The Causal Effects of Economic Incentives, Health and Job Characteristics on Retirement: Estimates Based on Subjective Conditional Probabilities*

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ABSTRACT

Data on subjective conditional probabilities, such as the probability of working after age 70 conditional on being in good health versus conditional on being in bad health, constitute an informative tool to study causal effects. Under the assumption that respondents are able to accurately envision their work effort under the conditioning events, the difference between the two conditional probabilities, which we call the subjective causal effect, would be a good indicator of the actual causal effect. We fielded a survey in the RAND American Life Panel that asked about working at age 70 under varying conditions of health, wage rate, wealth, longevity, and several job characteristics. We find that the subjective causal effect of health on retirement is substantial as are alterations in the wage rate and large windfall gains in wealth. Of the job characteristics we asked about, the ability to work flexible hours, becoming self-employed, reduced stress and physical effort, and reduced commuting times had the largest effects. In contrast, the subjective causal effects of longevity, and having a part-time job were small. The estimated causal effects were typically larger for workers and for low-income individuals. We conclude that subjective conditional probabilities may be useful tools in estimating causal effects of economic incentives and job characteristics on labor supply.

Key words: subjective causal effects, retirement, health, job characteristics, expectations

JEL codes: J26, D84

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1. Introduction

Because of increasing life expectancies in all developed countries, it has been frequently argued that it would be desirable if people retired at later ages (Maestas and Zissimopoulos, 2010). Longer working lives would improve older individuals' financial security and it would potentially relieve some of the financial pressures on entitlement programs such as Social Security, Medicare and Medicaid in the U.S. A large economic literature has focused on understanding how various socio-economic, and institutional factors as well as business practices affect retirement (e.g., Bound, Cullen, Nichols & Schmidt, 2004; Bound, Stinebrickner & Waidmann, 2010; French & Jones, 2011; Gruber & Wise, 2004; Gustman & Steinmeier, 2005; Maestas et al, 2017; Maestas, Mullen & Strand, 2013).

Estimating the causal effects of certain factors on retirement, however, has been challenging, because it is hard, if not impossible, to find exogeneous variation in these factors. For example, even though the wage rate, financial wealth, and individuals' health all strongly correlate with retirement patterns, it is not known how much of the correlation is due to a causal mechanism. Individuals with different levels of income and wealth likely differ in many important personal characteristics, such as unobserved personal productivity or preferences for present and future outcomes (personal discount rate). Similarly, the health of workers and the characteristics of their jobs, such as the flexibility of work hours, likely interact with the workers' unobserved characteristics in the way they influence retirement decisions.

This paper introduces an alternative strategy: estimating the *subjective causal effect* of many factors on retirement. We ask individuals about the probabilities that they would work after age 70 conditional on varying financial incentives, future health and varying job characteristics, and quantify how individuals change their stated subjective probabilities of retirement.

Subjective unconditional probabilities, such as the probability of working after age 65, have been used in a wide variety of research, such as the effect of health on retirement, or forecasts of labor force participation (Hurd, 2009). There is little research, however, on *subjective conditional probabilities*, such as the probabilities of working after age 70 conditional on being in good health. By asking multiple questions with varying conditions, subjective conditional probabilities can be used to recover the *subjective* causal effects of the conditions (i.e. health) on outcomes (retirement). This approach is related to stated preferences, with the important difference that the probability format of subjective conditional probabilities offers individuals the opportunity to express uncertainty. Stated choices typically do not allow any nuance in response; the respondent has to choose one or the other. Our

approach provides a novel way to study causality, and if successful, it could be applied across a wide range of topics in social science.

Like subjective probabilities in general, subjective conditional probabilities have the desirable property that they are properly scaled so that it may be possible to compare average responses to the corresponding actual outcomes. Such a comparison is not possible with qualitatively stated responses (Manski, 2004).

In the RAND American Life Panel (ALP) we asked a series of questions about the subjective probabilities that individuals would work after age 70 conditional on their future health, income, wealth, longevity and conditional on a number of job characteristics. Among others, we considered the effects of reduced and flexible work hours, shorter commutes, self-employment, and having physically, cognitively and mentally less demanding jobs.

We hypothesized that respondents would find it easier to form and report conditional probabilities than joint probabilities, such as the probability of good health *and* working after age 70. The latter is cognitively more demanding, and we had observed in an earlier survey that few respondents were able to compute the joint probability of two events in a relatively simple example. To find out whether our hypothesis was correct, we also queried some joint subjective probabilities along with the conditional probabilities.

This paper first presents indicators of the validity of the subjective conditional probability measures: we examine if the responses are internally and externally consistent; and we compare randomized question formats. Second, we estimate subjective causal effects, and, in some cases, we compare them to objective values from the Health and Retirement Study (HRS).

We find that the means and the distributions of subjective conditional expectations show strong consistency with each other and with the unconditional probabilities, and conclude that they are promising tools to study causality in retirement behavior. This stands in contrast to responses to joint probability questions which we found to be largely inconsistent with unconditional probabilities. It appears that respondents have difficulties to form joint probabilities, while thinking in terms of single conditioning events seems to work well. We conclude that breaking up joint events into single conditions increases the quality of answers.

Our estimates of the subjective causal effects of health, income, and wealth on retirement are large, while the effect of longevity on retirement is considerably smaller. As for job characteristics, working in

a job that permits flexible hours, offers a short commute, is not physically demanding, or is not stressful would each increase the subjective probability of working after age 70 by 10 to 15 percentage points on a base of about 30.0%.

Our framework permits estimating subjective causal effects at the individual level, which is typically not possible from revealed preference data. We find that the casual effects tended to be larger for those who worked compared to those who did not, possibly because the latter group included individuals who already left the labor market and faced large hurdles of re-entry. We also typically found larger subjective effects for poorer individuals. We saw small and non-consistent differences by gender, race, education, and health.

2. Subjective causal effects: Theory

This section illustrates how subjective conditional probabilities can be used in economic analysis. Imagine that we are interested how factor X affects the retirement decisions of workers. X, for example, could be a particular working condition, such as flexible work schedules.

A policy maker may be interested in whether and by how much the mandatory adoption of X would increase the fraction of the population working after age 70. The causal effect, Δ, of the factor on the employment rate is given by:

$$\Delta = F\left(W_{70} \mid X = 1\right) - F(W_{70} \mid X = 0), \tag{1.1}$$

where $F\left(W_{70} \mid X = 1\right)$ denotes the fraction of the labor force that would be working after age 70 if all workers had a job with X, $F\left(W_{70} \mid X = 0\right)$ denotes the same fraction without X. The fundamental identification problem is that individuals can only be observed in one state, that is, if X is either 0 or 1. Unless the factor is randomly assigned, the observed difference between the set of individuals with and without X does not yield the causal effect of X.

Our approach is to replace $F\left(W_{70} \mid X = j\right)$ with the average of the subjective conditional probability that individuals would work under the two hypothetical states:[1]

[1] If one of the scenarios coincides with the status quo then there would be only one hypothetical scenario.

$$\Delta^S = \frac{1}{N}\sum_{i=1}^{N}\Delta_i^S, \tag{1.2}$$

$$\Delta_i^S = \Pr_i\left(W_{70} \mid X = 1\right) - \Pr_i\left(W_{70} \mid X = 0\right), \tag{1.3}$$

where $\Pr_i\left(W_{70} \mid X = 1\right)$ denotes individual *i*'s subjective conditional probability of working after age 70 if the factor applies, $\Pr_i\left(W_{70} \mid X = 0\right)$ denotes his or her subjective conditional probability of working without the factor, Δ_i^S is the subjective causal effect on individual *i*, and Δ^S is the average subjective causal effect of the factor.

Because all individuals in the sample are asked about their work expectations if the factor is turned on and in the counterfactual state in which the factor is turned off, the fundamental problem of identification does not apply. This is a major advantage of this approach.

A related stated preference approach would ask individuals if they would work in the two scenarios (yes or no). Then the average of the yes/no answers might also identify the subjective effect of the factor. However, as pointed out by Manski (2004) and Juster (1966), that favorable outcome might not obtain. For example, if all individuals have a 45% probability of working past age 70, all may say they would not choose that outcome; yet in realization 45% would have. The main advantage of our approach is that it allows individuals to express their uncertainty about their future choices. For example, no one can know for sure how they would choose their labor force status in the future without fully observing all other important factors that may affect their future choices.

Subjective conditional probabilities provide a rich framework to evaluate policies and provide evidence that, in some ways, is superior to natural experiments and randomized controlled trials. First, as opposed to revealed preference data, which require the restrictive assumption that younger and older cohorts behave similarly, subjective conditional expectation questions can be directly asked from the target population, those younger individuals who are not yet retired.

Second, natural experiments and randomized controlled trials are often not feasible or just not available for social scientists. Instead, subjective conditional probabilities can be asked on a wide range of topics.

Third, subjective conditional probabilities provide information on possibly heterogeneous behavioral effects across individuals rather than a single "average treatment effect" such as is produced by a controlled trial (Deaton, 2010).

