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Reforming the U.S. Social Security system accounting for employment uncertainty*

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Abstract

The discussion about the need for Social Security reforms has recently resurfaced, and is expected to continue to be part of the political agenda in the near future. Our paper is a step in the direction of providing a framework for policy analysis that accounts for employment uncertainty, something that has been relatively overlooked in terms of its link with retirement decisions. In this context, we explicitly consider the participation decision of older individuals along with their decision to claim Social Security retirement benefits, using a sequential decision structure. We have numerically solved and simulated a benchmark model of the inter-temporal decision problem that individuals face in the United States. Our results show that the model is able to explain with great accuracy the strikingly high proportion of individuals who claim benefits exactly at the Early Retirement Age. The model is also able to replicate the declining labor force participation at older ages. Additionally, we discuss a number of policy experiments that suggest that individuals claiming and labor supply decisions are responsive to measures likely to be on the table for policy makers when considering the reforms of the U.S. Social Security system.

JEL Codes: J14, J26, J65
Keywords: employment uncertainty, retirement, life-cycle models, Social Security Reform

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1 Introduction and Motivation

The need for Social Insurance reform in the United States, and other developed countries, seems to be uncontroversial given two well documented processes: an unfavorable demographic performance, and a tendency towards reducing the age of retirement on those economies (see Gruber and Wise, 1999 and 2004). The former process has not improved in the last few years, especially in Europe, despite growing immigration, but the latter shows some signs of being affected by the recent trend, especially in the United States, towards higher labor force participation by older individuals. All this has motivated economists and policy makers to explore the links between the incentives set up by a wide variety of social insurance programs and retirement behavior.

While most of the discussion in the U.S. in the last years has concentrated on the need to continue to reform Medicare, policy makers acknowledge the need to also reform the Old Age (Retirement) Benefits part of the Social Security system, and it is clear that they are likely to approach the process with a very similar point of view as it was done thirty years ago when it was reformed under the first Reagan Administration. Namely, with a combination of increases in the Normal Retirement Age, and incentives to promote labor force participation at older ages. However, in order to appropriately model the effects of any reform on labor supply we need to account for the fact that older workers also face employment uncertainty, which is likely linked to claiming decisions which are in turn linked to labor supply choices.

In this paper we explicitly consider the participation decision of older individuals, accounting for employment uncertainty, by using a sequential decision structure. We assume that older individuals make participation decisions comparing the utility they receive from retirement benefits today, with the expected utility from continuing active in the labor market. This participation decision, however, is subject to employment uncertainty. If the probability of becoming unemployed (and eventually re-employed) is ignored, the expected utility from work is overestimated. This could lead to an underestimation of the probability of claiming retirement benefits, especially at early ages, because individuals would not internalize the likely drop in their Social Security wealth and expected utility, resulting from a period of unemployment.[1]

This mechanism, as employment uncertainty has evolved over time, can explain part of the striking shift of benefits claim from the Normal Retirement Age to the Early Retirement Age in the United States, and also the fact that this early claiming has remained high even as the penalty for early retirement has become steeper with the increases in the Normal Retirement Age that started in the year 2000, and that will continue later in this decade.

Social Security provides fairly complex incentives that affect the labor supply and benefit uptake behavior of individuals between the Early Retirement Age (ERA) and the maximum retirement age. These incentives, analyzed in detail in the Appendix, and carefully modeled in our work, are especially involved between the early and Normal

[1] A period of unemployment results in a zero in the history of earnings for an individual who has not claimed benefits, and therefore the expected Social Security wealth is decreasing once employment uncertainty is introduced. Additionally, a period of unemployment, even if accompanied by unemployment benefits, leads to a lower expected utility level compared to a situation of total control of the labor supply, and interacts with the value in utility terms of receiving Social Security benefits. The latter provides a kind of insurance to workers who could lose their jobs, insurance that only becomes available once the individuals reaches the ERA.

Retirement Ages (NRA). In the U.S., two of the most important incentives are the Social Security Earnings Test (ET), which determines the maximum level of earnings that do not result in benefit withholdings for individuals who have claimed retirement benefits before the NRA, and the Actuarial Reduction Factor (ARF), which determines the permanent reduction in benefits that individuals face if they claim benefits early.

The model used in this paper is closely related to those presented in Rust and Phelan (1997), Benítez-Silva, Buchinsky, and Rust (2003),and Benítez-Silva and Heiland (2007). Our model also shares a number of characteristics with the work of French (2005), van der Klaauw and Wolpin (2008), and Blau (2008) among other researchers who solve, simulate, and in some cases estimate, dynamic retirement models under uncertainty. The importance of modeling in detail the incentive structure related to early retirement and claiming behavior has been convincingly emphasized by Benítez-Silva and Heiland (2007 and 2008), and Benítez-Silva et al. (2009). These researchers are the first to explain in the US context the trend towards early claiming, which has been documented using administrative micro data in Benítez-Silva and Yin (2009). However, even in those complex models the authors ignore unemployment uncertainty, and assume a perfect control by the individual over its labor supply. Coile and Levine (2006) discuss the importance of taking into account unemployment uncertainty when analyzing retirement programs, but they do it within a reduced form context in which the discussion of possible reforms to the system is not meaningful, given that they do not explicitly model the behavior of the individuals or the incentives of the system.

Our research contributes to the vast retirement literature by paying special attention to unemployment uncertainty within a model which allows us to analyze some policy reforms in the United States. By carefully modeling unemployment uncertainty in a life-cycle model of retirement behavior, we correctly assess the trade-offs that individuals face when deciding whether to claim benefits early, and whether to drop from the labor force. The risk of unemployment is very important for old workers, whose productivity and grade of adequacy to new technologies tend to be lower as time passes. Hence, if we ignore the firing risk for old workers, or their likelihood of re-employment if they lose their jobs, we would be overestimating the utility workers derive from the option of continue working and, on the contrary, under-estimating the option of exiting earlier from the labor market to retirement. Our work is strongly connected with Benítez-Silva, Jiménez-Martín, and García-Pérez (2012), but their work concentrates on the effects of wealth changes and increases in uncertainty instead of analyzing the effects on labor supply and claiming of possible reforms to the system.

The calibration of the model presented allows as to explain with great accuracy the benefits claiming behavior of older Americans; namely, the strikingly high proportion of individuals who claim benefits exactly at the ERA. The model also matches well the fact that early claimants are predominantly individuals who were not working before reaching the ERA,[2] and as could be expected we find that this group had lower wealth and worse labor market prospects (e.g. lower wages in the period they last worked) than those who worked in the period before claiming, and also those who claim later. For those workers early claiming of pension benefits (access to their pension wealth) provides self insurance against unemployment uncertainty and helps them to smooth their consumption. As a major difference to other countries (see for example, García-Pérez and

[2]This results can be also found in García-Pérez and Sánchez-Martín (2010) or Hairault et al. (2010)

Sánchez-Martín (2010) for the Spanish case or Hairault et al. (2010) for the French case), in the U.S. this income can be further complemented after the early retirement age by labor income. Therefore, early claimants can maintain the option of going back to the labor force while protecting themselves against labor market uncertainties. Interestingly, the set up of the Earnings Test provisions fosters this insurance-like behavior, since the withholdings of benefits to those working above certain wage levels are not permanent and are returned in the form of higher benefits once the individual reaches the NRA. Furthermore, if the early claimant decides to return to work it might be that thanks to the yearly recalculation of benefits his or her Social Security wealth would further increase. These last two effects directly (in the case of the earnings test provision) or indirectly (in the case of recalculation) reduce the penalty incurred by individuals when they choose early retirement, making early claiming less costly when reaching the ERA (and any age before the NRA), explaining further why so many individuals claim early especially from unemployment.

The model also does a good job in capturing the declining labor force participation at those same ages, and shows that both claiming and labor supply are responsive to the existence of employment uncertainty. Another important finding is that it is key to model uncertainty properly, otherwise claiming hazards at age 62 (65 and 66) are widely underestimated (overestimated) by as much as 15 percentage points (10 percentage points), labor supply is overestimated, and wealth accumulation in the 60s is underestimated by between 2% and 8% depending on age, if employment uncertainty is ignored.

We then analyze the effects of a number of policy experiments in the presence of employment uncertainty, and find that labor supply can be quite responsive to certain policies that make work at older ages comparatively more attractive, like reductions in the Social Security taxes paid by older workers, and especially (with, at some ages, double digit increases in labor supply and considerable delay in claiming) increases in the average wage used to compute retirement benefits for those that work in their 60s and beyond. We also find that completely removing the earnings test leads to small effects once this incentive is properly modeled, and that increasing the Normal Retirement Age to age 69 increases work and delays claiming.

The structure of the paper is the following. After presenting the basic stylized facts regarding retirement and claiming behavior in the U.S. in Section 2, we describe our life-cycle model in Section 3. In Section 4 we present our basic simulation results, and Section 5 describes the policy experiments we propose and their budgetary consequences. Finally, Section 6 concludes.

