Communicating Social Security Reform*

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PRELIMINARY

Abstract

In the context of a Danish social security reform that links eligibility ages to cohort life expectancy, we propose a measurement method and a research design that cleanly identifies knowledge from policy uncertainty. We measure the subjective probability distribution over eligibility age for 9,500 Danes and implement a simple information treatment experiment presenting statutory eligibility ages to half of the sample. The control group expects, on average, to become eligible one year earlier than the statutory eligibility age. The treatment reduces this gap by 80 percent. The information treatment has no impact on subjective uncertainty. Our results suggest that simple and very cheap policy communication is an underused policy instrument.

Keywords: social security, belief updating, information treatment, policy uncertainty

JEL codes:

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1 Introduction

Policies that change social security eligibility and benefits are at the top of the agenda and are being implemented around the world. Social security and retirement reforms have been implemented in most European countries and in the US, but also Russia has delayed the official retirement age in 2018 and China is currently planning to do it.[1] These policies are a corner-stone in the attempt to make people work longer and to reduce public expenditures following population aging. The importance of this topic is emphasized by the fact that an entire NBER program has been devoted to mapping and understanding the consequences of these programs (Börsch-Supan and Coile, 2018).

It is widely recognized that the design of social security policy and how it is communicated makes a big difference for knowledge about the policy. Several studies have documented incomplete knowledge about existing social security rules (e.g., Gustman and Steinmeier, 2005; Rohwedder and van Soest (2006)) and how information can affect choices (e.g.Dolls et al. (2018); Liebman and Luttmer (2015); Mastrobuoni (2011)). Concerns about how people internalize information about *new* policies with consequences far out in the future are only greater. Communicating social security reform is complicated by the fact that such reforms are typically decided many years before they directly affect people. This creates inherent policy uncertainty as the policy can potentially be changed before it is implemented. Recent evidence suggests that people do in fact associate significant uncertainty to such policies (Ciani et al., 2019). Despite the obvious importance, almost nothing is known about how policy uncertainty and lack of knowledge about the program *jointly* shape peoples' beliefs about when they become eligible.

In this paper we study workers' beliefs about when they become eligible for social security following the 2006 announcement of a major Danish social security reform that changed the social security eligibility age from 65 to being based on longevity prospects according to life tables. We propose a measurement method and a research design that cleanly identifies knowledge from policy uncertainty. To do this we field a representative survey where we collect answers from about 9,500 Danes where we elicit subjective beliefs

[1] Russia has delayed the official retirement age by 5 years in 2018. China decided to increase the official retirement age by one year every six years until 2045.

about participants' social security eligibility age. Following the lead by Manski (2004) we elicit the entire subjective distribution concerning retirement eligibility age using the balls-in-bins method introduced by Delavande and Rohwedder (2008). Eliciting the subjective probability distribution makes it possible to construct measures of subjective mean beliefs and subjective uncertainty. To learn about ignorance about the social security eligibility rules, we conduct a randomized information treatment experiment where half of the sample is shown the table specifying the statutory social security eligibility ages. The design is based on the insight, that people update their beliefs only if they find the information credible and relevant and had not already internalized it.

We present several findings. First, for the group who are not information treated we document a significant social security eligibility gap, i.e., a gap between the mean of subjective beliefs about the social security eligibility age and the statutory eligibility ages. We find that respondents expect to become eligible earlier than the statutory eligibility age and that the eligibility gap is increasing in the number of years until eligibility. Our results document that the original policy announcement has not been successful in conveying the consequences of the reform well to the Danish population at large. It is essential that people internalize the policy information for them to be able to plan for their retirement. The information treatment reduces the eligibility gap. The gap reduction increases in the number of years until reaching the eligibility age. However, we also find that the information treatment does not lead to complete updating. The eligibility gap is still significant and it is larger for people who have many years before reaching the statutory eligibility age than for people who are close to it. The fact that people update their beliefs imply that the respondents found that the information treatment contained some relevant information that was not already internalized.

Second, we document that the subjective uncertainty about the eligibility age is significant and that people who are far from the statutory eligibility age are more uncertain than people who are close to it. The information treatment leaves subjective uncertainty unchanged. This arguably reflects that social security reform is associated with inherent policy uncertainty that cannot be removed.

Third, we also elicit beliefs about the age of expected retirement. We find that the

expected retirement age and the subjective uncertainty about the retirement age are increasing with the distance to social security eligibility. The information treatment affects beliefs about the age at which the respondents expect to retire. Respondents in the information treatment group expect to retire later than respondents in the group who are not information treated. However, the uncertainty about the retirement age is unaffected by the information treatment. These results indicate that the information treatment concerning the social security eligibility age impacts retirement plans and hence that the shifting of social security eligibility beliefs is likely to have real consequences.

Fourth, using additional survey instruments, where we elicit the sensitivity of retirement age beliefs to variation in the age of social security eligibility and the expected annuity value from retirement savings, we document that the degree of retirement sensitivity is declining in retirement income meaning that retirement sensitivity is in part incentive driven: Those who expect to rely more on social security as a source of income in retirement are more retirement sensitive to the social security eligibility age. Furthermore, we show that retirement sensitivity is predictive of the eligibility gap. Individuals who are more retirement sensitive have a smaller social security eligibility gap. This means that individuals, for whom social security is financially more important in retirement, have social security eligibility beliefs that are closer to the official social security eligibility table.

Finally, we rationalize our key findings with a simple model of belief updating. The model is developed to mimic the Danish policy environment: A social planner announces the social security reform that links the social security age to the life expectancy for each birth cohort. Cohort-specific life expectancy changes as time passes, but to enable people to plan for their retirement, the social planner fixes social security ages 15 years in advance. This means that the actual social security eligibility ages are fixed for the oldest cohorts whereas the policy maker forms beliefs about the eligibility age of the youngest birth cohorts. Agents form beliefs about their subjective eligibility age, where the updating rule is specified to be a fraction of the deviation between the social planner's beliefs and the individual's prior belief. A calibrated version of the model is able to replicate the baseline (no information treatment) findings from the survey data: Subjective beliefs

exhibit an eligibility gap and subjective variance that both increase with the number of years until eligibility. Calibrating the model to match the outcome for the information treatment group suggests that simple information provision reduces the eligibility age for the younger cohorts by an amount that would otherwise have taken them five to seven years. Given the low cost of providing such information these findings suggest that policy communication is an under-used policy tool in the context of social security reform.

The rest of the paper is organized as follows. Section 2 presents the Danish social security reform. Section 3 presents the sampling strategy, the survey design and the information treatment. Section 4 presents the core results. Section 5 develops a model of belief updating which is used for quantifying the distribution of information internalization caused by the information treatment. Section 6 dives into the anatomy of the eligibility gap to explore the role of incentives and how the results vary by other observable characteristics. Section 7 concludes. Before that, we link our work to existing literature.

Related literature. Our work relates methodologically to a recent literature measuring the effect on beliefs of information treatments in macro, public, and political economics and in household finance, see Haaland et al. (2021) for a survey. Within public economics, our paper is most closely related to a literature that is concerned with information and adaption of existing policies. Chetty and Saez (2013) conduct an experiment with Earned Income Tax Credit (EITC) recipients, in which a random subset received personalized information about the EITC schedule. Kostøl and Myhre (2021) study how personalized information about tax incentives affect labor supply in Norway. Dolls et al. (2018) find that the comprehensible information about the German pension system increases people's pension savings and labor supply. Mastrobuoni (2011) studies the effect of a Social Security Administration annual statement which informs US workers aged 60+ with an estimate of benefits at different claiming ages. He finds that the letter affect people's knowledge about their benefits, but that it does not affect retirement behavior. Liebman and Luttmer (2015) conduct a randomized field experiment where they send out information about social security rule to older workers. They find that the intervention increases labor supply. Common to these papers, is that they do not model

how beliefs about the policy are shaped. Conceptualizing the belief-updating process is, however, important for assessing the likely impact of future information efforts. Moreover, the focus is on documenting how people lack understanding of the current policy scheme and how information conveyed about it may affect behavior.

Concerns about the internalization of policy information are only amplified when new policies are decided and the consequences affect people only far out in the future. This is exactly the case with social security reforms which are typically announced many years in advance of the point where people actually become eligible. This is an area that is much understudied. van der Klaauw and Wolpin (2008) model policy uncertainty over social security benefit levels in a structural life cycle model of retirement and savings. However, very little empirical evidence exists about how much uncertainty people actually associate with social security policies. Delavande and Rohwedder, 2011) and Luttmer and Samwick (2018) show that people view public pension entitlements as risky. In a recent paper, Ciani et al. (2019) further develops the agenda and study expectations about whether governments will increase the national retirement age or decrease pension benefits in European countries using the SHARE data base. They find that people have incomplete information upon policy announcement. This aligns with our results from analysis of prior beliefs. Furthermore, they find evidence of considerable pension reform uncertainty and document increased online search around points of policy announcement suggesting that information acquisition is costly. However, knowledge about the effects of communicating social security reform is still limited. For example, little is known about how subjective beliefs are jointly influenced by lack of knowledge and policy uncertainty related to the fact that social security reform affects people in the future. We push this literature forward by studying a Danish social security reform that changes the age-eligibility in a staggered fashion related to birth cohort. This case makes it possible to implement a research design where we carefully elicit the entire distribution of subjective beliefs and measure the effect of an information treatment experiment. We link the design of the empirical analysis explicitly to a model of belief updating developed to capture the context of the Danish social security reform. It conceptualizes the underlying forces that drive subjective belief formation and the effect of information treatment about the social

security policy change. The combination of the staggered reform, the tailor-made survey combined with registry data, the experimental design, and the theory is essential for being able to assess the value of the communication (Frankel and Kamenica, 2019), and we use it to quantify the importance of policy uncertainty and lack of knowledge about the policy.