Fourth, it is far cheaper to collect and analyze data on subjective conditional probabilities than designing and implementing randomized controlled trials.

However, the value of conditional expectations depends on whether survey answers represent beliefs that individuals use to forecast their own future behavior and situation, and whether their forecasts are accurate. A potential concern with hypothetical questions, such as the subjective conditional expectations, is the "fill-in problem": do individuals provide *ceteris paribus* answers, or do they fill-in different unspecified future conditions? For example, when we ask about retirement probabilities conditional on a low future income, some individuals may infer that their (unspecified) future health would also be lower or that a low future income would accompany a job with reduced demands or harsh working conditions. In this paper we test the fill-in problem by randomly assigning individuals alternative question wordings, in which we either leave any other conditions unspecified (potentially suffering from the fill-in problem), or we explicitly specify some of these other conditions.

3. Data and methods

3.1. The RAND American Life Panel

We designed and fielded a survey of individuals over the age of 50 in the RAND American Life Panel (ALP). The ALP is an ongoing Internet panel survey with a sample of about 6,000 respondents over age 18, operated and maintained at RAND. It covers the U.S. population age 18 and over. The majority of the panel members have their own Internet access. RAND has ensured Internet access for the remaining panel members by providing a laptop or an Internet service subscription or both. Accordingly the sample does not suffer from selection due to a lack of Internet access. Post-stratification weights are provided so that after weighting, the ALP approximates the distributions of age, sex, ethnicity, education, and income in the Current Population Survey. About twice a month, respondents receive an email request to visit the ALP website to complete questionnaires that typically take no more than 30 minutes to finish. Respondents are paid an incentive of about $20 per 30 minutes of survey time, and pro-rated accordingly for shorter surveys. Response rates are typically between 75 and 85% of the enrolled panel members, depending on the topic, the time of year, and how long a survey is kept in the field.

A strength of the ALP is that it takes advantage of Internet technology. There turn-around time between questionnaire design and the fielding of a survey is short, facilitating rapid responses to new events or insights. Thus, surveys can be operated at high frequency, reducing the risk of missing events or the

effects on households. This speed is in sharp contrast to the large household surveys where the time from planning to fielding can be as much as a year, and the time from fielding to data availability can exceed a year.

The ALP has conducted a large number of longitudinal surveys of its respondents, so that over time it has accumulated data on a wide range of covariates. For example, ALP respondents have been asked about their financial knowledge, their retirement planning, and hypothetical questions designed to reveal parameters such as risk aversion. They have been given the HRS survey instrument in modules one at a time over an extended period, so that we have responses to the HRS health queries, income and asset data and to the HRS cognitive battery. These data can be linked to the data collected in any other ALP survey such as ours.

Our analytic sample consists of 1,691 individuals aged 50-69. In some cases we further restrict the sample based on labor force status.

3.2. Subjective retirement probabilities conditional on health

3.2.1. Data

Beyond the substantive interest of asking about the subjective effect of health (and other determinants), we also use these questions to validate the measures. For example, we examine if the unconditional retirement probabilities align with the conditional probabilities, and if the unconditional probabilities align with joint probabilities, in which we asked about the probabilities of joint events (i.e. labor force and health outcomes).

Among those aged 50-69 we asked a series of questions about current health, future health and work at age 70. First, we asked about current self-assessed health:

> *Would you say your health is excellent, very good, good, fair, or poor?"*

And we asked about the chances of future health. To reduce respondent burden we grouped future self-assessed health into "good" and "bad" with *good* being excellent, very good or good, and *bad* being fair or poor:

> *What are the chances that your health will be excellent, very good or good at age 70?*

We asked about the probability they would be doing any work for pay after age 70 (P70).[2]

> *What are the chances that you will be doing any work for pay after you reach age 70?*

We asked about the subjective probability of working after age 70 conditional on health being good, and the joint probability of good health and working after age 70. The purpose of this set of questions is to study the consistency of subjective probabilities with the laws of probability and to find the format that seems to produce the highest quality data.

The subjective conditional probability was queried as follows:

> *Suppose when you reach age 70 your health is excellent, very good or good. In that case what are the chances that you will be doing any work for pay after you reach age 70?*

A similar question was asked about P70 conditioning on future fair or poor health.

We elicited the joint probability as follows:

> *And what are the chances that both will happen: At age 70 your health will be excellent, very good or good, and you will be doing any work for pay after you reach age 70?*

We wanted to know whether question ordering mattered, so we randomized the order of questions: one group was first asked about the conditional probability of working at age 70 and then the joint probability; the order was reversed for the second group. We found that question order made little difference, and so we will not discuss the ordering further.

3.2.2. Methods: subjective causal effects and validation

The subjective causal effect of health is defined as the difference between the subjective probabilities of working conditional on good, and conditional on bad health:

$$\Delta_i^{health} = \Pr_i\left(W_{70} \mid H = G\right) - \Pr_i\left(W_{70} \mid H = B\right). \tag{1.4}$$

Both terms on the right-hand side are available in the survey.

[2] We asked about a target age of 70 because of the increasing labor force participation in the population at age 70 and because of the shifting effect of the Social Security full retirement age in these cohorts. The HRS has added a target age of 70 to its traditional target ages of 62 and 65.

To validate the conditional probabilities, we investigate if they are consistent with the reported unconditional probabilities, and the law of total probability:

$$\Pr_i\left(W_{70}\right) = \Pr_i\left(W_{70} \mid H = G\right)\Pr_i\left(H = G\right) + \Pr_i\left(W_{70} \mid H = B\right)\left(1 - \Pr_i\left(H = G\right)\right) \quad (1.5)$$

All terms in (1.5) are available in the survey, and we check if the reports satisfy the equation.

To inspect the consistency of the reported joint probabilities with the unconditional probability, we use the equation

$$\Pr_i\left(W_{70}\right) = \Pr_i\left(W_{70}, H = G\right) + \Pr_i\left(W_{70}, H = B\right). \quad (1.6)$$

We also compare the conditional probabilities in the ALP with conditional actual outcomes in the HRS.

3.3. Subjective retirement probabilities conditional on income

3.3.1. Data

In addition to eliciting the subjective response to income changes, we used these questions to test the fill-in problem by randomizing three versions of the questions regarding the effect of earnings on retirement.

> ***Version 1:*** *Suppose that Congress changed the tax system in a way that all workers above age 70 would bring home 20% more in wages compared to what they currently make.*
>
> *In this case, what are the chances that you would be doing any work for pay after you reach age 70?*

The objective of the wording of this question was to encourage the respondent to think that the demands of the job would not increase, and that no unspecified treatment of taxes would come into play.

It is possible that some individuals implicitly condition on (fill-in) being in good health when they answer the Version 1 question, even though the question does not intend to condition on health. To test this, the conditional statement in Version 2 further specified that individuals' health would be good at age 70:

> ***Version 2:*** *Suppose that Congress changed the tax system in a way that all workers above age 70 would bring home 20% more in wages compared to what they currently make. Suppose further that when*

you reach age 70, your health would be excellent, very good or good.

Similar responses to the Version 1 and Version 2 questions would suggest that Version 1 suffers from the fill-in problem (that some individuals assume good health). Conversely, if individuals provide higher probabilities of working when their health is explicitly conditioned to be good (Version 2), then we may conclude that Version 1 does not suffer from the fill-in problem.

Version 3 used a more compact wording:

Version 3: *Now imagine that you earned 20% more than you do now…*

While short and simple, this wording leaves open any fill-in. For example, individuals may assume that they make more money, because they are in better health or because they got a much better job than what they currently have. Furthermore, Version 3 could be interpreted as specifying that earnings would be 20% higher at the current age, and possibly at all future ages.

We followed each version with a corresponding version concerning pay reductions of 20%. For example, Version 1 was followed by

Now suppose instead that Congress changed the tax system in a way that all workers above age 70 would bring home 20% less in wages compared to what they currently make.

Each individual was assigned to the same version number in the wage decrease follow-up as in the wage increase question, and also in other experiments involving wealth and longevity.

3.3.2. Methods

The subjective causal effect of 20% wage increase would be

$$\Delta_i^{wage,*} = \Pr_i\left(W_{70} \mid \Delta y = 20\%\right) - \Pr_i\left(W_{70} \mid \Delta y = 0\%\right) \tag{1.7}$$

where $\Pr_i\left(W_{70} \mid \Delta y = 20\%\right)$ is the probability of working after age 70 if wages increase by 20%, and $\Pr_i\left(W_{70} \mid \Delta y = 0\%\right)$ is the probability that the wage rate remains the same. The counterfactual conditional probability, however, is not available in the survey. Instead, we use the conditional probability with respect to a 20% wage cut, and define the subjective causal effect as

$$\Delta_i^{wage} = \frac{\Pr_i\left(W_{70} \mid \Delta y = 20\%\right) - \Pr_i\left(W_{70} \mid \Delta y = -20\%\right)}{2}\ , \tag{1.8}$$

We divide this difference by 2, so that the estimated effect corresponds to a 20% (rather than 40%) change in wages.

