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Uncertain Pension Income and Household Saving

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Abstract

I study the relationship between household saving and pensions, and estimate both the displacement effect of pensions on private saving and the precautionary saving effect due to uncertainty in pension income. Using a lifecycle framework, the consumption function depends on expected pension benefits and pension risk. I estimate the savings equation implied by the model using survey data for Dutch households, with subjective expectations on pension benefits and uncertainty. Exploiting exogenous variation due to pension fund performance, I show that savings decrease significantly with expected pension income, and that households save more due to uncertainty in pension income.

Keywords: Precautionary saving, Displacement effect
JEL: D91, H55

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1. Introduction

The standard lifecycle model emphasizes the importance of saving during working life for consumption during retirement. A simple version of this model predicts that private saving decreases one-for-one with increases in pension wealth, that is, perfect displacement (or crowding out) of private savings by pension savings. The displacement effect is an important policy parameter to assess the welfare effects of changes in the pension system. In particular, less than perfect displacement would suggest that households save too little to smooth consumption over the lifecycle. This notion ignores precautionary saving motives to compensate possible adverse health or labor market outcomes. The aim of this paper is to allow for a precautionary saving motive stemming from uncertainty in pension benefits, and to estimate both the displacement effect as well as the precautionary effect using micro data.

Since the seminal article of Feldstein (1974), many studies have made attempts to estimate the displacement effect. Gale (1998) estimates the displacement effect of pensions on non-pension wealth to be 82.3% (39.3%) using least absolute deviations (robust) regressions. Engelhardt and Kumar (2011) and Alessie et al. (2011a) 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%. 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%. 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 offset 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 200% 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% for middle aged to 75% for nearly retired individuals regarding occupational pensions.

The contribution of this paper is to relax two restrictive assumptions made in aforementioned papers studying the effect of pensions on household saving. First, the regression equations in the papers above are based on either certainty or certainty equivalence. Yet, among others Skinner (1988), Zeldes (1989) and Caballero (1990, 1991) emphasize the importance of precautionary savings in aggregate savings. In this paper, I allow for a precautionary savings motive in the lifecycle model presented in Section 4, and argue that my data is suitable for estimating the effect of pension income uncertainty on private savings. Second, expectations are taken to be rational and static, meaning that the introduction of the social security system in Kapteyn et al. (2005) or the reform of the pension system in Attanasio and Rohwedder (2003) or Attanasio and Brugiavini (2003) comes as a surprise, that households perfectly understand the consequences of the change in the pension system and that the change is considered to be permanent and, therefore, immediately incorporated into household consumption and saving programs over the lifecycle. Instead, I have available expectations of the pension income replacement rate for several time periods in a panel of households. I do not have to make restrictive assumptions on the expectation formation process, nor assume static expectations.

A few other studies have also relaxed the assumption on static expectations by using subjective expectations data. Guiso et al. (1992) analyze precautionary savings against uncertain labor earnings, while Guiso et al. (1996) analyze portfolio choice in the presence of income risk. 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% 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. (2012, forthcoming) 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. (2012, forthcoming) by using a saving equation derived from a lifecycle model. 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.

I use data from the DNB Household Survey (DHS), an annual survey collecting panel data from the Netherlands, and the Pension Barometer, an annual survey presented to a subset of respondents from the DHS, which elicits 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). These questions allow for the calculation of the expected level of the retirement income replacement rate, as well as the variance of the replacement rate. I have subjective expectations data at my disposal for the period 2006-2011, and both the expected level of the replacement rate and its variance vary over time and over households.

To make progress on obtaining causal effects, I exploit exogenous variation in pension fund performance across respondents to estimate the baseline model. In The Netherlands, almost all employees are covered by an employer pension plan, administered by (usually sector-level) pension funds. Due to the financial crisis, pension fund performance has been rather weak, causing pension funds to have low funding ratios; 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 a large variation in this funding ratio. As expected, the expected pension benefit increases with the funding ratio, and the variance of pension income decreases with the funding ratio. I use the funding ratio as an instrument to estimate the savings equation, and find large effects of expected pension income on savings: A one standard deviation decrease in the expected replacement rate increases saving by approx. €3,260 or the saving rate by approx. 9%-points. Similarly, a one standard deviation increase in the variance of the replacement rate increases saving by approx. €6,860 or the saving rate by approx. 19%-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 10.8% to 5.3%, 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 downwards due to lack of measures of uncertainty, such as those I have available.

