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UNCERTAIN PENSION INCOME AND HOUSEHOLD SAVING*

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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 implied by a simple life-cycle 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 house holds 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.

JEL Codes: D91, H55, J26

Keywords: precautionary saving, displacement effect, subjective expectations

1. Introduction

The relationship between pensions and household savings is important in order 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 life-cycle 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 life-cycle model would predict. Departures from this 100 percent displacement effect are often rationalized by the existence of liquidity

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[1] The main contributions to this field are reviewed in Section 2.

constraints and various sources of uncertainty, which are absent in 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 life-cycle model where retirement income is a random variable, giving rise to a precautionary motive to save. The contribution of this paper is to estimate both the displacement effect of pensions on saving and the precautionary motive to save using micro-data.

It is intuitively appealing to view retirement income as a random variable, 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 depend on the entire earnings profile until retirement, requiring a forecast of earnings until retirement. Moreover, the exact benefit level for those purchasing an annuity at retirement will depend on 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 based on a pay-as-you-go system administered by the state, and defined-benefit (DB) occupational pensions 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 percent of earnings for an average earner (OECD, 2015) At the same time, population aging and low returns for pension funds have raised concerns about future generosity. Despite the calls for and discussions on reforms in the political arena, a lack of consensus has resulted in the (likely unsustainable) status quo, at least until the end of my sampling period. Given the uncertainty about future reforms, the estimation of 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 about the probabilities that the replacement rate of pension income will take various values. 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.

The estimation of a savings 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 (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 percent. These actions include increasing pension premia and forgoing inflation adjustment as well as, in the extreme, cutting nominal pension rights. Matching respondents to their pension funds, I show that, cross-sectionally, there is meaningful variation in this funding ratio to explain household retirement income expectations. Expected pension benefits increase 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 individuals not changing pension fund over time, to rule out sorting by fund performance, and excludes pension funds that change their pension premiums, to rule out direct impacts of fund performance on disposable income and, potentially, household savings.

I use the level and four-quarter change in the funding ratio as instruments to estimate the savings equation, and find significant effects of expected pension income on savings: an additional euro of pension wealth decreases private saving by 32 cents. A one standard deviation (SD) 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-SD 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, the saving rate would have dropped from 13.1 percent to 11.5 percent if uncertainty had been the same in 2011 as it was in 2007. Finally, I find 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 that 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 discusses the empirical strategy. Section 5 presents the results and Section 6 concludes.

1.1. *Related Literature*

Since the seminal paper 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 (39) 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 United States (U.S.) 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 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 12 cents.

Attanasio and Rohwedder (2003) and Attanasio and Brugiavini (2003) estimate a model for annual household saving, using pension reforms in the United Kingdom (U.K.) 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 two 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 U.K.'s basic state pension, and ranges from 55 cents for middle-aged to 75 cents for nearly retired individuals regarding occupational pensions.

Using administrative data from Denmark, Chetty *et al.* (2014) analyse total savings when persons switch to firms with higher pension contribution rates. The estimated displacement effect is around 20 cents, implying that job switches to firms with high contribution rates stimulate retirement savings. In contrast, retirement saving subsidies are unable to increase total savings, as most individuals are passive savers who 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 U.S. 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 defined-contribution (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) use panel data and 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 65 cents, using Italian pension reforms to identify this effect. The survey questions that these authors employ preclude the calculation of a measure of uncertainty.

Guiso *et al.* (2013) use similar probabilistic survey questions as employed in this paper to calculate individual-level expected replacement rates of pension income, as well as the SD as a 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 SD, in line with the life-cycle 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 expected (negative) sign.

This paper extends the analysis of Guiso *et al.* (2013) by estimating a saving equation derived from a life-cycle 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 €1,057 for singles and €1,470 for couples. The accrual rate equals 2 percent for every year lived in The Netherlands, implying maximum benefits after living in The Netherlands for 50 years. The second pillar, occupational pensions, is mandatory for all employees if the employer offers a pension plan,[3] and both employers and employees contribute to a DB pension fund. Traditionally, the Dutch occupational pension system is one of the most developed in the world, with pension funds holding around 150 percent of GDP in investments in 2013 (OECD, 2015). Finally, the third pillar concerns private pension savings, such as annuities or private retirement saving accounts. The third pillar is less popular in The Netherlands, as documented by Mastrogiacomo and Alessie (2011).

