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Uncertain pension income and household saving

Peter van Santen*

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Abstract

This paper investigates the relationship between household saving and pensions, and estimates both the displacement effect of pensions on private saving and the precautionary saving effect due to uncertainty in pension income. I estimate the savings equation derived from a lifecycle model featuring income uncertainty using survey data for Dutch households, with subjective expectations on pension benefits and uncertainty. Exploiting exogenous variation due to pension fund performance, I find that households save significantly more due to uncertainty in pension income. Not controlling for uncertainty biases the estimated displacement effect of pensions on private savings towards zero.

Keywords: Precautionary saving, Displacement effect, Subjective expectations

JEL classification: D91,H55,J26

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1 Introduction

The relationship between pensions and household savings is important to understand the consequences of reforms to the pension system. Due to the aging of the population, many countries have reformed or will need to reform their pension system to be able to provide adequate pension benefits in a sustainable way. More recently, low returns on investment, low interest rates and lack of economic growth have further deteriorated the financial position of retirement income systems worldwide. According to the lifecycle hypothesis, forward looking agents will respond to changes in their expected pension wealth by adjusting their consumption levels.

The empirical literature, going back to Feldstein (1974),[1] suggests that increases in pension wealth reduce private saving, although typically less than one-for-one, as a simple lifecycle model would predict. Departures from this 100% displacement effect are typically ex-post rationalized by the existence of liquidity constraints, bequest motives and various sources of uncertainty, all of which are left out of the simple model based on certainty or certainty-equivalence. In this paper, I extend the empirical specification used in virtually all studies of the displacement effect, by including a measure of uncertainty over future pension benefits. This specification follows naturally from a lifecycle model where future retirement income is a random variable, giving rise to a precautionary motive to save. Hence, the contribution of this paper is to estimate both the displacement effect of pension income on current saving, as well as the precautionary motive to save using micro data.

Viewing retirement income as a random variable is intuitively appealing, as it is notoriously difficult to forecast future benefit levels. In many countries, social security systems are subject to policy risk (Dominitz and Manski, 2006), as pay-as-you-go systems are vulnerable to demographic trends and budget deficits down the road. Earnings-related, or occupational pensions, instead typically depend on the entire earnings profile until retirement, requiring a forecast of earnings until retirement. In addition, the exact benefit level for those purchasing an annuity at retirement will depend on such things as the interest rate and life expectancy prevailing at that point in the future.

The setting of this paper is The Netherlands, where social security is

[1] The main contributions to this field are reviewed in section 1.1 below.

based on a pay-as-you-go system administered by the state, and defined-benefit occupational pensions typically make up for around half of total pension income. By international standards, the pension system is generous, with a net replacement rate of 95.7% of earnings for an average earner (OECD, 2015). At the same time, population aging and low returns of the pension funds have raised concerns about future generosity. Despite the calls for and discussions on reforms in the political arena, lack of consensus resulted in the (likely unsustainable) status quo, at least until the end of my sample period. Given the uncertainty on future reforms, estimating future entitlements is even more challenging for working-age individuals.

The survey data used in this paper elicit expectations of pension benefits. To be precise, the expectations of pension benefits are elicited from probabilistic survey questions of the type suggested by Dominitz and Manski (1997) and Manski (2004), asking respondents to supply points on their subjective probability distribution function of future benefits. These questions allow for the calculation of both the expected level of retirement income, as well as its variance, separately for all households and time periods. The regression of interest relates household saving to the expectation and variance of pension income.

Estimating a saving equation using observational data is unlikely to give us the causal effects of interest. As Engelhardt and Kumar (2011) argue, omitted variable bias (due to, for instance, heterogeneity in unobserved tastes for saving) is the most prominent candidate to invalidate OLS regressions. To make progress on obtaining causal effects, I exploit exogenous variation in pension fund performance across respondents. In The Netherlands, almost all employees are covered by a mandatory employer pension plan, administered by pension funds. Due to the financial crisis, pension fund performance has been rather weak, causing pension funds to have low funding ratios (equal to the ratio of assets over liabilities). By law, pension funds are required to take corrective actions to increase the funding ratio to at least 105%. These actions include increasing pension premia, foregoing inflation adjustment as well as, in the extreme, cutting nominal pension rights. Matching respondents to their pension fund, I show that, cross-sectionally, there is meaningful variation in this funding ratio to explain household retirement income expectations. As expected, the expected pension benefit increases with the funding ratio, and the variance of pension income decreases with the funding ratio. As employees cannot influence the funding ratio of their pension fund without changing job, I argue that this variation is exogenous, and can be used to identify the causal effect of pension income expectations on private saving. Importantly, the sample is restricted to those individuals not changing pension fund over time to rule out sorting by fund performance, as well as to those pension funds not changing the pension premium between two years, to rule out direct impacts of fund performance on disposable income and, potentially, household savings.

I use the level and 4-quarter change in the funding ratio as instruments to estimate the savings equation, and find significant effects of expected pension income on savings: a dollar in additional pension wealth decreases private saving by 32 cents. A one standard deviation decrease in the expected replacement rate increases annual saving by €1,200 or the saving rate by 2.7 percentage points. Equally significant is the effect of uncertainty: a one standard deviation increase in the variance of the replacement rate increases saving by €1,500 or the saving rate by 3.6 percentage points. To shed light on the magnitudes, I note that if uncertainty had been the same in 2011 as it was in 2007, the saving rate would have dropped from 13.1% to 11.5%, which has potentially aggregate implications. As an extra result, I show that controlling for uncertainty increases the estimate of crowding out of private savings by pensions. In other words, virtually all estimates of the displacement effect in the literature are likely biased towards zero due to lack of measures of uncertainty, such as those I have available.

The paper is organized as follows. I review the relevant literature in section 1.1. Section 2 briefly discusses the Dutch pension system. Section 3 discusses the data on subjective pension income expectations. Section 4 presents a stylized lifecycle model, and discusses the empirical strategy. Section 5 presents the results and Section 6 concludes.

1.1 Related literature

Since the seminal article of Feldstein (1974), many studies have made attempts to estimate the displacement effect, which can be interpreted as the amount by which private wealth is reduced when pension wealth increases by one dollar. Gale (1998) estimates the displacement effect of pensions on non-pension wealth to be 82.3 (39.3) cents using least absolute deviations (robust) regressions. Engelhardt and Kumar (2011) and Alessie et al. (2013) use data on the entire earnings history of older respondents from, respectively, the Health and Retirement Study in the US and the SHARE household survey in Europe. Both studies estimate a model for discretionary household wealth as a function of pension wealth, and find evidence of limited displacement, between 47 and 67 cents. Kapteyn et al. (2005) exploit productivity differences across cohorts and the introduction of social security in the Netherlands to find a small but statistically significant displacement effect of 11.5 cents.