The paper is organized as follows. Section 2 briefly discusses the Dutch pension system. Section 4 presents the theoretical model, with derivations delegated to the appendix. Section 3 discusses the data and section 5 presents the results. Section 6 concludes.

2. Uncertainties in the Dutch pension system

The Dutch pension system consists of three pillars.[1] 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 50 years of living in The Netherlands. The second pillar, the occupational pensions, is mandatory for all employees if the employer offers a pension plan[2], 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 125% of Dutch GDP in investments in 2008. 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, and is a well known concept in the public debate regarding the Dutch 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. We can express this replacement rate in a simplified way[3] as $RR = (1/y_t) \cdot (\alpha \cdot K^{-1} \sum_{\tau=1}^{K} y_\tau + S_K)$, where y_t denotes current income, α the factor mapping career earnings to occupational pension benefits, $(1/K) \sum_{\tau=1}^{K} y_\tau$ denotes average career earnings when retiring at age K, and S_K social security benefits when retiring at age K.

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

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

[3] Here, we ignore potential effects of years lived abroad as well as the part of earnings (typically referred to as the franchise, roughly €14,000 per year) over which no pension rights are accrued.

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 after the subprime mortgage crisis in the US, followed by a global financial, economic and sovereign debt crisis, 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, including a reduction of nominal accrued pension rights, increasing the pension premium and/or not adjusting pension wealth to inflation. Hence, already under the implicitly risky DB contracts, income after retirement is not as certain as usually perceived.

Absent this uncertainty, the expected replacement rate, using the formula above, would simply equal $\mu \equiv E_t(RR) = RR$. However, a non-retired individual likely faces uncertainty on future career earnings, on the conversion factor α as well as on future social security benefits. If so, the expected replacement rate and its variance depends on expectations on all these factors, as well as covariances between them.[5] equals $\mu = (1/y_t) \cdot ()$, with variance $\sigma^2 \equiv Var_t(RR) = (1/y_t^2) \cdot ()$. The next section discuss the survey used to elicit these 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

[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.

[5]Using the same notation as in the text, it follows that $\mu = (1/y_t) \cdot \Big(K^{-1}\sum_{\tau=1}^{t} y_\tau \cdot E_t(\alpha) + E_t(K^{-1}\sum_{\tau=t+1}^{K} y_\tau) \cdot E_t(\alpha) + Cov(\alpha, K^{-1}\sum_{\tau=t+1}^{K} y_\tau) + E_t(S_K)\Big)$.

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. Details on the variables used in this study and summary statistics can be found in the Appendix.

3.1. Pension benefit expectations

The Pension Barometer survey is administered to a subset of respondents from the DHS. 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 from employees aged below the statutory retirement age of 65. 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 us to construct 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.[6] The observation-specific CDF equals

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

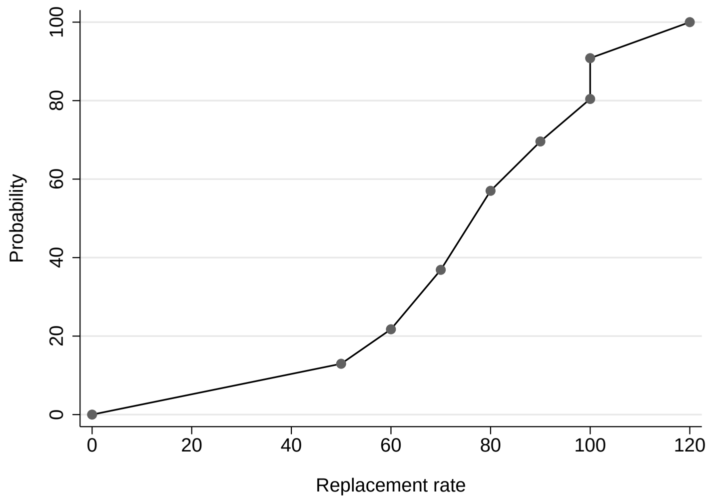
All the probabilities in 1 are known from the answers given by respondents. Writing the CDF as in 1 allows us to work with a continuous distribution function, with point mass at $RR = 100$, as the answers's to 2a and 2b might not add up to 100%, indicating that there is a positive probability associated to the event that the replacement rate is exactly equal to 100%. From the CDF, we can readily compute the expected replacement rate as well as its variance, to be used as measures of expected pension income and the uncertainty associated with future income (i.e. μ and σ^2 from the model in section 4).

