et al., 2013, 2017; Koszegi and Szeidl, 2013; Bushong et al., 2015; Heimer et al., 2019; Malmendier and Shen, 2018; Lusardi and Mitchell, 2011; Fulford and Schuh, 2017). We also show that a change in the agent's time-inconsistency problem rather than just a change in his or her patience is essential in generating an increase in savings after retiring.

The same correction of time-inconsistent overconsumption is present in a life-cycle model with expectations-based loss aversion, as developed by Kőszegi and Rabin (2009) followed by Pagel (2017). This model predicts that individuals will correct their overconsumption problem upon retiring because of the decrease in income uncertainty. When income is uncertain, as it is prior to retirement, 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. Because the agent dislikes this sure loss, he or she corrects her overconsumption problem after retirement as he or she starts consuming like a time-consistent agent.

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. Furthermore, we note that the change

in the effective time-inconsistency problem in these models may be consistent with a wide class of other models that in one way or another generate a change in preferences or planning behavior, information processing, or attention at retirement. For instance, individuals may have more time to plan after retirement, which may lead them to pay additional attention to their finances, resulting in less overconsumption.[7]

The remainder of this paper proceeds as follows. Section 2.2 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 common in Iceland. 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 Organization 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. More specifically, individuals older than 60 are labeled as retired if all of the following three conditions hold (1) we see them receiving at least 1,000,000 ISK (approximately 10,000 USD) in pension payments over the sample period, (2) the pension payment in the current month is at least 30,000 ISK (approximately 300 USD), and (3) monthly pension payments in the following three months or the last three months amount to at least 30,000 ISK. As an alternative measure, we can only label individuals as retired if these three conditions hold and (4) we do not see a labor income payment higher than 150,000 ISK (1,466 USD) in the current month or the three months before and after. Both retirement definitions are associated with a step down in total income. The retirement definitions are different for some individuals because some individuals in Iceland continue to work part-time after first claiming their annuitized pension payments. We thus have a first step down in income and then another step down for this subset of individuals. Our results are qualitatively and quantitatively similar for both measures, which we show as a robustness check. Note that, the pension payments are calculated for each individual and all bank accounts are individual-level (there are no joint accounts in Iceland).

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

[7] To this point, Carlin et al. (2017) show that individuals reduce their consumer debt after a reduction in the costs of monitoring one's finances.

discontinuities happened at the start of our sample period.

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. The system is designed so that an individual with the average life expectancy should be (actuarially) indifferent between working longer and retiring between the ages of 67 and 72. The additional benefits paid out from working longer at age 67 equal the forgone pension payment at age 67. Private pension savings can be withdrawn from age 60 on.

The additional benefit in pension payments from working for one more month are very small and approximately 10 USD or 0.5 percent of the monthly pension benefit (7 percent before the age of 67 and 6 percent after the age of 70 in annual pension benefits). The monthly payment is approximately 2,525 USD if one retires at the age of 67 while it is 3,112 USD if one retires at the age of 72. The total payments forgone between the ages of 67 and 72 are 151,500 USD (2,525 per month for 5 years). It thus takes about 22 years of receiving the higher rate (3,112 USD) to make it worth forgoing those first five years of the lower rate, i.e., individuals would have to reach the age of 94. The exact calculations and also the printouts of the Icelandic pension calculator is provided in Appendix C.[8]

The Icelandic pension is paid as an annuity and indexed to the consumer price level. Thus, pension payments are not subject to longevity or price risks. The occupational pension system is very transparent, and individuals can easily acquire all the necessary information about their annuitized and indexed retirement income using the aforementioned pension calculator. Appendix C contains a more detailed review of the key features of the pension system in Iceland.

For the purpose of interpreting our findings, we consider individuals who receive regular labor income before retirement. They then become eligible to retire and eventually choose to do so. Post-retirement, they have lower but certain income that is annuitized and indexed to the consumer price level. Thus, we can simply treat individuals as facing a step function in income and they can choose – to some extent – when exactly they take the step down. If they hold other savings or assets, we observe the income inflows of liquidating these assets. As a result, after retirement, individuals may or may not have other income from liquidating assets, but importantly, we observe that income and can control for it.

[8] See also http://www.oecd.org/els/public-pensions/PAG2017-country-profile-Iceland.pdf, https://www.tr.is/en/65-years, and https://www.tr.is/reiknivel/ for the pension calculator.

## 2.2 Data

Our analysis is based on data generated by Meniga, a financial aggregation software provider in Iceland. Meniga's account-aggregation platform lets users view all of their accounts and credit cards from multiple banks in one place and provides a comprehensive picture of individuals' personal finances for five main reasons: (1) The financial aggregation platform is used by about 20 percent of the Icelandic population (Carvalho et al., 2019). (2) Consumers in Iceland use electronic means of payments almost exclusively. This eliminates one limitation of similar data from other countries, where a significant fraction of expenditures are paid with cash. (3) 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. (4) We can identify individual spending and income because all financial accounts are personal in Iceland. Additionally, because household members can link their accounts in the app, we can also look at total household income as part of our robustness analysis. (5) Expenditure and income categories are very accurate and comprehensive. For instance, in the domain of restaurant spending, we observe very fine categories, such as "bakeries," and can also distinguish individual trips from all daily spending. 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 study a subsample of 12,143 active users with complete records, i.e., for whom we observe all balances, labor income arrivals, and transactions. All individuals in that sample have passed an "activity test" that is designed to verify that we are capturing all of their relevant financial information. More specifically, our user sample 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, disability 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 five food transactions per month in at least 23 months of a 24-months period. This activity test is designed so that we do not exclude any subsamples of the population, such as low income or uneducated consumers; it is designed to exclude individuals for whom we do not observe the whole financial picture because they did not link all of their financial accounts. We do not see more account-linking or app-joining activity before versus after retirement. We perform all our analysis on this final sample and consider individuals eligible for retirement after they reach age 60 for the summary statistics that we report. The data on spending by category, income by source, overdraft interest, and financial fees run from 2011 to 2017 and the data on balances and limits span from 2014 to

2017. We perform the analysis on user-level data aggregated at a monthly level.

### Categorizing transactions

When the data are extracted from the personal financial management (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 labor income. User rules apply when there are no system rules in place. If a user persistently categorizes transactions with certain text or code attributes to a specific category, the system will automatically create a rule that is applied to all future transactions. If neither system rules nor user rules apply, the system detects identical categorization rules from multiple users, which allows it to generate a community rule that applies the categorization across the entire community. The PFM system has already detected first-party transactions, such as transfers between two accounts belonging to the same individual, 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

For spending, we obtain categorized data on all transactions based on the type of retailer, and each category can be aggregated to both the individual and the household level. Thus, the panel provides individual- and household-level expenditure information for a number of spending categories. We consider 10 fairly broad categories: groceries, fuel, alcohol, ready-made food, home improvement, transportation, clothing and accessories, sports and activities, and pharmacies.[9] We also have more disaggregated categories. For example, for ready-made food, we know the type of restaurant, such as bakery, canteen, or fine dining. We consider only discretionary spending, such as on groceries and clothing, and exclude recurring expenditures like rents, utilities, or phone bills.

### Income

Payer identity and NACE category (The Statistical Classification of Economic Activities in the European Community)[10] are added to each income transaction whenever possible.[11] This

[9] 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.

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

[11] 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 collection of payments from the same sources even though the true source ID is unknown. All of these transactions are categorized as "other income."

enables us to sort income into 21 categories. Regular income categories are labor income, student loans, rental income, rental interest, child support, child benefits, disability benefits, parental leave, pensions, housing benefits, rental benefits, unemployment benefits, and other social benefits. The irregular income categories are damages, grants, insurance claims, investment transactions, reimbursements, tax rebates, travel allowances, and other income.

We generally call income all incoming transactions or inflows. Thus, when retirees receive their annuitized pension payments, such income is effectively dissaving their pension assets. That said, we call it pension income and then look at liquid savings in bank accounts rather than considering the dissaving in pension assets. 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."

**Bank account information**

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 checking 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-upon rate. Virtually all checking accounts in Iceland offer a pre-agreed upon overdraft facility, the limit 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, because the overdrafts are profitable for the bank and expensive for the customer. In Iceland, individuals rarely roll over credit card debt. Instead they repay their credit cards in full each month (in fact, the automatic payment is mandated for the vast majority of credit cards) and then roll over overdraft debt instead.

From the information on checking account balances, overdrafts, overdraft limits, savings account balances, credit card balances, and credit card limits, we create a measure of individuals' cash holdings and liquidity. Cash holdings are defined as checking account balances plus savings account balances. Liquidity is defined as cash holdings plus overdraft limits and credit card limits minus overdrafts and credit card balances. Furthermore, we define credit lines as overdraft limits and credit card limits minus overdrafts and credit card balances normalized by monthly income. We also have information on interest income from bank accounts and interest paid on overdrafts. We use these two variables as our measure of liquid savings and rolled over high-interest unsecured consumer debt.

Interest income and overdraft interest expenses are both affected by the interest rates, and different individuals get different interest rates (for instance, for different savings accounts, the interest rate may vary depending on the length of the fixed-term deposit). We thus always use

an overdraft interest expense indicator as well as an interest income indicator to measure the likelihood of having an overdraft and receiving interest income in a given month. The indicator measures are not influenced by different levels of interest rates.

In addition, we have information on three types of financial penalties: late payment interest, insufficient 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. Insufficient funds fees occur when the overdraft limit is exceeded in a consumer's checking 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

In Olafsson and Pagel (2018a), we discuss in detail the spending, income, and demographic summary statistics of our user population and how they compare to those of the representative consumer survey of Statistics Iceland. Overall, our demographic statistics are similar to those of the overall population. This is reassuring as, when using app data, there is a concern that the user population is very young, well-situated, male, and tech-savvy. Our summary statistics are very similar to those of the overall population because the app is marketed to consumers through their online banking interface. As mentioned, banks offer individuals the opportunity to sign up for the software when they access their bank accounts online, and the online banking penetration is 94 percent in Iceland.[12] Moreover, even if individuals never use the software or app, the moment they sign up, we obtain their data.

As discussed in Subsection 2.1, 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 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 3 well. For ages 60 to 64, only 20 percent of individuals eligible for retirement receive pension benefits, while for ages 65 to 66, it is 35 percent, and for age 69, it is 55 percent.

Table 1 displays summary statistics for retired and non-retired individuals who are eligible for retirement, i.e., have reached age 60, and who we observe as retired at some point during our sample period. We can see in the raw data that, on average, retired individuals have lower incomes, are more likely to hold liquid savings and less likely to hold consumer debt, pay less interest on their overdrafts, and incur fewer late fees. Note that spending reflects discretionary categories only and excludes recurring expenses such as rent and bill payments.

As discussed in Subsection 2.1, we consider two definitions of retirement, i.e., when we

[12] According to Eurostat, 94 percent of Icelanders used internet banking in 2018. Source: http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=isoc_bde15cbc&lang=en

condition only on the presence of pension payments or when we condition on both the presence of pension payments and the absence of labor income. The summary statistics for the latter definition of retirement can be found in A.10 in Appendix A and they are similar for both definitions of retirement. Note that, for the first definition of retirement, which conditions only on the presence of retirement income but not the absence of labor income, there is no drop in spending at retirement in the raw data mean averages. This cross-sectional mean comparison can be affected by outliers, time trends, and selection, which our regression specifications will take care of with month-by-year and individual fixed effects. For the second definition of retirement, we see a pronounced decrease in spending in the simple comparison of means in the raw data.

Figure 5 summarizes the labor income, pension-payment, and expenditure life-cycle patterns of men and women using binned averages by age. The figure shows how labor income decreases 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 1 and Figure 5 only display discretionary spending, i.e., spending in categories such as groceries and clothes, leaving out recurring spending such as rent payments and utilities bills.

# 3 Analyses and results

## 3.1 The effects of retirement on personal finances and expenditures

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

$$\log(C_{it}) = \beta Retired_{it} + \phi_t + \eta_i + \gamma\Theta_{it} + \epsilon_{it} \tag{1}$$

where $C_{it}$ is the dependent variable of interest. $\phi_t$ is a time fixed effect and $\eta_i$ is an individual fixed effect. Controlling for individual fixed effects allows us to compare individuals to themselves before and after retirement. $Retired_{it}$ is an indicator equal to 1 if individual $i$ is retired at time $t$, and hence, the $\beta$ coefficient measures the within-individual conditional mean effect of retirement on the outcome variable under consideration. We also provide results for additional specifications in which we include other control variables $\Theta_{it}$ of individual $i$ at time $t$, for instance, log income $\log(Y_{it})$.

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. Furthermore, between the ages of 67 and 72, it is only beneficial to work longer if individuals expect to live until the age of 94. The additional pension benefits from continuing to work for one more month are approximately 0.5 percent of monthly benefits or 10 USD which

exactly matches the forgone pension payment if individuals expect to receive the additional benefit for enough years. 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 $\beta$ has a causal interpretation. That said, we will discuss in detail in Section 4, the different explanations for our findings how voluntary retirement affects spending and personal finances. Thus, the interpretation of the endogenous effect of retirement, i.e., the coefficient $\beta$, is still informative and meaningful even if it is not causal.

In this paper, we are trying to learn from a comparison of the within-individual conditional means of consumer debt, liquid savings, and spending before and after retirement. We discuss in detail in Section 4 which omitted variables can serve as an explanation for our findings by driving the decision to retire and the effects of retirement on consumer debt, liquid savings, and spending. The estimated drop in income upon retirement depends on the retirement indicator we use (as discussed in Section 2.1). If we condition only on the presence of pension income, the fall in income equals approximately 8 percent. If we also condition on the absence of labor income, then we estimate a drop in income of approximately 22 percent, which is in line with estimates from the US, reported in Ameriks and Zeldes (2004) among others.[13]

## 3.2 Results for overdraft debt, liquid savings, financial fees, and credit lines

We first investigate the effects of retirement on personal finances, in particular, whether individuals hold overdrafts and liquid savings as well as their credit limits and bank fees. Table 2 displays the estimated effects of retirement on personal finances based on the individual fixed-effects model, Equation (1), with and without controlling for total individual income.