Finally, our paper is related to the literature about measuring subjective beliefs (Manski, 2004, Hurd, 2021). This literature proposes to measure beliefs by eliciting the entire distribution of subjective beliefs about various outcomes, including among other things income (Dominitz and Manski, 1997) and social security eligibility and benefit levels (Dominitz et al., 2003; Delavande and Rohwedder, 2008, Delavande and Rohwedder, 2011). This literature uniformly documents substantial heterogeneity in beliefs across respondents, suggesting that heterogeneous information acquisition plays a role. We contribute with careful elicitation of entire distribution of subjective beliefs concerning social security eligibility and retirement age beliefs and we show how the subjective mean and variance are both critical for understanding belief formation in the context of social security reform.

2 Description of institutional context and the policy

Social security is universal in Denmark, i.e. it applies to all Danish citizens who are above an age threshold. It constitutes the first pillar in the pension system, where the two other pillars are occupational pensions and privately organized pensions savings accounts, see Chetty et al. (2014) for more details. Social security is pay-as-you-go funded through the tax system and due to the population aging, concerns about the sustainability of public spending led the parliament to decide on a major welfare reform package in 2006 (The Welfare Agreement). A key objective of this reform package was to make public finances more robust to increasing life expectancy and one of the specific policy initiatives was to increase the social security eligibility age. The Welfare Agreement was passed through parliament in June 2006 with a majority vote of 158 out of 179, i.e. the reform package and the decision to index the social security eligibility age to life expectancy had very broad support.

Table 1: *Social Security Eligibility Age by year and Birth Cohort*

Birth date	Eligibility Age
-31 December 1953	65.0
1 January 1954-	65.5
1 July 1954-	66.0
1 January 1955-	66.5
1 July 1955-	67.0
1 January 1963-	68.0
1 January 1967-	69.0
1 January 1971-	70.0*
1 January 1975-	71.0*
1 January 1979-	72.0*
1 January 1983-	73.0*
1 January 1987-	73.5*
1 July 1991-	74.0*
1 January 1996-	74.5*
1 July 2000-	75.0*

Notes: The social security eligibility age is set by law and will be regulated every 5 years 15 years ahead. If life expectancy increases then social security age will also increase. The social security ages marked with '*' are therefore expected values.

The 2006 reform package and a subsequent modification in 2011 resulted in a gradual increase of the age threshold for social security eligibility by 6 months per year from 2019 to 2022 to move the social security eligibility age from 65 to 67.[2] After that, the eligibility age is indexed to the life expectancy of 60-year-olds. Each five years the age thresholds will be updated based on the development in life expectancy, and the decision takes effect 15 years after. The first revision was in 2015 and the latest was in 2020. In 2021 the current social security eligibility age is 66.5 years and the parliament has now decided that the eligibility threshold will be 69 years by 2035. For cohorts born in 1971 or later the social security eligibility age is currently an estimate. Social security eligibility ages, at the time of the survey, by year and birth cohort are tabulated in Table 1.

[2]In 2006 it was originally decided that this transition should take place over the period 2024 and 2027, but in 2011 parliament decided to speed up the increase such that it started in 2019.

3 Survey and estimation

3.1 Sample

The sample invited to participate in the survey is recruited from the Danish population registry. The population registry is a complete registry of all persons who are born or have ever had a registered address in Denmark. It contains the CPR-number, which is a personal identifier applied universally to record any contact an individual has with the public sector. The CPR-number is linked to the birth date and the sex of the individual. For conducting our survey we have been given access to a random sample of individuals born during the period 1st January 1951 to 31st December 2000. The survey was fielded in January-February 2021, i.e., the sample of invitees were between 21-70 years old at the time where the survey was completed. Invitations to participate were sent out to a random selection of Danes aged 20-70 years using an official email account, called e-boks, which all Danes are equipped with. We collected 9,572 responses corresponding to a response rate of about 13 percent.

Within the Danish research data infrastructure it is possible to link survey responses to administrative registries. In this study we make use of administrative records compiled by Statistics Denmark from various government agencies with information about gender, age, education, employment status, earnings, and wealth, including wealth held in retirement accounts. In Table 12 in the Appendix we display summary statistics for participants and non-participants. The Table shows that participants are slightly more likely to be female, tend to be slightly older, more likely to have a college degree, more likely to have a job and hence have higher income. Participants also have higher wealth balances than non-participants. While these differences are statistically significant, in most cases the quantitative differences are modest. Furthermore, the standard deviation of the variables considered is quite large reflecting that our sample includes a lot of heterogeneity.

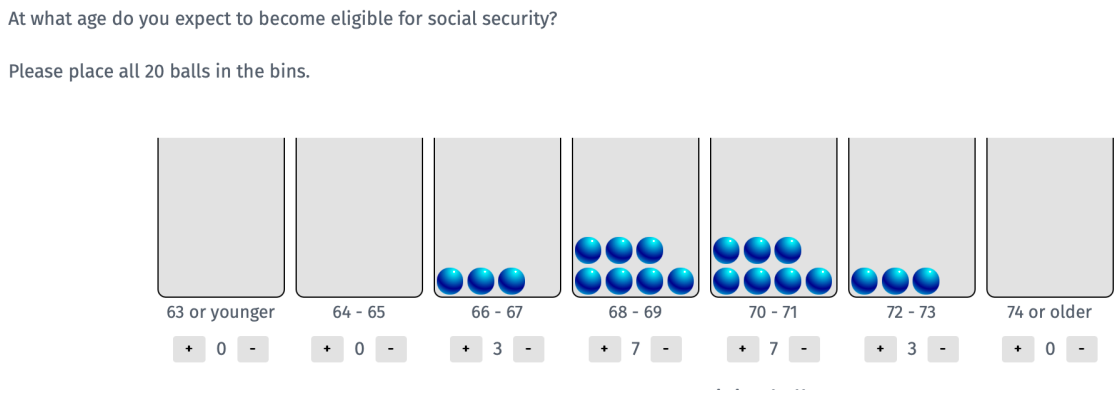
3.2 Survey instruments

In order to elicit beliefs about future social eligibility, we ask about the probability of becoming eligible at different ages. Specifically, we ask :

> *At what age do you expect to become eligible for social security?*
>
> *Please place all 20 balls in the bins*

Along with the question, respondents are shown a graphical representation of seven bins into which 20 balls should be distributed, cf. Figure 1, by pressing the '±' buttons underneath the bins.

Figure 1: *Balls in bins*



Notes: The graphical user interface where the respondents place 20 balls in seven bins to reflect their subjective beliefs.

For each respondent, i, we then estimate the mean, μ_i, and standard deviation, σ_i, of the subjective probability distribution:

$$\mu_i = \frac{1}{20}\sum_{b=1}^{20} x_{ib} \quad , \quad \sigma_i^2 = \frac{1}{20}\sum_{b=1}^{20}(x_{ib} - \mu_i)^2$$

where we assume that each ball, x_{ib}, takes the value of midpoint of the bin.[3]

[3]Each bin is two years wide, the midpoint of each bin are the odd numbers - for example, for the bin "68-69", the midpoint is 69. If a respondent has a retirement eligibility age of 68, she will put her balls in bin "68-69", resulting in $\mu_i = 69$. This is of course not desirable, and to correct for this, we changed all x_{ib}'s that are placed in the correct bin (according to the correct social security eligibility age according to Table 1). As a robustness test, we also tried an alternative approach where we assigned each ball, x_{ib}, a random value from a uniform distribution within the boundaries of the bin, but this did not affect the results.

In the analysis, we are also going to make use of some additional survey instruments eliciting expected retirement age as well as questions eliciting how sensitive retirement is to the social security eligibility age. Also for these questions, beliefs are elicited using the balls-in-bins method. The questions are described in detail in Appendix C.

3.3 Information treatment

The information treatment is very simple. We randomly select half of the sample and show them Table 1 before they answer the question about beliefs about when they become eligible for social security

> *The Danish Parliament decided to adjust the age at which people become eligible for social security according to when people are born, such that later born individuals qualify later for social security. This is change is implemented to reflect the fact that people who are born more recently can expect to live longer. The new eligibility ages are tabulated in the table below. [Display Table 1]*

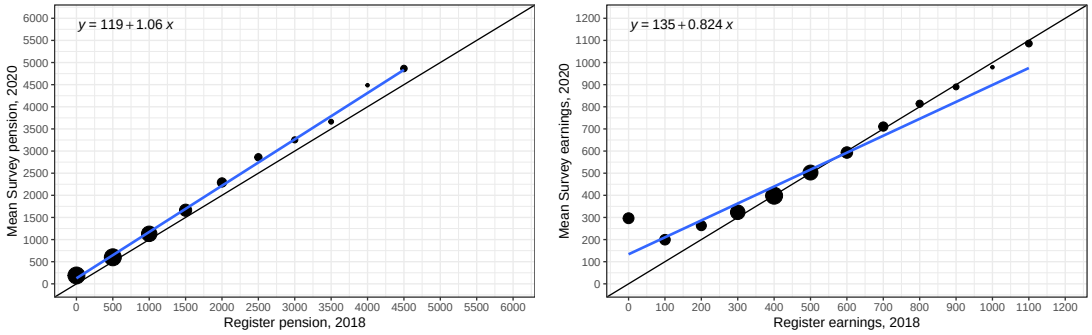
3.4 Validation

An important question is whether respondents are able and willing to respond accurately to the questions that they are asked in the survey. To assess this we asked the respondents about pension wealth and earnings in 2020 and we then we compare stated pension wealth and earnings from the survey with their third-party reported counterparts from the administrative registers. Note the survey responses pertain to 2020 whereas the register data are for 2018.[4] This adds some noise to the earnings measure as respondents could very well have changed labor market status during the two years. Figure 2, panel (a), reports average pension wealth as reported in the survey in 2020 by DKK500,000 bins of pension wealth as recorded in the administrative register in 2018. Panel (b) reports average earnings as reported in the survey in 2020 by DKK100,000 bins of earnings according the administrative register in 2018. In both panels, the size of the dots indicate number of observations and the blue line is a weighted OLS regression through the micro data with coefficients reported in the top-left of the panel.

[4] register data for 2020 have not yet been made available for research.