Attanasio and Rohwedder (2003) and Attanasio and Brugiavini (2003) estimate a model for annual household saving, using pension reforms in the United Kingdom and Italy respectively to alleviate endogeneity and attenuation biases affecting the displacement effect. Attanasio and Brugiavini (2003) find that the displacement effect differs per age group, ranging from close to zero for young adults and nearly retired individuals to 2 dollars for middle-aged individuals, although the coefficients differ per specification. Attanasio and Rohwedder (2003) find that the displacement effect is close to zero for the basic state pension, and ranges from 55 cents for middle aged to 75 cents for nearly retired individuals regarding occupational pensions.

Chetty et al. (2014) analyse total savings when persons switch to a firm with higher pension contribution rate using administrative data from Denmark. The estimated displacement effect is around 20 cents, implying that job switches to firms with high contribution rates stimulate retirement savings. In contrast, Chetty et al. (2014) find that retirement saving subsidies are unable to increase total savings, as most individuals are passive savers that do not respond to incentives. Increasing automatic contributions therefore has much more impact (less displacement) on total savings.

Finally, Blau (2016) shows how uncertainty matters in a calibrated life cycle model, mimicking the US pension system. In a world where uncertainty is eliminated, the displacement effect increases from 9 to 39 cents for DB pensions, and from 56 to 73 cents for social security; for DC plans, the displacement effect instead drops slightly from 37 to 32 cents. Overall, these magnitudes imply a sizeable role for precautionary savings.

A few other studies have also used subjective expectations data to study pension crowd out and/or precautionary savings. Guiso et al. (1992) analyze precautionary savings against uncertain labor earnings, while Guiso et al. (1996) and Delavande and Rohwedder (2011) analyze portfolio choice in the presence of labor and retirement income risk, respectively. Bottazzi et al. (2006) have panel data for Italian households at their disposal, and use a subjective measure of expected pension benefits to study displacement of private wealth by social security wealth; their IV estimate of the displacement effect equals 64.5 cents using Italian pension reforms to identify this effect. The survey questions these authors employed do not allow the calculation of a measure of uncertainty however, and thus excludes the precautionary savings motive.

Guiso et al. (2013) use similar probabilistic survey questions as used in this paper to calculate individual-level expected replacement rates of pension income, as well as the standard deviation as measure of uncertainty. Using probit regressions on a cross-section of Italian investors, the authors find that the probability of investing in a pension fund decreases with the expected replacement rate, and increases with its standard deviation, in line with the lifecycle model. The same sign and significance are obtained for the probability of having health insurance. For life insurance and casualty insurance, only the expected replacement rate is significant, with the correct (negative) sign.

This paper extends the analysis of Guiso et al. (2013) by estimating a saving equation derived from a lifecycle model, and by exploiting exogenous variation to estimate the displacement effect and precautionary motive. Moreover, in this paper I extend the certainty equivalence model used in nearly all studies estimating the displacement effect, by modeling pension income as a random variable, thus allowing for precautionary saving motives.

2 Uncertainties in the Dutch pension system

The Dutch pension system consists of three pillars.[2] The first pillar is the flat-rate state pension benefit, provided to all inhabitants aged 65 and above. In 2010, the gross monthly benefit amounted to €1057 for singles and €1470 for couples. The accrual rate equals 2% per year for every year lived in The Netherlands, implying maximum benefits after living in The Netherlands for 50 years. The second pillar, the occupational pensions,

[2]See Bovenberg and Gradus (2008) for an overview of the Dutch pension system and its reforms.

is mandatory for all employees if the employer offers a pension plan[3], and both employers and employees contribute to a defined benefit pension fund. Traditionally, the Dutch occupational pension system is one of the most developed in the world, with pension funds holding around 150% of GDP in investments in 2013 (OECD, 2015). Finally, the third pillar concerns private pension savings, such as annuities bought from banks or insurance companies or private retirement saving accounts. The third pillar is less popular in the Netherlands, as documented by Mastrogiacomo and Alessie (2011).

The replacement rate, i.e. the ratio of pension benefits (summing up the first and second pillar benefits) to wage income, is often used to express the generosity of the pension system. Whereas social security benefits are a fixed amount, occupational pension benefits are determined based on the average earnings during the career. The survey question used in this paper concerns future pension benefits in relation to the current wage of employees.

Bodie (1990) argues that employer pensions can serve as insurance against replacement rate inadequacy, deterioration of social security benefits, longevity risk, investment risk and inflation risk. However, this "insurance contract" is far from complete. The recent turmoil on financial markets during the Great Recession, in addition to population aging in many developed economies has led to revisions in pension systems worldwide. In The Netherlands, these include an increase in the statutory retirement age, from currently 65 to 67 between 2016 and 2023, as well as a shift from a defined benefit (DB) to a defined contribution (DC) system for occupational pensions, making explicit the dependence of pension benefits on asset returns.[4] In recent years, Dutch pension funds have taken different measures during the crisis due to funding shortages resulting from sharp negative investment returns and low interest rates, including a reduction of nominal accrued pension rights, increasing the pension premium and/or not adjusting pension wealth to inflation. Hence, already

[3]Around 90% of the labor force is covered by occupational pension schemes; see Bovenberg and Gradus (2008).

[4]The sample period in this study ends in 2011, before changes in the retirement age or a transition from DB to DC occupational pensions are implemented. In June 2011, unions and employer's federations published further details regarding the future reforms; see Sichting van de Arbeid (2010, 2011) for details.

Table 1: Household saving

Answer	0	1	2	3	4	5	6	7
Saving interval (€'000)	$(-\infty, 0)$	$(0, 1.5)$	$(1.5, 5)$	$(5, 12.5)$	$(12.5, 20)$	$(20, 37.5)$	$(37.5, 75)$	$(75, +\infty)$
Midpoint (€)	0	750	3,250	8,750	16,250	28,750	56,250	75,000
Frequency (%)	26.0	17.6	31.2	18.0	4.3	1.8	0.6	0.6

under the implicitly risky DB contracts, income after retirement is not as certain as usually perceived. The next section discusses the survey used to elicit pension benefit expectations from a sample of non-retired households.

3 Data

For the empirical analysis, I use two sources of survey data: the DNB Household Survey (DHS) and the Pension Barometer (PB). Both surveys are administered by CentERData, Tilburg, The Netherlands, and have unique identifiers allowing us to merge the two data sets at the individual level. The respondents represent the Dutch population aged 16 and above. Both surveys are administered via the internet, and internet access is provided to those that do not have access themselves. The DHS collects information on many socio-economic characteristics of the household, including a detailed breakdown of household income and wealth holdings, which can be used to construct measures of total assets, financial assets and housing assets; see Alessie et al. (2002) and Teppa and Vis (2012) for an extended description. The Appendix contains more details on the survey and variables used in this paper; here I discuss the most important measures.