2 Stylized facts regarding retirement

The large retirement literature developed during the 1980s and 1990s in the U.S. focused on explaining the connection between retirement incentives and retirement behavior.[3] It concluded, quite convincingly, that the retirement peaks at age 62 and age 65 could be explained if the full set of incentives were included in the model. However, in the data used in those studies the majority of Americans were claiming benefits at age 65, while in the 1980s and 1990s the peak started to move towards age 62. By the end of the 1990s, close

[3]For a survey of this broad retirement literature see Lumsdaine and Mitchell (1999). Hurd (1990), Lumsdaine (1995), and Ruhm (1996) provide good discussions of the earlier literature.

to 60% of older Americans were claiming benefits at age 62, and it has stayed around that level, even with the implementation of the 1983 Amendments that penalize early claiming of benefits, and reward late claiming at a higher rate, along with the substantial increase in expected longevity since the 1970s. In fact, as of the end of 2009, 71.86% of men and 74.69% of women claimed Social Security benefits before the Normal Retirement Age (NRA), compared to 36% and 59% in 1970, respectively.[4] Clearly, the economic incentives seem to be insufficient to achieve the objective of prolonging average work lives, given the strong correlation between benefit claiming and labor supply.

As it is clearly shown in Table 1 which uses male data from the Public-use microdata extract from the Master Beneficiary Record, the take-up of retirement benefits at the earliest possible age has become prevalent in the U.S. economy. The peaks are at the eligibility ages of 62 and 65 which comes as no surprise given this well established response to program incentives. Between 1994 and 2004, almost 50% of claimants have been taking their benefits at age 62, and between 20% and 28% wait for the normal age of retirement. Notice that in 2004 we already see a large increase in claiming at age 66, the new Normal Retirement Age for those born after 1937.[5] This trend will be captured in our model which will assume an NRA of 66. The reason we use this source of data to discuss what our model should be matching, is because it provides the more reliable and closer to what our model can predict, since it focuses on males and on individuals claiming on their own working histories, instead of showing aggregate data that includes dependents.

It is important to note the striking trend in (actuarially adjusted) benefits in the last few years, in which the level of benefits of those receiving benefits early has increased while the level of those claiming late has decreased quite sharply. Benítez-Silva and Yin (2009) discuss this interesting issue in detail, arguing that has much to do with the elimination of the Earnings Test and the increases in the NRA. Our model will provide an empirical counterpart to the benefit levels shown in Table 1, once we adjust our prediction by the Actuarial Reduction Factor and the Delayed Retirement Credit.

In Table 2 we present the main stylized facts regarding labor supply of older workers, according to data from the Current Population Survey (CPS) in the 1996-2006 period. Firstly, it is quite remarkable that part-time is very stable at all ages: around 12-14% of them are observed working part-time (defined as working less than 35 hours per week). This fact likely reflects the considerable self-selection and labor demand factors that influence the possibility of working part-time, which makes quite challenging to try to match this within our model without relying on some ad-hoc assumption about part-time offer arrival rates which are hard to justify on empirical grounds. It is also important to note that the fraction of people working full-time at age 60+ has increased considerable (especially for those over 61) in the 10 years we present here, which corroborates the aggregate evidence that labor force participation of older workers is on the rise. Finally, the fraction of those not working increases substantially at age 62 and reaches 70% after age 67.

Our model relies heavily on a number of empirical specifications, for example regarding

[4]See the Annual Statistical Supplement to the Social Security Bulletin (2009), Table 6A4, and also the Social Security Bulletin, OASDI Monthly Statistics, 1970 - 2007. The latter statistics are no longer available but are comparable to the ones given in the Statistical Supplement.

[5]Strictly speaking the NRA equals to 66 only applies to those born between 1943 and 1954, since those born between 1938 and 1943 had the original NRA of 65 increased by 2 months per earlier year of birth, meaning that someone born in 1938 had an NRA of 65 and two months, and someone born in 1939 had an NRA of 65 and 4 months. In the data, any claiming after age 65 is registered as claiming at age 66.

health uncertainty, the evolution of average wages, and the characterization of employment uncertainty. For the latter we use the first six waves of the HRS, which cover the 1992 to 2002 period of the US economy. The HRS is a nationally representative longitudinal survey of 7,700 households headed by an individual aged 51 to 61 as of 1992-93. The primary purpose of the HRS is to study the labor force transitions between work and retirement with particular emphasis on sources of retirement income and health care needs (see Juster and Suzman 1995). The way we approximate average wages is explained in the following section. For the empirical characterization of unemployment and re-employment probabilities we have used the Current Population Survey (CPS) for the 1986 to 2006 period, as well as the NLSY-79 and NLSY-97 when we could not use the CPS due to variable definitions, like for the re-employment uncertainty.

3 Methodology and the Dynamic Model

In our model, individuals maximize expected discounted life-time utility, where the per period utility function $u(c, l, h, t)$ depends on consumption c, leisure l, health status h, and age t.

$$u_t(c, l, h, t) = \frac{c^\gamma - 1}{\gamma} + \phi(t, h, \overline{w}) \log(l) - 2h, \tag{1}$$

Here $\phi(t, h, \overline{w})$ is a weight function that can be interpreted as the *relative disutility of work*. We use the same specification for ϕ and the disutility from working as in Benítez-Silva, Buchinsky, and Rust (2011).[6] This model assumes that individuals are forward looking, and discount future periods at a constant rate β, assumed fixed in our calibration exercises, and equal to 0.965. Individuals can accumulate balances and receive a fixed interest rate of 2%.[7]

We allow for four different sources of uncertainty in our model: (a) *lifetime uncertainty*: modeled to match the Life Tables of the United States with age and health specific survival probabilities; (b) *wage uncertainty*: modeled to follow a log-normal distribution function of average wages as explained in more detail below; (c) *health uncertainty*: assumed to evolve in a Markovian fashion using empirical transition probabilities from a variety of household surveys, including the NLSY79 and the HRS. And finally (d) *Employment uncertainty*: modeled following the empirical distributions using the CPS from 1989 to 2006 to account for the probability of losing a job, as well as NLSY-79 and NLSY-97 to capture re-employment probabilities.

Given that we allow for employment uncertainty and therefore the possibility of losing a job and the probability of not finding one after unemployment, it is quite important to model unemployment benefits, which in the United States, and until the current economic crisis, covered individuals during 26 weeks, and at a level of approximately 50% of their previous wage. We will model the latter as a function of the average wage of the individual, which in our framework plays the role of a permanent income measure.

We solve the dynamic life-cycle model by backward induction, and by discretizing

[6] İnmohoroğlu and Kitao (2009) discuss the role of different utility characterizations when using a an extended version of this kind of models to simulate Social Security reform.

[7] Table A.1. in the Appendix shows a summary table with the values we use for the key parameters we use in the paper.

the space for the continuous state variables.[8] The terminal age is 100 and the age when individuals are assumed to enter the labor force is 21. Prior to their 62^{nd} birthday, agents in our model make a leisure and consumption decision in each period. At 62 and until age 70, individuals decide on leisure, consumption, and application for retirement benefits, denoted $\{l_t, c_t, ssd_t\}$, at the beginning of each period, where l_t denotes *leisure*, c_t denotes *consumption*, which is treated as a continuous decision variable, and ssd_t denotes the individual's Social Security *benefit* claiming decisions. We assume two possible values for ssd_t. If ssd_t equals 1 the agent has initiated the receipt of benefits. If the individual has not filed for benefits or is not eligible then ssd_t is equal to 0.

After age 70 it is assumed that all individuals have claimed benefits, and again only consumption and leisure choices are possible. Leisure time is normalized to 1, where $l_t = 1$ is defined as not working at all, $l_t = .543$ corresponds to full-time work, and $l_t = .817$ denotes part-time work. These quantities correspond to the amount of waking time spent non-working, assuming that a full-time job requires 2000 hours per year and a part-time job requires 800 hours per year.

The *state* of an individual at any point during the life cycle can be summarized by six state variables: (i) Current age t; (ii) net (tangible) wealth a_t; (iii) the individual's Social Security benefit claiming state ss_t; (iv) the individual's health status, and (v) the individual's average wage, $\overline{w}_t$, and (vi) employment state em_t. The average wage is a key variable in the dynamic model, serving two roles: (1) it acts as a measure of *permanent income* that serves as a convenient *sufficient statistic* for capturing serial correlation and predicting the evolution of annual wage earnings; and (2) it is key to accurately model the rules governing payment of the Social Security benefits. In the U.S., an individual's highest 35 years of earnings are averaged and the resulting *Average Indexed Earnings* (AIE) is denoted as $\overline{w}_t$. The PIA is the potential Social Security benefit rate when retiring at the NRA. It is a piece-wise linear, concave function of $\overline{w}_t$, whose value is denoted by $P(\overline{w}_t)$. The employment state takes the value 1 when the person is employed and zero if unemployed in a given period. We do allow for voluntary unemployment, but in that case individuals do not receive unemployment benefits, although are subject to the same re-employment probability λ as those who lose their jobs.