The reported pension wealth is very close to the 45-degree line but is shifted slightly up. This to be expected, as the survey measure includes two years of additional saving compared to the register based measure. Reported earned income is also very close to the 45-degree line, except at the bottom end of the 2018 distribution, where there is some deviation. This is likely because some respondents were out of the labor force in 2018 (enrolled in education, on parental leave, etc.), but are in the labor force in 2020. Overall, Figure 2 shows that survey responses align remarkably well with objective third-party reported measures from the administrative register data. These findings confirms that respondents are able and willing to provide meaningful answers in the survey.

Figure 2: *Validation of survey responses*



(a) *Mean reported pension savings, 2020* **(b)** *Mean reported earnings, 2020*

Notes: The figure shows the relationship between reported pension wealth, panel a, (earnings, panel b) in 2020 against the corresponding measure that is third-party reported in the administrative register in 2018. The panels show binned scatterplots (black circles) where the bins are defined over intervals of the register measure. The size of the dots is proportional to the number of observations in the bin. A regression line (blue) is overlaid and regression coefficients are reported in the upper-left corner.

4 Results

4.1 Social Security Eligibility Beliefs

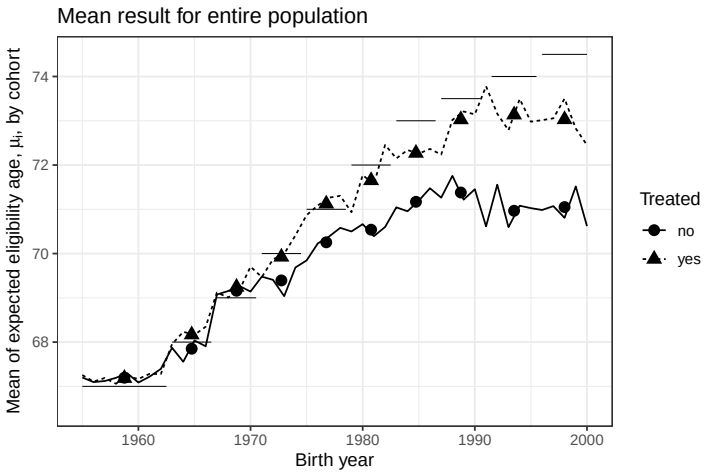
Figure 3 presents the core results from our survey. The figure shows statutory social security eligibility ages with horizontal lines. The solid line shows average subjective means of beliefs about social security eligibility age by birth cohorts for the group that is not information treated. The dots on the solid line show the average of subjective means

within the cohorts specified in Table 1. The dotted line shows the corresponding line for the information treatment group.

The control group, i.e., the group that was not information treated, is informative about the extent to which the original policy announcement has been internalized. Figure 3 shows that eligibility age beliefs are increasing in distance to eligibility and that expected eligibility age is above the universal pre-reform level at 65. Cohorts born up to about 1970, on average, have mean eligibility beliefs about the age at which they become eligible for social security that approximately match the table values. These are the birth cohorts for whom the eligibility age has been finally decided by law. For younger cohorts, the eligibility gap, i.e., the difference between the table age and the mean of stated belief, start to increase such that the eligibility age beliefs are consistently smaller than the eligibility ages listed in Table 1.

The pattern for the baseline group shown in Figure 3 is interesting because it document that the original policy announcement in 2006 has only partially been internalized and that the eligibility gap is higher among cohorts for whom eligibility is more distant.

Figure 3: *Average Mean Social Security Eligibility Beliefs of Treatment and Control Groups*



Notes: Dots and triangles indicate averages within cohorts that share the same statutory eligibility. Horizontal lines show statutory eligibility ages.

The dotted line in Figure 3 show the average of subjective mean of beliefs for the group that was information treated. The triangles indicate the average within the cohort

groups in Table 1. It is evident that the average of mean beliefs of the treated group are closer to the statutory eligibility ages, indicating that the information treatment reduces the eligibility gap. The average of subjective mean beliefs tracks the statutory eligibility ages closely up until around cohort 1980. For younger cohorts the eligibility gap widens.

Table 2, column (1), presents estimates for regression models parameterizing the patterns shown in Figure 3. The table, top panel of column 1, shows that there is a significant eligibility gap for older cohorts belonging to the group that was not information treated. The gap is small for cohorts that are close to eligibility, but it widens when moving to younger cohorts.

In summary, the evidence presented in Figure 3 and Table 2, column (1), document significant, but not complete, information updating. The fact that there is a significant eligibility gap in the untreated group indicate that the original policy has not been fully internalized by young cohorts in particular. The fact that a simple information treatment can reduce the eligibility gap suggests that lack of knowledge about the consequences of the policy for the respondents plays a role.

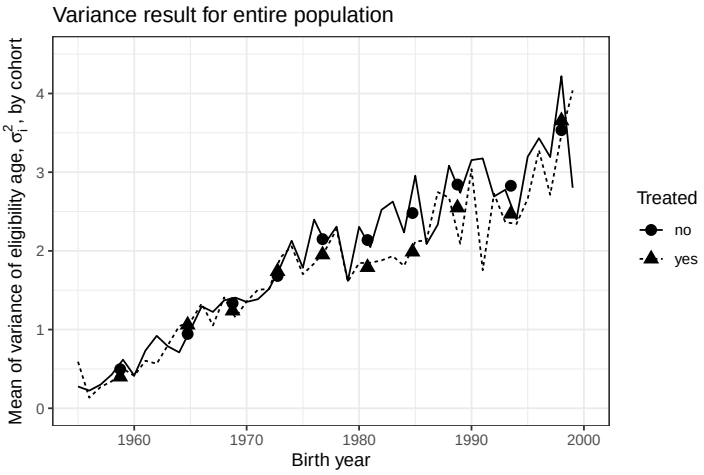
4.2 Subjective Uncertainty

Figure 4 shows average of subjective variances by birth cohort organized in the same way as Figure 3. The solid line in Figure 4 shows that the average subjective uncertainty (measured as the individual variance, σ_i^2) pertaining to the belief about the social security eligibility age, is monotonically and almost linearly increasing in the birth cohort year, i.e., young people who have many years until reaching the eligibility age are more uncertain than people who are close to eligibility.

The dotted line in Figure 4 shows the average subjective uncertainty pertaining to the belief about the social security eligibility age for the group that was information treated. Interestingly, the pattern for the average of subjective variances almost coincide with that of the control group, i.e., subjective uncertainty is not affected by the treatment.

Table 2, column (2), reproduces these findings in regression format. The top panel shows that the average subjective variance is increasing as younger cohorts are considered. The bottom panel presents estimated effects of the information treatment. The

Figure 4: *Average of Subjective Variances of Social Security Eligibility Beliefs for Treatment and Control Groups*



Notes: Dots and triangles indicate averages within cohorts that share the same statutory eligibility.

regression results confirm that the information treatment does not significantly affect average subjective uncertainty.

4.3 Impact on Retirement Beliefs

Social security eligibility is not a choice variable, but rather a circumstance that people are facing. Retiring from the labor market is, however, a choice variable, and previous studies have shown evidence that social security eligibility can drive the decision to retire (e.g. Gruber and Wise, 1998; Atalay and Barrett, 2015, Seibold, 2021, Gruber et al., 2020).

To analyze this, we elicit beliefs about when the respondents expect to retire. We do this using the balls-in-bins methodology that we also used for eliciting social security eligibility. The specific question is listed in the Appendix C. In Figure 5 we use the answers to this question to examine how subjective beliefs about retirement vary across birth cohorts and whether the social security eligibility information treatment also affects retirement plans. Figure 5 shows that mean retirement age beliefs are close to the social security age for the oldest cohorts who are close to the social security eligibility age, but that younger cohorts consistently expect to retire before they become eligible for social security. Panel (b) shows that the subjective variance of retirement age beliefs increase

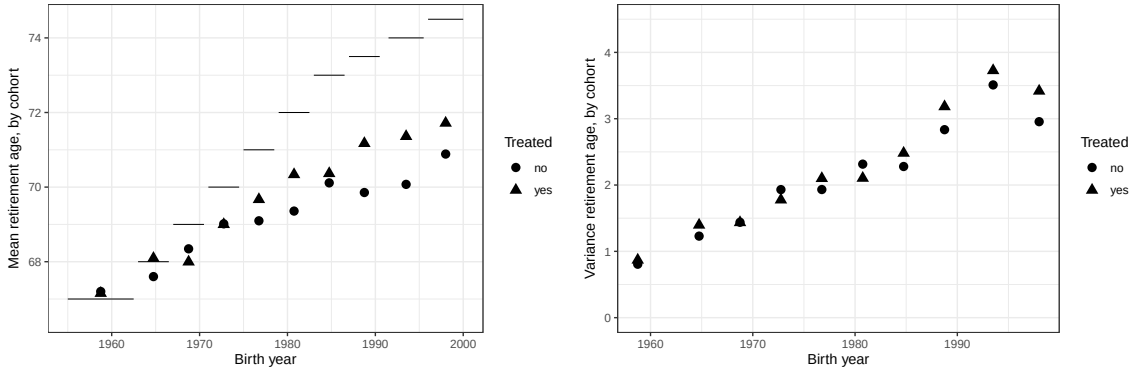
Table 2: *Regression analysis on baseline beliefs and effect of information treatment*