Two alternative subjective causal effects can be defined:

$$\Delta_i^{wage,2} = \Pr_i\left(W_{70} \mid \Delta y = 20\%\right) - \Pr_i\left(W_{70}\right) \quad (1.9)$$

$$\Delta_i^{wage,3} = \Pr_i\left(W_{70}\right) - \Pr_i\left(W_{70} \mid \Delta y = -20\%\right) \quad (1.10)$$

(1.9) and (1.10) use slightly stronger assumptions than (1.8), but they allow comparing the effects of positive and negative shocks in wages. They assume that the unconditional $\Pr_i\left(W_{70}\right)$ probability is equivalent with the counterfactual conditional probability if the scenario is *not* implemented (i.e. $\Pr_i\left(W_{70} \mid \Delta y = 0\%\right)$). This would be true if people assign a 0% chance that Congress would adopt such tax changes in the future. This may be a reasonable assumption, given that there is no current discussion about such tax changes. But our preferred method is (1.8), because it is valid under milder conditions.

3.4. Subjective retirement probabilities conditional on wealth

3.4.1. Data

To test the fill-in problem also in another context, we randomized three versions of the questions regarding the effect of wealth on retirement:

> ***Version 1:*** *Now please think about your situation today, including your current health and financial situation. Suppose you were to inherit $500,000.*
>
> *In this case, what are the chances that you would be doing any work for pay after you reach age 70?*

This version explicitly directs the respondent toward a ceteris paribus interpretation. This is reinforced by specifying that the wealth shock is the result of an inheritance, rather than by, say, past saving which may cause the respondent to think of higher earnings.

> ***Version 2:*** *Suppose you were to inherit $500,000.*

This version does not restrict fill-in about (unspecified) aspects of the financial situation.

> ***Version 3:*** *Suppose you had $500,000 more in financial assets than you do today.*

In this version, the respondent may think that many other relevant things are different including past behaviors and earnings.

3.4.2. Methods

The subjective causal effect of $500,000 of wealth is

$$\Delta_i^{wealth} = \Pr_i\left(W_{70} \mid \Delta a = \$500,000\right) - \Pr_i\left(W_{70} \mid \Delta a = \$0\right). \quad (1.11)$$

The counterfactual conditional probability (i.e. working after 70 *without* inheriting $500k, $\Pr_i\left(W_{70} \mid \Delta a = \$0\right)$) is not available in the survey, and we replace it with the unconditional probability, $\Pr_i\left(W_{70}\right)$. Therefore, we assume that individuals either do not currently expect to inherit $500,000, or if they do, they interpreted our questions as receiving an *additional* $500,000. The question wording suggests such a ceteris paribus interpretation. Some individuals in the sample, however, may have expected a large inheritance and at the same time they did not interpret the conditional probability question as a ceteris paribus change in wealth. The subjective causal effects for these individuals would be biased toward zero, but we expect this bias to be small.

3.5. Subjective retirement probabilities conditional on longevity

3.5.1. Data

If people expect to live longer, they may need to retire at a later age. We randomized three versions of the questions regarding the effect of longevity on retirement.

> ***Version 1:*** *Now imagine that scientists discover a new medicine that adds an extra ten years to your life, and those would be 10 healthy years. All other aspects of your life would be unchanged…*
>
> ***Version 2:*** *Now imagine that scientists discover a new medicine that adds an extra ten years to your life, but all other aspects of your life would be unchanged.*
>
> ***Version 3:*** *Now imagine that scientists discover a new medicine that adds an extra ten years to your life.*

Version 1 and Version 2 again direct respondents toward a ceteris paribus interpretation, while Version 3 offers the simplest wording. Version 1 further specifies "good health" to test if people filled this condition in.

3.5.2. Methods

The subjective causal effect of longevity is

$$\Delta_i^{longevity} = \Pr_i\left(W_{70} \mid \Delta l = 10\right) - \Pr_i\left(W_{70} \mid \Delta l = 0\right). \quad (1.12)$$

The counterfactual conditional probability (i.e. working after 70 *without* the discovery of this new drug) is not available in the survey, and is, again, replaced by the unconditional probability, $\Pr_i\left(W_{70}\right)$. The assumption is that individuals either do not currently expect the discovery of such a drug, or if they do, they interpreted the condition as providing an *additional* 10 years of life compared to their current expectations. We believe this is a reasonable assumption.

3.6. Subjective retirement probabilities conditional on becoming self-employed

3.6.1. Data

Self-employment may be attractive for some older individuals who wish to continue working in a more flexible environment. To test this, we asked the following conditional probability question:

> *Suppose that you became self-employed at some point. In this case what are the chances that you would be doing any work for pay after you reach age 70?*

Prior to this question we also asked about the probability of the condition:

> *What is the percent chance that you will become self-employed at some point?*

3.6.2. Methods

The subjective causal effect of becoming self-employed at some point would be

$$\Delta_i^{self} = \Pr_i\left(W_{70} \mid \text{Ever S}\right) - \Pr_i\left(W_{70} \mid \text{Never S}\right). \quad (1.13)$$

We, however, did not ask the counterfactual conditional probability, $\Pr_i\left(W_{70} \mid \text{Never S}\right)$. Instead, we use the probability of the condition, $\Pr_i\left(\text{Ever S}\right)$ and the law of total probability to recover it using the formula

$$\Pr_i\left(W_{70} \mid \text{Never S}\right) = \frac{\Pr_i\left(W_{70}\right) - \Pr_i\left(W_{70} \mid \text{Ever S}\right)\Pr_i\left(\text{Ever S}\right)}{1 - \Pr_i\left(\text{Ever S}\right)} \quad (1.14)$$

All three terms on the right-hand side of (1.14) are available in the survey. The few cases where the estimated probabilities were outside the [0,1] interval were censored at 0 or 1. Then, the estimated probability was used in (1.13) to obtain the subjective causal effect.

3.7. Subjective retirement probabilities conditional on working conditions

3.7.1. Data

To find how people value certain working conditions we asked about P70 conditional on a job having those characteristics, one at a time. In this paper we only analyze responses among those currently working.[3] We asked about the following conditions:

- Employer offering the possibility to work from home (if not currently offering); or the employer not offering the possibility to work from home (if currently offering)
- Employer offering the possibility to reduce hours to part-time (from full-time workers)
- Employer offering flexible work schedules
- If the commute times were shorter (if commute currently takes at least an hour a day)
- The job was not stressful
- The job required no concentration
- The job was not physically demanding

Appendix A.3. lists the wording of all questions. To illustrate, we show here the two questions about telecommuting. Among those working lacking the opportunity to work from home we asked:

> *Suppose you had the opportunity to work from home either at your current job or at a different job. In this case, what are the chances that you would be doing any work for pay after you reach age 70?*

Among those working whose job does offer the opportunity to work from home we asked:

> *Suppose you did not have the opportunity to work from home, either at your current job or at other jobs. In this case, what are the chances that you would be doing any work for pay after you reach age 70?*

[3] Some of the questions were asked from non-workers as well, but the question formats were not directly comparable.

3.7.2. Methods

The counterfactual conditional probability was not asked, and we used different techniques to recover the subjective causal effects of these working conditions. For the following conditions we replaced the counterfactual conditional probability with the unconditional probability, similarly to the wealth and longevity effects in (1.11):

- Employer offering the possibility to work from home (if not currently offering); or the employer not offering the possibility to work from home (if currently offering)
- If the commute times were shorter (if commute currently takes at least an hour a day)
- The job was not stressful
- The job required no concentration
- The job was not physically demanding

For these conditions, thus, we assume that people answered the unconditional probability of working after age 70 assuming that these conditions were not met. For the telecommuting and the commuting times questions it is a reasonable assumption, since the questions were asked from individuals for whom the conditions are currently not met. For the job stress and job concentration questions it may also be reasonable, because most jobs involve at least some stress and require some concentration. The physical demand question may be more problematic, because not all jobs are physically demanding. The estimated subjective causal effect of physically demanding jobs, thus, may be biased toward zero.

For part-time work and flexible work schedule questions we asked about the probabilities of the conditions,[4] and we used formulas similar to the effect of self-employment discussed in Section 3.6.2. The flexible work schedule question asked about the probability of working for the current employer after age 70, and we therefore show the subjective causal effect on that probability.

3.7. Other variables

In our regression analyses we use the following control variables:

- Age
- Gender

[4] There were two questions about the probability of moving into part-time jobs: 1) The probability the employer would allow moving to part-time jobs; and 2) The probability the person would move into a part-time job if the employer allowed it. We used the product of these two probabilities to get the probability of moving into a part-time position.

- Education
- Race and ethnicity
- Marital status
- Subjective health status (1. Excellent; 2. Very good; 3. Good; 4. Fair; 5. Poor)
- Labor force status (1. Works full time (more than 35 hours a week); 2. Works part-time; 3. Retired, 4. Not working, not retired)
- Self-employment
- Cognitive job index of the main job
- Physical job index of the main job
- Social job index of the main job
- Total family income
- Earnings (main jobs and all other jobs)

The three job characteristics measures were constructed from aggregating answers to several subjective job-characteristic ratings. Appendix A provides details.