Surprisingly, we find that individuals delever after retirement. When we measure consumer debt by interest expenses, we find a 54.9 percent reduction (56.1 percent after controlling for income).[14] Furthermore, the likelihood to borrow, as measured by the indicator for holding an overdraft at any point in a given month, also decreases by 4.4 percent (4.5 percent after controlling for income). The baseline probability is 46 percent (Table 1) which thus amounts to an approximately 10 percent decrease. Thus, individuals reduce their consumer debt considerably.

Additionally, we find that both the likelihood of receiving interest income in a given month as well as the amount of interest income increases after retirement. The increase in the likelihood equals 3.6 percent on a baseline probability is 32 percent (1), which thus amounts to an approximately 10 percent increase, and the increase in interest income payments is 28 per-

[13] Our results are qualitatively and quantitatively similar for either definition of retirement, which we show in a comprehensive robustness check.

[14] Because the outcome variables may include zeros, they are measured in terms of their inverse hyperbolic sine to accommodate observations with zero values. Our estimates are not qualitatively or quantitatively affected by winsorizing to address outliers or taking the log of the outcome variables and replacing the log of all values between zero and one Icelandic krona with zero to avoid losing these observations. Moreover, our results are not affected by controlling for winsorized income or log income.

cent. Thus, individuals appear to have more financial resources after retirement than before retirement to decrease their consumer debt and increase their liquid savings.

We can also look at credit limits and overall liquidity, or borrowing capacity, as measured by credit lines (borrowing capacity, i.e., the difference between the credit limits and the current balances, normalized by monthly income). However, we do not find that individuals are more borrowing-constrained after retirement. Finally, individuals also reduce late fee payments by 24.9 percent (28.4 percent after controlling for income).

When we look at the dynamics of the reduction in overdraft interest expenses, it appears as if the most important changes occur right around retirement, but there are no differences between years 1 to 3 as can be seen in Table 3. This table shows the coefficients for three dummies: whether an individual is retired for less than 12 months, between 12 and 24 months, and more than 24 months. We can see that all three dummies are large and significant in the neighborhood of 50 percent reductions in overdraft expenses and 5 percent for the likelihood of overdrawing the checking account. Again, we do not find an effect on borrowing capacity as measured by available credit. Furthermore, we find an effect on the amount of interest income individuals receive that is larger in the first two years after they retire, with and without controlling for income. We find the same pattern in the indicator variable for having interest income.

We have limited ability to look at longer trends in overdrafts and savings before and after retirement because our sample period only covers six years and we do not observe all individuals the entire period. That said, we still have an opportunity to evaluate how personal finances respond over time, using a window of a few years around the onset of retirement. Figures 6 and 7 show the dynamic response of overdraft usage and holdings of interest-bearing bank deposits for the subset of individuals that we observe for a long enough period around retirement. These figures nicely show that the effects we estimate are indeed associated with the onset of retirement because we do not see any clear anticipatory effect and they do not disappear over time. Note that we have less statistical precision here because of the smaller sample size. After all, we can only include individuals in this event study who we observe for at least two years before retirement and for at least three years after. That said, the effect is still statistically significant and displays a smooth response over the first year of retirement.

Figures 8 and 9 show the life-cycle profiles of an indicator for overdrawing the checking account as well as overdraft interest payments. Consumer debt features a pronounced hump similar to that of income.

We find similar results when we control for total individual income. Controlling for all income is of the 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. We can measure and control for income at the household level, because individuals can linking family members within the app and we observe these links. Controlling for household instead of individual income does not affect our results materially.

As additional robustness checks, we add individual, month-and-year, and month-by-year fixed effects and show that our coefficient is robust to including these as well as various income controls. The results can be found in Table 4. Our results are similarly robust when we use overdraft expenses as the outcome variable. In Table 4, we want to emphasize the coefficient when we control only for individual fixed effects. This is a simple conditional mean within-individual comparison of overdraft debt levels before and after retirement. As can be again clearly seen, the average individual decreases his or her overdraft debt after retirement.

As discussed, we find that individuals not only delever but also increase their liquid savings (as measured by whether individuals receive interest income in a given month and how much interest income they receive). This again hints at individuals rethinking their financial plans at the onset of retirement. Figures 10 and 11 display the life-cycle profile of an indicator for interest earnings from bank account deposits and actual interest earnings from bank account deposits, respectively, and show a clear increase around the time of retirement.

As seen in Table 2, the overall coefficient on the interest income indicator is positive and statistically significant. This finding is robust to the inclusion of our set of fixed effects and different household-level controls for income as shown in Table 5. Here again the coefficient when we control only for individual fixed effects is a simple conditional mean within-individual comparison of liquid savings levels before and after retirement. As can be seen, the average individual increases his or her liquid savings after retirement. Interest income may vary depending on the interest rates individuals get for the length of any fixed-term deposits for instance. To get around that problem, we use the interest income indicator to measure the likelihood of having receiving interest income in a given month.

Our results are the same when we employ a stricter definition of retirement that not only conditions on the presence of pension payments but also the absence of labor income. Both retirement definitions are associated with a step down in total income. They are not the same for some individuals who continue to work part-time after first claiming their annuitized pension payments. We thus have a first step down in income and then another step down. When we look at the second step down in income, in the raw data, we see a (by definition) larger fall in income and spending but also a decrease in overdraft debt and an increase in savings as seen in Table A.10 in Appendix A. Furthermore, we can look at the dynamic effects of retirement in our individual fixed-effects model in Table A.11 in Appendix A. We see the same negative effect on overdraft debt as well as a positive effect on interest income. The positive effect on interest income takes a bit longer to manifest in this specification but it is positive overall and conceivably individuals want to repay their overdraft debt before accumulating liquid savings.

We thus observe robustly across a number of specifications that households not only delever but also increase their liquid savings. We will discuss in detail how to interpret our findings in Section 4. But first, we will briefly present the estimation results when we look at spending as the outcome variable.

### 3.3 Results for spending by category

Table 6 shows the estimated effect of retirement on spending based on the individual fixed-effects model, Equation (1), with and without controlling for total income. These results show that spending drops upon retirement by 21.6 percent (26.8 percent when we control for income). 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. Thus, controlling for income in these regressions is informative about why individuals cut their consumption, which we discuss in detail in Section 4.

Our results are consistent with a reduction in work-related expenses: spending on fuel, ready-made food, and clothing drops substantially. We can only analyze overall spending, i.e., quantities times prices, and do not know whether more time spent shopping or senior discounts have a major effect on prices while quantities stay the same. That said, for a number of consumption categories, such as groceries or home production, there are no pricing schemes conditional on pension status and the gains from bargain hunting are probably limited. As we discuss below, we can look at the number of shopping or restaurant trips and types of grocery stores and restaurants (expensive versus cheap).

We can also investigate whether we can replicate the familiar hump-shaped profiles 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 10 broad consumption categories. Figure A.16 in Appendix A plots the age dummy coefficients for log total monthly discretionary spending. The omitted age dummy is age 20 (the omitted category). The figures thus plot the estimated age coefficient from the regression of spending relative to the coefficient for age 20. The expenditure profiles exhibit the conventional hump-shaped patterns, in which spending peaks in the late 30s, at a bit less than 40 percentage points higher than the level for 20 year olds, and spending declines by about the same amount from the individual's late 50s until retirement age.

Aguiar and Hurst (2013), Agarwal et al. (2015), and Figure A.16 in Appendix A 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 20s and then stay more or less constant until they decline in the 60s. Alcohol expenditure is constantly rising, while spending on clothes and accessories is constantly falling.

The drops in spending in certain categories, such as groceries, may well 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 overconsumption problem. Other spending that can hardly be attributed to work, such as alcohol bought in stores and pharmacy spending, also falls upon retirement. We find the same to be true when turning to a finer categorization of food. Analyzing spending on food in more detail than previous studies is important because food expenses have received the most attention in the retirement consumption literature (for instance, Aguiar and Hurst, 2005, among many others).

**Results for spending by grocery store and type of restaurant**

Figure A.16 in Appendix A also shows the life-cycle profiles of restaurant spending and expenditure in different types of restaurants, such as bars or fine dining. 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 A.12 in Appendix A we see that individuals exhibit a drop for all categories of food spending after retirement.

We can interpret the different patterns among more refined food categories. Expenditures on fast food increase in the individual's 20s and stay more or less constant until they start falling around the age of 60. 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 work related or a substitute for home production and thus likely to be relatively unaffected by labor-market status. That said, fine dining expenses fall at the onset of retirement and so do all other food categories.

These findings based on very fine categorization of food expenditures therefore suggest that the drop in expenditures upon retirement are not exclusively explained by work-related expenses. After all, we also observe a drop in expenditures that is difficult to argue is work related, e.g., fine dining. We are not aware of other studies that have been able to evaluate the hypothesis that work-related expenses/home production explain the drop in expenditure upon retirement using such detailed information about expenditures. Analyzing these spending patterns, however, does not paint a fully conclusive picture of whether the retirement puzzles are really puzzling. For instance, fine dining could be a work-related expense as well. As we argue below, we believe we also learn from our results on personal finances about the relevance of the retirement-consumption puzzle and work-related expenses as its leading explanations.

## 3.4 Replicating the analysis in other data sets

Before moving on to discussing how we can interpret our findings, we show in this section, that we can replicate our results in commonly used survey data sets from the US and in another

transaction-level bank account data set from Germany. It is reassuring that we can document the same results in US survey consumption data most commonly used in the literature. However, the CEX and the SCF suffer from selection bias and measurement error due to their survey design and non-longitudinal structure.[15] To further bolster the credibility of our findings, we replicate our analysis using survey data sets from the US in which we can run individual fixed effects regressions (the PSID and HRS) and consider another transaction-level data set from Germany. Overall we conclude that our results are not specific to Iceland. In the following subsections, we briefly discuss our results. Additional detail on the data work can be found in Appendix B.

### CEX data

We use data from the CEX for 1980 to 2002 following Aguiar and Hurst (2013). 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 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 B.13 in Appendix B 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 percent. But, given that we cannot control for household fixed effects, this result may be driven by selection: richer households are retiring earlier. However, all the results hold, even when we control for income, which is probably the main variable capturing wealth heterogeneity. The CEX data may suffer from underreporting of spending and we use income minus consumption as our measure of savings. However, to the extent that the underreporting does not get worse discretely after retirement, this should not bias our results.

### SCF data

We use SCF data from six waves from 1992 to 2007 and estimate the effect of retirement jointly controlling for age, time, and cohort fixed effects. Table B.14 in Appendix B 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 regardless of whether 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 percent controlling for income. We also find similar results for related variables, such as overdraft debt, credit card, checking,

[15] Existing literature has documented problems with survey-based measures of consumption (see e.g., Pistaferri, 2015).

current, and call account balances.[16]

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 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. Retirement status is identified via the transaction descriptions that flag federal pension payments. The results can be found in Table B.15 in Appendix B. We find that savings (measured as income minus consumption) increases when individuals retire, and we see increases in checking account balances and portfolio values and decreases in credit account balances. Again, we log all outcome variables and obtain coefficients of percentage increases that are in line with the Icelandic results.

### PSID data

We also use PSID data from 1968 to 2015. Because the PSID surveys the same households multiple times, 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.[17] These results can be found in Table B.16 in Appendix B.

### HRS data

Finally, we replicate our results using the HRS and the findings are consistent with our previous results. When they retire, individuals consume less but increase their savings, IRA assets, and overall wealth. The results can be found in Table B.17 in Appendix B.

When we run the same regressions without household fixed effects in the three data sets, 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

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

[17] 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.

effects likely to be present in CEX and SCF data overstate the consumption drop and savings increase and demonstrate 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 data sets, we obtain coefficients perfectly in line with the Icelandic results. Spending decreases by 10 percent to 20 percent and savings increase by 10 percent to 20 percent.

# 4 Potential theoretical explanations of our findings

We loosely categorize potential explanations for our findings as follows: We first consider explanations that are consistent with rational planning for retirement, in the sense that they do not feature a limited rationality component, such as cognitive or planning constraints, or a behavioral component, such as non-standard preferences or beliefs. We then move on to explanations that have a limited rationality or behavioral component. 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. Here, the explanation based on present bias is supposed to capture a much wider class of limited rationality explanations that is corrected at retirement. We then consider a full-fledged, life-cycle model and show that our non-standard preferences generate a simultaneous drop in consumption at retirement and an increase in savings by running our empirical specification in the simulated consumption data.

## 4.1 Explanations consistent with rational planning

Overall, our results on liquid savings and consumer debt suggest that we may not yet be able to retire the consumption puzzles. In principle, any rational agent will save more before retirement, given that she expects a fall in income. However, we observe that individuals do the opposite: they save more 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 may be difficult to reconcile with a rational model of consumption smoothing. In the following, we dissect this argument in greater detail. Furthermore, we put special emphasis on discussing work-related expenses and health shocks coupled with medical expense risks as these are the leading explanations for the retirement-consumption and savings puzzles. We then discuss some additional potential explanations for our findings consistent with rational planning, but we conclude that 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 this question here, we outline five scenarios for individuals' income and pension profiles. (1) A flat income profile before retirement and a lower but also

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 but 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 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 that income falls; thus, we can rule out this scenario. (5) A flat income profile before retirement and a pension profile that is lower than income but by less than work-related expenses after retirement. In this scenario, a patient agent might increase savings at the start of retirement. We now discuss this scenario further.

If work-related expenses are larger than the difference between pension and labor income, then individuals would increase savings at the start of retirement. However, in this case, individuals should retire early unless the additional monthly pension benefits for an additional month of work exceed the savings from retiring. That said, only near the retirement benefits thresholds ages of 60, 65, 67, and 70, the additional benefits increase discontinuously. Between the ages of 67 and 72, the additional pension benefit from one month of work is very small: approximately 0.5 percent or 10 USD per month (as discussed in Section 2.1 and Appendix C). This additional monthly benefit of 0.5 percent is much smaller than the 50 percent reduction in overdrafts and increases in liquid savings we observe. Note that, the initial positions in overdraft debt and liquid savings are large and equal more than one month of pension income. In Table 1, we can see that the average overdraft interest per month equals 24 USD which implies that, at 13 percent annualized interest (see Figure 13 for the Icelandic policy and overdraft rates over the sample period), the overdraft balance is 24*12/0.13 = 2,215. The average interest income is 45 which implies that, at 6 percent annualized interest, the savings account balance is 9,000. A 55 percent reduction in overdrafts and a 28 percent increase in savings equal monthly repayment of overdrafts in the neighborhood of 0.55*2,215/12 = 102 USD and increases in savings balances of approximately 210 USD per month. Individuals thus save much more than the additional 10 USD per month or 7 percent per year they would receive in pension payments (which equal 1,899 USD on average as displayed in Table 1). Therefore, if consumption falls by more than income because of work-related expenses, individuals should retire earlier.