	Dependent variable	
	Eligibility gap	Variance of belief
	(1)	(2)
Eligibility age: 68	0.393*** (0.097)	0.479*** (0.127)
Eligibility age: 69	0.117 (0.098)	0.806*** (0.128)
Eligibility age: 70	0.834*** (0.104)	1.223*** (0.136)
Eligibility age: 71	0.990*** (0.114)	1.659*** (0.149)
Eligibility age: 72	1.767*** (0.121)	1.524*** (0.158)
Eligibility age: 73	2.071*** (0.128)	1.913*** (0.167)
Eligibility age: 73.5	2.433*** (0.129)	2.218*** (0.169)
Eligibility age: 74	3.183*** (0.147)	2.143*** (0.193)
Eligibility age: 74.5	3.589*** (0.169)	2.290*** (0.221)
Treatment	0.078 (0.082)	−0.106 (0.107)
Treatment x Eligibility age: 68	−0.370*** (0.138)	0.227 (0.180)
Treatment x Eligibility age: 69	−0.185 (0.141)	0.023 (0.185)
Treatment x Eligibility age: 70	−0.583*** (0.146)	0.157 (0.191)
Treatment x Eligibility age: 71	−0.950*** (0.158)	−0.104 (0.206)
Treatment x Eligibility age: 72	−1.189*** (0.167)	−0.172 (0.219)
Treatment x Eligibility age: 73	−1.185*** (0.176)	−0.226 (0.230)
Treatment x Eligibility age: 73.5	−1.696*** (0.178)	−0.156 (0.233)
Treatment x Eligibility age: 74	−2.169*** (0.200)	−0.356 (0.261)
Treatment x Eligibility age: 74.5	−2.066*** (0.209)	0.579** (0.274)
Observations	7,982	7,982
R^2	0.203	0.121
Controls	*Yes*	*Yes*

Notes: The dependent variable in column (1) is the eligibility gab, i.e., the difference between the statutory social security eligibility age and the mean of the subjective belief. The dependent variable in column (2) is the subjective variance of the social security eligibility belief. Both regressions include an intercept, but the estimate is not reported. The reference group is untreated with eligibility age 67. Robust standard error in parenthesis. */**/*** represent significance level 10/5/1%. Controls include gender, education, income decile dummies, expected retirement income deciles, and a dummy for currently working. Table 5 in the Appendix shows the regressions with and without controls.

almost linearly in the number of years until eligibility for social security indicating that retirement plans are, naturally, more uncertain the longer the horizon is. The information treatment shifts the mean of retirement age beliefs up for the youngest cohorts but the variance is left practically unaffected across cohorts. This pattern broadly tracks the patterns documented for the social security eligibility beliefs suggesting that social security beliefs do impact retirement plans.[5]

Figure 5: *Retirement beliefs of treatment and control groups*



(a) *Average of individual mean beliefs* **(b)** *Average of individual variance*

Notes: Dots and triangles indicate averages within cohorts that share the same statutory eligibility. Horizontal lines in panel (a) show statutory eligibility ages.

5 A Model of Belief Formation

Our empirical results document a distinct pattern of beliefs about social security eligibility where the staggered nature of the social security eligibility policy clearly plays a role and where the eligibility gap and subjective uncertainty is increasing in distance to eligibility. We also document that a very simple information treatment is able to shift mean beliefs but not subjective uncertainty. In this section we develop a simple model of belief formation that can rationalize these findings. The objective is that the model conceptualizes the main mechanisms and that a calibrated version of the model is able

[5]In Table 8 in the Appendix we present regression counterparts to the results in Figure 5. The regression results confirm the impression from the figure that the information treatment increases beliefs about the mean retirement age but leaves the uncertainty unchanged.

to broadly match the pattern of eligibility beliefs documented in Figure 3.

We start out by characterizing baseline beliefs, i.e., the beliefs of people who have not been subject to any experimental information treatment. The model has two layers. The first layer characterizes the inherent policy uncertainty facing the social planner, and the second layer describes how the individual updates her beliefs based on the beliefs of the policy maker. Having characterized baseline beliefs, we move on to model the impact of the information treatment experiment on beliefs.

5.1 Characterizing baseline beliefs

To characterize baseline beliefs we start out from the basic policy uncertainty that faces the social planner. A goal of the staggered social security eligibility policy is that the eligibility age is tied to cohort-specific life expectancy such that each cohort will have an eligibility age that leaves individuals with approximately 15 years on social security.[6] As in most developed countries, the life expectancy is higher for younger cohorts, and this is the reason for the staggered nature of the policy, cf. Table 1. In reality cohort-specific life expectancy may change over time and this means that the social planner's beliefs about eligibility ages is updated. It is this process that motivates revisions of the law on social security eligibility age every five years as described in section 2 presenting the institutional setup. As part of the five-year updates, eligibility ages are "locked in" for cohorts who are within 15 years from their eligibility age. This measure is supposed to give people time to plan for retirement. However, for younger cohorts the announced eligibility ages reflect the expectation of the policy maker.

We start out specifying the social planner's beliefs and then specify how this impacts individual beliefs. The social planners cohort-specific belief about the eligibility age is $R_{c,y}$, where c is the cohort and y is the calendar year. $R_{c,y}$ consists of an expected mean $\mathbb{E}[R_{c,y}] = \tilde{\mu}_{c,y}$ and a variance $\mathbb{V}[R_{c,y}] = \tilde{\sigma}^2_{c,y}$. Additionally, let $k = y - c$ be the current age.

Changes to cohort-specific life expectancy is translated into changes in $R_{c,y}$, and for

[6] In practice, the link between eligibility ages and life tables is not completely mechanical and the determination of cohort specific eligibility ages are subject to a political process. However, for the present purpose we abstract from the link between life expectancy and eligibility age, and only model beliefs on eligibility age.

simplicity, these changes are modelled as annual innovations, δ_y, that are assumed to be drawn from the same *iid* distribution: $\mathcal{N}(\mu_\delta, \sigma_\delta^2)$. This process can be thought of as changes to life expectancy translated into changes in statutory eligibility ages. In a given year, y, the social planner's beliefs on eligibility age for a given cohort is given by:

$$R_{c,y} = R_0 + \sum_{j=y}^{R-k-15} \delta_j + \nu_c \tag{1}$$

where the sum is unique for each cohort/year combination and distributed $\mathcal{N}(\sum \mu_\delta, \sum \sigma_\delta^2) = \mathcal{N}(\tilde{\mu}_{\delta,c,y}, \tilde{\sigma}^2_{\delta,c,y})$. ν_c is a deterministic term that captures the differences between cohorts (younger cohorts live longer). The term $R-k-15$ above the sum should be interpreted as "number of periods until there is only 15 years until eligibility age". When a cohort has 15 years until planned eligibility age, the age is fixed and no longer subject to change, in the beliefs of the social planner.

For each cohort in each year, we can now specify the distribution that governs the sum in equation (1) (the social planner's beliefs about the eligibility age), which we assume is fully characterized by mean and variance, $\mathcal{N}(\tilde{\mu}_{\delta,c,y}, \tilde{\sigma}^2_{\delta,c,y})$, and given by:

$$\tilde{\mu}_{\delta,c,y} = (R-k-15)\mu_\delta \tag{2}$$

$$\tilde{\sigma}^2_{\delta,c,y} = (R-k-15)\sigma^2_\delta \tag{3}$$

Equation (2) along with R_0 and ν_0 determines the level of $R_{c,y}$ and equation (3) determines the inherent policy uncertainty of $R_{c,y}$ faced by the social planner. Both the level and the uncertainty of $R_{c,y}$ is increasing in the number of years until eligibility as more life expectancy revisions has to be drawn. This means that uncertainty is bigger for people who have longer time until eligibility. Note, that equations (2) and (3) allow the social planner's beliefs about eligibility age to change with both cohort and calendar year.

The next step is to model how the social planner's beliefs feed into subjective beliefs and we suppress subscripts c, y for readability. The moments of the initial beliefs are given

by (μ_0, σ_0^2), and they are updated iteratively as follows (for all cohorts in all periods):

$$\mu_1 = \mu_0 + (\tilde{\mu}_\delta - \mu_0)\theta_{\mu,k} \tag{4}$$

$$\sigma_1^2 = \sigma_0^2 + (\tilde{\sigma}_\delta^2 - \sigma_0^2)\theta_{\sigma^2} \tag{5}$$

Equation (4) states that the individual starts out with mean beliefs, μ_0. Her mean belief is then updated by a fraction $\theta_{\mu,k} \in [0, 1]$ of the difference between the social planners mean beliefs and her own prior, resulting in the updated belief, μ_1. Note, that $\theta_{\mu,k}$ is allowed to vary over the life cycle. If it is zero, there is no internalization, if it is one, subjective beliefs are updated to mirror the social planner's beliefs exactly. Equation (5) gives the corresponding expression for the variance of subjective beliefs. Both equations are updated y times.

5.1.1 Calibration

In order to see whether the model is able to broadly replicate the pattern of baseline beliefs in the data, cf. Figure (3), we now calibrate equations (2)-(5). For simplicity, we assume that all individuals have the pre-policy beliefs that are uniformly anchored at 65, the statutory eligibility age for all people since 1984. This translates to $R_{all,2005} = [\tilde{\mu}_{all,2005}, \tilde{\sigma^2}_{all,2005}] = [65, 0]$. This is convenient, but not essential for our results. The social planners beliefs about cohort-specific eligibility ages, $R_{c,y}$, are set so $R_{c,2020}$ corresponds to the current table ages. μ_δ is estimated on historic data, the other parameters are set in order for the model to match the cross sectional beliefs data in 2020.

The updating parameter for the mean, $\theta_{\mu,k}$, is set to model that attention to the policy grows as individuals age. We capture this using a linear function that is growing in age, k. An interpretation of such an age-dependent pattern of $\theta_{\mu,k}$ is that respondents pay less attention to the statutory social security ages while young, but gradually increase attention towards the need to plan for retirement such that their updating of information becomes more focused.