The number series score measures fluid intelligence (McArdle, Smith, and Willis, 2009) and it follows the HRS protocol (See appendix A). The probability numeracy score measures individuals' understanding of the laws of probability using a validated 4-item battery (Hudomiet, Hurd, Rohwedder, 2018).

Table 1 shows unweighted descriptive statistics about our sample. The sample is balanced in gender, age, and race, but it is more educated than the general U.S. population. This is a feature of the ALP in general. The sample is fairly diverse in subjective health, labor force status, and income.

4. Results

4.1. Validation of subjective conditional and joint probabilities

Table 2 compares the percent of the population working and the projected percent from the subjective conditional probabilities.[5] The first column shows the percent working at ages 68-72 aggregated from HRS waves 2006-2014 stratified by the actual health of individuals at those observed ages. For example, among those whose health was excellent, very good or good, 32.2% were working. The next column shows similar percentages from our ALP survey. We note the close consistency between the HRS and

[5] The tables display weighted averages and percentages.

the ALP percentages. The last column shows the average subjective conditional probability: conditional on health being excellent, very good or good, the average probability is 35.4%. In steady-state, where successive cohorts reach retirement age with similar expectations and similar determinants of retirement we would expect the averages in the three columns to be similar, and, indeed, they are.

We asked about the probability of health states at age 70, about the conditional and joint probabilities of working and of health. Table 3 compares the consistency of the conditional and the joint probabilities with the unconditional probabilities using the method described in 3.2.2.

The average values of P70 calculated from the conditional probabilities are closely consistent with the unconditional probabilities at all health levels and for the entire sample. However, the joint probabilities imply unconditional probabilities that are much larger than the actual, subjective, unconditional probabilities.

The consistency of P70 based on the conditional probabilities is found throughout the distribution of P70, not just in the mean, and the inconsistency of P70 based on the joint probabilities is also found throughout the distribution. Figure 1 compares the cumulative distribution functions of P70. It shows the distributions of P70, of P70 derived from the conditional probabilities and of P70 derived from the joint distributions. The cumulative distribution function of P70 derived from the conditional probabilities tracks closely the cumulative distribution function of P70 whereas the distribution function of P70 derived from the joint distributions is shifted far to the right. For example, some 20% of the implied values of P70 are 100% or more. Figures 2 and 3 show the nonparametric regression of P70 from the conditional probability and P70 from the joint probabilities on P70 as reported unconditionally. The P70 value calculated from conditional probabilities line up very closely with the unconditional P70 below the value of 50%. At values of P70 greater than 50%, the calculated values fall short but the discrepancies are mostly minor. In contrast, the values of P70 calculated from the joint probabilities are substantially greater than the unconditional P70 at all parts of its distribution.

Table B1 in the appendix shows the components that are used in the calculation of P70 from the conditional and joint subjective probabilities. We found that respondents in all health categories do not distinguish between the conditional and joint probabilities. It seems people do not understand joint probabilities or they are not able to express accurately joint probabilities. We have found this lack of understanding joint probabilities in prior work (Hudomiet et al, 2018) where we tested individuals' knowledge of various laws of probability. An implication is that if an analysis needs joint probabilities, it

is best to ask respondents about conditional and marginal probabilities and then compute the joint probability.

We also looked at the heterogeneity in the biases in P70 when calculated from the subjective conditional probabilities and when calculated from the joint probabilities in Table B2 in the appendix. The bias from conditional probabilities, as shown in column [3], is small and varies little by sex, ethnicity, education, number series (cognition), or probability numeracy.

Turning to the variation in bias from joint probabilities in column [4] we see there is considerable variation with the probability numeracy quintile, but even among those in the highest quintile the bias is 14.1 percentage points. There is little or no variation by sex, ethnicity or education. One question in the probability numeracy battery specifically was about joint probabilities: just 23% correctly answered that question in the probability numeracy battery. Among those who correctly answered it the bias is considerably reduced; nonetheless, it is still positive: 13.9 percentage points on a P70 base of about 24%.

4.2. The effect of health on retirement

Table 4 shows the unconditional P70 values stratified by current self-assessed health (measured at the time of the survey at ages 50-69); and compares them to P70 values that condition on future health (at age 70). The unconditional probability (column 1) varies by current health, as expected, but the main division is between those whose self-assessed health is excellent, very good or good versus those whose health is fair or poor. Except for those in "poor" health, the conditional probabilities (columns 3 and 4) vary less with current health, which indicates that conditioning works as intended: current health has a reduced effect on future labor force status if future health is controlled. There is some residual variation with current health which is to be expected because the conditioning is relatively coarse; thus, someone with current excellent health may expect to be toward the top of the "health good or better" band at age 70 whereas someone with current good health may expect to be toward the bottom of the band. Under the condition "health good or better" (column 3) the increase in P70 relative to unconditional P70 among those whose actual health is good or better is small (on the order of 6 ppts.) indicating that those individuals already put a fairly high probability on their health at age 70 being "good or better." That is, the conditioning contained only a modest amount of news so that respondents only modestly updated their probabilities. Among those whose initial health was fair or poor the gains are about 12 ppts., indicating that the conditioning contained considerable news. When the conditioning is to bad health (health fair or poor) the reductions in P70 are large among those

initially in good or better health (12 to 15 ppts.) again reflecting the large amount of news, and small among those already in fair or poor health, reflecting the small amount of news.

The subjective causal effect of health is large and, except for those initially in poor health, it does not vary much with current health. The overall effect, 19 percentage points., is substantial compared with the current labor force participation rate in the older population: among those 70-74 the participation rate was 19.7%.

Table 5 shows linear regressions of the subjective causal effect on a series of demographic and economic predictors. Recall that we measured the subjective causal effect on the individual level, and hence running this regression is feasible. The first model was run on the total sample including both workers and non-workers. The strongest predictor was, in fact current labor force status. The causal effect of health on labor supply is largest for workers, independently of full or part time status, smallest for the retired, and it is in between for those who are not working and are not retired. The effect may be the smallest for the retired, because many of them do not plan to work under any circumstances.

The subjective causal effect is even larger for the self-employed compared to regular employees. It may be because self-employed individuals have a lot of freedom in choosing their own working conditions, but health is something that is substantially beyond their control.

The causal effect is smaller for wealthier households. Other covariates are not related strongly to the outcome variable.

We also ran two other regression models based on labor force status, but nothing stood out strongly. The effect of the predictor variables does not seem to vary much by labor force status.

4.3. The effects of income, wealth and longevity, and the fill-in problem

The subjective causal effect of wage on labor supply is in Table 6. We first notice that although respondents were randomized into three groups, P70 (column 2) is greater in the second group.

The preferred Version 1 did not specify good health in addition to a wage increase. The effect of a 20% increase in wage is an increase in P70 of 9.4 ppts. Version 2, which also specifies being in good health at 70, increases P70 by slightly more, 11.5 percentage points. Note that specifying good health increased the expected labor supply both conditional on a 20% wage gain and conditional on a 20% wage cut. The difference between these two options, however, grew less. We interpret this as evidence that most individuals did not fill-in good health when answering the preferred unspecified question format (version 1).

Version 3 is ambiguous because the statement does not say whether earnings would be permanently increased, that is, up to and beyond age 70. If respondents did interpret the conditioning in that way, there could also be a wealth effect: some of the increased earnings in the years leading up to age 70 would be saved, and the greater wealth would discourage work at age 70 relative to Version 1. An additional source of fill-in is that increased earnings would normally be associated with increased effort, which would depress P70. These factors may explain why P70 increased only by 3 percentage points.

So far we estimated the subjective causal effects of income by subtracting the reported probabilities conditional on a wage gain and on a wage loss. We did not directly ask about the probability conditional on *no change* in wages. But under the assumption that the reported unconditional probability of working past age 70 corresponds to "no change" in wages, we can compare the effects of wage gains to wage losses (See Section 3.3.2.). Our preferred version 1 implies fairly symmetric effects, with a slightly larger response to wage losses: The effect of a 20% wage gain is 8.3 ppts, and the effect of a 20% wage cut is 10.4 ppts.

Table 7 shows the effects of wealth on retirement. The windfall gain in wealth produced fairly large effects on P70, 14.2 percentage points on a base of 30.3%. Thus, work effort would decline by about 50%. However, question wording does not seem to matter much, and there is no evidence of any "fill-in problem." For this particular investigation Version 2 seems best because of its simplicity.

Table 8 shows the effect of longevity. Added longevity has a small positive effect on working at age 70, about three percentage points (Table 8, Versions 2 and 3); there is little difference between the versions. Thus the fill-in problem seems to be unimportant in this case. Specifying that the added years are healthy years, however, increases P70 by nine percentage points. We can think of two explanations. The first is that if the added years are healthy years it is likely that health would be good at age 70, so we are observing a health effect on work due to fill-in. The second is that if the added years are healthy people will want more wealth to spend in the healthy state, and so will work longer.