In principle, one needs to keep as state variables the entire past earnings history for the computation of $\overline{w}_t$. To avoid this, we follow Benítez-Silva, Buchinsky, and Rust (2011) and approximate the evolution of average wages in a Markovian fashion, i.e., period $t+1$ average wage, $\overline{w}_{t+1}$, is predicted using only age, t, current average wage, $\overline{w}_t$, and current period earnings, y_t. Hence, following Benítez-Silva, Buchinsky, and Rust (2011), we have that:

$$\log(\overline{w}_{t+1}) = \gamma_1 + \gamma_2 \log(y_t) + \gamma_3 \log(\overline{w}_t) + \gamma_4 t + \gamma_5 t^2 + \epsilon_t. \quad (2)$$

We then use the observed sequence of average wages as regressors to estimate the following log-normal regression model of an individual's annual earnings:

$$\log(y_{t+1}) = \alpha_1 + \alpha_2 \log(\overline{w}_t) + \alpha_3 t + \alpha_4 t^2 + \eta_t. \quad (3)$$

This equation describes the evolution of earnings for full-time employment. Part-time workers are assumed to earn a pro-rata share of the full-time earnings level (i.e., part-time earnings are, say, $0.8 \cdot 800/2000$ of the full-time wage level given in equation (3)). The factor of 0.8 here incorporates the assumption that the rate of pay working part-time

[8]See Rust (1996), and Judd (1998) for a survey of numerical methods in economics.

is 80% of the full-time rate. We actually use data from the CPS in the 1996 to 2006 period to estimate this part-time penalty.[9]

The advantage of using $\overline{w}_t$ instead of the actual Average Indexed Earnings, especially in the U.S., is that $\overline{w}_t$ becomes a sufficient statistic for the person's earnings history. Thus we need only keep track of $\overline{w}_t$, and update it recursively using the latest earnings according to (2), rather than having to keep track of the entire earnings history in order to determine the 35 highest earnings years, which the AIE requires.

With all these elements defined, we have that the expected present discounted value of utility from age t onward for an individual with state variables $(a, \overline{w}, ss, h, em)$ where a stands for assets and em for employment status, is represented by the following two Bellman equations that correspond to the core of the model we are analyzing. We separate the value of being employed and the value of being unemployed. One of the keys of the model is that we are adding the probabilities of losing a job δ, and the probability of finding a job (receiving a job offer) λ, to a dynamic life cycle model of consumption, asset accumulation and retirement.

3.1 The value functions

The value of being employed

$$\begin{aligned} V_1^t(a, \overline{w}, ss, h, em = 1) \quad = \quad & \max_{c_t, l_t, ssd} u(c_t, l_t, h_t, t) + \\ & \beta \left[(1 - \delta_t) \; Emax \; (V_1^{t+1}(w_t), V_0^{t+1}) + \delta_t \; V_0^{t+1} \right] \end{aligned} \tag{4}$$

where δ denotes the probability of losing the employment. The value function is subject to,

$$a_{t+1} = (1 + \overline{r})(a_t - c_t) + w_t(1 - l_t) + I\{ssd = 1\}P_t \tag{5}$$

As stated above, individuals choose their consumption and leisure levels, and make their Social Security decision regarding claiming of Retirement Benefits. The continuation value in the Bellman equation, with probability $1 - \delta_t$, comes down to the labor supply choice next period between working at an expected wage and being voluntary unemployed ($vu = 1$). However, with some probability δ_t they are not able to work next period and just obtain the utility of not working starting tomorrow.

In the budget constraint above, we can see that only those who decide to claim benefits, $I\{ssd = 1\}$, will obtain a pension, P_t.

[9]Given the relatively small number of part-time workers at some ages, we had to aggregate across a wide range of ages. In Table A.1. we show the penalties we have assumed for ages 62 and above, since we normalize the penalty to zero for younger individuals. Additionally, since self-selection issues can be important, and we do not model part-time offer arrival rates, we have calibrated these penalties to approximately match the proportion of part-time work we observe in the data.

The value of being unemployed

$$V_0^t(a, \overline{w}, ss, h, em = 0) = \max_{c_t, l_t, ssd} u(c_t, 1, h_t, t) + \beta\,[(1-\lambda)V_0^{t+1} + \lambda Emax\,(V_1^{t+1}(x), V_0^{t+1})] \tag{6}$$

where λ is the probability of receiving an offer. The value function is subject to,

$$a_{t+1} = (1+\overline{r})(a_t - c_t) + I\{ssd = 0\}b_t + I\{ssd = 1\}P_t \tag{7}$$

Notice here that the budget constraint of an unemployed worker includes as income the possible availability of unemployment benefits (b_t). As explained before, unemployment benefits are computed as a function of the average wage, $\overline{w}_t$, but is zero if the person is voluntarily unemployed, which in the model essentially means in a given period the individual chooses not to work when work is available.

We then define:

$$b_t = \begin{cases} 0 & \text{if } vu_t = 1; \\ g(\overline{w}_t) & \text{otherwise.} \end{cases} \tag{8}$$

We include here the previous employment state as one of our state variables, which means that someone who is displaced or someone who chooses to be voluntarily unemployed will see that the arrival offer rates are controlled by λ, which we model here just as a fixed parameter equal to 0.35, which we have computed using NLSY79 and NLSY97 re-employment probabilities across ages and unemployment durations. In Benítez-Silva, Jiménez-Martín, and García-Pérez (2012) this re-employment probability is allowed to vary over ages and over unemployment duration, providing a richer but considerably more complex model.

3.2 Other details of the model

The function $EV_{t+1}(a, \overline{w}, ss, h, em, c, l, ssd)$ in each of the two labor status denotes the conditional expectation of next period's value function, given the individual's current state $(a, \overline{w}, ss, h, em)$ and decisions (c, l, ssd). Specifically, we have

$$EV_{t+1}(.) = \int_{y'} \sum_{h'=0}^{2} \sum_{ss'=0}^{n} V_{t+1}(wp_t(a, \overline{w}, y', ss, ssd), awp_t(\overline{w}, y'), ss') \times k_t(h'|h) g_t(ss'|a, \overline{w}, ss, ssd) f_t(y'|\overline{w}) dy', \tag{9}$$

where the number of Social Security states, n, is eighteen for the United States, once we have to take into account the possibility of claiming early, and also the proper modeling of the earnings test, which results in early claimers who work above the earnings test limit seeing their benefits increased by the time they reached the NRA (See Benítez-Silva and Heiland (2007) for a detailed description). Additionally, $awp_t(aw, y)$ is the Markovian updating rule that approximates Social Security's exact formula for updating an individual's average wage, and wp_t summarizes the law of motion for next period's wealth, that is,

$$wp_t(a, \overline{w}, y, ss, ssd) = R\left[a + ssb_t(\overline{w}, y', ss, ssd) + y' - \tau(y', a) - c\right], \tag{10}$$

where R is the return on saving, and $\tau(y, a)$ is the *tax function,* which includes income taxes such as Federal income taxes and Social Security taxes and potentially other types of state/local income and property/wealth taxes. The awp_t function, derived from (2), is given by

$$awp_t(aw, y) = \exp\left\{\gamma_1 + \gamma_2 \log(y) + \gamma_3 \log(aw) + \gamma_4 t + \gamma_5 t^2 + \sigma^2/2\right\}, \tag{11}$$

where σ is the estimated standard error in the regression (2).

Above, $f_t(y|\overline{w})$ is a log-normal distribution of current earnings, given current age t and average wage $\overline{w}$, that is implied by (3) under the additional assumption of normality in η_t. The discrete conditional probability distributions $g_t(ss'|a, \overline{w}, ss, ssd)$ and $k_t(h'|h)$ reflect the transition probabilities in the Social Security and health states, respectively.

Some additional assumptions implicit in our Dynamic Programming are:

- A period of employment (at least) follows the decision to work from unemployment or from the previous job (after accepting a job-to-job offer), if displacement does not occur.

- An employed individual receives at least one job offer at the end of every period. Individuals decide to accept or not the offer, and even if they accept the offer, they could be displaced before they start to work that period. We do not differentiate here between someone who continues to work in a given job, and someone who changes jobs without a period out of the labor market. This assumes implicitly the portability of the accumulated tenure, a feature believed to be widely available to high skill individuals. For unemployed individuals (regardless of whether this is a voluntary decision or not) the job offer arrival rate is controlled by λ, which as discussed above is assumed to be fixed at 0.35.

- There is, at least, a period of unemployment after displacement.

- The unemployment probability δ is likely a function of some individual characteristics like average wage and age, but in our model we use the empirical probabilities from the CPS which only vary by age.

- We do not model the institutional details of private pension schemes or disability insurance. However, we do model private savings.

- We assume an initial level of assets in the first period, $a(0) = a_0$, and assume they face borrowing constraints, $a(t) \geq 0$ for every $t \geq \tau$.