The variance of subjective beliefs is mainly driven by the inherent policy uncertainty as reflected by the variance of the social planner's beliefs, and the parameter θ_{σ^2} is

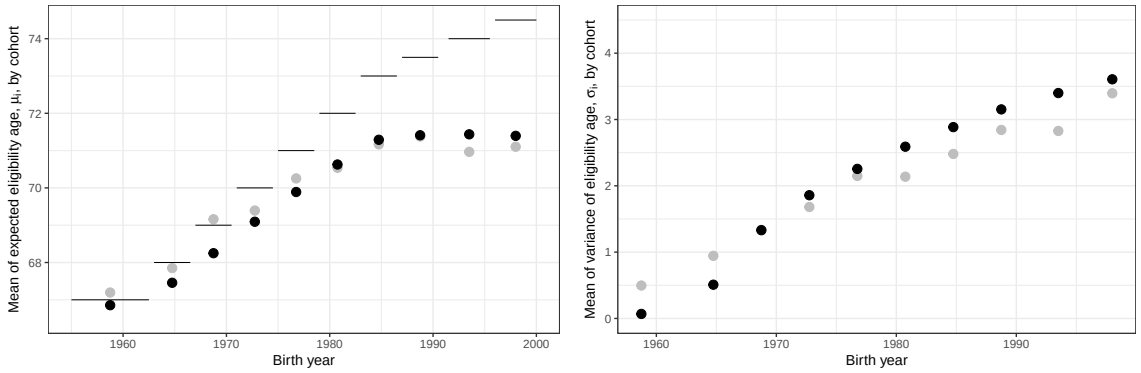
therefore set to 0.10 for all ages. The model is not very sensitive to this parameter since the uncertainty of all respondents in 2020 is already very close to the uncertainty of the social planner.

Table 3: *Parameter calibration*

parameter	value
μ_0	65
σ_0^2	0
μ_δ	0.15
σ_δ^2	0.40
$\theta_{\mu,k}$	0.04+0.003k
θ_{σ^2}	0.10

The calibration in table 3 yields means, $\mu_{c,y}$, and variances, $\sigma^2_{c,y}$ of beliefs by cohort and year. In Figure 6 the averages of beliefs in 2020 are plotted in the same fashion as in Figure 3, and the data points from Figure 3 are included as grey dots.[7] The figure shows that the model is able to replicate the evolution in beliefs of the control group, for both means and variances of individual beliefs.

Figure 6: *Beliefs Control Group, Model and Data*



(a) *Average of individual mean beliefs* **(b)** *Average of individual variance*

Notes: Beliefs Control Group, black dots are from the model, grey dots are from the data. Horizontal lines in panel (a) show statutory eligibility ages. Figure 11 in Appendix D shows the evolution of the mean of R_0, according to the calibrated model.

[7] In Appendix D the full set of year-cohort profiles are plotted.

5.2 Estimating the effect of the treatment

The next step is to develop the model of belief updating to incorporate the effect of the information treatment. The data shows that the variance of beliefs does not change significantly when treated implying that subjective variances align with the social planner's and thus reflect the inherent policy uncertainty related to future updates of life expectancy. As opposed to this, the data shows that the information treatment reduces the eligibility gap. We model this as an additional updating process, $\theta_{\mu,T}$

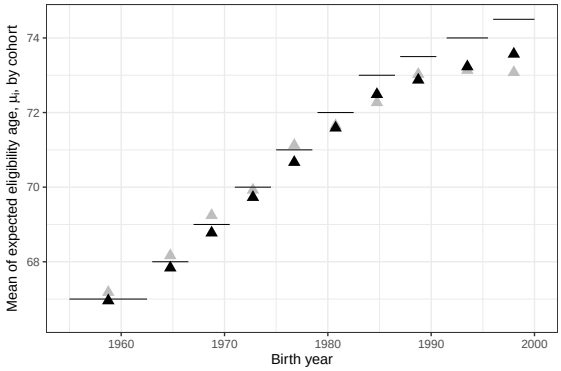
$$\mu_T = \mu + (\tilde{\mu}_\delta - \mu)\theta_{\mu,T} \tag{6}$$

where T denotes treatment. μ is the untreated mean belief absent treatment. Equation (6) corresponds to equation (4) and $\theta_{\mu,T} \in [0,1]$ captures the fraction of the deviation between the social planners belief and the individuals belief (absent treatment) that is updated when the individual is information treated. We fix $\theta_{\mu,T} = 0.7$ to match the average of the mean beliefs in the data. The magnitude of the updating parameter is sizeable and comparable to five to seven years of natural updating for the youngest cohorts. The result is shown in Figure 7. The black triangles show the average subjective mean beliefs for the treated as simulated from the calibrated model of belief updating. The grey triangles replicate the actual data from Figure 3. The results in Figure 7 shows that our model of belief updating is able to replicate average subjective beliefs in our data well. Note, that the information treatment has almost no effect for the oldest cohorts. This is because they already share the beliefs of the social planner and consequently shift their beliefs only marginally. The information treatment, however, impacts the beliefs of younger cohorts significantly, and reduces their bias by an amount that would otherwise take them approximately five to seven years.

6 The Anatomy of Ignorance

The analysis up to now has shown that the Danish 2006 social security reform was only partially internalized by the Danish population and that a simple information treatment

Figure 7: *Beliefs Treatment Group, Model and Data*



(a) *Average of individual mean beliefs*

Notes: Beliefs Treatment Group, black triangles are from the model, grey triangles are from the data. Horizontal lines show statutory eligibility ages.

reduced the gap between statutory eligibility ages and subjective (mean) beliefs. Uncertainty is increasing in the distance to eligibility, but it is not affected by the information treatment and thus appears to be related to the inherent policy uncertainty and not ignorance. In this section, we analyze whether the eligibility gap and the reduction of it following the information treatment is concentrated on individuals with certain characteristics. First, we focus on the importance of incentives as measured by the fraction of total retirement income that will be made up by social security. We then turn to explore the importance of learning costs by examining how the effect of the information treatment varies by educational attainment.

6.1 The Importance of Incentives

The importance of social security payments for people potentially depends on how much retirement savings they have and expect to accumulate until they retire. If people expect to rely more on social security payments in retirement, then they might also be more attentive to changes changes in social security eligibility and this is potentially an important source of heterogeneity.

In this section we explore whether such incentive effects are important. We do this in several steps. First, we elicit, at the individual level, how sensitive retirement plans are to changes in the social security eligibility age. We then investigate whether retire-

ment sensitivity is correlated with expected retirement income. Finally, we explore how retirement sensitivity predicts the effect of the information treatment.

To quantify how sensitive retirement age is to the age at which respondents become eligible for social security we elicit retirement beliefs conditional on being eligible for social security at age 65, the universal eligibility age before the policy, as well as retirement beliefs conditional on being eligible as specified in Table 1. The specific questions are listed in Appendix C. In both cases, beliefs are elicited using the balls-in-bins method.

Retirement sensitivity (RS) is defined

$$RS = \frac{\mathbb{E}\left[\text{RetAge}|\text{TableAge}\right] - \mathbb{E}\left[\text{RetAge}|\text{Age65}\right]}{\text{TableAge} - 65} \tag{7}$$

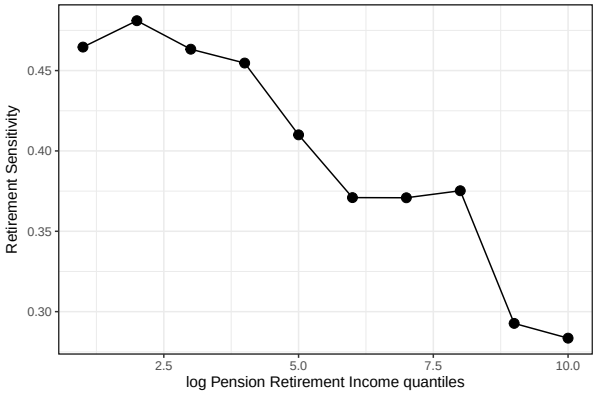
RS essentially quantifies how much the mean expected retirement age is moved relative to how much the social security eligibility policy changes the social security age. We also elicit beliefs about expected retirement income arising from pension savings (see the exact question in the appendix).

To learn about how retirement sensitivity varies with the importance of social security in retirement income, we present in Figure 4 a binned scatter plot of retirement sensitivity, RS, against deciles of expected retirement income. At high levels of expected retirement income, social security is relatively less important as a source of income in retirement, i.e., the financial incentive provided by social security is smaller the higher is expected retirement income. The figure shows that retirement sensitivity is clearly negatively correlated with the expected retirement income level.[8] This indicates that the financial incentive matters for the retirement sensitivity to the social security eligibility age.

In order to investigate how retirement sensitivity impact the beliefs about social security eligibility, we split the sample in to two equally sized groups by the size of the retirement sensitivity measure, RS. The results are shown in Figure 9. The low sensitivity group has a large eligibility gap, and the high sensitivity group has a small eligibility gap. The treatment reduces the eligibility gap for both groups.

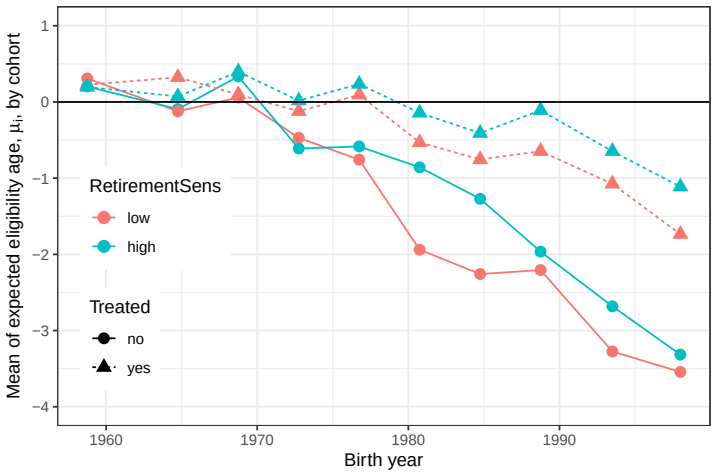
[8]Table 9 in the appendix shows that the finding from Figure 8 replicates in a regression with and without controls.

Figure 8: *Pension income, deciles*



Notes: The figure shows a binned scatter plot of retirement sensitivity (c.f., equation (7)) and deciles of expected pension income.

Figure 9: *Social Security Eligibility Beliefs by above/below Median Retirement Sensitivity*



Notes: Social Security Eligibility Beliefs of Treatment and Control Groups by above/below median retirement sensitivity. Dots and triangles indicate averages within cohorts that share the same statutory eligibility age. Triangles refer to the information treatment group and dots refer to the control group. Red is for the above average RS group and green is for the below average RS group.