4.4. The effect of job characteristics

The main results are in Table 9. Panel A shows the effect of job characteristics on workers and Panels B includes individuals currently not working. In all panels, we ordered the working conditions based on the estimated effect size, and we include the health, wealth and income responses as well for comparison.

Among workers, health and wealth have the largest effect on expected labor supply. With respect to the working conditions, the largest effect is for working in a job that permits flexible hours, which would

increase the subjective probability of working after age 70 by 15.2 percentage points on a base of 17.6%. The effect is larger than a 20% increase in take-home pay. Other notably large effects are associated with becoming self-employed, having a job that is not stressful, or not physically demanding, and a short commuting time (estimated on the sample that commutes at least an hour a day) and telecommuting. In contrast the possibility of part-time work, and having a job that does not require much concentration would have little effect on working at age 70, each increasing the subjective conditional probability by just about 5-6 percentage points on a base of about 32 percentage points.

The patterns are somewhat different among non-workers. The effects of health, wealth and wages are substantially lower compared to workers. This may be explained by the fact that most of these individuals are already retired facing hurdles of re-entry into the labor force. However, becoming self-employed does increase their probability of working after 70 substantially (by 16.5 ppts), which is even larger than the effect on workers (11.9 ppts). Overall, it seems that a non-trivial fraction of individuals who are not working would consider reentering the labor force under some conditions.

Table 10 shows OLS regressions of selected conditions on the same predictor variables as in Table 5. Table 11 shows similar regressions in the sample of workers. According to Table 10, by far the strongest predictor of the subjective causal effect is labor force status: Similarly to what we have seen in Table 9, the causal effect of wage and wealth on labor supply are much larger in absolute value among workers. (Note we emphasize *absolute* value, because the effect of wealth is negative, but the effects of the other conditions are positive.) High-income individuals may also have smaller effects (in absolute value), though the differences are not always statistically significant. The effects tend to be somewhat muted among 65-69-year-old individuals, and we see some differences by gender and race, but the patterns are not consistent. The effects of education and health are small and almost never significant statistically.

5. Discussion and Conclusions

We had several objectives. First, we wanted to produce evidence on the validity of subjective conditional probabilities. The value of conditional expectations depends on whether survey answers represent beliefs that individuals use to forecast their own future behavior and situation, and to make current decisions that will impact the future. We found conditional probabilities to be very consistent with unconditional probabilities: the calculated P70 based on the conditional probabilities and the unconditional health probabilities align well with the unconditional P70. We found conditional

probabilities to line up very closely with actual conditional outcomes measures in the large HRS. We also found conditional probabilities to vary in systematic and meaningful ways with other variables: P70 increases when health is specified to be better, when wages are higher, and when longevity increases; P70 declines with a windfall wealth gain.

Second, we wanted to explore the fill-in problem. Mostly we found that responses were similar irrespective of specifying *ceteris paribus* (in common language), but that they changed substantially when adding an important condition such as good health. For example, in Table 7 the subjective causal effects of a wealth shock were similar across versions even though the additional information differed. In Table 8, Version 1 differed from Versions 2 and 3 most likely because it had the additional specification of good health; yet, Versions 2 and 3 were similar although they were worded differently. However, in Table 6, Versions 1 and 3 produced different results, especially for a wage reduction. An obvious reason is the different specification of the timing of the wage change, but we cannot rule out fill-in. Nonetheless, we conclude that, while the fill-in problem is a potential concern, in our applications any evidence for its empirical importance is limited. Subjective conditional expectations questions should ideally be asked in a way that implies a *ceteris paribus* interpretation.

Our third objective was, conditional on favorable outcomes for the first two goals, to quantify causal effects on labor supply based on subjective conditional probabilities. We found that the subjective causal effect of health was large among both workers and non-workers. The effect of financial wealth was large among workers, but less so among non-workers. As for job characteristics, becoming self-employed, working in a job that permits flexible hours, is not stressful, is not physically demanding, or offers a short commute have the largest effect sizes. In contrast, the possibility of part-time work, telecommuting, and having a job that does not require much concentration would have little effect on working after age 70.

An implication is that a widespread adoption of job characteristics such as flexible hours would increase labor force participation at age 70 by as much as 50 percent. The effects are similar to a 20% increase in take-home pay.

Because the fill-in problem does not seem to be quantitatively important, in next steps we will relate individual-level subjective conditional probabilities to individual-level covariates such as wealth. We would expect, for example, that the marginal utility of wealth of low wealth individuals would be strongly affected by an infusion of $500 thousand, which would require a large adjustment in labor supply; but, the marginal utility of wealth of a high wealth person would be more stable, requiring a

smaller adjustment. Thus the responses in P70 to conditioning should be modified an a systematic and predictable way.

An additional important future research topic concerns whether individuals use subjective conditional probabilities in making current decisions, whether their survey responses represent those beliefs and whether their survey responses are good forecasts of their own future behavior. Subjective conditional probabilities, such as stated preferences in general, are subject to the problem that the measures may differ from actual outcomes. Despite this potential drawback the technique solves the problem of unobserved tastes and characteristics that may undermine causal estimations based on revealed preference data.

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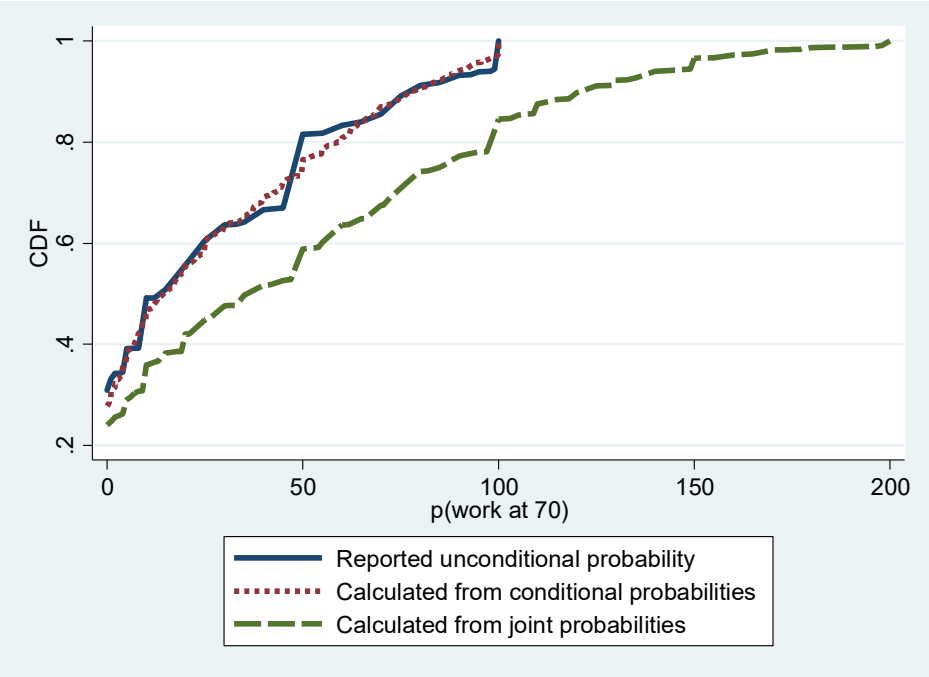
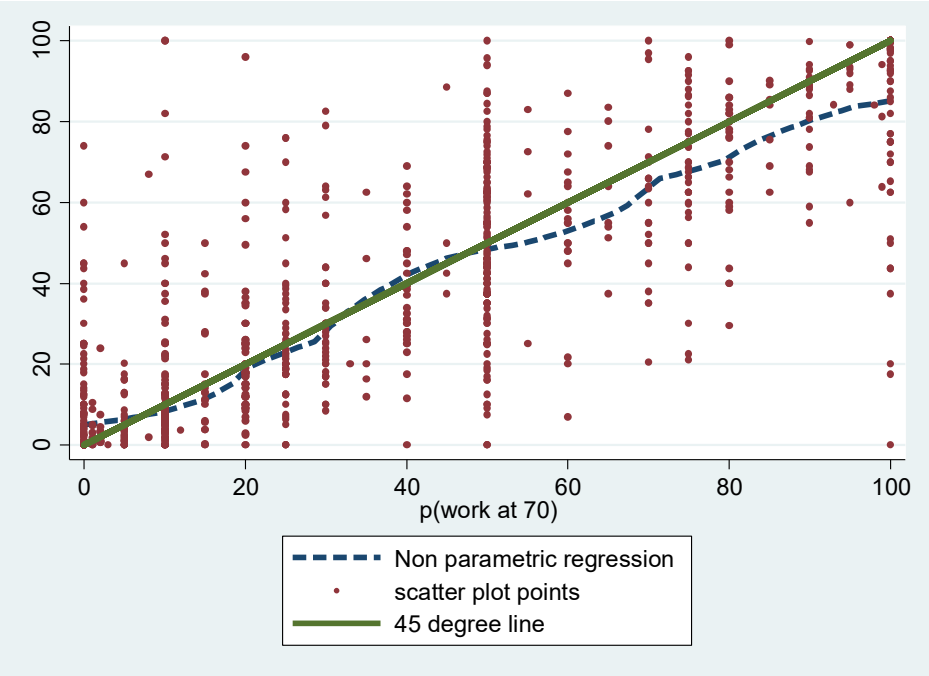
Figures and Tables