The replacement rate—that is, the ratio of pension benefits (summing up 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 average earnings during the career. The survey question used in this paper concerns future pension benefits relative 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 in the financial markets during the Great Financial Crisis, in addition to population aging in many developed economies, has led to reforms 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 DB to a DC system for occupational pensions, making explicit the dependence of pension benefits on asset returns.[4] In recent years, Dutch pension funds have taken various measures 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 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.

[2]For an overview of the Dutch pension system and its reforms, see Bovenberg and Gradus (2008).

[3]Around 90 percent 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 were implemented. In June 2011, unions and employer's federations published further details regarding the future reforms; for details, see Sichting van de Arbeid (2010, 2011).

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[5] and have unique identifiers 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 socioeconomic 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; for an extended description, see Alessie *et al.* (2002) and Teppa and Vis (2012). Appendix A (in the Online Supporting Information) 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, using 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. 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? ... %

[5]https://www.centerdata.nl/en.

TABLE 1
HOUSEHOLD SAVING

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

The probabilities answered by the respondent define seven points on the subjective cumulative distribution function of pension income. I assume a maximum replacement rate of 120 percent, and use linear interpolation between the thresholds to derive the complete distribution for each respondent in each survey year.[6] The observation-specific CDF is as follows:

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

All the probabilities in equation (1) are known from the answers given by respondents. Writing the CDF as in equation (1) yields a continuous distribution function, with point mass at $X = 100$, as the answers to questions 2(a) and 2(b) might not add up to 100 percent, leaving a positive probability associated to the event that pension income equals the current wage. 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.

The average distribution is shown in Figure 1. The average probabilities imply an expected replacement rate of 71.3 percent, with a SD of 30.1 percent, 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.

[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 non-parametric 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 probability given in question 2(a), or fails to converge, such as a 50 percent probability response to each question 2(a)–(g). Nonetheless, the correlation between the expected replacement rate (SD) from the parametric versus the non-parametric approach is 91 percent (74 percent), and hence the results are robust.

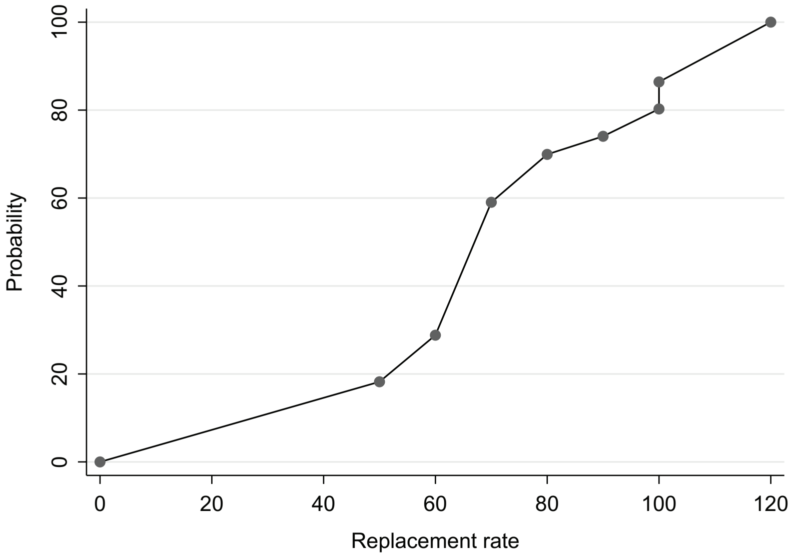

Figure 1. The Average Cumulative Distribution Function

The determinants of the expected value and SD 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 an 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 2008–11, compared to 2006 and 2007, possibly due to the financial crisis. Similarly, the expected replacement rate was lower in later years.[7]

4. Empirical Approach

I estimate linear regression models for household saving, as a function of the expected value and variance of pension income derived from the probabilistic survey questions explained in the previous section. The models can be written as follows:

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

where s_i denotes annual saving of household i, μ_i denotes expected pension income, and σ_i^2 denotes the variance of pension income. This specification can be derived from a simple life-cycle model with CARA preferences (see Appendix B, in the Online Supporting Information), although a similar expression would result from other (linearized) life-cycle models with uncertainty over future income. In line with such models, we expect $\gamma_1 < 0$ (the permanent income or displacement effect) and $\gamma_2 > 0$ (the precautionary saving effect).