However, 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 age 60, but this is a mechanical effect, because we start defining individuals as retired after they reach age 60. Since we restrict the analysis to individuals over 60 and include individual fixed effects, we do not identify our effects based on this mass. Furthermore, there is no dis-

continuous increase in the number of retirees at age 65 or 67; if anything, the mass is larger at ages 64 and 69. We thus conclude that individuals do not immediately retire at the benefits thresholds. On average, individuals appear to retire voluntarily at least a couple of months after they reach the age thresholds and oftentimes years after. The average retirement age is 70 years as shown in Table 1 or 71 years if the retirement definition also conditions on the absence of all labor income in Table A.10 in Appendix A. The results for consumer debt do not depend on the definition of retirement but the effect on savings is slightly larger for the first definition of retirement. This makes sense as for the first definition of retirement we see a smaller drop in income than for the second. Our results thus square with the known comparative static documented in (see Bernheim et al., 2001, among others): when the drop in income is larger, there is a larger drop in consumption.

Our argument is illustrated in Figure 12. In a rational model, if an agent expects a fall in income and expenditures, then savings will increase as long as the fall in spending is smaller than the fall in income. If the fall in spending is larger than the fall in income, then savings will increase. In that case, however, the agent gains on net by retiring early when the gain from retiring is larger than the small increase in income after retiring. Overall, we thus conclude that work-related expenses, while certainly present, are unlikely to explain our finding that savings increase after retirement without additional assumptions about how information or expectations change at retirement. In general, it appears non-trivial to explain, in any rational model, the joint observation that savings increase after retirement and individuals who are eligible do not retire immediately. We now discuss what other explanations (i.e., shocks or omitted variables) may drive the decision to retire, the fall in spending, and the increase in savings.

In order to explain our joint findings with work-related expenses, we thus need to model why the agent kept working, for instance, it could be that individuals derive utility from working even though they could save money by retiring. Alternatively, we may assume that the marginal utility of consumption changes unexpectedly with individual work status (Laitner and Silverman, 2005; French, 2005; Han et al., 2019), which we briefly discuss now as they might be simply reinterpreted as a reduction in work-related expenses.

**Opportunity costs of time and labor-leisure substitution**

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. Laitner and Silverman (2005) explain the drop in consumption at retirement with inseparable preferences over consumption and leisure as well as discrete work choices. A priori, it is unclear whether additional leisure time results in an increase or a decrease in the marginal utility of consumption, but 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 lifetime resources by retiring early. The same is true if individuals simply need less consumption, because of inseparable preferences, when they have more leisure time. This can also simply be interpreted as a type of work-related expense, and the same argument applies: if individuals know they need much less spending, they should retire early to save lifetime resources.

In the model in French (2005), the ability to self-insure by increasing hours worked or by postponing retirement reduces the need for precautionary savings before compared to after retirement. Flexible labor supply and the option to delay pension-claiming can serve as substitutes for financial savings, and these self-insurance margins are lost after retirement. This mechanism would increase savings after retirement. Furthermore, consumption and leisure are assumed to be substitutes in the model which necessarily implies that consumption drops at retirement. But again, if savings can be increased after retirement and the drop in spending is effectively larger than the drop in income, the agent should retire early to save in lifetime resources. This is inconsistent with the observation in our data that individuals do not retire at the thresholds.

**Health shocks and medical expense risk**

Individuals may choose to retire in response to an adverse health shock. While it is 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 (if it manifests immediately) should decrease and not increase savings. In that sense, any negative wealth shock has 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, for the following three reasons, we do not think that health shocks in combination with medical expense risk can fully explain our findings.

First, we find that pharmacy spending is insignificant but qualitatively falls upon retirement by 7.4 percent (12.3 percent after controlling for income) with a standard error of 8.86 percent (8.69 percent). This 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. Copayments are capped at a certain level of expenditures on medicine in a given year. Therefore, for people who were at or above the threshold before retirement, we would expect no change, but for people below the threshold, we would expect an increase in expenditures up to the cap if it were in fact health shocks that caused the individuals to retire. However, the documented drop in healthcare expenditure shows that this is not the case for

the average individual. That said, we have to note that pharmacy spending may drop because individuals also buy household goods, such as cosmetics, in pharmacies. Such expenses may be work-related, but they are typically much lower than the average copayment for medicals. Thus, while pharmacy spending is not a perfect measure, the large fall we document seems inconsistent with health shocks being the predominant reason that individuals retire. Second, the Icelandic health care system is very comprehensive relative to the US one and there are no large expense risks such as those that individuals in the US face. Therefore, we think that the explanation in DeNardi et al. (2010), i.e., documenting that the increase in savings after retirement is due to the risk of health expenses, is not applicable in our context. Third, even if a strong precautionary savings motive because of health expenses is there, it should be present before retirement and not only after, i.e., individuals should start saving for medical expenses before rather than at the time of retirement.

In order to explain our joint findings with health shocks and medical expense risk, we thus need to assume that the marginal utility of consumption changes unexpectedly with individual health (Finkelstein et al., 2013; Brown et al., 2016; Bound et al., 2010).

**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 consumption drop 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 consumption drop. In principle, however, in order 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 (e.g., other income contains any other inflows such as 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. As discussed, investment transactions are identified via the transaction-system categorization, and income that cannot be classified is listed as "uncategorized" income and could be due, for example, to the sale of real estate or other assets. We therefore estimate the effect of retirement on these two income categories, and the results can be found in Table 7. 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 individu-

als 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, i.e., the total income of two linked spouses in Tables 4 and 5.

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 14. 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 the return to savings. It could be that retired individuals receive higher interest rates on savings and have to pay higher rates on overdrafts and thus increase their savings after retirement and decrease their overdrafts. The overdraft interest rates in Iceland, however, are mandated by regulations and do not change with the status of retirement. Furthermore, we have no evidence that retired individuals receive higher returns to savings, and, again if that is the case, they should decide to retire early. Additionally, we also document the same results for an interest income indicator that is independent of the interest rate.

**Credit constraints, consumption insurance, inventory considerations, or lump-sum pension withdrawals**

It could be that banks reduce individuals' overdraft or credit limits when they observe them retiring. However, we do not find significant effects on overdraft limits, credit limits, credit lines, or liquidity and can thus rule out this explanation (see Table 2).

Alternatively, the reduction in the likelihood of overdrawing the checking account in a given month may be brought about by reduced income uncertainty once individuals retire. Indeed the standard deviation of income is lower after retirement and thus individuals may use overdraft debt less as a vehicle to insure against transitory shortfalls in income. However, we find significant and large reductions, not only in the likelihood of having an overdraft but also in the amounts of overdrafts. Furthermore, the baseline likelihood of having an overdraft is almost 50% in our sample of working individuals but still 38% for our sample of retired individuals. Thus, even retired individuals use overdrafts happily despite the absence of large variation in income. For our alternative definition of retirement, we observe very little irregular income uncertainty and thus do not think that, in the baseline, the 31% of times that individuals overdraw the checking account are driven by transitory income shocks. Furthermore, in general, overdraft debt is not negatively correlated with income, as consumption insurance would predict, as we show in two related papers (Hundtofte et al., 2019; Olafsson and Pagel, 2019). Instead, overdrafts are very persistent at the individual level. Finally, the explanation of less need for

transitory income insurance after retirement that decreases overdrafts is not consistent with the simultaneous increase in savings that we observe. Income insurance would predict the need for liquid savings to decrease after retirement, which we do not find in any specification or for either definition of retirement.

If individuals were to withdraw their pension payments less frequently after retirement than they received their labor income before retirement, then, logically, 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 is the labor income of the vast majority of working individuals. In principle, voluntary pensions can be withdrawn in any fashion after the age of 60 (free of restrictions or transaction costs), however, in practice we do not observe lump-sum withdrawals for the average individual. This can be easily verified in Figure 5 showing a smooth increase in pension payments. Furthermore, the standard deviation in income payments is less after retirement than before retirement. Moreover, as mentioned, we can control for all income payments with no effect on our estimated coefficients. In Table 7, we see a decrease in income from all uncategorized sources and an insignificant coefficient for income from investment transactions after retirement. Finally, when we look at the dynamics of the reduction in overdraft debt we do not find that the initial effect disappears over time.

**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 in households. On average, wives gain bargaining power and use this to exert their preferences for increased savings, because women have on average higher life expectancy than men. Furthermore, Addoum (2016) and Olafsson and Thornquist (2018) provide evidence of an 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 of first-order importance. 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. Additionally, we can control for income at the individual as well as household level in various specifications and demonstrate the robustness of our results for different income measures in Tables 4 and 5.

**Dissaving in total assets**

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

those inflows as uncategorized income, but do not find a positive effect of retirement on this income category (see Table 7). Thus, we simply interpret the pension system in Iceland as an implied step function in income. This allows us to draw conclusions from looking at liquid savings and consumer debt as to whether individuals plan optimally for the onset of retirement, i.e., a step down in income, which sheds light on the retirement puzzles and their leading explanations.

## 4.2 Explanations based on limitations to rationality or non-standard preferences

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 limitations to rationality that are reflected in non-standard information, attention, or expectations as well as insufficient planning; second, there are models of non-standard preferences that generate an overconsumption problem before retirement. We now discuss whether the two types of models may be able to explain an increase in savings at retirement on top of a fall in consumption.

### Insufficient planning

One possible theoretical explanation for the drop in consumption at retirement and a simultaneous increase in savings 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. This theory would predict a systematic reduction in debt and an increase in savings if insufficient attention or time for planning results in overconsumption before retirement that is corrected after retirement. 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) and 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 or 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 difficult. That said, this class of models could be captured in a change in the effective time-inconsistency problem that we model below.

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 that individuals eventually pay attention to retirement, savings should not increase. Combining these models with the systematic arrival of information about health shocks that increase precautionary savings, for instance, may generate a fall in consumption as well as an increase in savings. While we do not explicitly model this idea, we also note that the model we analyze below of a change in the time-inconsistency problem at retirement would

capture this intuition. 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 would be 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 Campbell and Mankiw (1989). As alternative explanation, we could think of models of salience, memory, focusing, or relative thinking as in Bordalo et al. (2013), Bordalo et al. (2017), Koszegi and Szeidl (2013), or Bushong et al. (2015). It could be that income and spending after retirement are more salient, memorable, focused, or easier to compare in relative terms, which would all imply a change in planning behavior around retirement. The insufficient planning or salience models can be combined with an update in information or planning ability to generate an increase in savings on top of a drop in consumption at retirement. Again, this class of models could be captured in a change in the effective time-inconsistency problem that we model below showing that it succeeds in explaining our results.

**Overconsumption and present bias**

There is widespread evidence for individuals having overconsumption problems (refer to Do, 2011, for a literature survey). The most highly-cited and widely-applied models of overconsumption 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 with substantial liquidity. Furthermore, if individuals hit their liquidity constraint, their savings would be zero before retirement. If income falls at retirement, their savings should be zero after retirement as well and should not increase.

To rationalize a drop in consumption and an increase in savings after retirement in the hyperbolic-discounting framework, one needs to assume that the hyperbolic discount factor changes when the individual retires. This change could be interpreted as a change in the agent's patience, but it could also be interpreted as a change in the agent's information or planning

abilities and is thus related to our earlier discussion of insufficient planning models. While the model feels somewhat reverse-engineered, it encompasses a variety of explanations that cause a change in present bias at retirement.

In the following section, we theoretically analyze whether a change in the exponential or hyperbolic discount factor, and thus in the agent's degree of impatience or present bias, can explain a drop in consumption at the same time as an increase in savings at retirement in a full-fledged, life-cycle model that is calibrated realistically in line with the literature. As mentioned, this change in impatience or present bias can be interpreted as a change in planning abilities or information. Furthermore, we analyze a model that is, to the best of our knowledge, the only existing one that generates a fall in consumption and an increase in savings at retirement simultaneously without ex-post tweaking 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 cited models of beliefs-based preferences (Olafsson and Pagel, 2018b), which makes it worthwhile to see 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 subsection, we describe the intuition for this result closely following the exposition in Pagel (2017) to 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 overconsumption today yields a sure loss in future consumption, and this loss would hurt more than today's overconsumption would give pleasure, because 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 preference-based explanations in a life-cycle model

We now move on to illustrate a fully-fledged, life-cycle model with different preference specifications to assess which preferences' quantitative predictions about the drop in consumption at retirement roughly match the empirical evidence. We also assess what type of preferences can generate a simultaneous increase in savings.

We consider four preference specifications: standard, hyperbolic, temptation-disutility, and expectations-based reference-dependent preferences. 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 only experiences temptation disutility before retirement, not after. For the standard agent, we also assume that the exponential discount factor increases to one after retirement, so that he becomes more patient as well.

We hope to thus encompass an entire class of models that, for one reason or another, cause agents to become more patient after retirement. For instance, it could be that agents become better at planning, have updates in information, or their income and spending become more salient. The only distinction we are making here is the presence of a time-inconsistency problem versus the absence of it. The hyperbolic discounting model features a change in the degree of present bias, whereas the standard and temptation-disutility models do not feature a change in the time-inconsistency problem; they just feature a change in patience.

More formally, we consider a discrete-time, life-cycle model with periods indexed by $t \in 1, ..., T$ and agents with four types of preferences: 1) standard preferences (Carroll, 1997), 2) hyperbolic-discounting preferences (Laibson et al., 1998), 3) temptation-disutility preferences (Gul and Pesendorfer, 2004), or 4) 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 the consumption utility, the contemporaneous news utility about current consumption $C_t$, and the 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 the 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 $\eta > 0$ 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. The 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 exponentially discounts the prospective news utility by $\beta \in [0, 1]$. Moreover, he discounts the prospective news utility relative to the contemporaneous news utility by a factor $\gamma \in [0, 1]$. Thus, he puts a weight $\gamma\beta^\tau < 1$ on the 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 the prospective versus the 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 will not experience the 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 the prospective versus the contemporaneous news utility is weakly larger than the inverse of the coefficient of loss aversion, $\gamma \geq \frac{1}{\lambda}$. In this case, the pain associated with a certain loss in future consumption is larger than the pleasure gained from present consumption. However, if $\gamma < \frac{1}{\lambda}$, the agent deviates and must choose a consumption path that just meets the consistency constraint, thereby behaving as a hyperbolic-discounting agent, with a hyperbolic discount factor of $\frac{1+\gamma\eta\lambda}{1+\eta} < 1$. Thus, during retirement, the implications of the agent's prospective news discount factor $\gamma$ are simple: it must be high enough to keep the news-utility agent on the standard agent's track.