Household saving is based on a bracketed response question, with answer categories, intervals and midpoints shown in table 1. The empirical model for saving uses either the scale (0-7), the midpoint (i.e. the amount of saving) or the ratio between midpoint and income (i.e. the saving rate) as dependent variables.

3.1 Pension benefit expectations

The Pension Barometer survey is administered to a subset of respondents from the DHS, in particular to employees aged below the statutory retirement age of 65. The survey started in 2006, and 2011 is the most recent survey year at my disposal. Among other questions, the PB elicits expectations of pension benefits. More specifically, the PB contains probabilistic survey questions of the type suggested by Dominitz and Manski (1997) and Manski (2004) that elicit the subjective distribution of the pension income replacement rate. Using the responses to these questions allows the construction of individual-specific measures of expected pension benefits and subjective uncertainty of pension income, by calculating the first and second moment of the distribution.

The exact wording of these questions is as follows.

Question 1 *At which age do you think you can retire at the earliest, following your employer's pension scheme?*

The answer to this question, say age K, is used in the subsequent question:

Question 2 *If you would retire at age K, please think about your total net pension income including social security, compared to your current total net wage or salary. What do you think is the probability that the purchasing power of your total net pension income in the year following your retirement will be:*

a)	*more than 100% of your current net wage?*	... %
b)	*less than 100% of your current net wage?*	... %
c)	*less than 90% of your current net wage?*	... %
d)	*less than 80% of your current net wage?*	... %
e)	*less than 70% of your current net wage?*	... %
f)	*less than 60% of your current net wage?*	... %
g)	*less than 50% of your current net wage?*	... %

The probabilities answered by the respondent define 7 points on the subjective cumulative distribution function of pension income. I assume a maximum replacement rate of 120%, and use linear interpolation between the thresholds to derive the complete distribution for each respondent in each survey year.[5] The observation-specific CDF equals

$$F(RR) = \begin{cases} P(RR < 50)\left(\frac{RR}{50}\right) & \text{if} \quad 0 \leq RR < 50 \\ P(RR < 50) + P(50 \leq RR < 60)\left(\frac{RR-50}{10}\right) & \text{if} \quad 50 \leq RR < 60 \\ P(RR < 60) + P(60 \leq RR < 70)\left(\frac{RR-60}{10}\right) & \text{if} \quad 60 \leq RR < 70 \\ P(RR < 70) + P(70 \leq RR < 80)\left(\frac{RR-70}{10}\right) & \text{if} \quad 70 \leq RR < 80 \\ P(RR < 80) + P(80 \leq RR < 90)\left(\frac{RR-80}{10}\right) & \text{if} \quad 80 \leq RR < 90 \\ P(RR < 90) + P(90 \leq RR < 100)\left(\frac{RR-90}{10}\right) & \text{if} \quad 90 \leq RR < 100 \\ P(RR < 100) + P(RR = 100) & \text{if} \quad RR = 100 \\ P(RR \leq 100) + P(100 < RR < 120)\left(\frac{RR-100}{20}\right) & \text{if} \quad 100 < RR < 120 \end{cases} \tag{1}$$

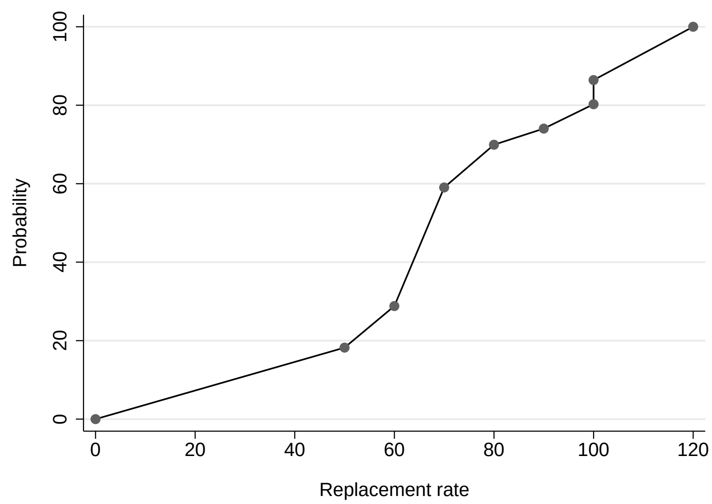
All the probabilities in 1 are known from the answers given by respondents. Writing the CDF as in 1 allows us to work with a continuous distribution function, with point mass at $RR = 100$, as the answers's to 2a and 2b might not add up to 100%, indicating that there is a positive probability associated to the event that the replacement rate is exactly equal to 100%. From the CDF, we can readily compute the expected replacement rate, denoted by μ as well as its variance (σ^2), to be used as measures of expected pension income and the uncertainty associated with future income.

Evaluated at the sample averages of the probabilities responded to question 2, the CDF is shown in figure 1. The average probabilities imply an expected replacement rate of 71.3%, with a standard deviation of 30.1%, revealing substantial uncertainty over future income. I emphasize

[5] Dominitz and Manski (1997), Manski (2004) and De Bresser and van Soest (2013) instead fit a log-normal distribution to the probabilities to compute moments for each respondent. I prefer the nonparametric approach used here, as the distributional assumption is not testable. Moreover, the least-squares fit can be severely biased for certain answer sequences, such as a high response to question 2a, or fails to converge, such as a 50% probability response to each question 2a-2g. Nonetheless, the correlation between the expected replacement rate (standard deviation) from the parametric vs. nonparametric approach is 91% (74%), and hence the results are robust.

that the CDF, and hence the variables μ and σ^2 can be computed for *each* observation in the data, which are used to estimate the savings equation.

Figure 1: Average cumulative distribution function



The determinants of the expected value and standard deviation of the replacement rate have been investigated in Van Santen et al. (2012), who show that the expected benefit is U-shaped in age with a minimum at 48, while uncertainty is inverted U-shaped with age with maximum at age 36. Educational attainment depresses the expectation, and increases uncertainty. The uncertainty is highest in the years 2008-2011, compared to 2006 and 2007, possibly due to the financial crisis. Similarly, the expected replacement rate was lower in these years.[6]

[6]De Bresser and van Soest (2013) also report the determinants of the expectations, with an emphasis on identifying response patterns to these type of questions (such as rounding, focal points and non-response).

4 Model

To guide the empirical analysis, I construct a simple model of a lifecycle consumer which allows for a precautionary savings motive, in the spirit of Leland (1968). I consider a two-period model with uncertainty over income in the second period, interpreted as retirement. The per-period utility function is of the Constant Absolute Risk Aversion (CARA) type, and future income is a normally distributed variable with expected value μ and variance σ^2, following Cantor (1985) and Caballero (1990, 1991). To keep the model as simple as possible, labour income, y as well as the retirement date and terminal date are assumed to be exogenous. Moreover, the interest rate and the rate of time preference are set to zero.