[7]De Bresser and van Soest (2013) obtain very similar results.

The vector $\mathbf{x}_i$ contains last-period wealth, household income, age, and control variables.[8] The control variables capture other factors explaining household savings, 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). Appendix A 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 several reasons why OLS may lead to inconsistent estimates: unobserved heterogeneity, reverse causality, measurement error, 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. Unobserved heterogeneity 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).[9] Third, the distribution function defined in equation (1) above might introduce some measurement error in the measures of expected pension income and its variance; for instance, due to the linear interpolation between thresholds.

Fourth, the sample from which consistent answers to probabilistic questions are obtained—that is, 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 2(a) and 2(b) exceeds 100 percent. Monotonicity is violated if, for instance, the answer to question 2(b) is strictly less than the answer to question 2(c).[10] As Van Santen *et al.* (2012) show, using the same data, the endogenous sample selection from removing inconsistent answers to the probabilistic survey questions, biases the results towards more pessimistic expectations and excess uncertainty in the replacement rate.[11]

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

[9]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.

[10]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.

[11]This finding is based on comparing model-generated predicted values with and without a Heckman selection correction (see Van Santen *et al.* 2012, Table 7). For instance, low-educated individuals are more likely to be dropped from the sample. Low-educated individuals also have higher expected replacement rates and lower uncertainty. Hence, dropping the inconsistent respondents implies a selected sample of relatively high-educated respondents, who will have relatively low expected replacement rates and high uncertainty.

To identify the effects of interest, I use an instrumental variables estimator, corrected for non-random sample selection. I discuss the instruments and selection correction in turn.

4.1. *Instrumental Variables*

I use instruments for both μ_i and σ_i^2 to estimate the parameters of interest γ_1 and γ_2 in equation (2). The instruments are derived from the performance of the respondent's pension fund.

One way to assess the performance of the pension fund is the funding ratio, which equals 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 percent. Whenever assets fall short of 105 percent 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 percent. To restore solvency, the pension fund can increase its premium (paid by employers and/or employees), forgo inflation adjustments, and/or cut (nominal) pension rights. For example, in 2013, 68 pension funds out of 415 had to cut the (nominal) pension rights of 2 million employees, by 1.9 percent on average; 19 of them cut entitlements by 7 percent. 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 percent over the period 2009–11, while inflation was 4.8 percent 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 can be matched to the respondent's pension fund. In total, we are able to match 106 pension funds to the respondents.[12] Quarterly data on the funding ratio from the Federation of the Dutch Pension Funds (the interest association of many pension funds) are used to construct two instruments: (1) the level of the funding ratio and (2) the change in the funding ratio over the past four 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.

The instruments are valid if the exogeneity and relevance conditions are satisfied. To support the latter, 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 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 3).

In support of the exogeneity condition, it is important to stress that the performance of the pension fund is exogenous to the employee within a spell of