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 74.5%, with a standard deviation of 25.3%, revealing substantial uncertainty over future income. I emphasize 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.

The determinants of the expected value and standard deviation of the replacement

[6] 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.

Figure 1: Average cumulative distribution function



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 was higher in 2008 and 2009, compared to 2006 and 2007, possibly due to the financial crisis. Similarly, the expected replacement rate was lower in these years.

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 we use 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. More-

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

over, we include a measure of (pre-retirement) income risk, constructed as the household-specific residual variance of income. The appendix contains definitions and an elaboration on the income risk measure. 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, measurement errors 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, response patterns to the subjective probability questions are typically characterized by rounding and focal points (50-50) (Bruine de Bruin et al., 2000; Manski and Molinari, 2010; De Bresser and van Soest, 2013; Kleinjans and Soest, 2014). In addition, the mean and variance of the subjective distribution, such as that shown in Figure 1, need to be inferred from a few observations on the shape of the CDF. Either of these could imply that the computed moments of the replacement rate distribution differ from the true moments. In other words, measurement errors can bias the estimated parameters.[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 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

[8] Of course, other control variables, such as income and wealth, may suffer from measurement errors as well when using survey data.

[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.

uncertainty in the replacement rate.

We use an instrumental variables estimator, corrected for non-random sample selection, to overcome these potential problems. In particular, we 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 first instrumental variable is a directly asked replacement rate from the DHS, i.e. measuring the same information content as μ but asked in a non-probabilistic way. Having two measures of the same underlying variable can help alleviate the measurement error problem.

The second instrument is 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 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 121 pension funds to the respondents.[11] For each matched pension fund,

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

[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 137 pension funds. Out of 169 pension funds, we are able to get performance data of 121 pension funds.

we obtained quarterly data on the funding ratio from the Federation of the Dutch Pension Funds (the interest association of many pension funds). We construct a dummy variable equal to 1 whenever the fund's funding ratio (averaged over the quarters in a given year) fell short of 105% (the regulated minimum). Variation in this instrument stems from (cross-sectional) variation in pension fund performance, depending on which pension fund the respondent invests in.