The problem the currently young individual faces is to maximize lifecycle utility subject to the consolidated lifetime budget constraint; formally,

$$\max_{c_t, c_{t+1}} -\frac{1}{\alpha}\exp\left[-\alpha c_t\right] - \frac{1}{\alpha}E_t \exp\left[-\alpha c_{t+1}\right] \tag{2a}$$

$$\text{s.t. } c_t + c_{t+1} = A_{t-1} + y_t + y_{t+1} \tag{2b}$$

where c_τ is consumption in period τ, A_{t-1} is predetermined wealth and E_t is the expectation operator conditional on information available in period t. In this setup, the consumption function is easily shown to be given by

$$c_t = \frac{1}{2}\left(A_{t-1} + y_t + \mu\right) - \frac{1}{4}\alpha\sigma^2 \tag{3}$$

The first term denotes the familiar expected present value of future income streams (or permanent income). Without uncertainty, consumption would be equal to permanent income. With uncertainty over retirement income, consumption is adjusted downwards due to risk-aversion.

As the data does not contain expenditures, but does report annual savings, the equation taken to the data reads

$$s_t = \frac{1}{2}\left(y_t - A_{t-1} - \mu\right) + \frac{1}{4}\alpha\sigma^2 \tag{4}$$

Equation 4 yields two hypothesis to be tested: savings should increase with uncertainty over pension income, and decrease with the expectation of retirement income.

4.1 Identification strategy

The empirical counterpart to equation 4 can be written as

$$s_i = \boldsymbol{x}_i' \boldsymbol{\beta} + \gamma_1 \mu_i + \gamma_2 \sigma_i^2 + u_i \tag{5}$$

where we expect $\gamma_1 = -1/2 < 0$ and $\gamma_2 = \alpha/4 > 0$. The vector $\boldsymbol{x}_i$ contains last-period wealth A_{it-1}, household income y_{it}, age and control variables. The control variables will capture other factors explaining household savings[7], most notably, health status and subjective survival probabilities (to capture saving for future medical expenditures or longevity risk); bequest motives, planning horizon and risk aversion (to capture preference heterogeneity); household composition; education; and home ownership. Moreover, I control for income risk, by computing the variances of permanent and transitory shocks, respectively (Carroll and Samwick, 1997). The appendix contains definitions and an elaboration on the income risk measures. Finally, we add year fixed effects to control for common factors, and hence exploit cross-sectional variation.

Given a random sample, we can estimate the population parameters of interest γ_1, γ_2 consistently by OLS as long as the error term, u, is orthogonal to the explanatory variables. There are at least three reasons why OLS may lead to inconsistent estimates: unobserved heterogeneity, reverse causality and sample selection.

First, the presence of unobserved heterogeneity (such as a "taste for saving") could bias the estimates. A natural story here could be that savers accumulate wealth in all forms, including pensions; alternatively, savers sort into jobs with generous pension entitlements. Taste for saving makes it difficult to identify the effect of pensions on savings separately from preferences. Second, pension benefit expectations may be optimistic because of large private savings (reverse causality).[8]

Third, the sample from which consistent answers to probabilistic questions are obtained, i.e. probabilities satisfying the law of total probability and monotonicity of the cumulative distribution function, is a selected sample. For the question at hand, the law of total probability is violated

[7]Unless indicated otherwise, all variables refer to the household head.

[8]Note that , for reverse causality to be a concern, it must be that the individual does not interpret the questions literally, as expectations refer to public and occupational pensions only, whereas saving refers to discretionary private savings.

if the sum of answers to questions 2a and 2b exceeds 100%. Monotonicity is violated if, for instance, the answer to 2b is strictly less than the answer to 2c.[9] As shown in Van Santen et al. (2012) using the same data as used here, the endogenous sample selection from removing inconsistent answers to the probabilistic survey questions, biases the results toward more pessimistic expectations and excess uncertainty in the replacement rate.

To identify the effects of interest, I use an instrumental variables estimator, corrected for non-random sample selection. In the IV approach, I will use instruments for both μ_i and σ_i^2 to estimate the parameters of interest γ_1 and γ_2 in equation 5. The instruments are derived from the performance of the respondent's pension fund. As explained in section 2, pension fund participation is mandatory for employees, and the choice of pension fund is fully determined by the employer. Moreover, most pension funds cover many or all firms in a particular sector.[10] In particular, employees can not change pension fund within a given employment spell, if, say, the pension fund's performance deteriorates.

One way to assess the performance of the pension fund is given by the funding ratio, equal to the ratio between the market value of assets and the pensions to be paid in the future (i.e. the discounted market value of liabilities). The regulatory framework specifies a minimum funding ratio of 105%. Whenever assets fall short of 105% of liabilities, funds must submit a recovery plan to the regulator (the Dutch Central Bank) detailing how the fund plans to return to the minimum funding ratio of 105%. To restore solvency, the pension fund can increase their premium (paid by employer's and/or employees), forego inflation adjustments and/or cut (nominal) pension rights. For example, in 2013, 68 pension funds out of 415 had to cut (nominal) pension rights of 2 million employees, by on average 1.9%; 19 of them cut entitlements by 7%. As another example of recently taken actions, the largest Dutch pension fund, ABP, covering around 2.8 million employees, has increased existing pension claims by 0.28% over the period 2009-2011, while inflation was 4.8% over the same

[9]Unlike the Survey of Economic Expectations data used in, for instance, Dominitz and Manski (1997), the survey design for eliciting the probabilities did not ask respondents to correct their answers when monotonicity of the CDF or adding up was violated. Respondents are free to choose any number between 0 and 100 (inclusive) for a given probability.

[10]88% of employees in 2010 were covered by a sectoral or professional pension fund.

period. These actions are responses to low returns on assets and the low interest rate used for discounting future pension payments, following the financial crisis.

The survey data allows us to match the respondent to a pension fund. In total, we are able to match 106 pension funds to the respondents.[11] For each matched pension fund, we obtained quarterly data on the funding ratio from the Federation of the Dutch Pension Funds (the interest association of many pension funds). For the instruments, we construct 1) the level of the funding ratio, and 2) the change in the funding ratio over the last 4 quarters. Variation in these instruments stems from (cross-sectional) variation in pension fund performance, depending on which pension fund covers the respondent's current job.

Although the performance of the pension fund is exogenous to the employee within an employment spell, one could still argue that sorting across sectors based on pension fund performance may invalidate this instrument. We believe this to be of minor importance, however. Most labor flows occur within narrowly defined industries (Davis et al., 1998), while most pension funds cover many or all firms within such an industry. Moreover, with low vacancy levels after the recession, switching jobs only based on the performance of the pension fund, is unlikely.[12] Finally, Engelhardt and Kumar (2011) find no evidence of the sorting hypothesis to invalidate the results in studying the effect of pensions on private wealth accumulation in the US.