After retirement, the agent is less inclined to overconsume. The basic intuition for overconsumption before retirement is that the agent consumes house money–that is, labor income that he was not certain to receive. Such uncertain income wants to be consumed before the agent's 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., $\gamma = 1$, the contemporaneous and the prospective marginal news utility cancel each other out. However, iff $\gamma < 1$, the agent reduces the weight on the future utility relative to the present utility by a factor of $\frac{1+\gamma\eta\lambda}{1+\eta\lambda} < \frac{1+\gamma\eta}{1+\eta} < 1$. After retirement, the news-utility agent follows the standard agent's consumption path if the prospective news discount factor $\gamma$ is sufficiently high, and otherwise follows a hyperbolic agent's consumption path with discount factor $b = \frac{1+\gamma\eta\lambda}{1+\eta}$. Because $\min\{\frac{1+\gamma\eta\lambda}{1+\eta}, 1\} > \frac{1+\gamma\eta}{1+\eta}$ iff $\gamma < 1$, the agent's factor for reducing the weight on future

utility is necessarily lower in the period just before retirement than afterward, which implies that consumption drops at retirement. This drop is 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 models can generate a simultaneous increase in savings.

We choose the model environment in line with the life-cycle consumption literature and present the numerical results of a power-utility model; that is, $u(C) = \frac{C^{1-\theta}}{1-\theta}$, with $\theta$ being the coefficient of constant relative risk aversion.[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 8 and discussed by Pagel (2017) among others.

Figure 15 contrasts the four agents' consumption paths with the empirical consumption and income profiles from the CEX data from age 54 to 74. 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 15 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 pro-

[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 D.

[19] Following Gourinchas and Parker (2002), we choose age 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 United Nations (UN).

file features a very small drop, and the standard agent's profile features only 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 a change in the effective discount factor. 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 9. In the news-utility and hyperbolic-discounting models, we obtain a negative and significant drop in consumption, while the standard and tempted agents' coefficients are basically zero. The news-utility agent's drop in consumption is larger than the hyperbolic agent's, even though the preference parameters generating the degree of present bias, $\gamma$ and $b$, are equal before retirement, and both agents become perfectly time-consistent after retirement, because $b$ 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 the agents' savings at retirement. Consumption falls by more than income initially. 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 closer to those of the standard and tempted agents.

We can introduce work-related expenses into the model. We simply assume that consumption falls by 10 percent at the time of retirement because of work-related expenses. We then run the regressions measuring the drop in consumption at retirement, which now trivially indicate

a 10 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 extensions of this simple life-cycle framework, none of which, however, would materially change our results. First, we can introduce a threshold for the incentives to retire and an endogenous retirement decision. In either case, however, at the time of retirement (whether endogenously chosen or exogenously induced), the hyperbolic agent's discount factor increases, and the reference-dependent agent's income uncertainty reduces, which both causes an increase in savings because 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 decreasing borrowing) is that the agent's degree of present bias changes at the time of retirement. As mentioned, this change could be brought about by a number of changes in the agent's information environment or to his or her limited rationality or insufficient planning.

# 5 Conclusion

The responsibility of retirement saving has shifted from employers to individuals in recent years. Understanding whether people are adequately prepared and save enough for retirement has therefore become of utmost importance. Using a large transaction-level data set from a financial aggregator on income, spending, account balances, and credit limits, we document a substantial increase in liquid savings and a substantial decrease in consumer debt around retirement. These findings are difficult to explain in a model based on rational planning. Whenever individuals expect a fall in income, even if spending falls as well or even if they expect large medical expenses after retirement, they should save before an anticipated fall in income rather than after. Decreasing consumer debt and increasing liquid savings is therefore the opposite of what a rational agent would do.

Our findings add to two existing empirical patterns in household consumption and savings

that have caused a stir in the academic literature: that consumption drops at retirement but savings and wealth appear to increase after retirement. These patterns are puzzling from the perspective of a standard economic model of rational planning for retirement. Researchers have singled out promising potential explanations for both of these empirical observations that are consistent with rational planning. First, consumption drops at retirement because of a reduction in work-related expenses. Second, savings increase after retirement because of longevity and medical expense risks. However, due data limitations, these explanations have not been subjected to much empirical scrutiny so far.

In this paper, we employ the detailed financial aggregator data to subject these two leading explanations for the so-called retirement puzzles to a new empirical test. What do these explanations imply for savings and consumer debt at retirement? If work-related expenses are smaller than the fall in income at retirement, then savings should decrease. If work-related expenses are larger than the fall in income, then savings should increase but individuals should retire as early as possible. Furthermore, if there is no update in information at the time of retirement about the extent of longevity and medical expense risks, then individual savings should not be affected by the onset of retirement. If individuals update their beliefs about medical expense risks and precautionary savings increase, we would also see health expenditures to be increasing up to the cap immediately. However, these predictions are not borne out in our empirical analysis.

Our setting provides several additional tests to evaluate the validity of work-related expenses and medical expense risks as explanations for our new findings. First, we can see whether individuals retire at the retirement thresholds beyond which disincentives to retire no longer apply. If work-related expenses are in fact larger than the fall in income and are not made up for by increased retirement income, then individuals should retire immediately at the thresholds, which is not the case in our data (the increase in pension benefits from working for one more month are very small compared to the amount of extra savings individuals achieve after retirement). Second, unlike in the US, medical expenses and longevity risks are low in Iceland. Icelandic pension payments are fully annuitized, indexed, and government-backed and the health system follows the Nordic welfare state model which comprehensively insures medical expense risk. This makes longevity and medical expense risks unlikely explanations in our setting. Furthermore, if people were to save rationally for retirement (and consider the magnitude and risks of expected medical expenses) and consumption falls only due to work-related expenses – we would not observe a simultaneous decrease in consumer debt and increase in liquid savings. Finally, information on pharmacy spending can be used to detect health shocks because copays for medical expenses are required in Iceland (capped by a threshold) and we show that pharmacy spending actually decreases upon retirement, making health an unlikely explanation for why individuals retire.

To further understand our findings and their potential explanations, we also look at pre- versus post-retirement spending. Detailed information on consumption categories suggest that the

drop in expenditure categories that are unlikely to include work-related expenses is not significantly different from the drop in expenditure categories that are likely to include work-related expenses. However, in order to investigate the questions of whether the drop in consumption at retirement and the increase in savings after retirement are puzzling and more broadly whether individuals save adequately for retirement, we think our analysis of personal finances is more informative. To the best of our knowledge, no existing paper has been able to compare 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 puzzles as well as their leading explanations. Beyond liquid savings, we also pay special attention to unsecured high-interest consumer debt at the time of retirement, which has been of increasing concern to both researchers and policy makers.

# 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.

**_ , Joseph Briggs, Andrew Caplin, Matthew D Shapiro, and Christopher Tonetti**, "Late-in-life Risks and the Under-insurance Puzzle," 2016.

**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.

**Anguelov, Chris E and Christopher R Tamborini**, "Retiring in Debt-Differences between the 1995 and 2004 Near-Retiree Cohorts," *Soc. Sec. Bull.*, 2009, *69*, 13.

**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.

**Bordalo, Pedro, Nicola Gennaioli, and Andrei Shleifer**, "Salience and consumer choice," *Journal of Political Economy*, 2013, *121* (5), 803–843.

**_ , _ , and _** , "Memory, attention, and choice," Technical Report, National Bureau of Economic Research 2017.

**Bound, John, Todd Stinebrickner, and Timothy Waidmann**, "Health, economic resources and the work decisions of older men," *Journal of Econometrics*, 2010, *156* (1), 106–129.

**Brown, Jeffrey R, Gopi Shah Goda, and Kathleen McGarry**, "Heterogeneity in State-Dependent Utility: Evidence from Strategic Surveys," *Economic Inquiry*, 2016, *54* (2), 847–861.

**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 Eu-*

*ropean Economic Association*, 2012.

**Bushong, Benjamin, Matthew Rabin, and Joshua Schwartzstein**, "A model of relative thinking," *Unpublished manuscript, Harvard University, Cambridge, MA*, 2015.

**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.

**Carlin, Bruce, Arna Olafsson, and Michaela Pagel**, "Fintech adoption across generations: Financial fitness in the information age," Technical Report, National Bureau of Economic Research 2017.

**_ , _ , and _** , "Generational Differences in Managing Personal Finances," in "AEA Papers and Proceedings," Vol. 109 2019, pp. 54–59.

**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, Arna Olafsson, and Dan Silverman**, "Misfortune and Mistake: The Financial Conditions and Decision-making Ability of High-cost Loan Borrowers," September 2019, (24405).

**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.

**Davies, James B**, "Uncertain lifetime, consumption, and dissaving in retirement," *Journal of political Economy*, 1981, *89* (3), 561–577.

**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.

**Fe, Eduardo**, "What Can We Learn About the Average Treatment Effect of Retirement on Consumption?," *Available at SSRN 3329588*, 2019.

**Finkelstein, Amy, Erzo FP Luttmer, and Matthew J Notowidigdo**, "What good is wealth without health? The effect of health on the marginal utility of consumption," *Journal of the European Economic Association*, 2013, *11* (suppl_1), 221–258.

**French, Eric**, "The effects of health, wealth, and wages on labour supply and retirement behaviour," *The Review of Economic Studies*, 2005, *72* (2), 395–427.

**Fulford, Scott and Scott D Schuh**, "Credit card utilization and consumption over the life cycle and business cycle," *Consumer Financial Protection Bureau Office of Research Working Paper*, 2017, (2017-03).

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

**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.

**Guo, Rui, Wei Sun, Jianqiu Wang, and Gang Xiao**, "Why do retired workers claim their social security benefits so early? A potential explanation based on the cumulative prospect theory," *Applied Economics*, 2020, *52* (5), 490–505.

**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.

**Hamermesh, Daniel S**, "Life-cycle effects on consumption and retirement," *Journal of Labor Economics*, 1984, *2* (3), 353–370.

**Han, Bing, David Hirshleifer, and Johan Walden**, "Visibility bias in the transmission of consumption beliefs and undersaving," Technical Report, National Bureau of Economic Research 2019.

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

**Heimer, Rawley Z, Kristian Ove R Myrseth, and Raphael S Schoenle**, "YOLO: Mortality beliefs and household finance puzzles," *The Journal of Finance*, 2019, *74* (6), 2957–2996.

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

**Hundtofte, Sean, Arna Olafsson, and Michaela Pagel**, "Credit smoothing," Technical Report, National Bureau of Economic Research 2019.

**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.

**Jones, John Bailey, Mariacristina De Nardi, Eric French, Rory McGee, and Justin Kirschner**, "The lifetime medical spending of retirees," Technical Report, National Bureau of Economic Research 2018.

**Jr, Melvin Stephens and Desmond Toohey**, "Changes in Nutrient Intake at Retirement," 2018.

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

**Kieren, Pascal and Martin Weber**, "When saving is not enough–The wealth decumulation decision in retirement," 2019.

**Koszegi, B. and A. Szeidl**, "A Model of Focusing in Economic Choice," *Quarterly Journal of Economics*, 2013, *128* (1), 53–104.

**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 and Dan Silverman**, "Estimating life-cycle parameters from consumption behavior at retirement," Technical Report, National Bureau of Economic Research 2005.

**_ , _ , and Dmitriy Stolyarov**, "The Role of Annuitized Wealth in Post-Retirement Behavior," *American Economic Journal: Macroeconomics*, 2018, *10* (3), 71–117.

**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.

**Lusardi, Annamaria and Olivia S Mitchell**, "Financial literacy and planning: Implications for retirement wellbeing," Technical Report, National Bureau of Economic Research 2011.

**Malmendier, Ulrike and Leslie Sheng Shen**, "Scarred consumption," Technical Report, National Bureau of Economic Research 2018.

**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 _** , "Borrowing in response to windfalls," Technical Report, Working Paper 2019.

**_ and Tomas Thornquist**, "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 M, Steven F Venti, and David A Wise**, "Were they prepared for retirement? Financial status at advanced ages in the HRS and AHEAD cohorts," Technical Report, National Bureau of Economic Research 2012.

**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.

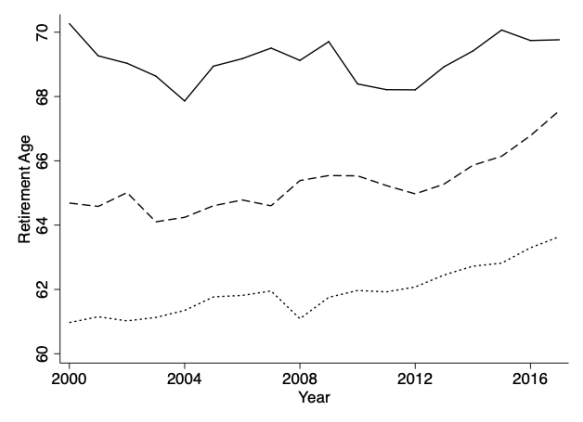
**Reis, Ricardo**, "Inattentive consumers," *Journal of monetary Economics*, 2006, *53* (8), 1761–

1800.

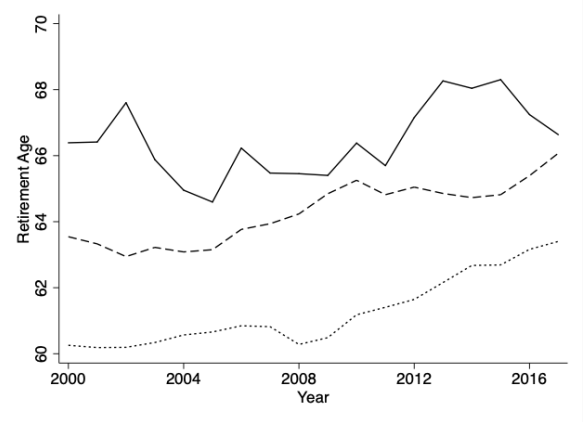
**Schwerdt, Guido**, "Why does consumption fall at retirement? Evidence from Germany," *Economics Letters*, 2005, *89* (3), 300 – 305.