In order to gain more detailed insight into the role of retirement sensitivity we run the following regression:

$$y_i = \beta_0 + \beta_1 Treated_i + \beta_2 RS_i + \beta_3 (Treated_i \times RS_i) \tag{8}$$

where $Treated_i$ is an indicator for being information treated, RS_i is the retirement sensitivity and y_i is the eligibility gap, i.e. the absolute distance between the statutory

eligibility age and the mean of the subjective belief about the social security eligibility age. The results are reported in Table 4. Consistent with theories of rational inattention they show that an increase in retirement sensitivity is associated with a reduced social security eligibility gap. As already seen, the information treatment reduces the eligibility gap.

Finally, the results in Table 4 show that there is no additional effect from the interaction between retirement sensitivity and the treatment indicator. As the treated has a lower eligibility gap than the untreated this means that the *relative* impact of retirement sensitivity on the eligibility gap is bigger. This suggest that people with a high level of retirement sensitivity have higher costs of gathering information about the consequences of the social security eligibility reform.

Table 4: *Regression analysis on Retirement Sensitivity and the information treatment*

	Dependent variable:
	Absolute eligibility gap
Treatment	-0.614^{***} (0.059)
Retirement Sensitivity	-0.259^{***} (0.076)
Treatment x Retirement Sensitivity	0.059 (0.103)
Observations	7,982
R^2	0.076
Controls	*Yes*

Notes: Reference group is untreated, Retirement Sensitivity ranges from -0.35 to 1.33 (1% and 99%). Robust standard error in parenthesis. */**/*** represent significance level 10/5/1%. The regression includes an intercept, but the estimate is not reported. Controls include gender, education, income decile dummies, expected retirement income deciles, and a dummy for currently working. Table 6 in the Appendix shows the regressions with and without controls. Table 7 in the Appendix shows the regressions with and without controls and interacted with eligibility age.

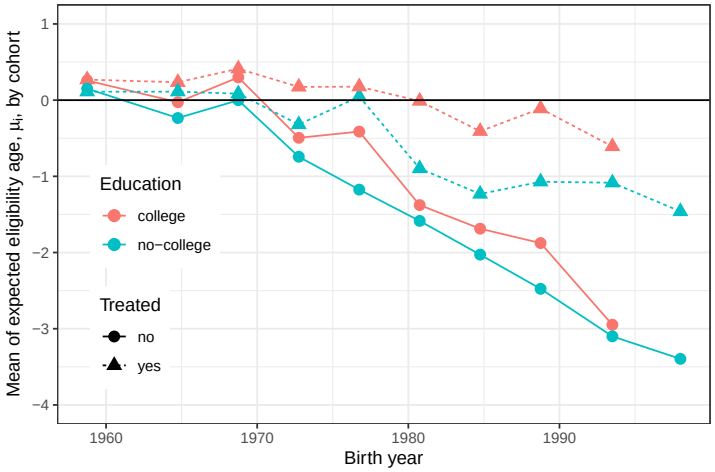
6.2 Heterogeneity by Education

Learning is arguably correlated with educational attainment. In figure 10 we split the sample into respondents with and without a college degree (Bachelor level or higher). The figure shows the deviations from the statutory eligibility ages in average mean beliefs (dots are control group, triangles are treated) - they are directly comparable to the dots and triangles in figure 3 panel (a), normalized to the horizontal lines. The figure shows that the college educated category has a smaller eligibility gap for both treatment and

control groups, and the treatment reduces eligibility gap more for the college educated category. These findings are confirmed in a regression analysis presented in Table 10 in the Appendix.

Overall, we find that the eligibility gap is sensibly correlated with indicators for incentives and learning ability.

Figure 10: *Beliefs by College Completion*



Notes: Social Security Eligibility Beliefs of Treatment and Control Groups by by College Completion. Dots and triangles indicate averages within cohorts that share the same statutory eligibility age. Triangles refer to the information treatment group and dots refer to the control group. Red is for the college group and green is for the no-college group. No mean is plotted for the youngest cohort in the college group. This is because there are few observations in this cell since few individuals in this cohort have completed college in 2018 where the register data about college completion are recorded.

7 Conclusion

We study how a Danish 2006 staggered social security eligibility reform has shaped subjective beliefs about when people become eligible for social security. We show that people have not internalized the original policy announcement. The degree of internalization decreases and the subjective uncertainty increases in the distance to eligibility. We conduct a simple information treatment experiment, where we display the statutory eligibility ages to half of the sample by random selection. The information treatment reduces the gap between the age displayed in the table and the subjective belief. The subjective uncertainty is not affected by the information treatment, a result that arguably reflects

inherent policy uncertainty.

Our findings have important implications for policy and for the conceptual understanding of how policy communication about social security eligibility reforms is internalized by the population. In terms of policy, we document that the original policy announcement has not been successful in conveying the consequences of the reform well to the Danish population at large. Moreover, the fact that a very simple information treatment can move people's beliefs such that the eligibility gap is reduced suggests that simple communication measures can radically improve internalization of the policy and help people plan better for their retirement. Our study also characterizes groups in the population who are particularly responsive to information. For example, those who have the biggest financial incentive to learn about the policy are in fact most likely to have acquired the information by themselves. This should be useful for policy makers who wish to design targeted information about the policy to achieve the most when planning their policy communication strategy.

We develop a model that conceptualizes how information about social security reform is internalized by those targeted by the policy. The model specifies the driving forces that shape peoples' beliefs. A key feature of the model is that inherent policy uncertainty is important in shaping subjective beliefs. Equally important, the model allows for incomplete updating reflecting that it is costly for people to internalize policy information. Appropriately calibrated, the model can replicate the empirical findings and be used to quantify how valuable policy communication is. Viewed through the lens of the model, policy communication, such as our information treatment, have significant effects, and repeated information treatments would likely be effective in moving peoples beliefs even further. As the costs of providing this information are very low our framework suggests that policy communication is an under-used policy instrument.

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A Full Regression Tables

Table 5: *Regression analysis on baseline beliefs and effect of information treatment*

	Dependent variable			
	Eligibility gap		subjective variance	
	(1)	(2)	(3)	(4)
Eligibility age: 68	0.344*** (0.094)	0.393*** (0.097)	0.448*** (0.118)	0.479*** (0.127)
Eligibility age: 69	0.035 (0.095)	0.117 (0.098)	0.839*** (0.120)	0.806*** (0.128)
Eligibility age: 70	0.802*** (0.101)	0.834*** (0.104)	1.185*** (0.127)	1.223*** (0.136)
Eligibility age: 71	0.941*** (0.111)	0.990*** (0.114)	1.653*** (0.140)	1.659*** (0.149)
Eligibility age: 72	1.656*** (0.118)	1.767*** (0.121)	1.641*** (0.148)	1.524*** (0.158)
Eligibility age: 73	2.026*** (0.124)	2.071*** (0.128)	1.984*** (0.155)	1.913*** (0.167)
Eligibility age: 73.5	2.316*** (0.121)	2.433*** (0.129)	2.346*** (0.153)	2.218*** (0.169)
Eligibility age: 74	3.229*** (0.124)	3.183*** (0.147)	2.331*** (0.156)	2.143*** (0.193)
Eligibility age: 74.5	3.592*** (0.137)	3.589*** (0.169)	2.899*** (0.173)	2.290*** (0.221)
Treatment	0.012 (0.075)	0.078 (0.082)	−0.097 (0.095)	−0.106 (0.107)
Treatment x Eligibility age: 68	−0.328** (0.133)	−0.370*** (0.138)	0.212 (0.167)	0.227 (0.180)
Treatment x Eligibility age: 69	−0.095 (0.137)	−0.185 (0.141)	−0.0001 (0.173)	0.023 (0.185)
Treatment x Eligibility age: 70	−0.542*** (0.143)	−0.583*** (0.146)	0.156 (0.180)	0.157 (0.191)
Treatment x Eligibility age: 71	−0.881*** (0.154)	−0.950*** (0.158)	−0.101 (0.194)	−0.104 (0.206)
Treatment x Eligibility age: 72	−1.124*** (0.165)	−1.189*** (0.167)	−0.250 (0.207)	−0.172 (0.219)
Treatment x Eligibility age: 73	−1.113*** (0.171)	−1.185*** (0.176)	−0.396* (0.215)	−0.226 (0.230)
Treatment x Eligibility age: 73.5	−1.660*** (0.170)	−1.696*** (0.178)	−0.197 (0.214)	−0.156 (0.233)
Treatment x Eligibility age: 74	−2.181*** (0.179)	−2.169*** (0.200)	−0.261 (0.225)	−0.356 (0.261)
Treatment x Eligibility age: 74.5	−1.985*** (0.193)	−2.066*** (0.209)	0.153 (0.242)	0.579** (0.274)
Observations	9,572	7,982	9,572	7,982
R^2	0.188	0.203	0.119	0.121
Controls	No	Yes	No	Yes

Notes: Reference group is untreated with eligibility age x 67. Regressions include an intercept, but the estimate is not reported. Controls include gender, education, income decile dummies, expected retirement income deciles, and a dummy for currently working. Robust standard error in parenthesis. */**/*** represent significance level 10/5/1%.

Table 6: *Regression analysis on Retirement Sensitivity and the information treatment*

	Dependent variable			
	Eligibility gap		Subjective variance	
	(1)	(2)	(3)	(4)
Treatment	−0.644*** (0.061)	−0.614*** (0.059)	−0.099 (0.075)	−0.074 (0.075)
Retirement Sensitivity	−0.124 (0.076)	−0.259*** (0.076)	−0.248*** (0.094)	−0.189* (0.097)
Treatment x Retirement Sensitivity	−0.002 (0.105)	0.059 (0.103)	−0.044 (0.130)	−0.003 (0.131)
Observations	8,727	7,982	8,727	7,982
R^2	0.024	0.076	0.003	0.041
Controls	*No*	*Yes*	*No*	*Yes*

Notes: Reference group is untreated. Regressions include and intercept, but the estimate is not reported.
Controls include gender, education, income decile dummies, expected retirement income deciles, and a dummy for currently working.
Robust standard error in parenthesis. */**/*** represent significance level 10/5/1%.