3.3 Solving and Simulating the Model

Our interest in solving and simulating a model with the level of complexity we have described is twofold. On the one hand, the model will be able to provide a variety of predictions which we can then compare with the data, like the proportion of individuals claiming at different ages, their benefit levels, their consumption patterns, their labor supply patterns, and their wealth levels. Additionally, the model will provide a set of structural parameters, and will validate beliefs about the future, which are the foundations of the model even when we change the incentive structure to analyze the effect of policy changes on the behavior of individuals.

As explained earlier, our model allows for four different sources of uncertainty. The random draws to simulate these sources of uncertainty, as well as the initial conditions regarding wealth levels and average wages, will be the same for all the models compared in what follows. Thus, the differences presented in the results are only due to the changes in the incentive schemes. Underlying these characterization of uncertainty is the assumption that agents behave rationally given the information they have about the future (stochastic) evolution of these state variables.

For computational simplicity, we assume that decisions are made annually rather than monthly, but we allow for the benefit adjustments due to earnings above the Earnings Test limit to happen semi-annually following Benítez-Silva and Heiland (2007).

4 Simulation Results

Table 3 presents our basic set of results. We show two panels of results, with the first panel using a benchmark model without employment uncertainty, but with the appropriate characterization of the Earnings Test and the adjustment factors. The second panel presents our full model, in which we introduce employment uncertainty, allowing for probabilistic displacement and re-employment.

This first panel shows that the claiming peaks, while qualitatively similar to the data, quantitatively are not in line with what we see in the data, where our benchmark are the proportions from the Public-Use microdata for males in Table 1. This result convinces us of the need to account for the full structure of beliefs (uncertainties) to characterize optimal behavior in line with the empirical facts.

From the second panel we can see that the implications of introducing employment uncertainty are very clear. First, it reduces employment at all ages except for age 65, with percentage drops well in the double digits in some cases. Secondly, it increases early claiming sharply, bringing it more in line with the data, and at the same time it decreases claiming at ages 65 and 66 that was very high in Model 1. In general the model improves further, and we now find a distribution of claiming ages much closer to the data reported by the U.S. Social Security Administration. In particular, we capture the sharp peak at age 62, with a simulated percentage almost identical to the males in the data, and we also capture the peaks at ages 65 and 66 that we see in the Public-Use microdata files. The main difference between the data and our results is that we predict a higher proportion of individuals claiming after the NRA, which results from the fairly high Delayed Retirement Credit (DRC) which has now reached 8%. In part this is due to the fact that in our model savings can only be made in riskless assets at a low fixed interest rate, and under certain conditions our moderately risk averse agents see the value in obtaining a substantially higher retirement benefit if they wait and live off their assets and wage income. A more complex characterization of the investment choices, and the introduction of other realistic beliefs about the evolution of the US retirement system (Benítez-Silva et al. 2009) would probably lead to a reduction in those claiming after the NRA.

These findings are no small accomplishment given how elusive has been for researchers to explain the claiming behavior of Americans in the last decade and a half. Notice that we accomplish this excellent fit without relying on heterogeneous preferences (Gustman and Steinmeier 2005) or hard to test beliefs about the future. Regarding labor supply, the qualitative results show a declining labor supply at older ages, starting at age 61 and 62, and then more pronounced at ages 64 to 66. The proportion of individuals working increases slightly at ages 67 and 68 mainly due to the phasing-out and eventual disappearance of the earnings test.

It is important to highlight that the proper consideration of employment uncertainty is correcting relevant biases in predicted labor supply and claiming behavior. For example, comparing the first and the second panels in Table 3 we can see that by not considering such uncertainty when solving the model we would be biasing upwards by large percentages the work decision of workers ages 60 to 64. For those over 65 the upward bias is also very large, again showing how important is to model employment uncertainty. With respect to claiming, the downward bias due to not considering employment uncertainty is very large, at about 15 percentage points at age 62, and the bias is upwards of around ten percentage points at ages 65 and 66. This table also provides the average monthly retirement benefits (for those claiming at those ages), the average monthly consumption levels (for all individuals of that age), and the average wealth levels (for all individuals of that age) for the 10,000 simulations of the full model. The retirement benefit levels are also remarkably in line with what we observe in the Social Security data once we take into account that the amounts should be modified by the adjustment factors (for those before the NRA) or delayed retirement credit (for those above the NRA) depending on the age of claiming. This give us confidence that our modeling strategy regarding the average wage process and the wage process reflect quite closely the earnings histories of the individuals currently claiming Social Security retirement benefits.

Regarding average monthly consumption, the levels we find seem reasonable for a single individual, and the average wealth level of individuals at different ages shows a declining wealth in the 60s. Notice also the effect that modeling employment uncertainty have on wealth accumulation, with wealth monotonically increasing at just about all ages (age 68 is an exception) once uncertainty is considered.

Finally, in terms of the average working life predicted for the two models, as could be expected, we get that it declines as we move from Model 1 to Model 2, that is, as we introduce employment uncertainty. In the model without such uncertainty the average working life is 38.83 years, while in model 2 it drops to 35.68 years, 3.14 years less, or around 8% less.

5 Policy Experiments

In this section we present the simulation results from various policy experiments we propose. In each case we simulate the labor supply consequences as well as the foreseeable impact on the Social Security claiming behavior of individuals conditional on the level of employment uncertainty present in our benchmark model (Table 3), and discuss the likely effect on the public accounts.

Table 4 presents the simulation results of four different policy experiments. The first set of panels of the table simulate the consequence of reducing (by 50%) the Social Security tax paid by individuals who decide to work beyond age 59, without modifying the effect of their earnings on their future benefits. This can be understood as a direct income effect for individuals who will keep a higher proportion of earnings, and also for employers, who will see this reduction as an opportunity to hire these workers. We should compare these results with those from the second panel of Table 3, labeled Model 2. We can see that the proportion of workers is slightly higher under this scenario for ages 64 to 66, and similar for other ages, and the proportion of individuals claiming early is about 2 percentage points higher, and the proportion claiming after the Normal Retirement Age, is around five percentage points higher. Finally, the retirement benefits are quite similar to those in Model 2, while the consumption levels are a big higher, and the wealth accumulated at the different ages are quite similar, with slightly lower accumulation up to age 65, and slightly higher after that.

This policy experiment is related in nature to the one proposed in Laitner and Silverman (2008), who within a fairly different life-cycle model, find that the elimination of the payroll tax after a certain age or a certain number of years with the resulting freeze of retirement benefits (and increases in payroll taxes at other ages to make the policy revenue neutral) would lead to a substantial extension of the working life, of about a year.[10] However, their model does not account for any type of uncertainty, any type of risk aversion, or any kind of intertemporal substitutabilities, and they do not model labor supply and claiming behavior separately. Given these differences it should not be surprising that our results are qualitatively different from theirs since we find that the average working life (35.79 years) does not vary much with respect to the benchmark model with employment uncertainty (35.68).

The second panel in Table 4 shows a slightly different policy, by increasing the average wage of those who work full-time after age 59 by 1.5%, above and beyond the possible increase in the average wage coming from actually choosing to earn a wage. Notice that this increase in average wage happens regardless of whether the individual in our simulations has started to receive benefits, which means that for those who already are receiving them, this policy is a proxy for a recalculation of benefits provision, which is in fact already in place in the US system but that due to the computational complexity involved in accounting for it we do not model. We can see that the proportion of workers is much higher under this scenario for all the ages shown but in particular for ages 63 and over where we see very large effects on labor supply. For example, the proportion of individuals working at age 64 goes from 49.2% in the benchmark model to 59.42% under the new policy. The effect is even larger at age 65, when work goes up by around 17 percentage points. These results come to show the sizable effect of making work more appealing by affecting the average wage, which directly affects future benefits for these workers. Regarding claiming behavior, the proportion of individuals claiming at age 62 is about 7 percentage points lower than in the benchmark simulation. After that, claiming is increased sharply for those claiming after the NRA. In terms of the average length of the working life, the increase is not substantial, suggesting that individuals make intertemporal decisions to compensate the increase in work later in life. The effect on Social Security benefits is quite striking for those claiming early who receive substantially higher benefits after working in the last two years, but the effect is diminished for later

[10]Van der Klaauw and Wolpin (2008) simulate also the effect of an increase in the payroll tax, and find sizable effects. In their setting this increase is instantaneous, and individuals cannot adjust to it intertemporally.

claimants. On the other hand, the effect on consumption is sizable, with levels around 5% higher than in the benchmark, which should not come as a surprise since the individuals willingness to reduce leisure has to be compensated by higher consumption possibilities.