Figure 1. The c.d.f. of the subjective probabilities of working past age 70: comparing the unconditional reports with values created from conditional and from joint probabilities, ALP, Age 50-69, unweighted



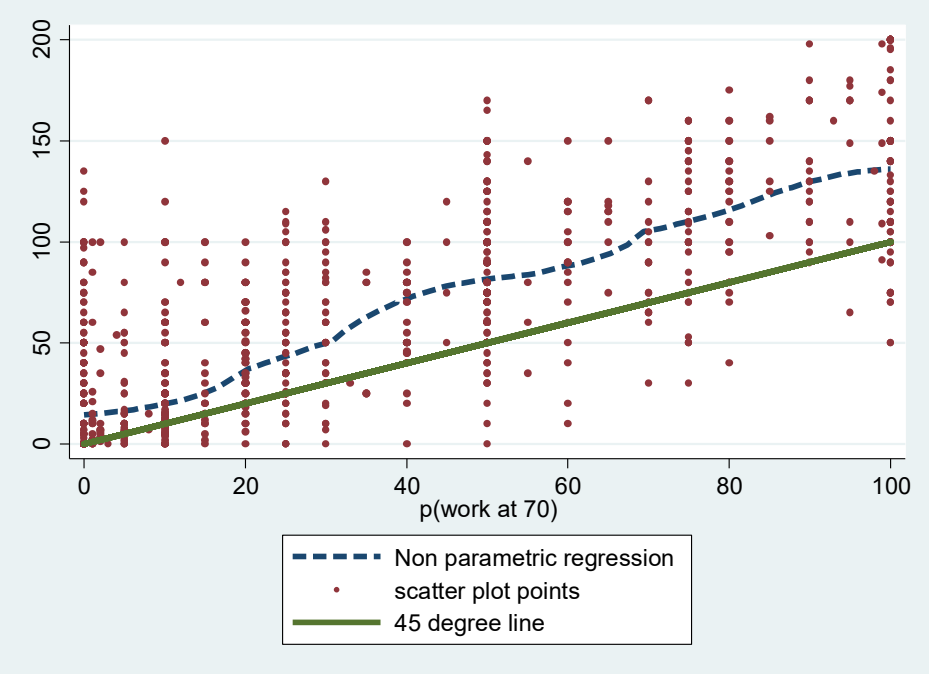
*Let Pr(W70|G) and Pr(W70|B) denote the reported probability of working past age 70 conditional on being in good or bad health at age 70. Similarly, Pr(W70 & G) and Pr(W70 & B) denote the joint probabilities of working and good or bad health. Pr(G) denotes the probability of being in good health at age 70. The following formula was used to calculate the probability of working past age 70 from conditional probabilities: $P70^{cond}$ = Pr(W70|G) Pr(G) + Pr(W70|B)(1- Pr(G)). The formula for joint probabilities was: $P70^{joint}$ = Pr(W70 & G) + Pr(W70 & B).

Figure 2. Scatter plot and non-parametric regression of calculated P70 on reported P70: calculated from subjective conditional probabilities, ALP, Age 50-69, unweighted



*See notes under Figure 1 for definitions.

Figure 3. Scatter plot and non-parametric regression of calculated P70 on reported P70: calculated from subjective joint probabilities, ALP, Age 50-69, unweighted



*See notes under Figure 1 for definitions.

Table 1. Summary statistics, ALP, Age 50-69, unweighted

	N	Mean	SD
Age	1,691	60.0	5.4
Female	1,691	0.550	0.498
Less than high school	1,691	0.020	0.138
High school	1,691	0.132	0.339
Some college	1,691	0.355	0.479
College or more	1,691	0.493	0.500
White non-Hispanic	1,691	0.792	0.406
Black non-Hispanic	1,691	0.083	0.276
Hispanic	1,691	0.088	0.284
Asian or Pacific Islander	1,691	0.013	0.113
Other non-Hispanic	1,691	0.024	0.152
Married/Partnered	1,691	0.636	0.481
Divorced/Separated	1,691	0.200	0.400
Widowed	1,691	0.052	0.222
Never Married	1,691	0.111	0.314
Single	1,691	0.361	0.481
Current Health: Excellent	1,689	0.125	0.331
Current Health: Very good	1,689	0.396	0.489
Current Health: Good	1,689	0.316	0.465
Current Health: Fair	1,689	0.121	0.327
Current Health: Poor	1,689	0.042	0.201
Probability Numeracy Score	1,691	0.122	0.793
Number Series Score	1,689	549.6	24.6
Self-Employed	1,691	0.119	0.324
Retired (and not working)	1,691	0.212	0.409
Other Not Working	1,691	0.101	0.302
Working Full Time	1,691	0.490	0.500
Working Part Time	1,691	0.196	0.397
Cognitive Job: Current Job	1,161	68.7	22.7
Cognitive Job: Last Job	528	71.3	23.1
Physical Job: Current Job	1,143	28.5	31.8
Physical Job: Last Job	524	34.7	35.3
Social Job: Current Job	1,156	68.6	20.7
Social Job: Last Job	527	67.7	21.2
Total family Income	1,691	83,474	68,678
Earnings, main job	1,094	67,130	292,366
Earnings, all other jobs	23	12,014	12,254
Earnings, last job	514	52,420	53,718

Table 2. Actual and subjective probabilities of working conditional on health, HRS and ALP, weighted

Health (actual or conditional)	Percent working, age 68-72		Subjective conditional probability of working, ALP, age 50-69
	HRS	ALP	
good or better	32.2	36.8	35.4
fair or poor	14.3	12.0	16.0
difference	17.9	24.8	19.4
N	13,845	375	1,431

* The actual probabilities of working measure the fraction of the HRS or ALP samples age 68-72 who are doing any work for pay, by their current health. The HRS values are based on the 2006-2014 waves; the ALP values are from wave 487.

Table 3. Mean subjective probabilities of working past age 70: comparing the unconditional reports with values created from conditional or joint probabilities, by current health, ALP, Age 50-69, unweighted

	N	Probability of working past age 70		
		Reported unconditional probability	Calculated from conditional probabilities	Calculated from joint probabilities
Current health	[1]	[2]	[3]	[4]
Excellent	168	30.2	33.9	54.4
Very good	499	32.5	31.3	55.2
Good	361	28.8	28	53.2
Fair	123	21.3	19.5	34.3
Poor	41	7.8	7.3	13.6
Total	1192	29.1	28.6	50.9

*See notes under Figure 1 or the text for definitions.

Table 4. Mean subjective probabilities of working past age 70, unconditional and conditional on health at age 70, by current health, ALP, Age 50-69, unweighted

	N	Probability of working past age 70			Subjective causal effect
		Reported unconditional	Conditional on health good or better	Conditional on health fair or poor	[3]-[4]
Current health	[1]	[2]	[3]	[4]	[5]
Excellent	184	29.5	36.9	16.3	20.6
Very good	556	32.3	36.6	17.0	19.6
Good	414	28.2	34.9	16.6	18.2
Fair	146	20.7	32.3	13.9	18.3
Poor	49	10.2	21.7	7.2	14.6
Total	1349	28.6	35.1	16.1	19.0

* "health good or better" conditions on health being excellent, very good or good. Current self-rated health is measured at ages 50-69.

Table 5. Linear regression model of the subjective causal effect of health on retirement, ALP, Age 50-69, unweighted