Table 7: *Regression analysis on Retirement Sensitivity and the information treatment*

	Dependent variable			
	Eligibility gap		Subjective variance	
	(1)	(2)	(3)	(4)
Treatment	0.070 (0.097)	0.087 (0.095)	−0.220* (0.125)	−0.198 (0.124)
Retirement Sensitivity	0.132 (0.133)	0.017 (0.131)	−0.325* (0.171)	−0.292* (0.172)
Eligibility age: 68	0.397*** (0.129)	0.453*** (0.128)	0.422** (0.166)	0.467*** (0.168)
Eligibility age: 69	0.230* (0.136)	0.356*** (0.134)	0.871*** (0.174)	0.907*** (0.176)
Eligibility age: 70	0.747*** (0.151)	0.834*** (0.148)	1.184*** (0.194)	1.206*** (0.194)
Eligibility age: 71	1.134*** (0.165)	1.170*** (0.163)	1.748*** (0.211)	1.782*** (0.214)
Eligibility age: 72	2.307*** (0.177)	2.407*** (0.176)	1.884*** (0.227)	1.802*** (0.231)
Eligibility age: 73	2.742*** (0.191)	2.715*** (0.191)	2.149*** (0.245)	2.150*** (0.251)
Eligibility age: 73.5	2.578*** (0.190)	2.659*** (0.195)	2.405*** (0.244)	2.034*** (0.256)
Eligibility age: 74	3.733*** (0.192)	3.646*** (0.211)	2.388*** (0.246)	2.473*** (0.277)
Eligibility age: 74.5	3.813*** (0.229)	3.886*** (0.241)	2.721*** (0.294)	2.589*** (0.317)
Treatment x Retirement Sensitivity	−0.081 (0.178)	−0.037 (0.175)	0.342 (0.229)	0.327 (0.229)
Treatment x Eligibility age: 68	−0.532*** (0.184)	−0.563*** (0.180)	0.520** (0.236)	0.487** (0.237)
Treatment x Eligibility age: 69	−0.108 (0.195)	−0.260 (0.193)	0.178 (0.251)	0.120 (0.253)
Treatment x Eligibility age: 70	−0.393* (0.207)	−0.465** (0.203)	0.467* (0.266)	0.507* (0.266)
Treatment x Eligibility age: 71	−0.860*** (0.229)	−0.933*** (0.227)	0.355 (0.294)	0.250 (0.298)
Treatment x Eligibility age: 72	−1.434*** (0.247)	−1.444*** (0.244)	−0.367 (0.317)	−0.471 (0.320)
Treatment x Eligibility age: 73	−1.678*** (0.258)	−1.486*** (0.259)	−0.166 (0.332)	−0.055 (0.340)
Treatment x Eligibility age: 73.5	−1.543*** (0.258)	−1.341*** (0.266)	−0.175 (0.332)	0.241 (0.349)
Treatment x Eligibility age: 74	−2.336*** (0.276)	−2.462*** (0.298)	0.168 (0.355)	−0.205 (0.391)
Treatment x Eligibility age: 74.5	−1.905*** (0.313)	−2.221*** (0.317)	0.819** (0.402)	0.549 (0.417)
Retirement Sensitivity x Eligibility age: 68	−0.117 (0.203)	−0.133 (0.201)	0.104 (0.261)	0.143 (0.265)
Retirement Sensitivity x Eligibility age: 69	−0.452* (0.243)	−0.573** (0.240)	−0.155 (0.312)	−0.136 (0.315)
Retirement Sensitivity x Eligibility age: 70	0.034 (0.247)	0.003 (0.244)	0.097 (0.318)	0.171 (0.320)
Retirement Sensitivity x Eligibility age: 71	−0.553* (0.313)	−0.446 (0.311)	−0.310 (0.402)	−0.208 (0.409)
Retirement Sensitivity x Eligibility age: 72	−1.479*** (0.305)	−1.459*** (0.309)	−0.623 (0.392)	−0.523 (0.406)
Retirement Sensitivity x Eligibility age: 73	−1.838*** (0.366)	−1.611*** (0.370)	−0.504 (0.471)	−0.496 (0.486)
Retirement Sensitivity x Eligibility age: 73.5	−0.628* (0.358)	−0.581 (0.376)	−0.097 (0.460)	0.533 (0.493)
Retirement Sensitivity x Eligibility age: 74	−1.300*** (0.376)	−1.272*** (0.420)	−0.213 (0.483)	−0.846 (0.552)
Retirement Sensitivity x Eligibility age: 74.5	−0.354 (0.450)	−0.820* (0.489)	0.228 (0.579)	−0.788 (0.643)
Treatment x Retirement Sensitivity x Eligibility age: 68	0.380 (0.278)	0.414 (0.276)	−0.640* (0.358)	−0.631* (0.363)
Treatment x Retirement Sensitivity x Eligibility age: 69	0.036 (0.351)	0.179 (0.348)	−0.477 (0.451)	−0.355 (0.457)
Treatment x Retirement Sensitivity x Eligibility age: 70	−0.246 (0.339)	−0.246 (0.334)	−0.747** (0.435)	−0.905** (0.438)
Treatment x Retirement Sensitivity x Eligibility age: 71	−0.015 (0.426)	−0.011 (0.424)	−1.039* (0.547)	−0.930* (0.557)
Treatment x Retirement Sensitivity x Eligibility age: 72	0.725* (0.423)	0.615 (0.424)	0.301 (0.544)	0.567 (0.556)
Treatment x Retirement Sensitivity x Eligibility age: 73	1.205** (0.495)	0.728 (0.502)	−0.466 (0.636)	−0.568 (0.659)
Treatment x Retirement Sensitivity x Eligibility age: 73.5	−0.381 (0.495)	−0.936* (0.522)	−0.464 (0.636)	−1.093 (0.686)
Treatment x Retirement Sensitivity x Eligibility age: 74	0.470 (0.530)	0.856 (0.574)	−1.029 (0.681)	−0.331 (0.754)
Treatment x Retirement Sensitivity x Eligibility age: 74.5	−0.297 (0.594)	0.492 (0.635)	−1.214 (0.763)	0.103 (0.834)
Observations	8,727	7,982	8,727	7,982
R^2	0.200	0.215	0.117	0.128
Controls	*No*	*Yes*	*No*	*Yes*

Notes: Regressions include and intercept, but the estimate is not reported. Reference group is untreated.
Controls include gender, education, income decile dummies, expected retirement income deciles, and a dummy for currently working.
Robust standard error in parenthesis. */**/*** represent significance level 10/5/1%.

Table 8: *Regression analysis of retirement age belief on statutory eligibility age and dummy for information treatment.*

	Dependent variable Retirement Beliefs			
	Eligibility gap		Subjective Variance	
	(1)	(2)	(3)	(4)
Eligibility age: 68	0.883*** (0.174)	0.883*** (0.174)	0.358** (0.178)	0.393** (0.180)
Eligibility age: 69	1.542*** (0.171)	1.583*** (0.172)	0.721*** (0.175)	0.758*** (0.179)
Eligibility age: 70	1.837*** (0.180)	1.844*** (0.181)	1.591*** (0.185)	1.685*** (0.188)
Eligibility age: 71	2.536*** (0.199)	2.503*** (0.201)	1.516*** (0.205)	1.540*** (0.208)
Eligibility age: 72	2.680*** (0.202)	2.587*** (0.207)	1.670*** (0.207)	1.657*** (0.214)
Eligibility age: 73	3.402*** (0.220)	3.319*** (0.225)	1.984*** (0.226)	1.947*** (0.234)
Eligibility age: 73.5	3.281*** (0.216)	3.150*** (0.228)	1.876*** (0.222)	1.791*** (0.237)
Eligibility age: 74	3.374*** (0.214)	3.324*** (0.248)	2.584*** (0.220)	2.620*** (0.257)
Eligibility age: 74.5	3.717*** (0.249)	3.685*** (0.295)	2.766*** (0.256)	2.471*** (0.306)
Treatment	−0.081 (0.144)	−0.120 (0.145)	−0.182 (0.148)	−0.161 (0.150)
Treatment x Eligibility age: 68	0.542** (0.243)	0.632*** (0.244)	0.186 (0.249)	0.181 (0.253)
Treatment x Eligibility age: 69	−0.172 (0.248)	−0.023 (0.251)	0.226 (0.255)	0.220 (0.261)
Treatment x Eligibility age: 70	0.821*** (0.252)	0.932*** (0.252)	−0.232 (0.259)	−0.356 (0.261)
Treatment x Eligibility age: 71	0.579** (0.278)	0.649** (0.280)	0.298 (0.286)	0.285 (0.290)
Treatment x Eligibility age: 72	1.174*** (0.294)	1.254*** (0.297)	−0.360 (0.302)	−0.393 (0.308)
Treatment x Eligibility age: 73	1.084*** (0.304)	1.038*** (0.311)	−0.149 (0.312)	0.065 (0.322)
Treatment x Eligibility age: 73.5	1.609*** (0.305)	1.561*** (0.319)	0.176 (0.313)	0.326 (0.331)
Treatment x Eligibility age: 74	1.921*** (0.306)	2.009*** (0.332)	−0.437 (0.314)	−0.736** (0.344)
Treatment x Eligibility age: 74.5	1.056*** (0.346)	1.143*** (0.365)	−0.495 (0.356)	−0.390 (0.378)
Observations	4,332	3,946	4,332	3,946
R^2	0.330	0.348	0.116	0.138
Controls	*No*	*Yes*	*No*	*Yes*

Notes: Regressions include an intercept, but the estimate is not reported. Reference group is untreated with eligibility age 67, Intercept is 67.26 for column (1). Only half of the respondents were asked this question. Robust standard error in parenthesis. */**/*** represent significance level 10/5/1%. Controls include gender, education, income decile dummies, expected retirement income deciles, and a dummy for currently working.