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

**Skinner, Jonathan**, "Are you sure you're saving enough for retirement?," *Journal of Economic Perspectives*, 2007, *21* (3), 59–80.



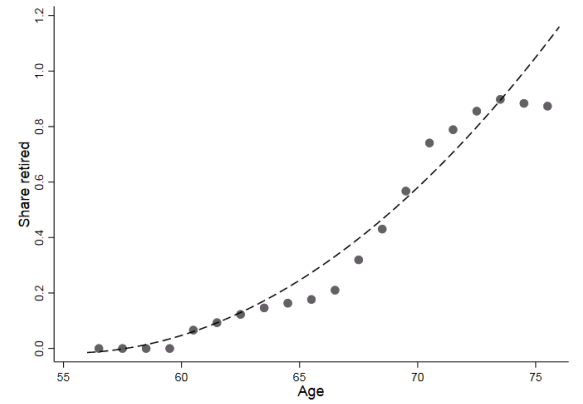

Men



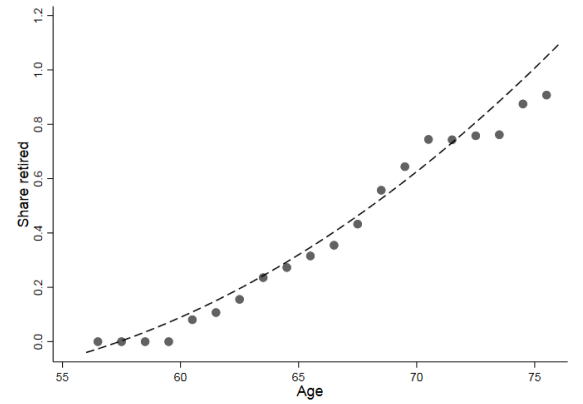

Women

Figure 1: Average Retirement Age by Year for Iceland, Germany, and the US

Notes: 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 Retired Individuals by Age

Notes: Raw data using the inferred retirement date as described in Section 2.1.

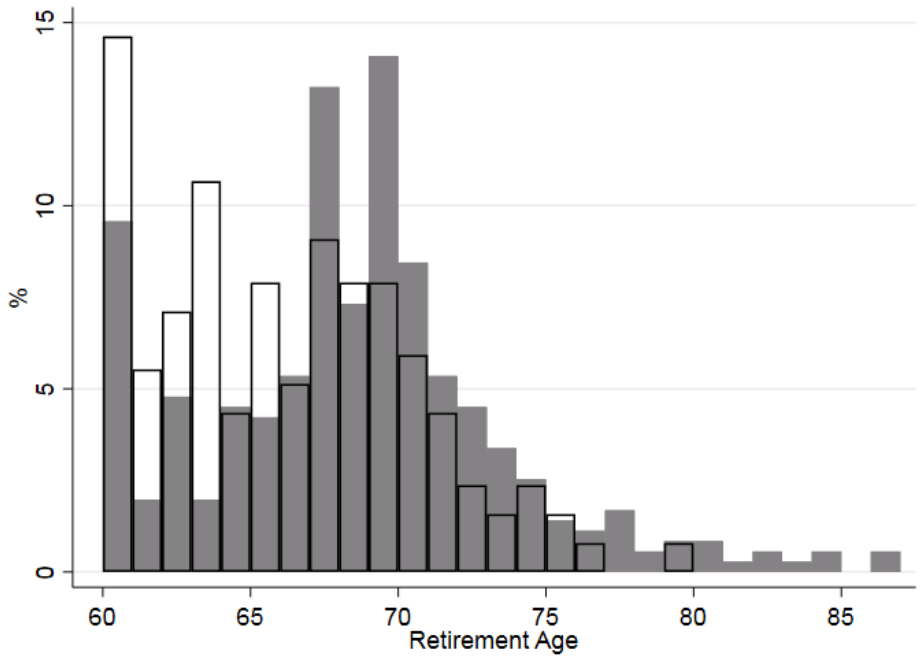



Figure 3: Distribution of Retirement Age in Iceland

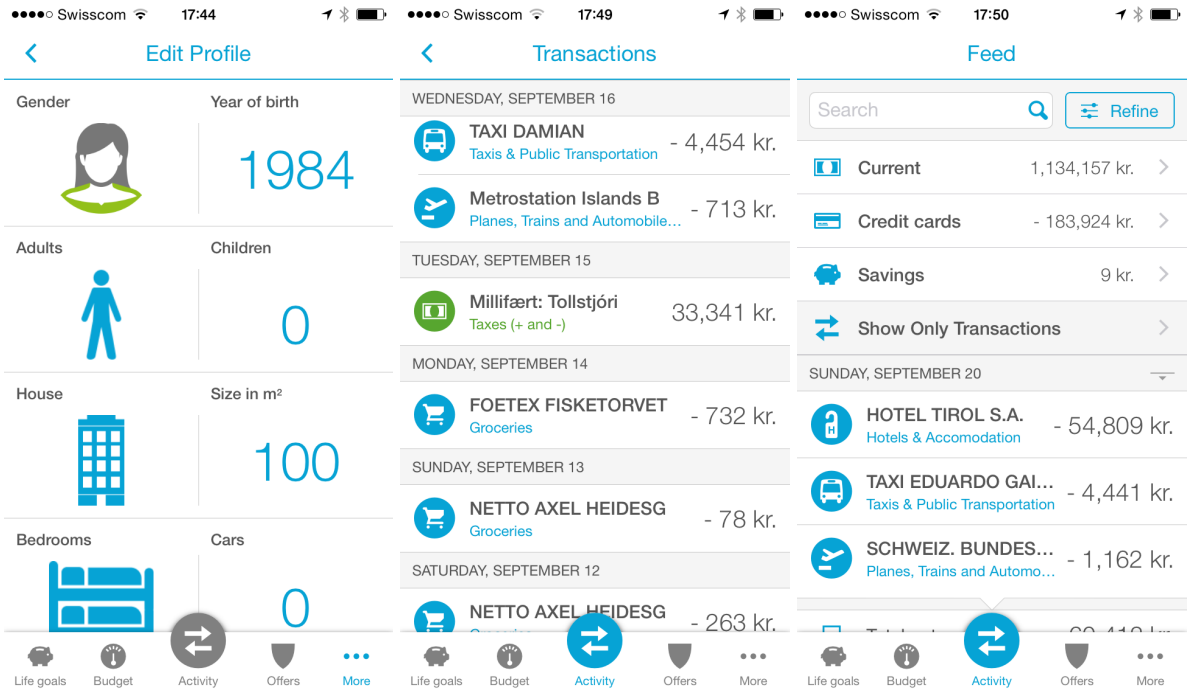
Notes: Raw data for women (white bars) and men (gray bars) using the inferred retirement date as described in Section 2.1. Statistics Iceland also reports the fraction of retired individuals by age group. These numbers match our data. For ages 60 to 64, only 20 percent of individuals eligible for retirement receive pension benefits, while for ages 65 to 66, it is 35 percent, and for age 69, it is 55 percent.

Table 1: Descriptive Statistics Before and After Retirement

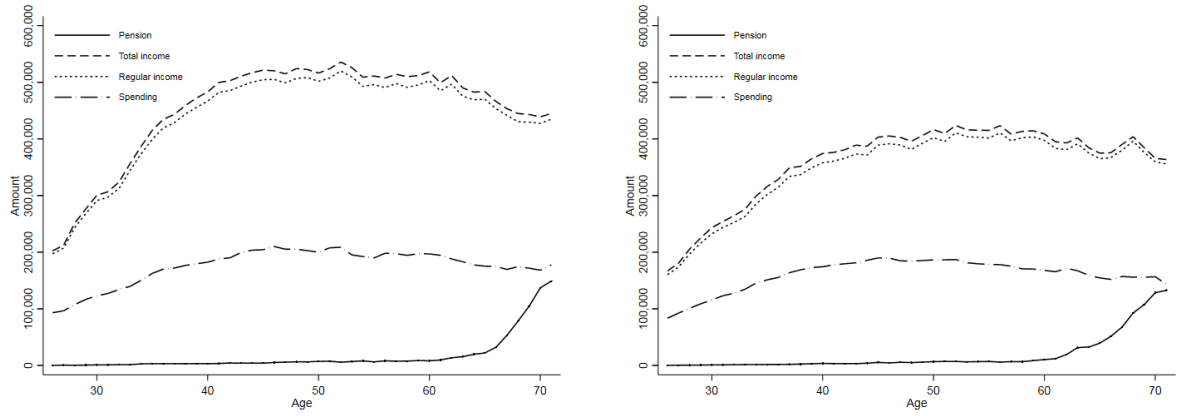
| | Eligible but not retired | | Retired | |
|---|---|---|---|---|
| | Mean | St.dev. | Mean | St.dev. |
| ***Demographics:*** | | | | |
| Age | 65.9 | 3.0 | 69.7 | 5.2 |
| Female | 0.43 | 0.50 | 0.4 | 0.5 |
| ***Monthly income:*** | | | | |
| Labor income | 4,497 | 5,610 | 2,276 | 4,862 |
| Pensions | 74 | 1,063 | 1,899 | 1,869 |
| ***Personal finances:*** | | | | |
| Overdraft indicator | 0.46 | 0.50 | 0.38 | 0.49 |
| # Overdrafts | 0.52 | 0.65 | 0.46 | 0.67 |
| Overdraft interest | 24 | 66 | 17 | 56 |
| Late fees | 6 | 36 | 5 | 31 |
| Interest income indicator | 0.32 | 0.47 | 0.53 | 0.50 |
| Interest income | 45 | 724 | 79 | 609 |
| Liquidity (in days of average spending) | 180 | 152 | 201 | 330 |
| ***Monthly spending:*** | | | | |
| Total discretionary | 1,809 | 1,987 | 1,887 | 2,480 |
| Groceries | 495 | 330 | 529 | 332 |
| Fuel | 291 | 270 | 230 | 222 |
| Alcohol | 94 | 156 | 96 | 169 |
| Ready-made food | 103 | 132 | 119 | 153 |
| Home improvements | 206 | 557 | 224 | 1,273 |
| Home security | 12 | 38 | 11 | 42 |
| Vehicles | 168 | 1,663 | 185 | 1,890 |
| Clothing & accessories | 96 | 186 | 97 | 191 |
| Sports & activities | 8 | 40 | 10 | 46 |
| Pharmacies | 70 | 88 | 80 | 94 |

Notes: All numbers are inflation adjusted and in US dollars. All income, spending, and interest statistics are at the individual-month level. We study a subsample 12,143 active users with complete records, i.e., for whom we observe all balances, labor income arrivals, and transactions. The "activity test" that is designed to verify that we are capturing all of their relevant financial information is described in Subsection 2.2. Discretionary spending excludes recurring spending such as rents or utilities bills.

Figure 4: The Financial Aggregation App: Screenshots




Notes: This figure shows the Meniga app interfaces.




Men

Women

Figure 5: Total and regular (salary) income, discretionary expenditure, and pension payments over age

Notes: Raw data averages by each age, discretionary spending excludes recurring spending such as rents or utilities bills.

Table 2: The Effects of Retirement on Personal Finances

| | (1) Overdraft indicator | (2) # overdrafts | (3) Overdraft interest | (4) Late fees | (5) Interest income indicator | (6) Interest income | (7) Credit lines |
|---|---|---|---|---|---|---|---|
| *Without controlling for income:* | | | | | | | |
| Retired | -0.044*** | -0.043** | -0.549*** | -0.249*** | 0.036** | 0.281*** | -0.060 |
| | (0.016) | (0.021) | (0.133) | (0.081) | (0.016) | (0.098) | (0.080) |
| $R$-sqr | 0.001 | 0.001 | 0.002 | 0.007 | 0.455 | 0.513 | 0.012 |
| *Controlling for income:* | | | | | | | |
| Retired | -0.045*** | -0.045** | -0.561*** | -0.284*** | 0.021 | 0.281*** | -0.058 |
| | (0.016) | (0.021) | (0.133) | (0.081) | (0.016) | (0.098) | (0.080) |
| $R$-sqr | 0.002 | 0.002 | 0.003 | 0.009 | 0.463 | 0.513 | 0.012 |
| # obs | 746,669 | 746,669 | 746,669 | 746,669 | 886,439 | 886,439 | 331,487 |
| # individuals | 12,143 | 12,143 | 12,143 | 12,143 | 12,143 | 12,143 | 12,143 |
| Individual FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Month-by-year FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

Notes: [a] This table shows regression results of the effect of retirement on interest payments, balances, and limits, using individual fixed effects, with and without controlling for total individual income. All specifications control for month and year fixed effects as well as their interactions, i.e., month-by-year fixed effects. Standard errors are clustered at the individual level and displayed in parentheses. All variables are measured in terms of their inverse hyperbolic sine to accommodate observations with zero values. All coefficients represent percentage changes.
[b] Significance levels: * p<0.1 ** p<0.05 *** p< 0.01

Table 3: The Dynamic Effects of Retirement on Personal Finances

| | (1) Overdraft indicator | (2) # overdrafts | (3) Overdraft interest | (4) Late fees | (5) Interest income indicator | (6) Interest income | (7) Credit lines |
|---|---|---|---|---|---|---|---|
| *Without controlling for income:* | | | | | | | |
| Retired for (months): | | | | | | | |
| $< 12$ | -0.050*** | -0.049** | -0.577*** | -0.263*** | 0.042*** | 0.487*** | -0.048 |
| | (0.016) | (0.020) | (0.134) | (0.084) | (0.015) | (0.098) | (0.081) |
| $12 > < 24$ | -0.037** | -0.031 | -0.468*** | -0.149 | 0.029 | 0.296*** | -0.134 |
| | (0.018) | (0.024) | (0.155) | (0.099) | (0.019) | (0.108) | (0.108) |
| $> 24$ | -0.039** | -0.043 | -0.574*** | -0.319*** | 0.033 | -0.047 | -0.020 |
| | (0.020) | (0.028) | (0.166) | (0.104) | (0.023) | (0.115) | (0.152) |
| $R$-sqr | 0.001 | 0.001 | 0.002 | 0.007 | 0.455 | 0.513 | 0.012 |
| *Controlling for income:* | | | | | | | |
| Retired for (months): | | | | | | | |
| $< 12$ | -0.051*** | -0.051** | -0.590*** | -0.300*** | 0.020 | 0.487*** | -0.047 |
| | (0.016) | (0.020) | (0.134) | (0.084) | (0.015) | (0.098) | (0.081) |
| $12 > < 24$ | -0.038** | -0.032 | -0.480*** | -0.182* | 0.013 | 0.296*** | -0.133 |
| | (0.018) | (0.024) | (0.155) | (0.099) | (0.018) | (0.108) | (0.109) |
| $> 24$ | -0.041** | -0.044 | -0.587*** | -0.355*** | 0.029 | -0.047 | -0.018 |
| | (0.020) | (0.028) | (0.166) | (0.104) | (0.022) | (0.115) | (0.152) |
| $R$-sqr | 0.002 | 0.002 | 0.003 | 0.009 | 0.463 | 0.513 | 0.012 |
| # obs | 746,669 | 746,669 | 746,669 | 746,669 | 746,669 | 746,669 | 331,487 |
| # individuals | 12,143 | 12,143 | 12,143 | 12,143 | 12,143 | 12,143 | 12,143 |
| Individual FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Month-by-year FE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