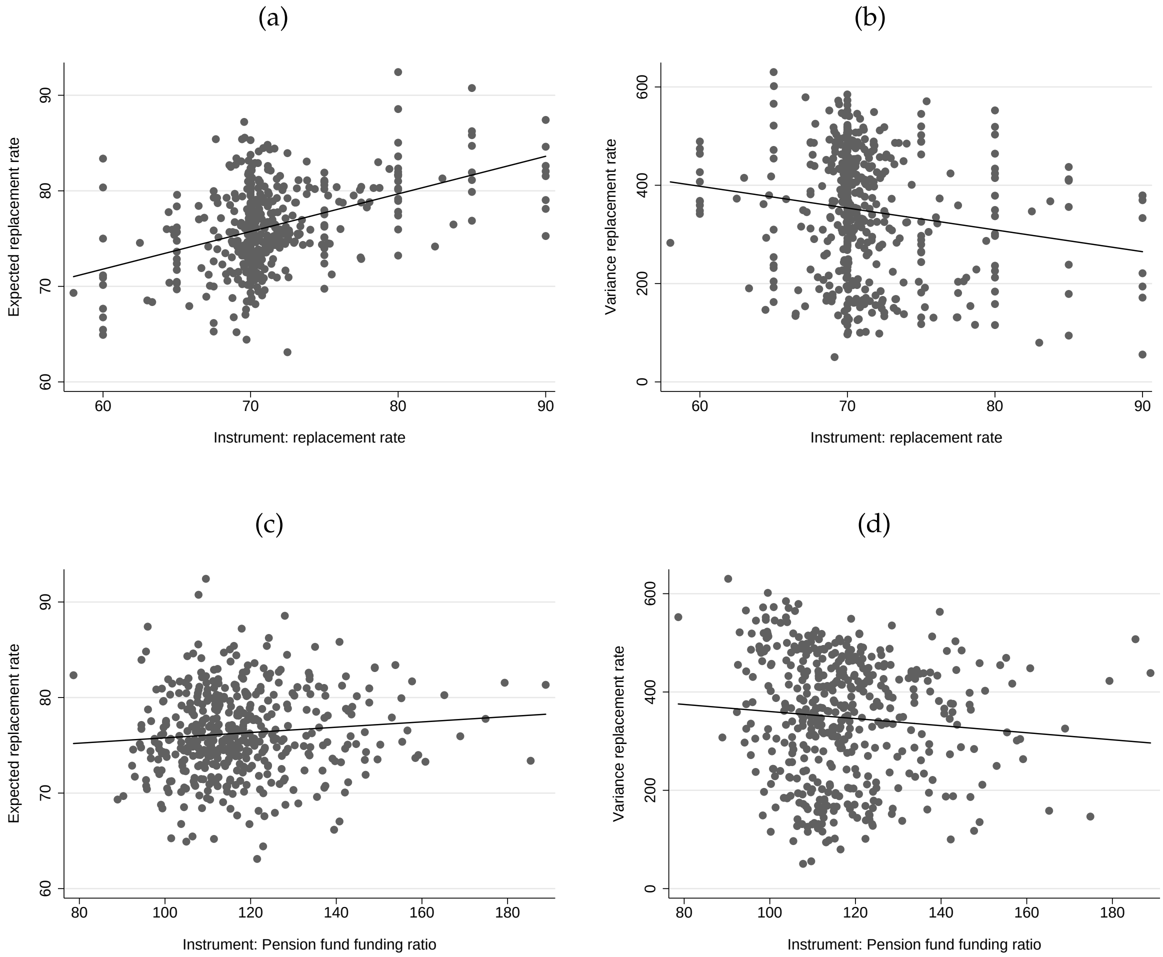
Although the performance of the pension fund is exogenous to the employee within an employment spell, one could still argue that sorting across sectors based on pension fund performance may invalidate this instrument. We believe this to be of minor importance, however. Most labor flows occur within narrowly defined industries (Davis et al., 1998). Moreover, with low vacancy after the recession, switching jobs only based on the performance of the pension fund, is unlikely. 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.

Figure 2 shows the first-stage relationships between the moments of the replacement rate distribution and the instruments, after collapsing the data by income quartile, age group and pension fund. The expected replacement rate is strongly positively correlated with both the directly-asked measure of the replacement rate and the pension fund funding ratio. The variance of the replacement rate correlates negatively with either instrument. These results confirm the intuition that pension fund performance matters in forming expectations on future retirement benefits.

4.2. Econometric model

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 observed), 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

Figure 2: Replacement rate moments and the instruments



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

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

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

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

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 expected replacement rate asked directly (rather than eliciting points on the CDF), as well as a dummy variable equal to 1 if the respondent's pension fund has a funding ration lower than 105, indicating. 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 1: Baseline results