Table 9: *Regression analysis of retirement sensitivity on pension income deciles*

	Dependent variable:	
	Retirement sensitivity	
	(1)	(2)
Pension income decile 2	0.014 (0.020)	−0.007 (0.021)
Pension income decile 3	−0.007 (0.020)	−0.016 (0.021)
Pension income decile 4	−0.013 (0.020)	−0.014 (0.021)
Pension income decile 5	−0.053*** (0.020)	−0.050** (0.021)
Pension income decile 6	−0.093*** (0.020)	−0.071*** (0.021)
Pension income decile 7	−0.096*** (0.020)	−0.062*** (0.021)
Pension income decile 8	−0.101*** (0.020)	−0.045** (0.021)
Pension income decile 9	−0.178*** (0.020)	−0.096*** (0.022)
Pension income decile 10	−0.177*** (0.020)	−0.102*** (0.022)
Constant	0.468*** (0.014)	
Observations	8,466	7,981
R^2	0.025	0.056
Adjusted R^2	0.024	0.053
Controls	*No*	*Yes*

Notes: Reference group is pension income decile 1, Retirement Sensitivity ranges from -0.35 to 1.33 (1% and 99%). Regressions include an intercept, but the estimate is not reported. Robust standard error in parentheses. */**/*** represent significance level 10/5/1%. Controls include gender, education, income decile dummies, and a dummy for currently working.

Table 10: *Regression analysis on baseline beliefs and effect of information treatment for college/no-college Education*

	Dependent variable:	
	Eligibility gap	
	College	No-college
Eligibility age: 68	0.312** (0.137)	0.412*** (0.140)
Eligibility age: 69	0.059 (0.129)	0.119 (0.152)
Eligibility age: 70	0.727*** (0.134)	0.842*** (0.163)
Eligibility age: 71	0.638*** (0.146)	1.277*** (0.182)
Eligibility age: 72	1.654*** (0.149)	1.706*** (0.202)
Eligibility age: 73	1.956*** (0.158)	2.164*** (0.209)
Eligibility age: 73.5	2.117*** (0.157)	2.601*** (0.209)
Eligibility age: 74	2.945*** (0.188)	3.187*** (0.204)
Eligibility age: 74.5	3.485*** (0.524)	3.317*** (0.192)
Treatment	0.029 (0.113)	0.095 (0.120)
Treatment x Eligibility age: 68	−0.272 (0.191)	−0.429** (0.201)
Treatment x Eligibility age: 69	−0.206 (0.187)	−0.136 (0.216)
Treatment x Eligibility age: 70	−0.621*** (0.192)	−0.492** (0.226)
Treatment x Eligibility age: 71	−0.604*** (0.200)	−1.346*** (0.255)
Treatment x Eligibility age: 72	−1.368*** (0.207)	−0.824*** (0.283)
Treatment x Eligibility age: 73	−1.360*** (0.214)	−1.074*** (0.296)
Treatment x Eligibility age: 73.5	−1.806*** (0.213)	−1.648*** (0.294)
Treatment x Eligibility age: 74	−2.156*** (0.257)	−2.276*** (0.282)
Treatment x Eligibility age: 74.5	−2.830*** (0.772)	−2.001*** (0.243)
Observations	4,160	3,969
R^2	0.177	0.216
Controls	Yes	Yes

Notes: Reference group is untreated with eligibility age x 67. Regressions include an intercept, but the estimate is not reported. Robust standard error in parenthesis. */**/*** represent significance level 10/5/1%. Controls include gender, education, income decile dummies, expected retirement income deciles, and a dummy for currently working.

Table 11: *Regression analysis on baseline beliefs and effect of information treatment for low/high Retirement Sensitivity*

	Dependent variable:	
	Eligibility gap	
	Low RSS	High RSS
Eligibility age: 68	0.456*** (0.153)	0.294** (0.119)
Eligibility age: 69	0.344** (0.157)	−0.127 (0.118)
Eligibility age: 70	0.851*** (0.165)	0.766*** (0.126)
Eligibility age: 71	1.009*** (0.180)	0.828*** (0.138)
Eligibility age: 72	2.229*** (0.190)	1.093*** (0.147)
Eligibility age: 73	2.541*** (0.202)	1.540*** (0.152)
Eligibility age: 73.5	2.374*** (0.207)	2.223*** (0.147)
Eligibility age: 74	3.249*** (0.216)	2.810*** (0.171)
Eligibility age: 74.5	3.620*** (0.250)	3.169*** (0.198)
Treatment	0.091 (0.131)	0.021 (0.099)
Treatment x Eligibility age: 68	−0.523** (0.220)	−0.167 (0.167)
Treatment x Eligibility age: 69	−0.269 (0.227)	−0.079 (0.169)
Treatment x Eligibility age: 70	−0.510** (0.231)	−0.623*** (0.178)
Treatment x Eligibility age: 71	−0.955*** (0.253)	−0.875*** (0.190)
Treatment x Eligibility age: 72	−1.513*** (0.268)	−0.782*** (0.202)
Treatment x Eligibility age: 73	−1.525*** (0.278)	−1.006*** (0.211)
Treatment x Eligibility age: 73.5	−1.584*** (0.278)	−2.000*** (0.209)
Treatment x Eligibility age: 74	−2.303*** (0.304)	−2.054*** (0.229)
Treatment x Eligibility age: 74.5	−2.017*** (0.330)	−2.005*** (0.255)
Observations	4,100	4,022
R^2	0.194	0.226
Controls	Yes	Yes

Notes: Reference group is untreated with eligibility age x 67. Regressions include an intercept, but the estimate is not reported. Robust standard error in parenthesis. */**/*** represent significance level 10/5/1%. Controls include gender, education, income decile dummies, expected retirement income deciles, and a dummy for currently working.

B Summary Statistics

Table 12: *Balance Table*

	Respondent	Non-respondent	Difference
N	9,572	62,594	
female	0.492	0.494	-0.002
	(0.5)	(0.5)	(0.005)
age	48.292	43.648	4.643
	(12.23)	(12.969)	(0.135)
college	0.48	0.329	0.151
	(0.5)	(0.47)	(0.005)
employed	0.852	0.781	0.071
	(0.355)	(0.413)	(0.004)
earnings	418,994	338,201	80,793
	(309,929)	(268,786)	(3,522)
wealth	336,837	186,465	150,373
	(3,726,172)	(2,102,302)	(39,002)
pension	953,363	573,280	380,083
	(1,291,520)	(1,039,111)	(13,909)

Notes: In column 2 and 3 the number in parentheses is standard deviation. In the Difference column it is standard error from a Welch Two Sample t-test. Variables measuring income and wealth are in DKK. Parentheses in column 1 and 2 are standard deviations. In column 3 parentheses are standard errors of difference.

Table 13: *Tabulation by social security eligibility age*

Eligibility age	Control	Treatment
67.00	1248	1297
68.00	614	591
69.00	586	520
70.00	496	488
71.00	384	421
72.00	331	344
73.00	293	322
73.50	306	318
74.00	289	263
74.50	227	234

C Additional Survey Instruments

Income 2020

What was your earned income during 2020?
Please report the most accurate value you think:

Retirement wealth 2020

Consider how much wealth you have accumulated in total in pension accounts by now.
Please report your belief about this accumulated amount.
Lowest possible amount:
Highest possible amount:
Please enter all 20 balls in the bins

Social Security

At what age do you expect to become eligible for social security?
Please enter all 20 balls in the bins

Retirement I

How old do you expect to be when you retire?
Please consider the various factors that are uncertain and that may affect your retirement age (for example, health, savings, or other factors that may be important).
Please enter all 20 balls in the bins

Retirement II

Suppose that you first become eligible for social security at the age of 65.
At what age do you expect to retire?
Please enter all 20 balls in the bins

Retirement III

Suppose that you first become eligible for social security at the age of [Table age]. At what age do you believe to retire?
Please enter all 20 balls in the bins

Income from Pension Wealth

Suppose you retire at age [Table age], and suppose you stay in your current job until retirement. How much annual income in retirement do you believe your pension would provide?
Lowest possible amount:
Highest possible amount:
Please enter all 20 balls in the bins

D A Simple Model of Belief Updating, Appendix Figures

Figure 11: $\mu_{c,y}$

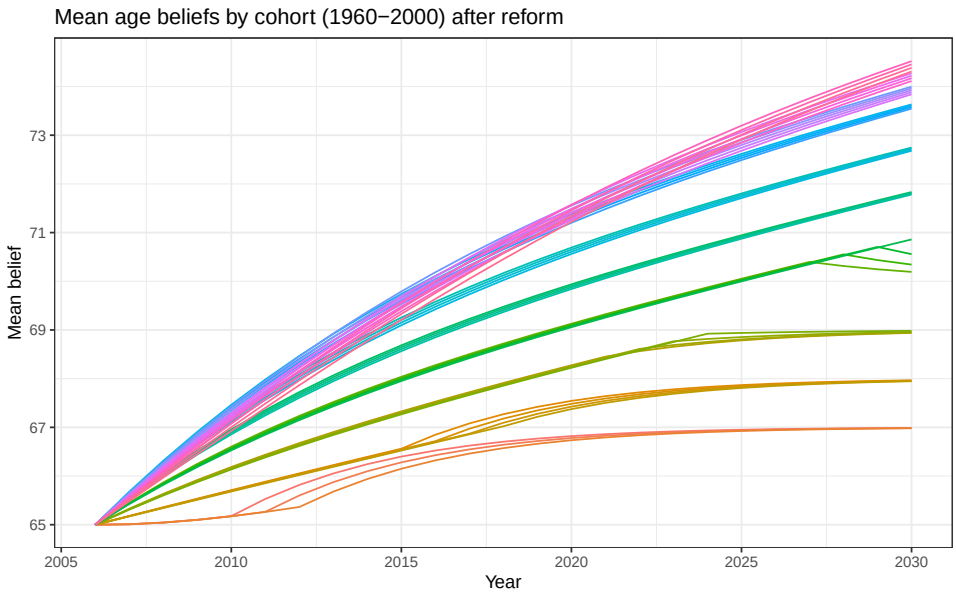


Figure 12: $\sigma_{c,y}$