More important is the notion that the pension fund performance measures are invalid as instruments whenever it has a direct influence on household savings, violating the exclusion restriction for IV's. This is particularly problematic whenever worse performance leads the pension fund to increase the pension premium, resulting in a net decrease of disposable income from labor. Controlling for labour income and a measure of labour income risk, as I do throughout, is unlikely to solve this issue

[11] The survey question asks respondents to choose one of 32 listed pension funds they invest in, or else to write down the name of their pension fund as an open question. We obtained the answers to the open question to identify an additional 74 pension funds.

[12] Even if persons switched based on (past or current) pension fund performance, there are no guarantees that performance of the pension fund of the new job is still better in the next quarter. In other words, individuals will have imprecise control over fund performance.

in full. Fortunately, the DHS includes a direct question on changes in the pension premium during the last year. In the analysis, I exclude all households that report a change in the pension premium during the last year.[13]

Figure 2: Replacement rate moments and the instruments

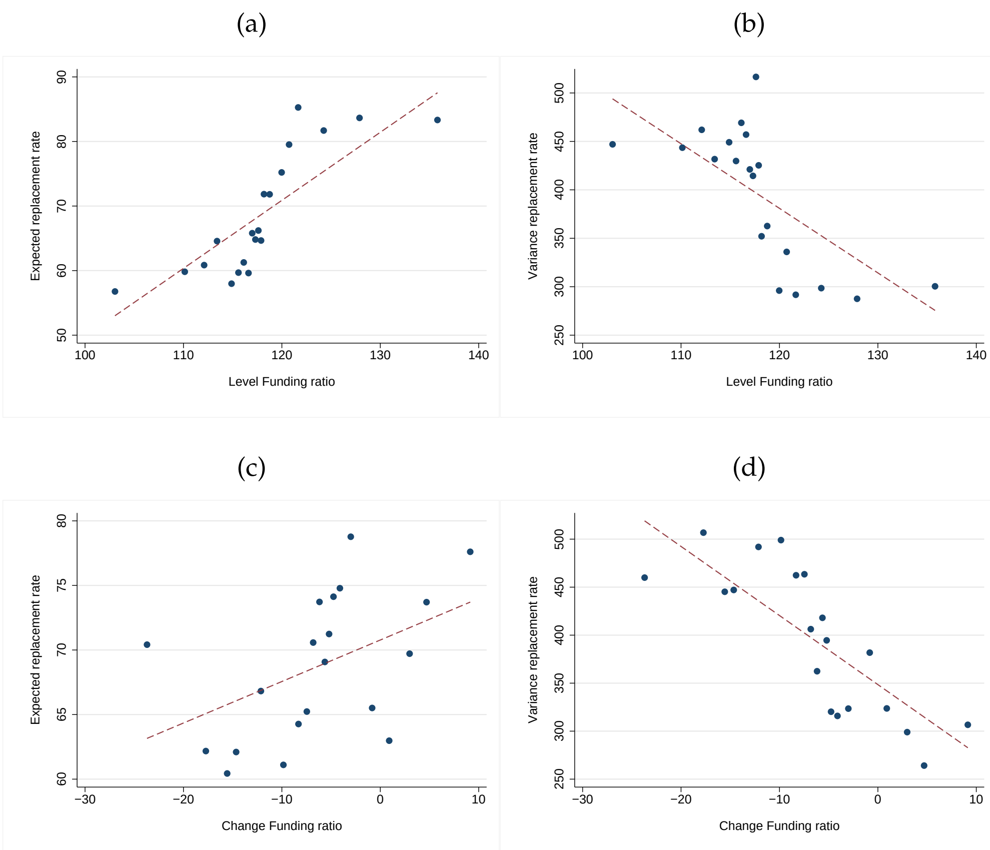


Figure 2 shows binned scatter plots depicting the relationships between the moments of the replacement rate distribution and pension fund performance. The expected replacement rate is positively correlated with both the level and trend of the pension fund funding ratio. The variance of the replacement rate correlates negatively with either instrument. These

[13]13 pension funds (8.7% of the sample) are removed due to changing premia.

results confirm the intuition that pension fund performance matters in forming expectations on future retirement benefits. The formal F-test for significance of the instruments shows that the instruments have sufficient explanatory power (see table 2).

4.2 Econometric model

The econometric model is a standard two-stage least-squares estimator with a Heckman (1979)-correction for the first-stage regressions. Formally, let d_i denote an indicator variable equal to 1 if the answer sequence to questions 2a-g satisfies the adding up and monotonicity requirements of a CDF (i.e. $d_i = 1$ if μ_i and σ_i^2 are computable from the CDF), let $\boldsymbol{w}_i$ denote a (vector of) observables explaining the selection process (exclusion restrictions), and let $\boldsymbol{m}_i$ denote a vector of instruments. The model used to estimate equation 5 can then be written as

$$P(d_i = 1|\boldsymbol{x}_i, \boldsymbol{m}_i, \boldsymbol{w}_i) = \Phi(\boldsymbol{x}_i'\boldsymbol{\beta}_d + \boldsymbol{m}_i'\boldsymbol{\theta}_d + \boldsymbol{w}_i'\boldsymbol{\kappa}) \tag{6a}$$

$$\mu_i = \boldsymbol{x}_i'\boldsymbol{\beta}_\mu + \boldsymbol{m}_i'\boldsymbol{\theta}_\mu + \alpha_\mu\hat{\lambda}_i + \eta_i \tag{6b}$$

$$\sigma_i^2 = \boldsymbol{x}_i'\boldsymbol{\beta}_\sigma + \boldsymbol{m}_i'\boldsymbol{\theta}_\sigma + \alpha_\sigma\hat{\lambda}_i + \epsilon_i \tag{6c}$$

$$s_i = \boldsymbol{x}_i'\boldsymbol{\beta} + \gamma_1\hat{\mu}_i + \gamma_2\hat{\sigma}_i^2 + u_i \tag{6d}$$

The equation of interest is the savings equation, 6d, where the variables μ and σ^2 have been replaced by fitted values from the respective first-stage equations, 6b and 6c. Absent $\hat{\lambda}$, equations 6b-6d define a standard 2SLS estimator. In addition, the first-stage relationships are corrected for non-random sample selection using the Heckman (1979) two-step approach. The selection-correction term, $\hat{\lambda}$, equals the Mill's ratio using the fitted values from the Probit regression in 6a. Standard errors in the savings equation are based on a bootstrap procedure, estimating each equation per replication, and drawing bootstrap samples of pension funds, to allow for correlation within pension funds.

As discussed, the instruments contained in $\boldsymbol{m}$ consist of the level of the pension fund's funding ratio, as well as the 4-quarter change in the funding ratio. To identify the selection model, we need excluding variables, $\boldsymbol{w}$, that appear only in the selection equation but not in the outcome equation. Our exclusion restrictions are the same as used in Van Santen et al. (2012), and are based on answering patterns to other probabilistic survey questions on income growth. The dummy variables Income adding-up error, Income probability error and Inflation probability error are all equal to 1 if the respondent's answer to probabilistic question on next-year income growth and expected inflation do not satisfy the law of total probability or monotonicity of the CDF. The appendix contains the exact wording of these questions.