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

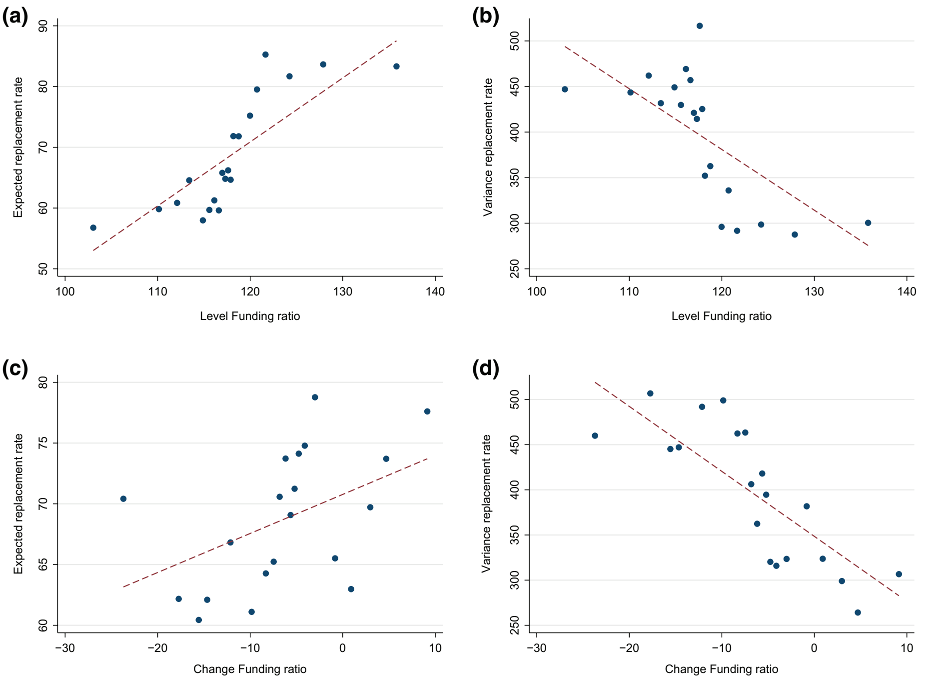

Figure 2. Replacement Rate Moments and the Instruments [Colour figure can be viewed at wileyonlinelibrary.com]

employment, as the choice of pension fund is fully determined by the employer, and participation is mandatory. Moreover, as explained in Section 2, many pension funds cover entire subsectors of the economy (such as healthcare employees or worker in the metal sector), so that switching employers within an occupation would likely leave the respondent with the same pension fund. One could still argue that sorting across sectors based on pension fund performance may invalidate the instruments. This is likely 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 in the recession, switching jobs based only on pension fund performance is unlikely.[13] 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 U.S.

The pension fund performance measures would be invalid as instruments if they had a direct influence on household savings. 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 labor income and a measure of labor income risk, as I do throughout, is unlikely

[13]Even if persons were to switch based on (past or current) pension fund performance, there are no guarantees that the new job's pension fund would still be performing better in the next quarter. In other words, individuals would have imprecise control over fund performance.

to solve this issue in full. In the analysis, I therefore exclude all pension funds changing their premium during the past year.[14]

Another potential threat to the validity of the instruments could be that individuals look directly at the funding ratio of their pension fund, and adjust their savings when that ratio changes. If the individual adjusts his or her expectation and uncertainty about future pension income by looking at the funding ratio, that would be strengthening the argument as to why the instruments are relevant. If, instead, the individual looks at the funding ratio and interprets it as a signal of the future state of the economy or its private situation over and above the expectation of future pension income, then the instruments would not be exogenous to the saving decision, and therefore invalid. I find this unlikely to be of concern, since funding ratios primarily impact one's own future pension income, and hence it should be picked up by the expectation and variance of the replacement rate. In addition, time fixed effects absorb other signals of the state of the economy.

One could also argue that the funding ratio is not an objective measure of risk, since the pension fund has to implement (unpopular) measures when the ratio falls short of 105 percent, potentially providing incentives to try to look healthier than it really is. There are two arguments why I believe that the funding ratio is an objective measure of risk. First, the setup of pension funds in The Netherlands is such that the administration and investment decisions are made by professional investors employed by the pension fund; that is, pension funds are independent. In particular, there is no overlap between workers investing in the fund and those managing the payments and investments. Pension funds are supervised by the Dutch Central Bank, and need to report their asset and liability position on a quarterly basis, with the possibility to be audited. Second, if indeed pension funds were to try to avoid taking measures by adjusting their funding ratios upwards, we would expect to see a gap in the distribution of funding ratio outcomes. I find no evidence of such gaps below the threshold.[15]

Finally, note that exploiting cross-sectional variation in pension fund performance to estimate the effects of pensions on savings is conceptually similar to the papers by Attanasio and Rohwedder (2003) and Attanasio and Brugiavini (2003), who exploit differences in pension wealth between occupational groups over time, induced by pension reforms. Their strategy is amongst the best in the literature. In The Netherlands, no (major) reforms took place over my sample period. Despite this, my main results are qualitatively similar when using the interaction between sector,[16] cohort, and year dummies, instead of pension fund performance measures. The identification assumption for these instruments to be valid is that savings do not vary systematically between cohort–sector groups over time, conditional on sector–year, sector–cohort, and cohort–year fixed effects (and other controls). The motivation for these instruments is that expected pension income and uncertainty over pension income develop differently over time for young and older workers in different occupations. A possible story here is that the financial crisis might have differently impacted workers of different ages, as young individuals have a

[14]Thirteen pension funds (8.7 percent of the sample) are removed due to changing premia.

[15]The results are available upon request.