The third panel in Table 4 shows the consequences of a complete elimination of the earnings test at all ages, similar in nature to what was done in the year 2000 for those above the Full Retirement Age. Under this scenario the decision to claim benefits and the decision to work are not connected through the level of benefits that the person will receive, although of course remain connected through the budget constraint of the individual in terms of total available resources. We can see that now the claiming is not affected in any substantial way, compared with the benchmark model, which should not be surprising given that we model the Earnings Test properly, which results in not having much of an effect in a full-rational model, in which individuals are completely aware of the details of the system, no matter how intricate. In reality, we would expect more of an effect in claiming as predicted empirically, for example in Benítez-Silva, H., and F. Heiland (2008), due to lack of full information by individuals. Similarly, labor supply is almost unaffected by this policy. The average length of the working career goes up by about a month compared with the benchmark model with employment uncertainty. Notice, that the level of benefits received is higher at all ages, which should not be very surprising since by separating the labor supply incentives from the claiming incentives, individuals see no withholding of benefits due to excessive earnings, and therefore receive the full benefit corresponding to the age that they claim. The consumption level is quite similar to the benchmark, but the wealth accumulated in noticeably higher after age 63.

The last panel of Table 4 shows the consequences of increasing the Normal Retirement Age to 69 (with an increase in the Maximum Retirement Age to age 72). The most clear consequence of this policy change is twofold. On the one hand, to delay retirement claiming considerably, with increases in those claiming at ages 67 and above, while the proportion claiming at age 62 remains almost identical. and reducing considerably those claiming at age 65 (about 5 percentage points). On the other hand, we have increasing labor supply at all ages from age 62, with especially sharp increases at age 65, with almost double digit percentage point increases. The average length of a working life goes up by over a year, with respect to the benchmark model with employment uncertainty, which is quite substantial. Notice, however, that claiming for the first time at exactly age 69, the new NRA, is not favored by our agents, which should not be surprising given that the agents face the same longevity expectations as before, while their benefits have been reduced considerably. This result is also due to the fact that, at the same time, they have lost the sizable Delayed Retirement Credit, which in the previous models increased retirement benefits by 8% for every year that the individuals delayed claiming beyond the NRA (66 in the previous panels). Overall, we can also see that they can consume at at lower level, especially after age 62, and the higher labor supply ends up translating into higher wealth accumulation at all ages.

5.1 Claiming behavior by employment status

Our model allows us to study claiming behavior by employment status in the previous period. In this sense, Table 5 and Figure 2, present the effect of the various experiments on claiming behavior by previous employment status. We distinguish between claiming from work and claiming from no work. Note first, that introducing uncertainty in the model leads to a slightly different distribution of claiming over the employment state, more clearly showing the sizable difference that labor supply in the previous period makes for claiming. Secondly, in almost all cases claiming from no work is larger than claiming from work, especially around the Early Retirement Age. In fact, it is important to emphasize that those who claim early from no-work have fairly different characteristics from those who claim early from work, and also from those who claim late. The key differences have to do with their wealth levels and wages in the period that they last worked. We find that those who claim from no work have a much lower average level of wealth holdings (around $33,000) than those who claim from work (around $121,000), and their wages were also much lower the last time they worked ($30,000 vs. $41,000). One possible explanation for this feature of the data and the model is that those who claim from no work are credit constraint individuals who need the resources from the retirement system after at least one period out of work, and who do not have enough resources to sustain themselves only with their financial assets, and who no longer can receive unemployment benefits. Thus, for them early claiming provides insurance against unemployment shocks.

The latter point, as mentioned in the introduction, is we believe worth emphasizing, since the possibility of claiming pension benefits early provides self insurance against unemployment uncertainty and helps them to smooth their consumption. As a major difference to other countries (see for example, García-Pérez and Sánchez-Martín (2010) for the Spanish case or Hairault et al. (2010) for the French case), in the U.S. this income can be further complemented after the early retirement age by labor income. Therefore, early claimants can maintain the option of going back to the labor force while protecting themselves against labor market uncertainties. Interestingly, the set up of the Earnings Test provisions fosters this insurance-demand like behavior, since the withholdings of benefits to those working above certain wage levels are not permanent and are returned in the form of higher benefits once the individual reaches the NRA. Furthermore, if the early claimant decides to return to work it might be that thanks to the yearly recalculation of benefits (not formally introduced in our model due to computational limitations) his or her Social Security wealth would further increase. These last two effects reduce the penalty incurred by individuals when they choose early retirement, making early claiming less costly when reaching the ERA (and any age before the NRA), explaining further why so many individuals claim early especially from unemployment.

Thirdly, totally removing the earning test leads to small changes in claiming behavior given that we have already modeled this incentive in detail. And, finally, the experiments that lead individual to postpone claiming are mainly the setting of the NRA to 69 and the increase in the Average Wage. Notice in the figure the striking difference between the claiming behavior of those who were employed at 61 from those who were not working at that age. An overwhelming majority of not workers at 61 claim at the earliest possible age, 62, while those who are working at age 61 are much less likely to claim early, and most of them claim by the time they reach age 67. This illustrates the fact that in order to understand early claiming it is key to understand the role that periods of work or out of work play at older ages.

5.2 Budgetary Consequences of the Policy Experiments

Table 6 shows the results of calculating the present values of Income Taxes paid, Social Security Taxes paid, and Benefits Received by agents, resulting from averaging 10,000 simulations of the benchmark model and the four policy experiments we have discussed above. The leftmost column shows the means and standard deviations of those measures for the benchmark characterization of our model, while the rest of columns shows the results for the policy experiments.

Interestingly, the different policy measures are fairly neutral from a budgetary perspective, except for the increase in the Normal Retirement Age to 69, which, not surprisingly, has a sizable dampening effect on the Present Value of Benefits received by the average individual. Notice that this is very much expected since an increase in the Normal Retirement Age is equivalent to a cut in benefits, conditional on individuals living the same average number of years after claiming benefits, which by construction is the case in our model. In general, the main defense of policies that increase the NRA is that they are implemented in order to be *generationally* and actuarially fair. This means that when we compare cohorts with different longevities, younger cohorts do not end up receiving more benefits over their lifetime than older cohorts whose longevities were generally shorter. The case of higher NRA also leads to slightly higher income taxes paid due to the increase in labor supply explained when discussing the last panels of Table 4, mainly when individuals are in their early 60s.

The only other policy that has a sizable budgetary effect is the increase in Average Wages for those 60 and over. This policy has an important effect on the Income Tax base, as well as the Social Security Taxes collected, due to the labor supply effect that we have described. It does not affect substantially the average actual benefits paid. From this perspective the policy that fosters work at older ages by affecting their average wage seems to be the one that has the more appealing effects since it seems to pay by itself, and on top of it, increase substantially the income taxes collected.

Finally, it is important to emphasize that given that we assume a stable population with the current distribution of longevity and working lives, it is not surprising that the total taxes collected by Social Security are substantially higher than the benefits paid, suggesting an increase in the Social Security Trust Fund under our assumptions. This is in fact what has been going on, until the number of individuals of working age has started to diminished at a faster rate than the increase in older individuals, a process not modeled within our partial equilibrium, and demographically neutral model.

6 Conclusions

While the possible reforms to the Old Age component of the Social Security system seem to have taken somewhat of a back seat compared with the discussions on the future of the Medicare system, we believe public policy needs more than ever the work of economists to provide a path towards sustainability of social insurance programs in a age of increased risks and increased challenges coming not only from the sky rocketing costs of health care, but also from increased longevity, declining fertility and growing immigration. In fact, the existence of an apparent consensus regarding the problems of the Old Age system, which needs to be able to adjust to the growing longevity of Americans and the demographic composition of the population, makes the reforms more likely. Our paper is a step in this direction by providing a model within which we can simulate the effects of possible reforms to the Social Security system, while accounting for a source of uncertainty that has been relatively overlooked in terms of its link with retirement decisions, but that has grown in importance as older workers are no longer confined to traditional careers with long tenure and little uncertainty over future employment.

We show that our extended model (which includes employment and re-employment uncertainty) does an excellent job in matching important (and rather elusive) features of the data, like the large proportion of early retirement claimants, and the fact that most of them had a period out of work before claiming. The latter suggest that early claiming provides self-insurance against unemployment shocks, and allows displaced individuals to smooth consumption, even while retaining the possibility of returning to work if the right job comes along, thanks to the incentives provided by the earnings test provisions and the recalculation of benefits rules. We also find that individuals claiming decisions and labor supply behavior are responsive to changes in employment uncertainty and unemployment benefits, suggesting that the changing retirement behavior (in terms of claiming benefits early and affecting the labor force participation) in the last decade is likely to be at least in part due to the changing labor market uncertainty faced by individuals. We find that introducing in a realistic fashion employment uncertainty in the model increases early claiming and reduces labor force participation at older ages, making them more in line with what we observe in the data.

Additionally, we also find that labor supply at older ages is responsive to a policy that would make work more attractive after age 59 by affecting the average wage of individuals, providing a policy recommendation worth considering to increase labor force participation at those ages. We also show that other policies likely to be considered, like lowering Social Security taxes for older workers, or the elimination of the Earnings Test, have comparatively small effects on labor supply, and the effects (also small) on claiming do not necessarily translate into a better balance for the public system. Finally, the most obvious reform, and also the most likely to happen, the increase in the NRA, reduces consumption considerably, increases working lives by about a year, and increases wealth accumulation, and makes the system much more sustainable.