5 Results

Table 2 shows the results of estimating the saving equation, using the 0–7 scale (columns 1,2), the midpoints (column 3) as well as the saving rate (column 4), dividing the midpoint by income (see Table 1).

Table 2: Baseline results

	Dependent variable: Annual Saving				
	(1)	(2)	(3)	(4)	(5)
	Scale 0-7	Scale 0-7	Midpoint (€)	Rate (%)	Rate (%)
	OLS	IV	IV	IV	IV, "Q"-adjusted
Expected replacement rate	-0.0015*	-0.014**	-125.15***	-0.275**	-0.317**
	(0.0008)	(0.007)	(41.53)	(0.106)	(0.126)
Variance replacement rate	-0.000034	0.0018***	13.98***	0.032***	0.040***
	(0.000069)	(0.00068)	(4.06)	(0.011)	(0.014)
Observations	2128	3196	3196	3196	3196
Pension funds	95	106	106	106	106
F-statistic exclusion restrictions		30.3	30.3	30.3	26.4
F-statistic instruments (μ)		23.4	23.4	23.4	27.2
F-statistic instruments (σ^2)		23.3	23.3	23.3	21.8

Control variables included: sector- and year fixed effects, age and its square, education, income, lagged wealth, gender, household composition, health, measures of risk aversion and planning horizon, bequest probabilities as well as the variances of permanent and transitory income shocks, computed as in Carroll and Samwick (1997).

Block-bootstrap (by pension fund) standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

OLS estimates in column 1, which do not correct for selection into correct answering or endogeneity of the variables of interest, show a small, significant negative impact of the expected replacement rate on private saving. Uncertainty on the other hand enters insignificantly.

The IV estimates in column 2 yield the expected signs of the coefficients: saving increases when uncertainty increases, and when expected pension income decreases. The magnitudes imply that a one standard deviation (approximately 10 percentage points) increase in the expected replacement rate causes a 7.9% decrease in annual saving. Similarly, a one standard deviation (or 110 unit) increase in the variance of the replacement rate increases saving by 12.3%. The F-statistics of 23 show that the pension fund performance measures have a significant impact on the moments of the replacement rate distribution.

In column 3, the dependent variable is the amount of annual saving, given by the midpoint of the range in Table 1. Here, a 1 S.D. increase in expected benefits reduces saving by around €1200; a 1 S.D. increase in the variance increases saving by around €1500.

Column 4 divides the midpoint of saving by income. This saving rate declines (increases) by 2.66 (3.62) percentage points for a 1 S.D. increase in the expected (variance) replacement rate.

Column 5 uses the saving rate as well, and in addition multiplies the replacement rate variables by Gale (1998)'s "Q"-variable, i.e. the age-related adjustment factor to correct for differences in years until retirement.[14] The advantage of doing so is that the coefficient on the expected replacement rate is a direct estimate of the displacement effect. An additional cent in expected pension wealth crowds out private wealth by 31.7 cents.

Table 3 shows the IV estimates, with different measures of expected benefits and uncertainty. Specifically, I use the median and support of the replacement rate distribution, respectively. The support is computed as the largest replacement rate with positive probability mass, minus the smallest rate with positive mass.

Across each saving measure, the median replacement rate decreases

[14] In the simple 2-period model presented in section 4, this factor equals 1/2. In an N-period model with CARA utility and non-zero real interest rate, this factor becomes $\sum_{\tau=K}^{N} R^{t-\tau} / \sum_{\tau=t}^{N} R^{t-\tau}$, where $R = 1 + r$ is the interest factor, t is the respondent's age, K is the retirement age and N the terminal period. I compute this adjustment using K from question 1, $N = 100$ and $r = 3\%$.

savings, while a larger support of the distribution increases saving. Hence, the results are robust with respect to the precise measure of expected pension benefits and uncertainty used.

Table 3: Robustness checks

Dependent variable: Annual Saving			
	(1)	(2)	(3)
	Scale 0-7	Midpoint (€)	Rate (%)
	IV	IV	IV
Median replacement rate	-0.031**	-265.59***	-0.621***
	(0.014)	(81.23)	(0.229)
Support replacement rate	0.026***	203.69***	0.493***
	(0.010)	(59.61)	(0.171)
Observations	3196	3196	3196
Pension funds	106	106	106
F-statistic exclusion restrictions	30.3	30.3	30.3
F-statistic instruments (μ)	22.9	22.9	22.9
F-statistic instruments (σ^2)	23.7	23.7	23.7

Control variables included: sector- and year fixed effects, age and its square, education, income, lagged wealth, gender, household composition, health, measures of risk aversion and planning horizon, bequest probabilities as well as the variances of permanent and transitory income shocks, computed as in Carroll and Samwick (1997).

Block-bootstrap (by pension fund) standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

5.1 Heterogeneity

The model in section 4 yields a specification linear in the expected replacement rate and its variance. With CRRA utility, instead of CARA, this linearity would no longer hold. In particular, one would expect wealth to impact on the decision how much to save, as a function of expectations: high-wealth respondents should attribute less weight to uncertainty in future income (Carroll and Kimball, 2001), and less weight to expected future income. Furthermore, even under CARA preferences, one would expect respondent age and risk aversion to matter for the relationships of interest.

Figure 3: Heterogeneous impacts

(a) Expected replacement rate

(b) Variance replacement rate

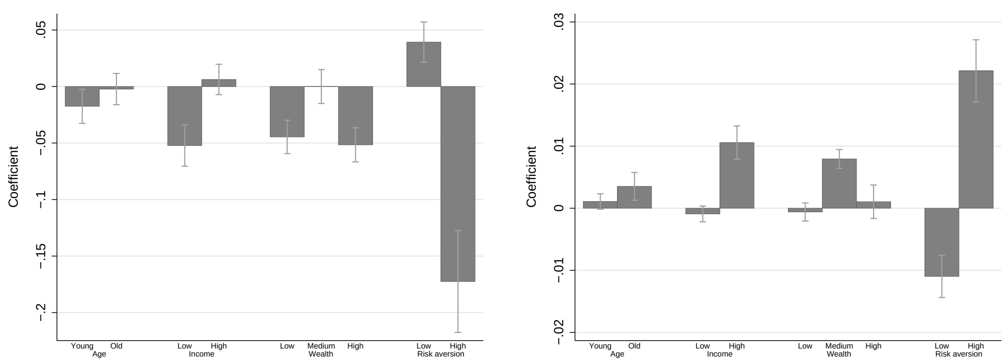


Figure 3 shows the coefficients and 95% confidence intervals, interacting the moments of the replacement rate distribution with 1) a dummy for being aged below 50, 2) a dummy having below-median income, 3) dummies for having low (below-median) or high (top quartile) wealth, and 4) a dummy for being risk averse.[15][16]

I find no significant difference between younger and older respondents in the marginal effect of expected benefits or its uncertainty on saving. As

[15]To estimate these models, I expand the instrument set by interacting the original instruments (level and trend of the funding ratio) with the dummies depicting the heterogeneity. Hence, for age, there are four first-stage regressions (two for the expected replacement rate (1 baseline and 1 interacted with the young age dummy) and 2 for the variance), and four instruments. For wealth, there are six first-stage regressions and six instruments. In all cases, the F-statistic exceeds 10, with a minimum of 12.59.