Notes: [a] This table shows regression results of the effect of retirement on interest payments, balances, and limits, using individual fixed effects, with and without controlling for total individual income. All specifications control for month and year fixed effects as well as their interactions, i.e., month-by-year fixed effects. Standard errors are clustered at the individual level and displayed in parentheses. All variables are measured in terms of their inverse hyperbolic sine to accommodate observations with zero values. All coefficients represent percentage changes.
[b] Significance levels: * p<0.1 ** p<0.05 *** p< 0.01

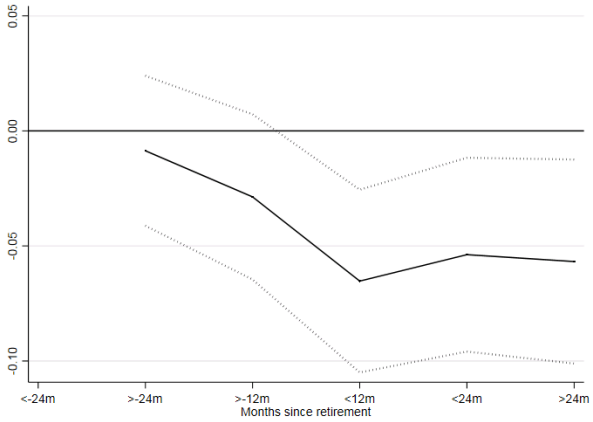



Figure 6: Indicator for Paying Overdraft Interest

Notes: This figure plots the estimated coefficients from a regression of an indicator for overdraft interest expenses on dummies for being 12-24 months from retirement, for being 0-12 months away from retirement, for being retired less than 12 months, for being retired 12-24 months, and for being retired more than 24 months. The regressions include month-by-year fixed effects as well as individual fixed effects. Standard errors are clustered at the individual level and confidence intervals are displayed.

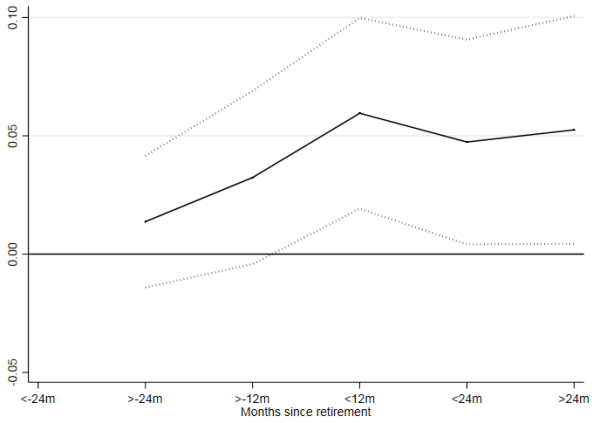



Figure 7: Indicator for Interest Earnings from Bank Deposits

Notes: This figure plots the estimated coefficients from a regression of an indicator for interest earnings from bank deposits on dummies for being 12-24 months from retirement, for being 0-12 months away from retirement, for being retired less than 12 months, for being retired 12-24 months, and for being retired more than 24 months. The regressions include month-by-year fixed effects as well as individual fixed effects. Standard errors are clustered at the individual level and confidence intervals are displayed.




Figure 8: Indicator for Paying Overdraft Interest

Notes: This figure plots the estimated coefficients from a regression of an indicator for overdraft interest expenses 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.




Figure 9: Overdraft Interest Expenses

Notes: This figure plots the estimated coefficients from a regression of overdraft interest expenses 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. Overdraft interest is measured in terms of its inverse hyperbolic sine to accommodate months when individuals do not have any overdraft interest expenses.

Table 4: The Effects of Retirement on an Indicator for Paying Overdraft Interest - Different Specifications

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| *FE type:* | None | Individual | Individual month, year | Individual month-by-year |
| Retired | -0.089*** | -0.047*** | -0.044*** | -0.044*** |
| | (0.017) | (0.015) | (0.016) | (0.016) |
| R-sqr | 0.001 | 0.000 | 0.001 | 0.001 |
| #obs | 746,669 | 746,669 | 746,669 | 746,669 |
| #individuals | 12,143 | 12,143 | 12,143 | 12,143 |

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| *Income control:* | Income | Regular income | Irregular income | Pension |
| Retired | -0.044*** | -0.044*** | -0.044*** | -0.047*** |
| | (0.016) | (0.016) | (0.016) | (0.016) |
| R-sqr | 0.001 | 0.001 | 0.001 | 0.001 |
| # obs | 746,669 | 746,669 | 746,669 | 746,669 |
| # individuals | 12,143 | 12,143 | 12,143 | 12,143 |
| Individual FE | ✓ | ✓ | ✓ | ✓ |
| Month-by-year FE | ✓ | ✓ | ✓ | ✓ |

Notes: [a] This table shows the estimated effect of retirement on overdraft interest using different fixed effects regimes and control variables. The top four specifications include fixed effects regimes as indicated in each column, the bottom four specifications control for individual as well as interacted month and year fixed effects, i.e., month-by-year fixed effects. Standard errors are clustered at the individual level and are within parentheses.
[b] Significance levels: * $p<0.1$ ** $p<0.05$ *** $p< 0.01$

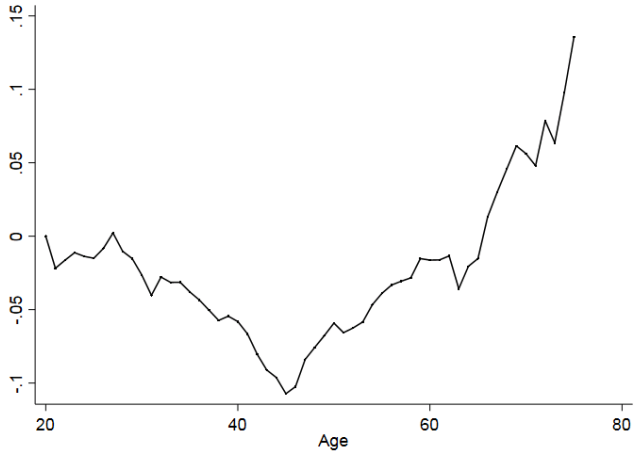



Figure 10: Indicator for Interest Earnings from Bank Deposits

Notes: This figure plots the estimated coefficients from a regression of an indicator for interest earnings from bank deposits on a full set of age dummies, with age 20 being the omitted age dummy. The regressions include month-by-year fixed effects.

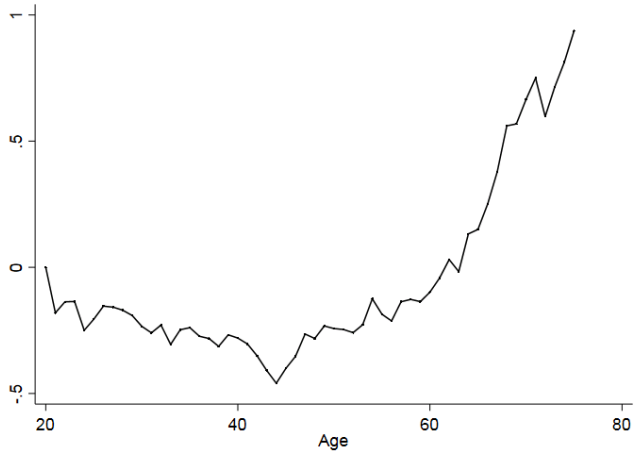



Figure 11: Interest Earnings from Bank Deposits

Notes: This figure plots the estimated coefficients from a regression of interest earnings from bank deposit 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. Interest earnings are measured in terms of their inverse hyperbolic sine to accommodate months when individuals do not earn any interest from their bank deposits.

Table 5: The Effects of Retirement on an Indicator for Interest Earnings from Bank Deposits - Different Specifications

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| *FE type:* | None | Individual | Individual month, year | Individual month-by-year |
| Retired | 0.196*** | 0.365*** | 0.035** | 0.036** |
| | (0.015) | (0.016) | (0.016) | (0.016) |
| R-sqr | 0.005 | 0.006 | 0.419 | 0.455 |
| #obs | 886,439 | 886,439 | 886,439 | 886,439 |
| #individuals | 12,143 | 12,143 | 12,143 | 12,143 |
| | (1) | (2) | (3) | (4) |
| *Income control:* | Income | Regular income | Irregular income | Pension |
| Retired | 0.036** | 0.036** | 0.036** | 0.032** |
| | (0.016) | (0.016) | (0.016) | (0.016) |
| R-sqr | 0.455 | 0.455 | 0.455 | 0.455 |
| #obs | 886,439 | 886,439 | 886,439 | 886,439 |
| #individuals | 12,143 | 12,143 | 12,143 | 12,143 |
| Individual FE | ✓ | ✓ | ✓ | ✓ |
| Month-by-year FE | ✓ | ✓ | ✓ | ✓ |

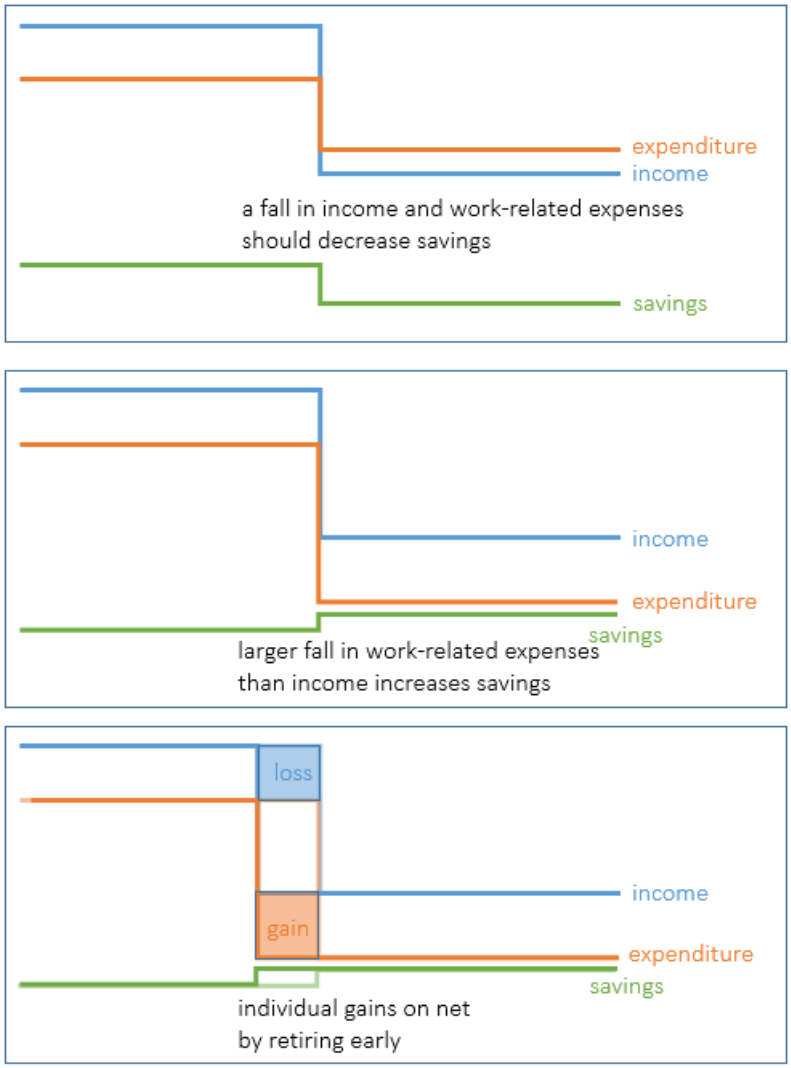
Notes: [a] This table shows the estimated effect of retirement on the propensity to hold liquid savings using different fixed effects regimes and control variables. The top four specifications include fixed effects regimes as indicated in each column, the bottom four specifications control for individual as well as interacted month and year fixed effects, i.e., month-by-year fixed effects. Standard errors are clustered at the individual level and displayed in parentheses. [b] Significance levels: * p<0.1 ** p<0.05 *** p< 0.01

Table 6: The Effects of Retirement on Expenditures 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 | -0.216*** | -0.236*** | -0.314*** | -0.265*** | -0.188** | -0.141 | -0.118 | -0.329*** | -0.204** | -0.240*** | -0.074 |
| | (0.0433) | (0.0729) | (0.1016) | (0.0893) | (0.0800) | (0.0858) | (0.0809) | (0.0886) | (0.0816) | (0.0690) | (0.0886) |
| $R$-sqr | 0.049 | 0.043 | 0.014 | 0.024 | 0.044 | 0.052 | 0.003 | 0.038 | 0.034 | 0.006 | 0.009 |
| *Controlling for income:* | | | | | | | | | | | |
| Retired | -0.268*** | -0.303*** | -0.381*** | -0.307*** | -0.250*** | -0.201** | -0.124 | -0.382*** | -0.259*** | -0.259*** | -0.123 |
| | (0.0416) | (0.0702) | (0.1012) | (0.0886) | (0.0781) | (0.0849) | (0.0809) | (0.0880) | (0.0806) | (0.0688) | (0.0869) |
| $R$-sqr | 0.074 | 0.060 | 0.022 | 0.026 | 0.055 | 0.055 | 0.003 | 0.041 | 0.036 | 0.006 | 0.012 |
| #obs | 787,316 | 787,316 | 787,316 | 787,316 | 787,316 | 787,316 | 787,316 | 787,316 | 787,316 | 787,316 | 787,316 |
| #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 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