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Appendix: Social Security Incentives for Early Retirement in the United States

Individuals who claim benefits before the NRA but continue to work or reenter the labor force can reduce the early retirement penalty by suspending benefit payments.[11] The Actuarial Reduction Factor, ARF, (or early retirement reduction factor), in turn, will be increased proportionally to the number of months without benefits, which will increase benefits permanently after the individual reaches the NRA.[12] This adjustment of the ARF allows those who become beneficiaries before the NRA to partially or completely reverse the financial consequences of their decision, averting being locked-in at the reduced rate. In the sequel of this section the exact details of these incentives are presented.

Benefit Calculation

Individuals aged 62 or older who had earned income that was subject to the Social Security payroll tax for at least 10 years since 1951 are eligible for retirement benefits under the Old Age benefits program (OA program). Earnings are subject to the tax up to an income maximum that is updated annually according to increases in the national average annual wage.[13] To determine the monthly benefit amount (MBA), the Social Security Administration calculates the Primary Insurance Amount (PIA) of a worker as a concave piece-wise linear function of the worker's average earnings subject to Social Security taxes taken over her 35 years of highest earnings. If the benefits are claimed at the NRA (66 for those born between 1943 and 1954, and currently at 65 and 8 months), the MBA equals the PIA. If an individual decides to begin receiving benefits before the NRA and exits the labor force or stays below the earnings limit, her MBA is reduced by up to 25%, assuming a NRA of 66. Under the current regulation of the OA program, the monthly benefit amount received upon first claiming benefits depends on the age (month) of initiation of Social Security benefits, in the following way,

$$MBA_t = \begin{cases} (0.75 + 0.05 * \frac{1}{12} * \text{MP3Y}) * PIA, \text{if claimed more than 3 years before NRA;} \\ (0.80 + 0.20 * \frac{1}{36} * \text{M3Y}) * PIA, \text{if claimed within the 3 years before NRA} \end{cases}$$

where MBA_t represents the monthly benefit amount before the NRA (see SSA-S 2005, p.18), MP3Y are the months not claimed in the period prior to 3 years before NRA, and M3Y are months not claimed in in the 3 years before NRA. Assuming that the individual continues to receive benefits, her MBA_t is permanently reduced. The Actuarial Reduction

[11] In this paper, we are not considering spousal benefits and joint decision making in the household. The complexities introduced by those considerations are out of the scope of this analysis. See Gustman and Steinmeier (1991), Coile et al. (2002), and Votruba (2003) for a discussion. By ignoring spousal benefits we are not taking into account the fact that approximately 5.96% of the individuals who receive some type of Old Age, Survivors, or Disability Insurance (OASDI) benefits receive them as spouses of entitled retirees. This percentage comes from the Public-Use Microdata File provided by the Social Security Administration and refers to a 1% random sample of all beneficiaries as of December of 2001.

[12] Given a NRA of 66, which will be the prevailing one for the cohort born between 1943 and 1954, the Actuarial Reduction Factor is a number between 0.75 and 1 depending on when the individual claims benefits, and how many months he or she earns above the Earnings Test after claiming benefits.

[13] As of 2006 this maximum was $94,600, and during 2013 this maximum is $113,700.

Factor (ARF) underlying this calculation is a permanent reduction of benefits by 5/9 of 1 percent per month for each month in which benefits are received in the three years immediately prior to the NRA. The reduction of benefits is 5/12 of 1 percent for every month before that. Thus, the maximum actuarial reduction will reach 30 percent as the NRA increases to 67 over the next few years (see SSA-S 2005, p.18).[14]

Actuarial Reduction Factor

One less-emphasized feature of the process of benefit reduction due to early retirement is the possibility to reduce the penalty even after initiating the receipt of benefits. The specifics of this adjustment to the Actuarial Reduction Factor are documented in the Social Security Handbook (SSA-H, §724. *Basic reduction formulas*, §728. *Adjustment of reduction factor at FRA*) and in the internal operating manual used by Social Security field employees when processing claims for Social Security benefits (SSA-M, RS00615. *Computation of Monthly Benefits Amounts*) but may not be well-understood by the retirees.[15] To illustrate this feature of the system, suppose the NRA is 66 years, and an individual claims benefits at age 62 and n months, where $n < 48$, receives checks for x months where $(n + x < 48)$, and suspends receiving checks after that until she turns 66 (after which she retires for good). In this case she receives x checks of

$$MBA_t = \begin{cases} (0.75 + 0.05 * \frac{1}{12} * n) * PIA & \text{if claimed more than 3 years before NRA,} \\ (0.80 + 0.20 * \frac{1}{36} * n) * PIA & \text{if claimed within the 3 years before NRA.} \end{cases}$$

After turning 66, her MBA will be permanently increased to

$$MBA_t = [0.75 + (0.20 * \frac{1}{36} * n) + (0.20 * \frac{1}{36} * (36 - n - x)) + 0.05] * PIA. \qquad (12)$$

It is important to note that the adjustment of the ARF is automatic and becomes effective only after reaching the NRA.

Earnings Test

The Earnings Test limit defines the maximum amount of income from work that a beneficiary who claims benefits before the NRA under OASI may earn while still receiving the

[14] The reductions in benefits for early claimers are designed to be approximately actuarially fair for the average individual. During the post-NRA period additional adjustments exist: Workers claiming benefits after the NRA earn the delayed retirement credit (DRC). For those born in 1943 or later it is 2/3 of 1 percent for each month up to age 70 which is considered actuarially fair. For those born before 1943 it ranges from 11/24 to 5/8 of 1 percent per month, depending on their birth year. For a discussion of the evolution of actuarial fairness in the last decades see Heiland and Yin (2011)

[15] The Social Security Administration does not use the term Actuarial Reduction Factor in their publications, but a number of the people we have talked to within the administration do use this terminology. In publications the related concept of "Reduction Factor(s)" (RF) which is simply the number of months in which benefits were received before the NRA is used. The RF maps into a "Fraction" that ranges between 0.75 and 1 (for an ERA of 62 and an NRA of 66). The latter corresponds to what we refer to as ARF. The ARF ("Fraction") is adjusted upwards at the NRA according to the number of months before the NRA in which benefits were withheld.

"full" MBA.[16] Earnings above the limit are taxed at a rate of 50 percent for beneficiaries between age 62 and the January of the year in which they reach the NRA, and 33 percent from January of that year until the month they reach the NRA (SSA-S 2005, p.19; SSA-S 2005, Table 2.A18). For the latter period, the earnings limit is higher, $40,080, compared with $15,120 for the earlier period as of 2013. As of 2006 this limits were $33,240, and $12,480, respectively. Starting in 2000, the Earnings Test was eliminated for individuals over the NRA.

Individuals who continue or reenter employment after claiming Social Security benefits before the NRA, and whose earning power or hours constraints are such that their income from work is around or below the earnings limit, are mailed their full monthly check from Social Security and are locked-in at the reduced benefit rate permanently. Those with earnings above the limit will not receive checks from Social Security for some months and thereby adjust their ARF.[17] Individuals have the option of informing Social Security to suspend the monthly benefit payment at any time if they believe they will be making earnings high enough above the Earnings Test. However, during the first year after claiming benefits, the Social Security Administration performs a monthly test to determine whether the person should receive the monthly check. As a result an early claimer who is not working or earns below the limit in the months after claiming ("grace year") will receive all monthly benefits even if earnings for that calendar year exceed the Earnings Test limit due to high earnings before claiming.[18] After the first year, the test is typically yearly and it depends on the expected earnings of the individual. Given the scarce documentation of the functioning of the ARF, having earned above the earnings limit, and thus receiving fewer checks, may be a common way for beneficiaries to learn about the possibility of undoing the early retirement penalty.[19]

[16]Some sources of income do not count under the Earnings Test. For details see SSA-H §1812. Notice that retirement contributions by the employer do not count towards the limit, but additional contributions by the employee even if they are through a payroll deduction are counted. This means that individuals earning above the limit cannot just increase their retirement savings to avoid being subject to the limit. We thank Barbara Lingg and Christine Vance from the Social Security Administration for clarifying this point, which is rarely discussed in any publication.

[17]A beneficiary may receive a partial monthly benefit at the end of the tax year if there are excess earnings that do not completely offset the monthly benefit amount (see SSA-H, §1806).

[18]Social Security claim specialists emphasized to us that during the first year after claiming they do what is most advantageous to the claimer, the monthly or the yearly test, if they have enough information. However, they failed to clarify what that means. Some of them said the number of checks individuals receive is maximized, but we were unable to find documentation of such practices. In any case, the internal operating instructions used by Social Security field employees when processing claims for Social Security benefits state that the monthly earnings test only applies for the calendar year when benefits are initiated unless the type of benefit changes (see SSA-M, RS02501.030).

[19]See Benítez-Silva and Heiland (2008) for a numeric example of the streams of income resulting from these incentives.