[16]For easier reading, I present the coefficient for the younger half of the sample by adding the baseline and interaction effects, and similarly for the other variables.

expected, uncertainty significantly increases saving for those closer to retirement. Low-income respondents react stronger to changes in the expected replacement rate, while high-income respondents save more if uncertainty increases.

Wealth differences have a non-linear impact: both low-wealth and high-wealth individuals react strongly to changes in the expected replacement rate, but not at all to uncertainty; the opposite is true for the middle class. For high wealth respondents, these results are in line with what a CRRA utility function would predict, where cash on hand essentially offsets uncertainty, leaving only the permanent income effect at work. In addition, low-wealth individuals should, under CRRA utility, be most affected by expected pension income, as Figure 3a suggests. However, the non-monotonicity in the responses to expected income and uncertainty are at odds with CRRA (or more general) utility functions. Finally, risk aversion has a major impact on the estimated coefficients: those stating to be risk averse strongly react to pension income expectations in line with what theory predicts. Surprisingly, the less risk averse group seems to behave opposite to predictions.

5.2 Bias in estimates ignoring uncertainty

How does the displacement effect change when ignoring uncertainty? The empirical literature thus far has almost exclusively omitted uncertainty from the empirical specifications for wealth or saving. Table 4 shows that the estimated displacement effect is biased towards zero when omitting this significant variable. In fact, none of the estimated coefficients are significantly different from zero once uncertainty is left out of the model. This feature is in line with the (ad-hoc) explanation in many studies that uncertainty can cause deviations from full (100%) crowd-out as a theoretical benchmark.

Ignoring uncertainty in addition allows me to test the overidentifying restrictions when using two instruments and one endogenous covariate. The bottom row of table 4 shows that the null of exogenous instruments cannot be rejected across each dependent variable.

Table 4: Estimates ignoring uncertainty

Dependent variable: Annual Saving				
	(1)	(2)	(3)	(4)
	Scale 0-7	Midpoint (€)	Rate (%)	Rate (%)
	IV	IV	IV	IV, "Q"-adjusted
Expected replacement rate	0.0007	-11.11	-0.010	-0.011
	(0.003)	(17.78)	(0.035)	(0.041)
Observations	3196	3196	3196	3196
Pension funds	106	106	106	106
F-statistic exclusion restrictions	30.3	30.3	30.3	26.4
F-statistic instruments (μ)	23.4	23.4	23.4	27.2
p-value over-identifying restrictions	0.86	0.30	0.75	0.75

Control variables included: sector- and year fixed effects, age and its square, education, income, lagged wealth, gender, household composition, health, measures of risk aversion and planning horizon, bequest probabilities as well as the variances of permanent and transitory income shocks, computed as in Carroll and Samwick (1997).

Block-bootstrap (by pension fund) standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

6 Conclusion

This paper quantifies the effect of uncertainty over future pension benefits on household saving. The retirement income replacement rate has been elicited probabilistically from a representative sample of Dutch employees. These subjective expectations allow the computation of both the expected replacement rate as well as its variance, both of which vary across individuals and time periods. Instrumental variable estimates, exploiting variation in pension fund performance, show that uncertainty significantly increases household saving. The displacement effect, i.e. the decrease in private saving following a dollar increase in pension benefits, is estimated to be 32 cents. This estimate drops to an insignificant 1 cent when not controlling for uncertainty.

The results in this paper highlight the role of uncertainty when making consumption and saving decisions. Some of this uncertainty is hard to resolve, for instance over future career paths, which impact on earnings and hence retirement wealth accumulation. However, policy risk, i.e. the uncertainty over future reforms of pension systems, is manageable, and should be minimized if saving rates are deemed to high, for instance in recessions.

This paper shows that the certainty equivalence equation typically estimated likely suffers from omitted variable biases in estimating the displacement effect. Future work can extend the typical saving (or wealth) equations estimated in this literature even more, for instance by using subjective expectations over health and medical expenditures or future labour income.

A Data appendix: DNB Household survey

The DNB household survey (DHS), formerly known as the VSB-CentER Savings Study, is a yearly survey that started in 1993 and covers about 2000 Dutch households representative of the population. Respondents answer questions on a broad range of topics, including household income, assets and liabilities, health, and economic and psychological concepts. We use the waves of 2006-2011, for which pension benefit expectations are available through the supplementary Pension Barometer modules.

A.1 Dependent variable: annual savings

From the DHS, we construct our dependent variable, private savings, as well as control variables. Private savings are obtained from two survey questions on money put aside over the last year:

Question 3 *Did your household put any money aside IN THE PAST 12 MONTHS?*

Question 4 *About how much money has your household put aside IN THE PAST 12 MONTHS?*

1 *less than € 1,500*

2 *between € 1,500 and € 5,000*

3 *between € 5,000 and € 12,500*

4 *between € 12,500 and € 20,000*

5 *between € 20,000 and € 37,500*

6 *between € 37,500 and € 75,000*

7 *€ 75,000 or more*

8 *Don't know*

The dependent variable Saving is categorical, and takes on the same values as stated in question 4 (on a scale of 0-7), where 0 is imputed for respondents answering "No" to question 3. Where possible, for those answering "Don't know" to question 4 as well as missing observations, the dependent variable is imputed using the change in financial wealth between $t-1$ and t, using the same cutoff values as in question 4; otherwise these observations are excluded from the analysis.[17] Financial wealth is defined as the sum of bank and saving accounts, stocks and bonds. In addition to the categorical variable, we use the midpoint of the interval, as well as the midpoint divided by income.

Most control variables used are standard: household income, age, gender, education, family composition (presence of partner and/or children), home ownership, beginning-of-period financial wealth, self-reported health status and the (self-assessed) probability of survival up to age 75 (of the head of the household). I also construct variables capturing preference heterogeneity: bequest motives, planning horizon and risk aversion. The bequest motive is captured by the (self-reported) probability of leaving a bequest. Planning horizon is a dummy variable equal to 1 if the respondent identifies a period of 5 years or longer as the most important horizon for making consumption or savings decisions. Risk aversion is a dummy variable equal to 1 if the respondent agrees with the statement that "it is more important to invest safely and get a guaranteed return than to take risks hoping for a higher return".