Notes: [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 as well as their interactions, i.e., month-by-year fixed effects. Standard errors are clustered at the individual level and displayed in parentheses. All outcome variables are measured in terms of their inverse hyperbolic sine to accommodate observations with zero values. All coefficients represent percentage changes. [b] Significance levels: * p<0.1 ** p<0.05 *** p< 0.01

Figure 12: Illustration of the argument



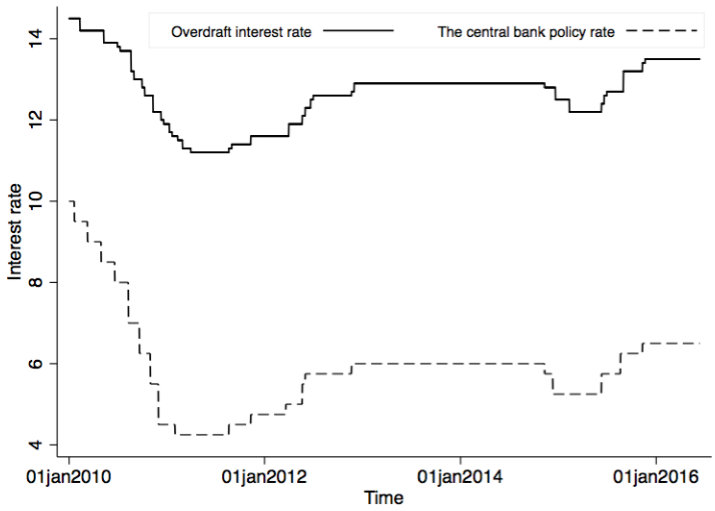

This figure illustrates why a rational model has difficulty explaining our two findings that 1) individual savings increase after retirement and 2) eligible individuals do not retire immediately. A fall in income and work-related expenses (or any other theory that would decrease consumption, such as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

Table 7: The Effects of Retirement on Investment Transactions and Uncategorized Income

| | Investment transactions | Uncategorized income | Investment transactions | Uncategorized income |
|---|---|---|---|---|
| Retired | -0.000 | -0.071** | -0.017 | -0.096** |
| | (0.013) | (0.029) | (0.012) | (0.040) |
| $R$-sqr | 0.024 | 0.024 | 0.032 | 0.035 |
| #obs | 886,439 | 886,439 | 7466,69 | 746,669 |
| #individuals | 12,143 | 12,143 | 12,143 | 12,143 |
| Individual FE | ✓ | ✓ | ✓ | ✓ |
| Month-by-year FE | ✓ | ✓ | ✓ | ✓ |
| Controlling for income | | | ✓ | ✓ |

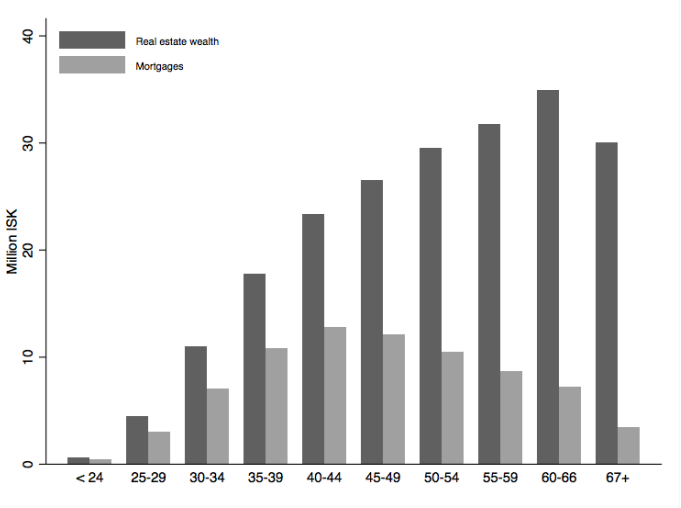
Notes: [a] This table shows regression results of the effect of retirement on log investment related income and uncategorized income. All specifications control for month and year fixed effects as well as their interactions, i.e., month-by-year fixed effects. Standard errors are clustered at the individual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

Figure 13: Central Bank Policy Rate and Average Overdraft Interest Rate




Notes: Trends of the central bank policy rate and average overdraft interest rate through the sample period. Data source: Central Bank of Iceland https://www.cb.is/ Our data on spending by category, income by source (including interest income), overdraft interest, and financial fees run from 2011 to 2017 and the data on balances and limits spans 2014 to 2017.

Figure 14: Housing Wealth and Mortgage Debt over Age




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

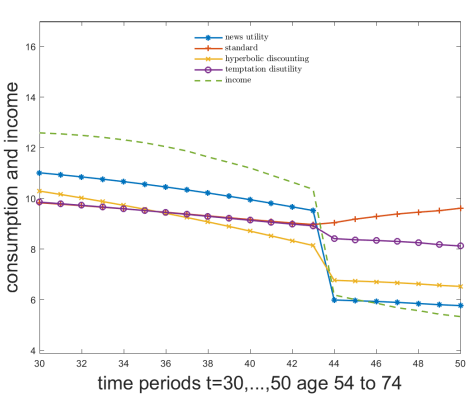
Table 8: Environmental and Preference Parameters

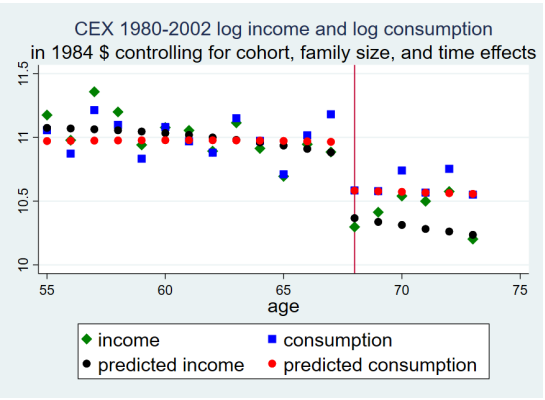
| parameter | $\mu_P$ | $\sigma_P$ | $\mu_T$ | $\sigma_T$ | $p$ | $G_t$ | $r$ | $P_0$ | $\frac{A_0}{P_0}$ | $R$ | $T$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| value | 0 | 0.1 | 0 | 0.1 | 0.01 | $\widehat{G_t}$ | 0.01 | 1 | 0.0096 | 11 | 78 |

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

This table displays all calibrated parameters.

Figure 15: Life-cycle Profiles and CEX Consumption and income data




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

Table 9: The Effects of Retirement on Expenditures 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) |
| Controlling for 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) |
| Controlling for income | ✓ | ✓ | ✓ | ✓ |
| #obs | 800 | 800 | 800 | 800 |

Notes: [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 Internet Appendix

Table A.10: Descriptive Statistics Before and After Retirement: Alternative Definition of Retirement

| | Eligible but not retired | | Retired | |
|---|---|---|---|---|
| | Mean | St.dev. | Mean | St.dev. |
| ***Demographics:*** | | | | |
| Age | 67.1 | 3.6 | 71.4 | 5.6 |
| Female | 0.41 | 0.49 | 0.40 | 0.49 |
| ***Monthly income:*** | | | | |
| Labor income | 4,574 | 6,291 | 818 | 3,681 |
| Pensions | 787 | 1,484 | 2,147 | 1,699 |
| ***Personal finances:*** | | | | |
| Overdraft indicator | 0.40 | 0.49 | 0.31 | 0.46 |
| # Overdrafts | 0.47 | 0.66 | 0.36 | 0.59 |
| Overdraft interest | 19 | 55 | 11 | 48 |
| Late fees | 5.1 | 31.9 | 3.8 | 23.6 |
| Interest income indicator | 0.42 | 0.49 | 0.53 | 0.50 |
| Credit lines | 11,043 | 10,549 | 9,394 | 19,798 |
| ***Monthly spending:*** | | | | |
| Total discretionary | 1,914 | 2,681 | 1,706 | 1,958 |
| Groceries | 514 | 340 | 507 | 318 |
| Fuel | 270 | 247 | 201 | 207 |
| Alcohol | 100 | 172 | 87 | 158 |
| Ready-made food | 113 | 141 | 106 | 142 |
| Home improvements | 230 | 1,537 | 187 | 500 |
| Home security | 13 | 36 | 11 | 46 |
| Vehicles | 195 | 1,956 | 152 | 1,673 |
| Clothing accessories | 98 | 190 | 83 | 167 |
| Sports & activities | 11 | 50 | 8 | 41 |
| Pharmacies | 77 | 90 | 78 | 94 |

Note: All numbers are inflation adjusted and in US dollars.

Table A.11: The Effects of Retirement on Borrowing and Savings: Alternative Definition of Retirement

| | (1) Overdraft indicator | (2) # overdrafts | (3) Overdraft interest | (4) Late fees | (5) Interest income indicator | (6) Credit lines |
|---|---|---|---|---|---|---|
| Retired for (months): | | | | | | |
| | | | *Without controlling for income:* | | | |
| $< 12$ | -0.052** | -0.059* | -0.585*** | -0.234* | -0.009 | -0.187 |
| | (0.021) | (0.033) | (0.195) | (0.130) | (0.024) | (0.123) |
| $12 > < 24$ | -0.033 | -0.014 | -0.492** | -0.321* | -0.004 | -0.224 |
| | (0.025) | (0.038) | (0.216) | (0.167) | (0.035) | (0.189) |
| $> 24$ | -0.052 | -0.068 | -0.675** | -0.432** | 0.074* | -0.209 |
| | (0.031) | (0.057) | (0.270) | (0.176) | (0.044) | (0.194) |
| R-sqr | 0.002 | 0.003 | 0.005 | 0.008 | 0.460 | 0.012 |
| | | | *Controlling for income:* | | | |
| $< 12$ | -0.053** | -0.060* | -0.595*** | -0.253* | -0.010 | -0.186 |
| | (0.021) | (0.033) | (0.195) | (0.130) | (0.024) | (0.123) |
| $12 > < 24$ | -0.033 | -0.015 | -0.497** | -0.330** | -0.004 | -0.224 |
| | (0.025) | (0.038) | (0.216) | (0.167) | (0.034) | (0.189) |
| $> 24$ | -0.052 | -0.068 | -0.677** | -0.435** | 0.073* | -0.209 |
| | (0.031) | (0.057) | (0.270) | (0.176) | (0.044) | (0.194) |
| R-sqr | 0.004 | 0.004 | 0.006 | 0.013 | 0.462 | 0.012 |
| #obs | 776,587 | 776,587 | 776,587 | 776,587 | 776,587 | 323,212 |
| #individuals | 12,088 | 12,088 | 12,088 | 12,088 | 12,088 | 12,088 |
| Individual fixed effect | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| month-by-year fixed effect | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

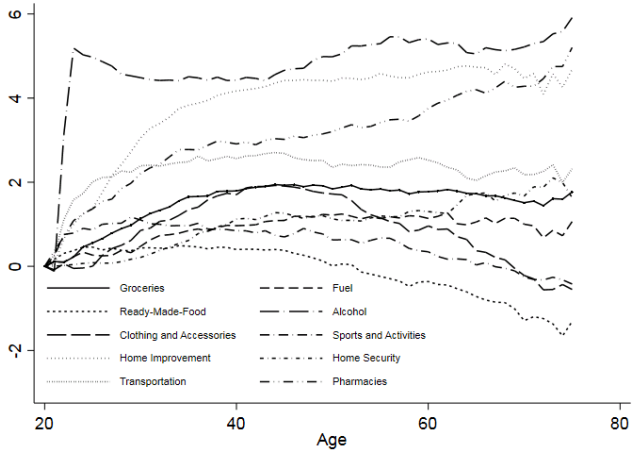
Notes: [a] This table shows regression results of the effect of retirement on log interest payments, balances, and limits, using individual fixed effects, with and without controlling for total income. All specifications control for month and year fixed effects as well as their interactions, i.e., month-by-year fixed effects. All coefficients represent percentage changes. All variables are measured in terms of their inverse hyperbolic sine to accommodate observations with zero values. Standard errors are clustered at the individual level and displayed in parentheses. [b] Significance levels: * p<0.1 ** p<0.05 *** p< 0.01



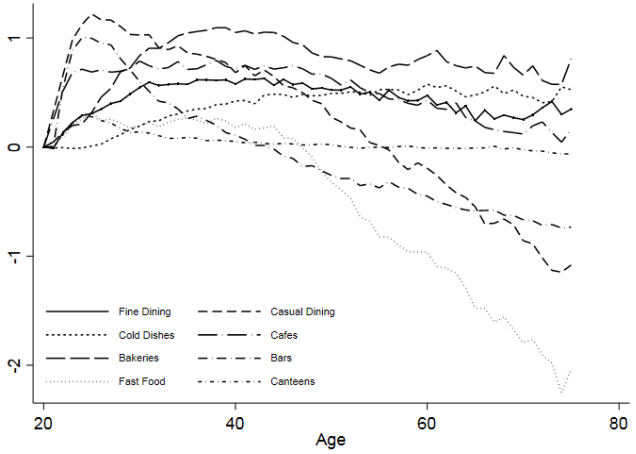

Log Monthly Total Discretionary Spending




Log Monthly Restaurant Spending




Log Monthly Spending by Category




Log Monthly Spending by Type of Restaurant

Figure A.16: Life-cycle Profiles of Expenditures

Notes: 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.