[16]The ten sectors included in the survey are Industry, Agriculture, Construction, Trade, Transportation, Services, Education, Healthcare, Government, and Other.

longer horizon until reaching retirement age, with more possibilities to offset crisis-induced reductions in pension wealth. Furthermore, different sectors are exposed differentially to the state of the economy. While it is reassuring that the qualitative results survive a completely different set of instrumental variables, I only present these results in Appendix C (in the Online Supporting Information), as (absent pension reforms) cohort–sector–year dummies leave open the mechanisms concerning how differences between cohort–sector groups affect expectations over time and, through those, saving.

4.2. *Sample Selection Correction*

The sample of respondents that provide probabilities satisfying adding up and monotonicity of distributions is a selected sample. Table 2 provides summary statistics for respondents violating these conditions versus those with consistent answers. The respondents with inconsistent answers have less wealth, are lower educated, are in worse health, and are less risk averse. In terms of outcome variables, only the level of saving is somewhat different between the groups.

In the main specification, I correct for non-random sample selection using the two-step approach of Heckman (1979).[17] To identify the selection model, the exclusion of variables that appear only in the selection equation but not in the outcome equation is required. The 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 and expected inflation. The dummy variables "Income adding-up error," "Income probability error," and "Inflation probability error" are each equal to 1 if the respondent's answer to the probabilistic question on next-year's income growth and expected inflation do not satisfy the law of total probability or monotonicity of the CDF (for the wording, see Appendix A). As Table 2 shows, respondents with inconsistent answers to question 2 are more likely to violate probability laws for other questions.

4.3. *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 2(a)–(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 $\mathbf{w}_i$ denote a (vector of) observables explaining the selection process (exclusion restrictions), and let $\mathbf{m}_i$ denote a vector of instruments. The model used to estimate equation (2) can then be written as follows:

[17]Rather than using a Heckman sample selection correction, one could adjust the answers to sequence 2(a)–(g) to force consistency with probability laws. One practical disadvantage of such direct adjustments to the data is that one needs to decide on some maximum adjustment (for instance, a maximum of 10 percentage points adjustment per person, or per person–question). The modeling of selection through a Heckman correction is a better alternative, especially since the survey data contain other probabilistic questions which provide meaningful information on answering patterns over and above the education level and financial literacy of the respondent, as shown in Van Santen *et al.* (2012).

TABLE 2
Summary Statistics and Sample Selection

Variable	Inconsistent	Consistent	All
Control variables			
Income (€)	35,314	35,952	35,739
Financial wealth (€)	30,916	38,736	36,123
Age	46	46	46
Male (%)	57	61	60
Partner (%)	77	76	76
Children (%)	46	47	47
High school or less (%)	65	52	56
Homeowner (%)	75	78	77
Good health (%)	81	86	84
Greater than 5 years planning horizon (%)	15	16	16
Risk averse (%)	53	63	60
Prob survival to age 75 (%)	71	69	70
Prob leave bequest (%)	66	74	71
Variance permanent income shocks	0.74	0.74	0.74
Variance transitory income shocks	0.30	0.29	0.30
Exclusion restrictions			
Expected income error (%)	16	11	12
Expected inflation error (%)	9	7	8
Expected income adding up error (%)	12	5	7
Instrumental variables			
Level funding ratio (%)	122	118	119
Change funding ratio (percentage points)	−6	−6	−6
Dependent variables			
Saving (0–7)	2	2	2
Amount saving (€)	4,474	5,106	4,895
Saving rate (%)	14	15	14
Number of observations	1,068	2,128	3,196

Notes: This table shows summary statistics by consistency of the answering pattern to question 2. The second column ("Inconsistent") includes those respondents violating the laws of probability. The third column ("Consistent") includes those respondents not violating the laws of probability. The fourth column ("All") includes all respondents.