	1. Total sample		2. Workers		3. Non-workers	
	coef.	s.e.	coef.	s.e.	coef.	s.e.
Age 50-54	ref.		ref.		ref.	
Age 55-59	-2.563	(1.835)	-2.487	(2.087)	-1.914	(4.103)
Age 60-64	2.553	(1.863)	1.276	(2.174)	4.012	(3.894)
Age 65-69	6.164***	(2.153)	9.842***	(2.707)	2.086	(3.942)
Female	1.117	(1.377)	1.544	(1.715)	0.133	(2.272)
High school or less	ref.		ref.		ref.	
Some college	3.925*	(2.050)	3.596	(2.646)	4.166	(3.098)
College or more	4.277*	(2.257)	4.446	(2.863)	3.513	(3.582)
White non-Hispanic	ref.		ref.		ref.	
Black non-Hispanic	0.975	(2.508)	0.746	(3.122)	0.00806	(4.080)
Hispanic	2.681	(2.393)	-0.615	(3.009)	9.253**	(3.809)
Other race	5.770*	(3.462)	5.198	(4.191)	8.294	(6.087)
Married/Partnered	-2.714*	(1.453)	-4.501**	(1.787)	1.557	(2.411)
Health: Excellent	ref.		ref.		ref.	
Health: Very good	-1.091	(1.967)	-1.738	(2.354)	2.227	(3.546)
Health: Good	-1.481	(2.063)	-1.892	(2.499)	0.951	(3.639)
Health: Fair	0.355	(2.613)	-3.649	(3.498)	6.779*	(3.967)
Health: Poor	-0.266	(3.689)	4.105	(6.168)	0.899	(4.684)
Probability Numeracy	1.182	(1.143)	1.903	(1.380)	-0.445	(2.031)
Number Series Score	0.00268	(0.0292)	-0.0124	(0.0372)	0.0339	(0.0458)
Family Income, $1,000	-0.0273***	(0.0105)	-0.0344***	(0.0130)	-0.0115	(0.0180)
Retired (and not working)	ref.		-		ref.	
Other not working	13.68***	(2.746)	-		11.62***	(2.863)
Working full time	18.49***	(1.947)	ref.		-	
Working part time	18.80***	(2.239)	0.00736	(1.922)	-	
Self-Employment	5.881***	(2.012)	5.566***	(2.120)	-	
Current/Last Job Characteristic Score: Cognitive	0.0721**	(0.0303)	0.0881**	(0.0381)	0.0377	(0.0476)
Current/Last Job Characteristic Score: Physical	0.0328	(0.0208)	0.0456*	(0.0265)	-0.00226	(0.0324)
Current/Last Job Characteristic Score: Social	-0.0166	(0.0304)	0.00200	(0.0385)	-0.0418	(0.0473)
Constant	-2.742	(16.61)	23.72	(20.91)	-19.23	(25.96)
R-squared	0.108		0.0690		0.107	
N	1410		1003		406	

Table 6. Mean subjective probabilities of working past age 70, unconditional and conditional on higher/lower wage, ALP, Age 50-69, unweighted

	N	Probability of working past age 70			
		Unconditional	Conditional on 20% wage increase	Conditional on 20% wage cut	Subjective causal effect of 20% wage, ([3] - [4])*0.5
Randomized versions	[1]	[2]	[3]	[4]	[5]
V1: wage change at age 70	437	27.4	35.7	17.0	9.4
V2: wage change at 70 and health good at 70	436	30.6	45.1	22.1	11.5
V3: wage change immediately	423	27.8	32.2	26.3	3.0
All	1296	28.6	37.7	21.7	8.0

* Condition in version 1: Congress changes the tax system so that workers above age 70 make 20% more/less. Condition in version 2 is the same, plus that the individual's health is good, very good or excellent at age 70. The condition in version 3: The wage of the person is 20% more/less than today.

Table 7. Mean subjective probabilities of working past age 70, unconditional and conditional on higher wealth, ALP, Age 50-69, unweighted

	N	Probability of working past age 70		
		Unconditional	Conditional on $500k more in wealth	Subjective causal effect, ([3] - [2])
Randomized versions	[1]	[2]	[3]	[4]
V1: $500k inheritance, all else equal	471	30.3	16.1	-14.2
V2: $500k inheritance	477	27.4	14.1	-13.3
V3: $500k more assets	457	28.2	15.9	-12.3
All	1405	28.6	15.3	-13.3

* Version 1 and 2 specify an inheritance of $500k, while version 3 specifies an increase of $500k of financial assets (source not specified). Version 1 further specifies that health and financial situation would not change except for the inheritance.

Table 8. Mean subjective probabilities of working past age 70, unconditional and conditional on longevity, ALP, Age 50-69, unweighted

	N	Probability of working past age 70		
		Unconditional	Conditional on 10 more years of life	Subjective causal effect, ([3] - [2])
Randomized versions	[1]	[2]	[3]	[4]
V1: 10 more health years, all else equal	471	30.3	39.4	9.1
V2: 10 more years, all else equal	477	27.4	30.3	2.9
V3: 10 more years	457	28.2	31.8	3.6
All	1405	28.6	33.9	5.3

* Version 1 specifies 10 extra years in good health, and that all other aspects of life would be unchanged. Version 2 adds 10 years of life but makes no statement about health; all other aspects of life would be unchanged. Version 3 adds 10 years of life but makes no statements about other aspects of life.

Table 9. The subjective causal effect of various conditions on working past age 70, ALP, Age 50-69, unweighted

	N	Probability of working past age 70			
		No condition	With condition	Subjective causal effect, ([3] - [2])	Standard error of [4]
Panel A: Workers	[1]	[2]	[3]	[4]	[5]
Health: good or better	1018	19.8	43.2	23.4	[0.8]
Wealth: $500k more	1007	35.7	18.4	-17.3	[0.9]
Employer offers flexible schedule	656	17.6	32.8	15.2	[1.4]
Become self-employed	712	28.1	40.0	11.9	[1.5]
Job not stressful	990	35.9	46.9	11.0	[0.9]
Wage: 20% more	338	31.2	42.1	10.8	[0.8]
Job requires no physical effort	975	35.4	45.8	10.3	[0.9]
Short commute	243	30.0	40.1	10.1	[1.8]
Work from home	989	32.6	41.7	9.1	[0.9]
Job requires no concentration	972	35.8	42.2	6.4	[1.0]
Employer offers part-time	543	32.1	36.9	4.8	[1.3]
Longevity: 10 more years	662	34.1	36.1	2.0	[1.0]
Panel B: Non-workers					
Become self-employed	340	7.8	24.3	16.5	[1.8]
Health: good or better	412	5.3	16.5	11.2	[1.0]
Wage: 20% more	138	13.6	20.6	7.0	[1.0]
Longevity: 10 more years	253	11.8	17.8	6.0	[1.5]
Wealth: $500k more	397	10.5	7.4	-3.1	[1.0]

*See section 3 for the methods used to estimate the probabilities.

Table 10. Linear regression model of the subjective causal effect of selected conditions on retirement, ALP, Age 50-69, unweighted, Part 1, workers and non-workers

	Wage: 20% more		Wealth: $500k more		Become self-employed	
	coef.	s.e.	coef.	s.e.	coef.	s.e.
Age 50-54	ref.		ref.		ref.	
Age 55-59	-0.230	(1.868)	-1.207	(2.021)	1.346	(3.458)
Age 60-64	0.110	(1.943)	2.100	(2.063)	2.307	(3.578)
Age 65-69	2.936	(2.208)	-11.07***	(2.359)	-9.804**	(4.155)
Female	2.294	(1.424)	2.336	(1.507)	1.853	(2.625)
High school or less	ref.		ref.		ref.	
Some college	2.406	(2.138)	1.112	(2.256)	5.414	(3.941)
College or more	1.440	(2.369)	-0.464	(2.469)	10.07**	(4.287)
White non-Hispanic	ref.		ref.		ref.	
Black non-Hispanic	1.186	(2.629)	3.993	(2.769)	10.62**	(4.794)
Hispanic	-2.314	(2.606)	5.294**	(2.667)	6.102	(4.426)
Other race	0.554	(3.665)	13.19***	(3.770)	5.423	(6.526)
Married/Partnered	-3.164**	(1.483)	1.515	(1.597)	6.100**	(2.798)
Health: Excellent	ref.		ref.		ref.	
Health: Very good	0.562	(2.145)	-3.414	(2.182)	-3.520	(3.828)
Health: Good	3.564	(2.251)	-2.866	(2.286)	2.018	(4.022)
Health: Fair	-3.358	(2.787)	2.704	(2.905)	7.642	(5.085)
Health: Poor	0.971	(4.091)	6.582	(4.207)	2.695	(7.257)
Probability Numeracy	-0.0377	(1.158)	1.114	(1.258)	1.303	(2.183)
Number Series Score	0.0281	(0.0307)	-0.0727**	(0.0323)	0.0308	(0.0564)
Family Income, $1,000	-0.00490	(0.0106)	0.0541***	(0.0119)	-0.0368*	(0.0209)
Retired (and not working)	ref.		ref.		ref.	
Other not working	3.856	(2.882)	-9.788***	(3.078)	-4.162	(5.247)
Working full time	4.664**	(2.027)	-20.83***	(2.138)	-7.856**	(3.558)
Working part time	5.803***	(2.235)	-20.02***	(2.488)	-4.010	(4.395)
Self-Employment	1.250	(2.129)	1.790	(2.232)	-	
Current/Last Job Characteristic Score: Cognitive	0.0184	(0.0310)	-0.0298	(0.0333)	0.0516	(0.0587)
Current/Last Job Characteristic Score: Physical	-0.00339	(0.0215)	0.0221	(0.0229)	-0.0279	(0.0416)
Current/Last Job Characteristic Score: Social	0.0370	(0.0323)	0.0233	(0.0334)	-0.0562	(0.0578)
Constant	-15.34	(17.46)	37.49**	(18.30)	-6.723	(32.02)
R-squared	0.0867		0.130		0.0459	
N	472		1382		1039	

Table 11. Linear regression model of the subjective causal effect of selected conditions on retirement, ALP, Age 50-69, unweighted, Part 2, workers only