	Selection	First stage μ	First stage σ^2	Saving
Expected replacement rate				-0.102**
				(0.049)
Variance replacement rate				0.008**
				(0.004)
Low educated	-0.344***	8.158***	-73.760***	-0.570***
	(0.050)	(0.858)	(15.800)	(0.208)
Log income	0.056	-3.574***	22.226	0.566***
	(0.056)	(0.842)	(16.508)	(0.140)
Partner	-0.069	1.128	3.484	0.065
	(0.066)	(0.906)	(16.993)	(0.123)
Children	0.061	0.824	-17.470	-0.411***
	(0.054)	(0.764)	(14.123)	(0.095)
Homeowner	-0.024	0.323	27.528	-0.173
	(0.064)	(0.952)	(18.212)	(0.176)
IH Financial wealth	0.001	-0.127	0.499	0.087***
	(0.006)	(0.097)	(1.925)	(0.014)
Age	0.036	-2.331***	23.690***	0.137**
	(0.024)	(0.353)	(6.496)	(0.058)
Age squared	-0.035	2.371***	-38.013***	-0.036
	(0.027)	(0.386)	(7.053)	(0.051)
Good health	0.181**	-0.125	39.962*	-0.179
	(0.074)	(1.194)	(22.674)	(0.183)
Survival probability	-0.045***	1.399***	-22.395***	0.040
	(0.014)	(0.196)	(3.781)	(0.029)
Long planning horizon	-0.057	-1.264	-9.877	0.571***
	(0.065)	(0.870)	(15.260)	(0.141)
Risk averse	0.177***	-2.395***	18.491	0.299***
	(0.049)	(0.785)	(14.551)	(0.115)
Bequest probability	0.004***	-0.081***	0.070	0.013***
	(0.001)	(0.013)	(0.256)	(0.005)
Labor income risk	-0.621***	7.307**	-126.609***	0.477
	(0.154)	(3.013)	(48.134)	(0.305)
Exclusion: Income probability error	-0.221***			
	(0.061)			
Exclusion: Inflation probability error	-0.144*			
	(0.073)			
Exclusion: Income adding-up error	-0.176***			
	(0.024)			
Instrument: replacement rate	-0.008*	0.510***	-4.027***	
	(0.004)	(0.059)	(1.092)	
Instrument: Funding ratio $<$ 105%	0.024	-1.976**	62.640***	
	(0.068)	(0.930)	(17.650)	
Mills ratio		-5.191***	42.162***	
		(0.641)	(5.655)	
Constant	-0.236	134.649***	62.029	-21.583***
	(0.809)	(11.664)	(232.511)	(8.018)
Observations	3317	2224	2224	3317
F-statistic exclusion restrictions	75.63			
F-statistic first stage		40.61	13.34	
R^2	0.071	0.116	0.138	0.230

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

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

Table 2: Results using different estimators

	OLS	IV	S-IV
Expected replacement rate	-0.001	-0.121**	-0.102**
	(0.009)	(0.070)	(0.049)
Variance replacement rate	0.004*	0.007**	0.008**
	(0.003)	(0.004)	(0.004)
Observations	2224	2224	3317
R-squared	0.233	0.160	0.230

Standard errors in parentheses

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

6. Conclusion

In this paper I show evidence of displacement of private savings by pension savings, as well as precautionary savings due to uncertain lifespan and uncertainty over pension income, for a sample of Dutch households. The estimated saving equation is based on a lifecycle model featuring rational individuals that work and consume or save before retirement; income after retirement income is uncertain from today's perspective, as is remaining life expectancy. I use the answers from subjective probabilistic survey questions to compute expected pension income and the standard deviation of pension income as a measure for uncertainty, as well as the subjective survival curve. Therefore, the subjective expectations vary between households, and within households over time. Quantile regression results show that, for the more affluent respondents, savings increase with the uncertainty in pension income and increase with longevity risk, as predicted by the theory. The displacement effect is significant for the higher quantiles as well, and shows that pensions crowd out private savings, especially for those that state to have a preference for saving for retirement. These results are robust to the inclusion of correlated random household effects, and are in line with the predictions from a version of the lifecycle model with liquidity constraints and retirement income uncertainty.

For policy purposes, the paper suggests that Dutch employees do prepare for retirement, as indicated by the expected sign for pension uncertainty and mortality risk. However, for the less affluent part of the sample, these effects are not found. Liquidity constraints may indeed be an explanation for this finding, although time-inconsistent preferences or financial illiteracy are likely to play a role as well, as argued by, amongst others, Alessie et al. (2011b) and Choi et al. (2011).

In future research, allowing for endogenous labor supply and retirement is the obvious next step, but the expectations data collected thus far are not sufficient at this moment. At the least, the subjective pension income expectations are shown to yield plausible results regarding saving behavior of the currently young population. Bigger samples and better ways to elicit expectations may increase the explanatory power of these subjective expectations.

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.

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.[12] Financial wealth is defined as the sum of bank and saving accounts, stocks and bonds.

Most control variables we use are standard: household income, age, gender, education, family composition (presence of partner and/or children), home ownership,

[12] 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.

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). We 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.

Exclusion restrictions

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 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. These four probabilities 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 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.

Data description control variables

Summary statistics table

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