Table A.12: The Effects of Retirement on Restaurant Expenditures and Visits

| | Total spending | Casual dining | Cold dishes | Fast food | Fine dining | Bakeries | Cafes | Bars | Meal kit delivery | Canteens |
|---|---|---|---|---|---|---|---|---|---|---|
| *Without controlling for income:* | | | | | | | | | | |
| Retired | -0.188** | -0.370*** | -0.097 | -0.328*** | -0.143** | -0.055 | -0.087 | -0.230*** | -0.172*** | -0.096*** |
| | (0.0800) | (0.0912) | (0.0706) | (0.0953) | (0.0588) | (0.0903) | (0.0768) | (0.0314) | (0.0224) | (0.0208) |
| $R$-sqr | 0.044 | 0.024 | 0.005 | 0.028 | 0.006 | 0.018 | 0.012 | 0.008 | 0.028 | 0.012 |
| *Controlling for income:* | | | | | | | | | | |
| Retired | -0.250*** | -0.425*** | -0.106 | -0.386*** | -0.165*** | -0.096 | -0.120 | -0.251*** | -0.174*** | -0.094*** |
| | (0.0781) | (0.0904) | (0.0704) | (0.0943) | (0.0588) | (0.0898) | (0.0768) | (0.0315) | (0.0224) | (0.0208) |
| $R$-sqr | 0.055 | 0.028 | 0.005 | 0.034 | 0.007 | 0.020 | 0.013 | 0.009 | 0.028 | 0.012 |
| | | | | | Number of visits | | | | | |
| *Without controlling for income:* | | | | | | | | | | |
| Retired | -1.549*** | -0.327*** | -0.015 | -0.393*** | -0.032*** | 0.023 | -0.035 | -0.129*** | -0.037*** | -0.030* |
| | (0.2274) | (0.0427) | (0.0162) | (0.1049) | (0.0114) | (0.0687) | (0.0311) | (0.0146) | (0.0044) | (0.0167) |
| $R$-sqr | 0.019 | 0.013 | 0.003 | 0.013 | 0.005 | 0.012 | 0.005 | 0.005 | 0.022 | 0.008 |
| *Controlling for income:* | | | | | | | | | | |
| Retired | -1.758*** | -0.353*** | -0.017 | -0.467*** | -0.036*** | 0.003 | -0.049 | -0.138*** | -0.037*** | -0.028* |
| | (0.2264) | (0.0424) | (0.0162) | (0.1049) | (0.0114) | (0.0685) | (0.0314) | (0.0147) | (0.0044) | (0.0167) |
| $R$-sqr | 0.022 | 0.014 | 0.004 | 0.016 | 0.005 | 0.013 | 0.005 | 0.006 | 0.022 | 0.007 |
| # obs | 787,316 | 787,316 | 787,316 | 787,316 | 787,316 | 787,316 | 787,316 | 787,316 | 787,316 | 787,316 |
| # 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 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

Notes: [a] This table shows regression results of retirement on spending in different types of restaurants and on the number of visits to different types of restaurants, with and without controlling for total income. All specifications control for individual fixed effects, as well as month and year fixed effects as well as their interactions, i.e., month-by-year fixed effects. Standard errors are clustered at the individual level and displayed in parentheses. Expenditures are measured in terms of its inverse hyperbolic sine to accommodate observations with zero values. All coefficients represent percentage changes. [b] Significance levels: * p<0.1 ** p<0.05 *** p< 0.01

# B Replicating the Analysis in Other Data Sets

### CEX data

We use data from the CEX for 1980 to 2002. Following Aguiar and Hurst (2013), we use the National Bureau of Economic Research (NBER) extraction files by John Sabelhaus and Ed Harris of the US 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 US 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 (e.g., furniture and house supplies), personal business, transportation (e.g., 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 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.

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 because time minus age equals cohort. In the portfolio-choice literature, it is standard practice to solve the identification problem by acknowledging age and time effects (as tradable and non-tradable 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.

### 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 therefore, we cannot 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 (e.g., cars and houses). Again, we log all outcome variables.

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 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, 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).

### 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.[20] 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.

### PSID data

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 after 1997. It included questions that relate to specific consumption and savings measures after 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).

### HRS data

Finally, we replicate our results using the 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 spending categories and total household income measuring all inflows. We construct the savings variable as the sum of the values of

[20]This transaction-level data set 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 data set contains information on all portfolio trades and holdings.

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, retirement savings accounts (IRA) assets, and overall wealth. Again, we log all outcome variables.

Table B.13: The Effects of Retirement on Personal Finances using CEX data

| | Income minus consumption | Income minus consumption | Current account | Checking 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) as well as 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 B.14: The Effects of Retirement on Personal Finances using SCF data

| | Leverage | | Debt | | Checking 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, as well as 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 B.15: The Effects of Retirement on Personal Finances using German bank data

| | Income minus spending | | Checking 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), checking 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 B.16: The Effects of Retirement on Personal Finances using 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 B.17: The Effects of Retirement on Personal Finances using 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

# C 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 percent to 60 percent of full-time earnings during employment in annuitized monthly pension payments. 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 indexed to the consumer price index.

The contribution can be divided into two parts. The first part goes toward acquiring pension rights, which (for a 40-year 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 toward 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 age 65, but then with a reduced benefit, or as late as age 70 with additional benefits. In general, the benefit rule in the new public sector scheme and in the private sector is neutral toward the choice of early or late retirement. The question of whether it is beneficial to postpone benefit withdrawal until after age 67 depends on how long individuals expect to live. The system is designed so that the individual should be indifferent if he or she expects to live until he or 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 withdrawal of their benefits.

The pension benefits system is transparent and there exists a pension calculator online provided by the Social Insurance Agency under https://www.tr.is/reiknivel/. In the following, we provide printouts of two calculation exercises: one in which the individual retires immediately at age 67 and one in which he or she delays for 60 months until age 72. We provide below both the input pages as well as the results pages. As can be seen, the monthly pension

payment then increases from a total of 252,457 ISK which equals approximately 2,525 USD to 311,235 ISK which equals approximately 3,112 USD. From working one month longer, the individual thus receives an additional (3,112-2,525)/60 = 9.78 USD in pension payments or approximately 0.5% in additional benefits.

**Pillar three - voluntary individual pension savings.** Employees can deduct from their taxable income a contribution to authorized individual pension schemes. Currently, the maximum taxable deduction by the employee is 4 percent. In addition, all employers have agreed in wage settlements to contribute 2 percent to those voluntary pension savings if the employee matched the amount with at least the same percentage. The total contribution can therefore be 6 percent. The voluntary pension savings cannot be distributed until the age of 60.[21]

[21] After the 2008 financial crisis, individuals were given permission to withdraw private pension savings to pay down debt. We observe all such one-time withdrawals but exclude individuals younger than age 60 in our analysis. This also implies that any lingering effects of the financial crisis, even if they affect older people differently than younger people, are captured by the inclusion of time fixed effects.

# Pension Calculator 2019

Please note that the calculator does not yield binding results

**Type of pension**

Ellilífeyrir

**With motor impairment assessment**

No Yes

**With old-age pension and social security supplement in 2016**

No Yes

**On a disability or rehabilitation pension for taking an old-age pension**

No Yes

**relationship status**

1951 eða fyrr

**Starts old age pension from TR**

2018 eða seinna

**Children under 18 years**

Á ekki maka

**at-home**

Býr ein(n)





**Children under 18 years**

Ekkert barn

**Get paid allowance**

Engu barni

**Accelerated old-age pension (number of months, 0-24)**

0 months

**Suspension of old-age pension (number of months, 0-60)**

0 months

**residential Percent**

100 %

**Tax card ratio at TR**

100 %

Capital income is considered to be shared by spouses and therefore the aggregate capital income of pensioners and spouses must be stated. The calculation takes this into account and dividends are divided into halves.

**Income before tax**

monthly annual earnings

**Income, among other things, from employment, pensions and unemployment benefits**

0 kr.

**Payments from pension funds**





0 kr.

**Payments from private pension funds**

0 kr.

**Other income**

0 kr.

**Capital Gains**

0 kr.

**Local taxable benefits**

0 kr.

**Deducted pension fund contributions**

0 kr.

**Foreign basic pension**

0 kr.

Calculate results





# Pension Calculator 2019

**Please note that the calculator will calculate payments based on the criteria you provide. The model is for guidance only but does not provide binding information on the final settlement of the case or the amount of payment.**

## breakdown

| Payments from the Social Insurance Agency | in a month | in a year |
|---|---|---|
| Old-age pensions | 248105 | 2977260 |
| household | 62695 | 752340 |
| Holiday and December allowances | 0 | 93555 |
| Total: | 310800 | 3823155 |

| | | |
|---|---|---|
| Deducted tax (1st tier) | 114810 | 1412273 |
| Personal Disc. (utilization of tax card 100%) | 56447 | 677364 |
| Total from TR after tax: | 252437 | 3088246 |

| Income from others | in a month | in a year |
|---|---|---|
| Income from employment | 0 | 0 |
| Payments from pension funds | 0 | 0 |
| Payments from private pension funds | 0 | 0 |

| Income from others | in a month | in a year |
|---|---|---|
| Other income | 0 | 0 |
| Local taxable benefits | 0 | 0 |
| Deducted pension fund contributions | 0 | 0 |
| Total: | 0 | 0 |

| | | |
|---|---|---|
| Deducted tax (1st tier) | 0 | 0 |
| Personal Disc. (tax card utilization 0%) | 0 | 0 |
| Total from others after tax: | 0 | 0 |

| Capital Gains | in a month | in a year |
|---|---|---|
| Capital Gains | 0 | 0 |
| Deducted capital income tax 22% | 0 | 0 |
| Total capital income after tax: | 0 | 0 |

| Total revenue | in a month | in a year |
|---|---|---|
| Payments from the Social Insurance Agency | 310800 | 3823155 |
| Income from others | 0 | 0 |
| Capital Gains | 0 | 0 |
| Total revenue: | 310800 | 3823155 |

| Withholding tax | 58363 | 734909 |
|---|---|---|
| Deducted capital income tax | 0 | 0 |
| Installment claims on TR: | 0 | 0 |





| Total after-tax disposable income: | 252437 | 3088246 |
|---|---|---|

**The calculator does not take into account the rules for interaction with pension funds (this interaction is settled in next year's settlement, but is not paid every month). The calculation of capital income tax is based on withholding. It does not take into account the taxable income limit and is referred to in the Directorate of Internal Revenue's instructions.**

Change the criteria





# Pension Calculator 2019

Please note that the calculator does not yield binding results

**Type of pension**

Ellilífeyrir

**With motor impairment assessment**

No Yes

**With old-age pension and social security supplement in 2016**

No Yes

**On a disability or rehabilitation pension for taking an old-age pension**

No Yes

**relationship status**

1951 eða fyrr

**Starts old age pension from TR**

2017 eða fyrr

**Children under 18 years**

Á ekki maka

**at-home**

Býr ein(n)





**Children under 18 years**

Ekkert barn

**Get paid allowance**

Engu barni

**Accelerated old-age pension (number of months, 0-24)**

0 months

**Suspension of old-age pension (number of months, 0-60)**

60 months

**residential Percent**

100 %

**Tax card ratio at TR**

100 %

Capital income is considered to be shared by spouses and therefore the aggregate capital income of pensioners and spouses must be stated. The calculation takes this into account and dividends are divided into halves.

**Income before tax**

monthly annual earnings

**Income, among other things, from employment, pensions and unemployment benefits**

0 kr.

**Payments from pension funds**

0 kr.

**Payments from private pension funds**

0 kr.

**Other income**

0 kr.

**Capital Gains**

0 kr.

**Local taxable benefits**

0 kr.

**Deducted pension fund contributions**

0 kr.

**Foreign basic pension**

0 kr.

Calculate results





# Pension Calculator 2019

**Please note that the calculator will calculate payments based on the criteria you provide. The model is for guidance only but does not provide binding information on the final settlement of the case or the amount of payment.**

## breakdown

| Payments from the Social Insurance Agency | in a month | in a year |
|---|---|---|
| Old-age pensions | 322537 | 3870444 |
| household | 81504 | 978048 |
| Holiday and December allowances | 0 | 121622 |
| Total: | 404041 | 4970114 |

| | | |
|---|---|---|
| Deducted tax (1st tier) | 149253 | 1835960 |
| Personal Disc. (utilization of tax card 100%) | 56447 | 677364 |
| Total from TR after tax: | 311235 | 3811518 |

| Income from others | in a month | in a year |
|---|---|---|
| Income from employment | 0 | 0 |
| Payments from pension funds | 0 | 0 |
| Payments from private pension funds | 0 | 0 |





| Income from others | in a month | in a year |
|---|---|---|
| Other income | 0 | 0 |
| Local taxable benefits | 0 | 0 |
| Deducted pension fund contributions | 0 | 0 |
| Total: | 0 | 0 |

| | | |
|---|---|---|
| Deducted tax (1st tier) | 0 | 0 |
| Personal Disc. (tax card utilization 0%) | 0 | 0 |
| Total from others after tax: | 0 | 0 |

| Capital Gains | in a month | in a year |
|---|---|---|
| Capital Gains | 0 | 0 |
| Deducted capital income tax 22% | 0 | 0 |
| Total capital income after tax: | 0 | 0 |

| Total revenue | in a month | in a year |
|---|---|---|
| Payments from the Social Insurance Agency | 404041 | 4970114 |
| Income from others | 0 | 0 |
| Capital Gains | 0 | 0 |
| Total revenue: | 404041 | 4970114 |

| | | |
|---|---|---|
| Withholding tax | 92806 | 1158596 |
| Deducted capital income tax | 0 | 0 |
| Installment claims on TR: | 0 | 0 |





| | | |
|---|---|---|
| Total after-tax disposable income: | 311235 | 3811518 |

**The calculator does not take into account the rules for interaction with pension funds (this interaction is settled in next year's settlement, but is not paid every month). The calculation of capital income tax is based on withholding. It does not take into account the taxable income limit and is referred to in the Directorate of Internal Revenue's instructions.**

Change the criteria

# D Derivation of the theoretical framework

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

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

Note that, if contemporaneous consumption is increasing in the realization of cash-on-hand then we can simplify $F^{T-2}_{C_{T-1}}(C_{T-1}) = F^{T-2}_{X_{T-1}}(X_{T-1})$. Returning to the maximization problem the third term represents the prospective news utility over future consumption $C_T$ experienced in $T-1$. As before, the 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

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

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

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

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

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

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

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

to find each corresponding grid value. Note that, the resulting two-dimensional grid for $c_{T-i}$ will be the normalized grid for each realization of $s^T_t$ and $s^P_t$, because we multiply both sides

of the first-order conditions with $(G_{T-i}e^{s^P_{T-i}})^{-\theta}$. Thus, the agent's consumption utility continuation value is

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

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

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

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

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

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

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

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

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

## D.2 The hyperbolic-discounting model

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

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

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

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

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

## D.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 but not more. This is because borrowing could be infinitely painful with power utility and a chance of zero income in all future periods. For illustration, in the second-to-last period the agent's maximization problem is

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

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

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

which results in the following first-order condition

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

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

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

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