Table A.1. Key Parametrizations of the Model

Parameter	Value	Use	Source
β	0.965	Discount Factor	Calibration
γ	-0.37	Risk Aversion	Utility Function Eq. (3)
Leisure of a FT Worker	0.54	Leisure	Utility Function Eq. (3)
Interest Rate	2%	Wealth Accumulation	Calibration
Maximum Taxable Earnings	94,600	Maximum Soc. Sec. Taxes	SSA 2006
Earnings Test ERA to 65	12,480	Work and Claim	SSA 2006
Earnings Test 65 to NRA	33,240	Work and Claim	SSA 2006
Part-time Penalty 1	1 on the $	Age 21 to 60	Calibrated
Part-time Penalty 2	0.65 on the $	Age 61 to 64	CPS 1986-2006 and Calibrated
Part-time Penalty 3	0.55 on the $	Age 65+	CPS 1986-2006 and Calibrated

Notes: When appropriate the sources are mentioned in some detail in the text.

Table 1: US Males Retirement Benefits Claiming Behavior. Public-Use Micro-data Files

	New Male claimants, proportions, 1994-2004 (w/o DI conversions)								
Age	**1994**	**1996**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
62	0.489	0.509	0.491	0.473	0.414	0.453	0.460	0.465	0.478
63	0.162	0.150	0.163	0.152	0.137	0.163	0.160	0.148	0.142
64	0.081	0.072	0.071	0.072	0.061	0.075	0.073	0.073	0.072
65	0.207	0.201	0.207	0.212	0.248	0.273	0.275	0.282	0.219
66	0.022	0.025	0.024	0.033	0.054	0.009	0.010	0.010	0.076
67	0.008	0.013	0.013	0.018	0.031	0.007	0.005	0.006	0.004
68	0.008	0.009	0.007	0.012	0.021	0.004	0.003	0.005	0.002
69	0.007	0.007	0.007	0.009	0.013	0.004	0.004	0.003	0.001
Claimants	5,766	6,001	6,344	6,970	8,169	7,195	7,266	7,404	7,794
	Average monthly benefits in $ of 2005. *Adjusted by the ARF and the DRC*								
Age	**1994**	**1996**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
62	1,203.60	1,179.96	1,233.06	1,302.46	1,315.69	1,352.61	1,402.60	1,414.35	1,356.50
63	1,161.82	1,178.75	1,199.40	1,205.90	1,275.80	1,264.56	1,310.93	1,355.05	1,317.45
64	1,209.15	1,227.03	1,209.64	1,223.97	1,240.47	1,322.56	1,344.97	1,359.56	1,354.08
65	1,260.02	1,264.51	1,243.25	1,234.88	1,258.35	1,298.34	1,348.48	1,384.61	1,349.91
66	1,333.34	1,275.72	1,279.76	1,286.73	1,331.57	944.09	856.84	1,157.49	1,300.07
67	1,205.93	1,261.28	1,155.12	1,274.97	1,398.17	848.03	869.19	925.18	1,078.54
68	1,062.62	1,191.53	1,238.22	1,183.47	1,367.90	918.91	922.04	679.81	678.86
69	1,311.41	1,218.69	1,140.63	1,211.33	1,333.55	1,069.62	852.70	712.98	836.69

Data Source: OASDI Public-Use Microdata File 2004. Social Security Administration.

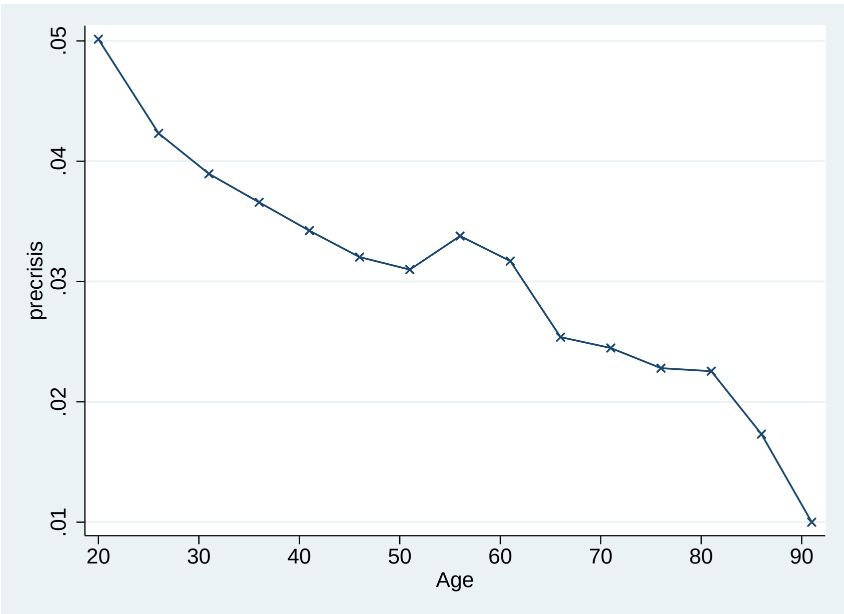

Figure 1: Heterogeneous Unemployment Probabilities

Table 2: Labor Supply Facts (CPS, 1996-2006)

full-time	1996	1998	2000	2002	2004	2006
60	56.27	50.63	54.56	52.79	54.87	56.64
61	51.17	50.80	57.67	48.02	52.05	54.46
62	39.95	41.10	39.93	39.09	41.94	44.45
63	30.09	31.39	31.32	32.88	37.45	39.76
64	23.81	26.08	30.78	30.32	30.31	32.87
65	21.48	18.06	23.20	23.47	23.14	26.05
66	15.65	15.42	22.98	19.20	20.41	20.47
67	12.66	12.52	15.76	16.94	17.70	15.61
part-time	1996	1998	2000	2002	2004	2006
60	10.73	12.91	10.34	11.19	11.79	11.27
61	12.38	12.76	11.03	12.16	10.96	11.14
62	11.28	13.35	12.14	13.61	10.86	12.59
63	15.28	14.66	12.76	13.32	12.98	13.87
64	13.12	10.69	13.95	14.91	12.30	12.70
65	14.68	14.30	13.65	13.95	13.74	13.95
66	16.66	12.34	13.32	13.74	12.35	14.74
67	14.61	12.04	15.04	14.06	11.53	12.45
no work	1996	1998	2000	2002	2004	2006
60	33.00	36.47	35.10	36.02	33.33	32.09
61	36.44	36.44	31.30	39.82	36.99	34.41
62	48.77	45.54	47.93	47.30	47.20	42.96
63	54.63	53.94	55.92	53.80	49.57	46.36
64	63.07	63.22	55.28	54.76	57.38	54.42
65	63.84	67.63	63.15	62.58	63.12	60.00
66	67.70	72.24	63.70	67.06	67.24	64.79
67	72.73	75.45	69.20	69.01	70.77	71.94

Table 3: US 10,000 Simulations of the Dynamic Retirement Model

Ages	Survivors	Work[a]	Claimers[b]	Benefits ($)	Consum. ($)	Wealth ($)
Model 1: Earnings Test with ARF Adjustments. No Uncertainty						
Age 60	8,331	5,995 (71.96%)	—	—	1,948	89,443
Age 61	8,205	5,560 (67.76%)	—	—	1,970	84,619
Age 62	8,055	5,254 (65.23%)	2,378(30.95%)	1,051	1,948	78,474
Age 63	7,883	4,933 (62.58%)	497(6.47%)	1,203	1,941	75,929
Age 64	7,726	4,717 (61.05%)	508(6.61%)	1,272	1,940	73,078
Age 65	7,555	2,637 (34.90%)	1,899(24.71%)	1,337	1,940	70,215
Age 66	7,357	2,928 (39.79%)	1,642(21.37%)	1,444	1,896	65,047
Age 67	7,152	3,763 (52.61%)	728(9.47%)	1,548	2,004	64,004
Age 68	6,959	3,901 (56.06%)	31(0.40%)	1,688	1,956	64,671
Model 2 (Benchmark Uncertainty): ET with ARF Adjustments and Employment Uncertainty						
Age 60	8,331	4,904 (58.86%)	—	—	1,898	96,740
Age 61	8,205	4,785 (58.32%)	—	—	1,902	89,660
Age 62	8,055	4,617 (57.32%)	3,520(45.58%)	855	1,885	82,214
Age 63	7,883	4,417 (56.03%)	633 (8.19%)	922	1,873	79,225
Age 64	7,726	3,801 (49.20%)	381 (4.93%)	1,123	1,875	76,463
Age 65	7,555	2,784 (36.85%)	931(12.06%)	1,255	1,852	71,965
Age 66	7,357	2,440 (33.16%)	999(12.93%)	1,399	1,813	67,046
Age 67	7,152	2,665 (37.26%)	1,064(13.78%)	1,536	1,845	64,142
Age 68	6,959	2,801 (40.25%)	195(2.52%)	1,687	1,824	63,132

Notes: [a]In numbers, and as percentage of survivors. [b]Number of First Claimers at that age, and as percentage of the total who ever claimed.