$$P(d_i = 1|\mathbf{x}_i,\mathbf{m}_i,\mathbf{w}_i) = \Phi(\mathbf{x}_i'\boldsymbol{\beta}_d + \mathbf{m}_i'\boldsymbol{\theta}_d + \mathbf{w}_i'\boldsymbol{\kappa}), \quad (3)$$

$$\mu_i = \mathbf{x}_i'\boldsymbol{\beta}_\mu + \mathbf{m}_i'\boldsymbol{\theta}_\mu + \alpha_\mu\hat{\lambda}_i + \eta_i, \quad (4)$$

$$\sigma_i^2 = \mathbf{x}_i'\boldsymbol{\beta}_\sigma + \mathbf{m}_i'\boldsymbol{\theta}_\sigma + \alpha_\sigma\hat{\lambda}_i + \epsilon_i, \quad (5)$$

$$s_i = \mathbf{x}_i'\boldsymbol{\beta} + \gamma_1\hat{\mu}_i + \gamma_2\hat{\sigma}_i^2 + u_i. \quad (6)$$

TABLE 3
Baseline Results: Dependent Variable—Annual Saving

	(1) Scale 0–7 OLS	(2) Scale 0–7 IV	(3) Midpoint (€) IV	(4) Rate (%) IV	(5) Rate (%) 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)
Number of observations	2,128	3,196	3,196	3,196	3,196
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

Notes: 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, and 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. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

The equation of interest is the savings equation, (6), where the variables μ and σ^2 have been replaced by fitted values from the respective first-stage equations, (4) and (5). Absent $\hat{\lambda}$, equations (4)–(6) define a standard 2SLS estimator. In addition, the first-stage relationships are corrected for non-random sample selection using the two-step approach of Heckman (1979). The selection-correction term, $\hat{\lambda}$, equals the Mill's ratio using the fitted values from the Probit regression in equation (3). 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 **m** consist of the level of the pension fund's funding ratio, as well as the four-quarter change in the funding ratio. The exclusion variables, **w**, that appear only in the selection equation but not in the other equations, are the dummy variables "Income adding-up error," "Income probability error," and "Inflation probability error."

5. Results

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

The 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 1-SD (approximately 10 percentage points) increase in the expected replacement rate causes a 7.9 percent decrease in annual saving. Similarly, a 1-SD (or 110 unit) increase in the variance of the replacement rate increases saving by 12.3 percent. 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-SD increase in expected benefits reduces saving by around \euro1,200; a 1-SD increase in the variance increases saving by around €1,500.

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

Column 5 uses the saving rate as well, and in addition multiplies the pension variables by Gale (1998)'s "Q"-variable; that is, the age-related adjustment factor to correct for differences in years until retirement.[18] The advantage of doing so is

[18]In the simple two-period model presented in Appendix B, 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 is the terminal period. I compute this adjustment using K from question 1, $N = 100$, and $r = 3$ percent.

TABLE 4
Results Without the Selection Correction: Dependent Variable—Annual Saving

	(1) Scale 0–7	(2) Midpoint (€)	(3) Rate (%)	(4) Rate (%), "Q"-adjusted
Expected replacement rate	-0.021^{***}	-195.74^{***}	-0.471^{***}	-0.515^{***}
	(0.008)	(55.08)	(0.153)	(0.168)
Variance replacement rate	0.0025^{***}	21.07^{***}	0.054^{***}	0.064^{***}
	(0.0008)	(5.76)	(0.017)	(0.020)
Number of observations	2,128	2,128	2,128	2,128
Pension funds	95	95	95	95
F-statistic instruments (μ)	23.57	23.57	23.57	27.36
F-statistic instruments (σ^2)	22.65	22.65	22.65	21.94

Notes: The control variables included are the same as in Table 3. This table presents estimates of the IV regression model presented in equation (3) without selection correction (i.e. excluding regression 3. Block-bootstrap (by pension fund) standard errors in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

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.

5.1. *The Gap Between OLS and Selection-Corrected IV Estimates*

The estimates differ substantially when using OLS (column 1) or selection-corrected IV (column 2), which could be due to instrumenting or to the treatment of selection bias (or both). Table 4 shows the results of estimating the system of equations (3), but without equation (3). The coefficients in Table 4 are therefore standard 2SLS estimates, obtained using the sample of respondents with answers satisfying monotonicity and adding up of probabilities. The IV results are qualitatively the same as the main results from Table 3. In fact, the results are even slightly stronger for the results without the Heckman correction, as the coefficients are somewhat larger in absolute terms. Presumably, those respondents with less knowledge of probabilities (and hence dropped when not using the Heckman correction) are also those less likely to behave according to the life-cycle model, and are perhaps more rule-of-thumb savers, although such a claim is hard to prove. In any case, the difference between the IV and OLS results is not exacerbated by the inclusion of respondents who do not satisfy the laws of probabilities.