	Employer offers flexible schedule		Job requires no physical effort		Job not stressful	
	coef.	s.e.	coef.	s.e.	coef.	s.e.
Age 50-54	ref.		ref.		ref.	
Age 55-59	5.132	(3.627)	2.294	(2.495)	3.226	(2.507)
Age 60-64	3.311	(3.921)	0.790	(2.615)	3.006	(2.615)
Age 65-69	7.679	(5.341)	-8.911***	(3.230)	-10.18***	(3.204)
Female	-7.792**	(3.133)	3.368*	(2.034)	2.974	(2.039)
High school or less	ref.		ref.		ref.	
Some college	-1.090	(4.771)	2.401	(3.209)	4.701	(3.210)
College or more	4.267	(5.164)	2.811	(3.454)	4.606	(3.446)
White non-Hispanic	ref.		ref.		ref.	
Black non-Hispanic	9.610*	(5.517)	3.374	(3.723)	3.103	(3.756)
Hispanic	-3.249	(5.281)	8.936**	(3.621)	8.704**	(3.711)
Other race	12.47*	(7.341)	6.920	(5.208)	7.056	(5.043)
Married/Partnered	1.956	(3.244)	1.261	(2.162)	1.292	(2.156)
Health: Excellent	ref.		ref.		ref.	
Health: Very good	-0.680	(4.342)	-1.505	(2.827)	-1.901	(2.833)
Health: Good	-2.501	(4.573)	3.874	(2.999)	1.901	(3.001)
Health: Fair	-5.207	(6.513)	-4.295	(4.211)	-4.387	(4.214)
Health: Poor	-18.13	(14.07)	-5.106	(7.644)	-9.353	(7.926)
Probability Numeracy	-2.902	(2.527)	-1.361	(1.640)	-2.015	(1.643)
Number Series Score	-0.0810	(0.0672)	-0.0325	(0.0443)	-0.0722	(0.0442)
Family Income, $1,000	-0.0276	(0.0246)	-0.0113	(0.0156)	-0.0174	(0.0156)
Working full time	ref.		ref.		ref.	
Working part time	2.052	(3.830)	2.597	(2.368)	3.657	(2.367)
Self-Employment	-		-4.519*	(2.565)	-4.497*	(2.583)
Current/Last Job Characteristic Score: Cognitive	0.0618	(0.0705)	-0.0124	(0.0461)	0.0300	(0.0461)
Current/Last Job Characteristic Score: Physical	-0.123**	(0.0505)	0.0406	(0.0318)	0.0441	(0.0319)
Current/Last Job Characteristic Score: Social	-0.0492	(0.0693)	0.00943	(0.0456)	-0.0325	(0.0459)
Constant	63.07*	(37.51)	22.90	(24.81)	44.39*	(24.85)
R-squared	0.0486		0.0567		0.0673	
N	647		958		975	

Appendix A: Additional Information about the data

A.1. Job Characteristics

Respondents were asked about the features and requirements of their current or last job. They were asked about 8 features such as ability to develop friendships and control their work schedule and 6 requirements such as requiring physical effort or using high-level skills. For each option, respondents answered (1) Absolutely yes, (2) partly yes/partly no, (3) absolutely no, or (4) it did not matter to me (features only). We convert these responses to a 0 to 100 scale, with "absolutely no" being valued at 0, "partly yes/partly no" and "it did not matter to me" being valued at 50, and "absolutely yes" being values at 100. The one exception is the "simple tasks" feature, which has a reversed scoring value.

We combine 12 of these values into three aggregate job characteristic scores based on correlations and similarities between the requirements and features. Specifically, we create the following using the mean of the scaled response inputs:

1. The cognitive job index uses the following items:
    a. My job requires monitoring a great deal of information.
    b. My job requires engaging in a large amount of thinking.
    c. My job requires a variety of skills.
    d. My job requires using a number of complex or high-level skills.
    e. The tasks are simple and uncomplicated (reversed).
    f. I solve problems that have no obvious correct answers.
2. Physical Job Score:
    a. My job requires a great deal of muscular strength.
    b. My job requires a lot of physical effort
3. Social Job:
    a. The people I work with are friendly.
    b. I have the chance to get to know other people
    c. I have the opportunity to develop close friendships.
    d. The people I work with take a personal interest in me.

A.2. Number Series

The number series section consists of 6 adaptive questions in two blocks. The first block is asked of everyone and then respondents are placed into a tiered second block of questions based on their

response in block 1. The questions, format, and scoring are from the number series section in the HRS for 2010. We use List A questions and scoring methods. Please see page 5-11 of "New Measures of Fluid Intelligence in the HRS" (https://hrs.isr.umich.edu/sites/default/files/biblio/dr-027b.pdf) for more details.

A.3. List of expectations questions about working conditions

Questions about telecommuting:

- If you wanted to, would your current employer allow you to work from home at least occasionally?
- Suppose you had the opportunity to work from home either at your current job or at a different job. In this case, what are the chances that you would be doing any work for pay after you reach age 70?
- Suppose you did not have the opportunity to work from home, either at your current job or at other jobs. In this case, what are the chances that you would be doing any work for pay after you reach age 70?

Questions about part-time work:

- Suppose that you wanted to move into a part-time position at your current job. What is the percent chance that your employer would allow you to do that?
- Suppose your current employer offered you the possibility to work either part-time or full-time. What is the percent chance that you would move into a part-time position eventually?
- Suppose you moved into a part-time position at your current employer at some point. In this case what are the chances that you would be doing any work for pay after you reach age 70?

Questions about flexible work schedules:

- Suppose that at some point you wanted to flexibly choose your work schedule while you still worked the required number of hours. What do you think the chances are that your employer would allow you to do that?
- Suppose your employer allowed you to flexibly choose your work schedule as long as you worked the required number of hours. In this case, what are the chances that you would still be working for your current employer after you reach age 70?

Questions about commuting times:

- How much time do you spend travelling or commuting to and from work on a typical day?
- Suppose that there were jobs available to you that were very close to your home with the same pay and job demands as your current job. You could take one of these jobs any time you wanted. In this case, what are the chances that you would be doing any work for pay after you reach age 70?

Questions about job demands:

- Suppose that there were jobs available to you that involved little or no stress with the same pay and job demands as your current job. You could take one of these jobs any time you wanted. In this case, what are the chances that you would be doing any work for pay after you reach age 70?
- Suppose that there were jobs available to you that required little concentration and attention with the same pay and job demands as your current job. You could take one of these jobs any time you wanted. In this case, what are the chances that you would be doing any work for pay after you reach age 70?
- Suppose that there were jobs available to you that required little or no physical effort and offered the same pay as your current job. You could take one of these jobs any time you wanted. In this case, what are the chances that you would be doing any work for pay after you reach age 70?

Appendix B: Additional Figures and Tables

Table B1. Subjective Probabilities: working at age 70 conditional on health at age 70; working at age 70 and health at age 70, by current health, ALP, ages 50-69, unweighted

	N	Pr(G)	Pr(W70|G)	Pr(W70 & G)	Pr(W70|B)	Pr(W70 & B)
Current health	[1]	[2]	[3]	[4]	[5]	[6]
Excellent	171	78.6	37.7	38.1	17	16.7
Very good	511	71.6	37	37.1	17	18.4
Good	372	57.9	35.2	32.9	17	19.6
Fair	129	22	31.8	16.2	14.1	16.9
Poor	43	6.6	22	5.2	6.1	7.8
Total	1226	60.9	35.5	32.6	16.3	18

* Pr(G) denotes the probability of being in good, very good or excellent health at age 70. Pr(W70|G) and Pr(W70|B) denote the probability of working past age 70 conditional on being in good or bad health at age 70. Pr(W70 & G) and Pr(W70 & B) denote the joint probabilities of working and good or bad health.

Table B2. Bias in P70 (percentage points) calculated from subjective conditional probabilities and from joint probabilities, ALP, ages 50-69, unweighted

	N	Method of calculating P70	
		from conditional probabilities	from joint probabilities
	[1]	[3]	[4]
PROBABILITY NUMERACY			
lowest quintile	200	-0.3	28.5
2nd	236	0.3	24.3
3rd	263	-0.2	25.1
4th	231	-0.7	18.7
highest quintile	262	-1.2	14.1
GENDER			
Male	564	-0.7	20.5
Female	628	-0.3	23
WHITE NON-HISPANIC			
No	233	0.8	27
Yes	959	-0.7	20.6
EDUCATION			
HS or less	151	0.1	24.4
some college	409	-0.3	25.4
BA,BS	342	-0.1	18.8
MA etc. to PhD	290	-1.4	19
ANSWERED PNUM 4** correctly			
No	909	0.1	24.1
Yes	277	-2.3	13.9
QUANTILES of number series			
Low	543	0.1	25.2
High	649	-0.9	19

*N = 1192. P70 refers to the probability of working after age 70. The bias is the difference between the directly reported P70 and calculated versions based on conditional or joint probability reports. See notes under Figure 1 or the text for definitions.
** PNUM 4 is the 4th item in the probability numeracy battery and it tests whether people can accurately calculate the joint probability of two independent events with 50% marginal probabilities. In this sample only about 20% gave the correct 25% answer.