Table 4: Experiments. US 10,000 Simulations of the Dynamic Retirement Model

Ages	**Survivors**	**Work**[a]	**Claimers**[b]	**Benefits ($)**	**Consum. ($)**	**Wealth ($)**
			Experiment 1: Lower Social Security Taxes for those 60+			
Age 60	8,331	4,903 (58.85%)	—	—	1,919	95,214
Age 61	8,205	4,786 (58.33%)	—	—	1,928	88,455
Age 62	8,055	4,698 (58.32%)	3,594(47.76%)	848	1,911	81,293
Age 63	7,883	4,476 (56.78%)	607(8.07%)	928	1,897	78,872
Age 64	7,726	4,094 (52.98%)	390(5.18%)	1,118	1,902	76,636
Age 65	7,555	3,148 (41.67%)	712(9.46%)	1,281	1,895	73,367
Age 66	7,357	2,585 (35.14%)	844(11.22%)	1,367	1,859	69,298
Age 67	7,152	2,602 (36.38%)	1,377(18.3%)	1,528	1,867	66,241
Age 68	6,959	2,782 (39.98%)	196(2.54%)	1,676	1,858	65,501
			Experiment 2: Higher Average Wage for those working at 60+			
Age 60	8,331	4,903 (58.85%)	—	—	1,992	90,361
Age 61	8,205	4,798 (58.48%)	—	—	1,987	82,047
Age 62	8,055	4,730 (58.72%)	2,949 (38.35%)	963	1,952	73,515
Age 63	7,883	4,675 (59.30%)	532 (6.92%)	1,036	1,919	69,670
Age 64	7,726	4,591 (59.42%)	577 (7.50%)	1,057	1,916	66,786
Age 65	7,555	4,503 (59.60%)	870 (11.31%)	1,283	1,938	64,427
Age 66	7,357	3,854 (52.38%)	856 (11.13%)	1,424	1,941	64,304
Age 67	7,152	2,727 (38.13%)	1,771(23.03%)	1,489	1,911	64,858
Age 68	6,959	2,666 (38.31%)	134(1.74%)	1,723	1,908	65,954
			Experiment 3: Removal of the Earnings Test			
Age 60	8,331	4,904 (58.86%)	—	—	1,901	96,468
Age 61	8,205	4,784 (58.31%)	—	—	1,909	89,355
Age 62	8,055	4,613 (57.27%)	3,519(45.56%)	1,069	1,889	81,825
Age 63	7,883	4,419 (56.06%)	735 (9.52%)	1,173	1,891	79,719
Age 64	7,726	3,770 (48.79%)	534 (6.91%)	1,238	1,889	77,962
Age 65	7,555	2,763 (36.57%)	829(10.73%)	1,268	1,858	74,629
Age 66	7,357	2,555 (34.73%)	884(11.44%)	1,413	1,807	69,607
Age 67	7,152	2,731 (38.18%)	1,024(13.26%)	1,545	1,836	66,303
Age 68	6,959	2,839 (40.79%)	198(2.56%)	1,688	1,814	65,063
			Experiment 4: Normal Retirement Age set to 69			
Age 60	8,331	4,903 (58.85%)	—	—	1,854	102,574
Age 61	8,205	4,798 (58.48%)	—	—	1,851	96,133
Age 62	8,055	4,698 (58.32%)	3,567 (46.25%)	601	1,829	89,475
Age 63	7,883	4,603 (58.39%)	618 (8.01 %)	690	1,788	86,263
Age 64	7,726	4,381 (56.70%)	416 (5.39 %)	878	1,786	83,942
Age 65	7,555	3,851 (50.97%)	532 (6.90 %)	1,012	1,800	81,353
Age 66	7,357	2,982 (40.53%)	985 (12.77 %)	1,101	1,738	78,789
Age 67	7,152	2,806 (39.23%)	1,329 (17.23 %)	1,198	1,671	72,862
Age 68	6,959	3,095 (44.47%)	264 (3.42%)	1,352	1,659	68,886
Age 69	6,721	3,161 (47.03%)	2 (0.026%)	1,480	1,683	65,868

Notes: [a]In numbers, and as percentage of survivors. [b]Number of First Claimers at that age, and as percentage of the total who ever claimed.

Table 5: US 10,000 Simulations: Claiming Hazards from Work and No-Work

Ages	From Work	From No Work
	Model 1: No Uncertainty	
Age 62	5.81%	79.94 %
Age 63	4.21%	58.84 %
Age 64	7.77%	26.93 %
Age 65	44.72%	34.32 %
Age 66	73.25%	63.37 %
Age 67	95.45%	95.85 %
Age 68	—	100 %
	Model 2: Benchmark Uncertainty	
Age 62	18.25%	79.75 %
Age 63	7.38%	47.56 %
Age 64	4.84%	35.37 %
Age 65	34.95%	14.19 %
Age 66	59.79%	36.58 %
Age 67	98.33%	82.91 %
Age 68	—	100 %
	Experiment 1: Lower S.S. Taxes	
Age 62	19.65%	80.01%
Age 63	7.00%	52.98%
Age 64	5.00%	39.83%
Age 65	24.06%	15.38%
Age 66	47.54 %	23.63 %
Age 67	96.53 %	85.33 %
Age 68	—	100 %
	Experiment 2: Higher AW	
Age 62	6.65%	79.31%
Age 63	5.07%	48.89%
Age 64	7.69%	64.00%
Age 65	21.27%	53.71%
Age 66	29.59%	43.75 %
Age 67	94.17%	88.86 %
Age 68	100%	100 %
	Experiment 3: No Earnings Test	
Age 62	17.71%	80.47%
Age 63	10.06%	47.47%
Age 64	9.28%	38.77%
Age 65	34.41%	14.51%
Age 66	55.46%	37.13%
Age 67	100%	82.46%
Age 68	—	100%
	Experiment 4: NRA set to 69	
Age 62	24.63%	72.29%
Age 63	6.39%	41.72%
Age 64	3.99%	41.25%
Age 65	11.97%	34.62%
Age 66	47.56%	18.88%
Age 67	93.48%	79.92%
Age 68	100%	99.19%
Age 69	—	100%

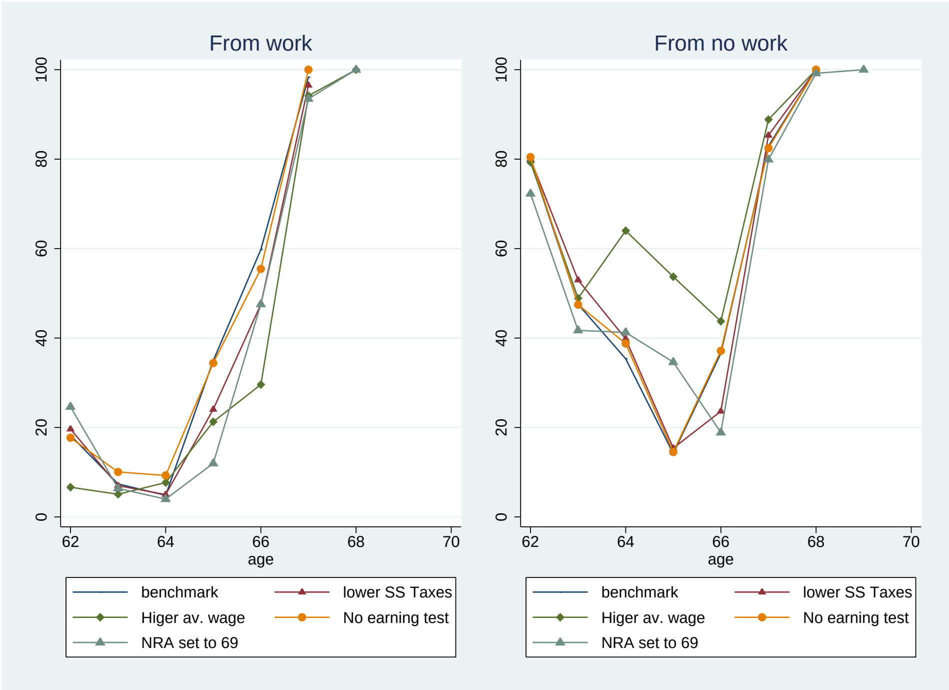

Figure 2: Claiming and Previous relationship with employment

Table 6: Budgetary Consequences of the Proposed Policy Reforms

Item	Benchmark	Lower S.S. Taxes	Higher AW	No E.T.	NRA=69
PV of Income Taxes Paid	125,073	125,606	128,348	125,195	126,020
Std. of Income Taxes	62,903	63,171	64,659	63,047	63,295
PV of Total Soc. Sec. Taxes Paid	68,946	69,178	70,127	68,949	69,666
Std. of Total Soc. Sec. Taxes	25,886	26,026	26,625	25,876	26,185
PV of Benefits Received	65,080	65,061	65,061	65,221	50,395
Std. of Benefits Received	51,227	51,339	51,696	50,667	39,967

Notes: Averages of 10,000 simulations, discounted to the initial period, assuming an interest rate of 2%, as in the model. Social Security Taxes paid include those paid by employers and employees, which account for a total of 10.6% of employees wages.

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