A.2 Exclusion restrictions

To identify the selection model, exclusion restrictions are placed on three variables that capture answering probabilistic survey questions inconsistently. The same variables as used here are also used by Van Santen et al. (2012).

Question 5 *What is the probability that the purchasing power of your total household income, in one year from now, will be* higher / lower *than it is now?*

Respondents provide two probabilities, one for the higher expected income and one for the lower. We construct the variable *Expected income*

[17] An alternative would be to use the change in financial wealth as a direct measure of private savings; the disadvantage of using this measure is that wealth is typically measured with error, which gets exacerbated when taking first differences. Moreover, due to panel attrition, the sample size is bigger using the direct survey questions on money put aside. For the subset of observations where we have both the direct savings measure as well as the change in financial wealth, the correlation between the direct survey questions and the similarly discretized change in financial wealth equals 0.35.

adding-up error, which is equal to one if these probabilities sum up to more than 100%, and zero otherwise.

The next question first elicits the minimum and maximum expected household incomes, after which a series of four follow-up questions are posed based on those answers:

Question 6 *What do you think is the probability that the total net yearly income of your household will be less than* €$[LOWEST + (HIGHEST - LOWEST) * \{0.2/0.4/0.6/0.8\}]$ *in the next 12 months?*

In words, respondents are asked the probability that their net household yearly income will be less than 20% above their lowest expected income, and similarly for 40%, 60%, and 80% above. Note that the survey software computes the nominal amounts, which is what respondents see on the screen when answering the four questions. The four probabilities answered should be increasing with the threshold level (less than 20% above the lowest expected income implies less than 40% above the lowest expected income), and we construct the variable *Expected income probability error*, which is equal to one if this monotonicity is violated, and zero otherwise. The final question has a setup similar to that of question 6 but concerns expected inflation, for which we construct the variable *Inflation probability error*, which is equal to one if monotonicity is violated, and zero otherwise.

A.3 Labour income risk

To construct a measure of labour income risk, I use the full panel of the DHS data (i.e. 1993-2013) to estimate a model for household income, and compute the household-level variance of the income growth innovation, following Carroll and Samwick (1997). Specifically, the income process is taken from Cocco et al. (2005):

$$\ln y_{it} = \alpha_i + \boldsymbol{z}_{it}'\boldsymbol{\beta} + \zeta_{it} \tag{7}$$

where y denotes household income, $\boldsymbol{z}$ are predictors and α is a household fixed effect. The error term ζ can be decomposed in a permanent and transitory component: $\zeta_{it} = \nu_{it} + \varepsilon_{it}$. The permanent component follows

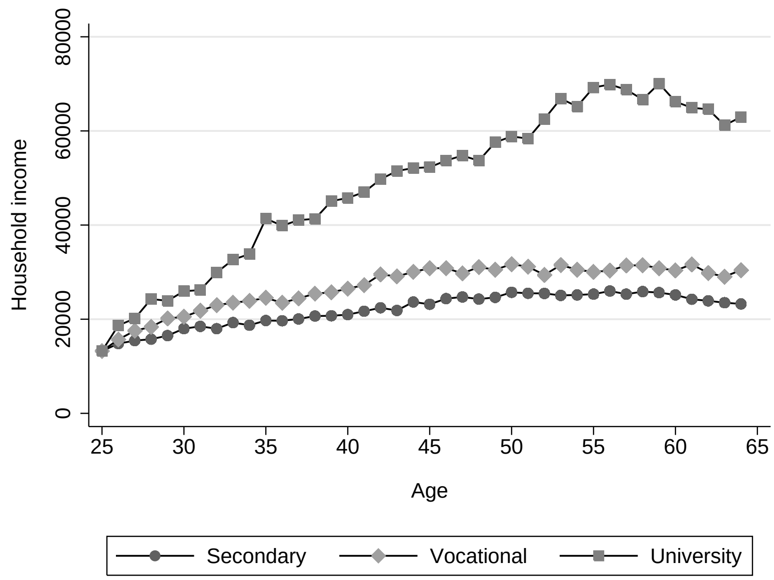


Figure A1: Age-Income profiles

a random walk: $\nu_{it} = \nu_{it-1} + \xi_{it}$ where $\xi_{it} \sim N(0, \sigma_{\xi}^2)$ is a shock to permanent income. The idiosyncratic temporary shock ε_{it} is distributed as $N(0, \sigma_{\varepsilon}^2)$, and independent of ξ_{it} at all ages.

As predictor variables $\boldsymbol{z}$, I use education-specific age dummies and household size. Income is deflated using the CPI. The estimated age-income profiles are shown in figure A1.

To estimate the variances of permanent and transitory income shocks, I follow Carroll and Samwick (1997) by first computing the income growth innovation, i.e. $r_{id} = \ln(y_{it}/y_{it-d}) - (z_{it} - z_{it-d})'\hat{\boldsymbol{\beta}}$. The sample variance of this innovation of length d is then given by

$$Var(r_{id}) = d\sigma_{i,\xi}^2 + 2\sigma_{i,\varepsilon}^2 \tag{8}$$

Estimates of $\sigma_{i,\xi}^2$ and $\sigma_{i,\varepsilon}^2$ are easily obtained by regressing, household-by-household, r_{id}^2 on d and a vector of 2's. As my panel is unbalanced, I use the longest possible time series for each household, with a minimum of two income growth differences.

A.4 Summary statistics

Table AI: Summary statistics

Variable	Mean	Median	SD
Control variables			
Income (€)	35,739	31,377	20,053
Financial wealth (€)	36,123	12,500	71,811
Age	46	47	10
Male (%)	60	100	49
Partner (%)	76	100	43
Children (%)	47	0	50
High school or less (%)	56	100	50
Homeowner (%)	77	100	42
Good health (%)	84	100	36
>5 years planning horizon (%)	16	0	37
Risk averse (%)	60	100	49
Prob survival to age 75 (%)	70	70	17
Prob leave bequest (%)	71	90	34
Variance permanent income shocks	0.74	0.73	0.08
Variance transitory income shocks	0.30	0.28	0.10
Gale's adjustment factor	0.84	0.83	0.09
Exclusion restrictions			
Expected income error (%)	12	0	33
Expected inflation error (%)	8	0	27
Expected income adding up error (%)	7	0	26
Instrumental variables			
Level funding ratio	119	110	18
Change funding ratio	-6	-2	19
Dependent variables			
Saving (0-7)	2	2	1
Amount saving (€)	4895	3250	9037
Saving rate (%)	14	8	26
Replacement rate variables			
Expected replacement rate	69	66	10
Median replacement rate	69	66	10
Variance replacement rate	395	332	113
Standard deviation replacement rate	18	18	7
Support replacement rate	80	70	30

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