The OLS results show very little offset of pensions by savings (significant at 10 percent) and no precautionary effect of uncertainty in future pension income. The weak finding using OLS is not unique in the literature. For instance, Gustman and Steinmeier (1999, Tables 12 and 13) report a positive offset between pension wealth and total wealth using OLS regressions. Engelhardt and Kumar (2011, Table 2 and Figure 1) also report that pension wealth crowds in private wealth using OLS. Their instrumental variable for (self-reported) pension wealth uses detailed administrative data on pension wealth and lifetime earnings to construct better measures of social security and pension wealth. Using IV, their coefficient on pension wealth turns negative. Hence, both the finding that OLS yields weak or even positive coefficients for pensions in a savings regression, as well as a negative coefficient when instrumenting, have appeared in the literature.[19]

5.2. *Robustness to Other Measures of Expectations*

Table 5 shows the IV estimates (with selection correction) using 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 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.

5.3. *Heterogeneity*

The model in Appendix B 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 Kimball 2001) and less weight to expected future income. Furthermore, even under CARA preferences, one would expect age and risk aversion to matter for the relationships of interest.

Figure 3 shows the coefficients and 95 percent 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) risk aversion, defined as 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."[20]

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

[19]Both Attanasio and Rohwedder (2003) and Attanasio and Brugiavini (2003) are IV estimates, with negative signs (although they do not report simple OLS specifications).

[20]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—one baseline and one interacted with the young-age dummy—and two 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.

TABLE 5
Robustness Checks: Dependent Variable—Annual Saving

	(1) Scale 0–7 IV	(2) Midpoint (€) IV	(3) Rate (%) 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)
Number of observations	3,196	3,196	3,196
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

Notes: The control variables included are the same as in Table 3. Block-bootstrap (by pension fund) standard errors in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

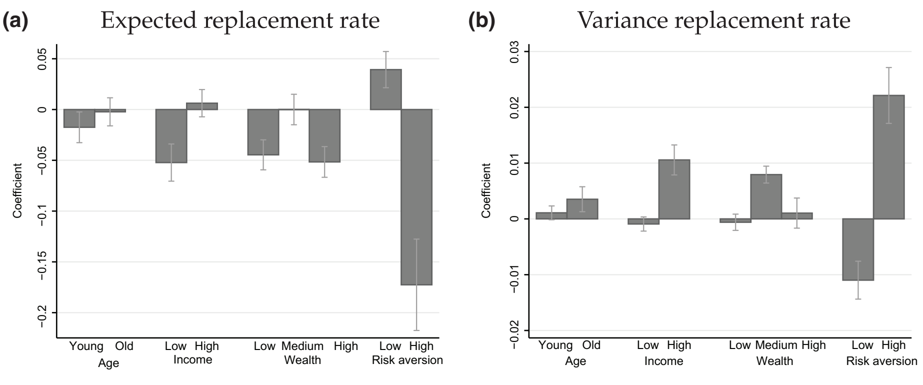

Figure 3. Heterogeneous Impacts

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 3 suggests. However, the non-monotonicity in the responses to expected income and uncertainty is at odds with CRRA (or more general) utility functions. Finally, risk aversion has a large 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.

5.4. *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 6 shows that the estimated displacement effect is biased toward 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 percent) crowd-out as a theoretical benchmark.

Ignoring uncertainty does allow me to test the overidentifying restrictions when using two instruments and one endogenous covariate. The bottom row of Table 6 shows that the null of exogenous instruments cannot be rejected across each dependent variable.

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—that is, 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

TABLE 6

Estimates Ignoring Uncertainty: Dependent Variable—Annual Saving

	(1) Scale 0–7	(2) Midpoint (€)	(3) Rate (%)	(4) 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)
Number of observations	3,196	3,196	3,196	3,196
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 overidentifying restrictions	0.86	0.30	0.75	0.75

Notes: The control variables included are the same as in Table 3. Block-bootstrap (by pension fund) standard errors in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

instance, over future career paths, which impact on earnings and hence retirement wealth accumulation. However, policy risk—that is, 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.

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Supporting Information

Additional supporting information may be found in the online version of this article at the publisher's web site:

Appendix A. DNB Household survey
Appendix B. A simple life-cycle model
Appendix C. Alternative instruments