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by

Hugo Benítez-Silva**

J. Ignacio García-Pérez***

Sergi Jiménez-Martín****

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** SUNY at Stony Brook, hugo.benitez-silva@sunysb.edu

*** Universidad Pablo de Olavide and FEDEA, jigarper@upo.es

**** Universitat Pompeu Fabra, Barcelona GSE and FEDEA, sergi.jimenez@upf.edu

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Jorge Juan, 46
28001 Madrid -España
Tel.: +34 914 359 020
Fax: +34 915 779 575
infpub@fedea.es

N.I.F. G-78044393

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Hugo Benítez-Silva† J. Ignacio García-Pérez‡
Sergi Jiménez-Martín§

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Abstract

Unemployment rates in developed countries have recently reached levels not seen in a generation, and workers of all ages are facing increasing probabilities of losing their jobs and considerable losses in accumulated assets. These events likely increase the reliance that most older workers will have on public social insurance programs, exactly at a time that public finances are suffering from a large drop in contributions. Our paper explicitly accounts for employment uncertainty and unexpected wealth shocks, something that has been relatively overlooked in the literature, but that has grown in importance in recent years. Using administrative and household level data we empirically characterize a life-cycle model of retirement and claiming decisions in terms of the employment, wage, health, and mortality uncertainty faced by individuals. Our benchmark model explains with great accuracy the strikingly high proportion of individuals who claim benefits exactly at the Early Retirement Age, while still explaining the increased claiming hazard at the Normal Retirement Age. We also discuss some policy experiments and their interplay with employment uncertainty. Additionally, we analyze the effects of negative wealth shocks on the labor supply and claiming decisions of older Americans. Our results can explain why early claiming has remained very high in the last years even as the early retirement penalties have increased substantially compared with previous periods, and why labor force participation has remained quite high for older workers even in the midst of the worse employment crisis in decades.

JEL Codes: J14, J26, J65

Keywords: employment uncertainty, wealth shocks, retirement, labor supply, life-cycle models

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†SUNY at Stony Brook, hugo.benitez-silva@sunysb.edu

‡Universidad Pablo de Olavide and FEDEA, jigarper@upo.es

§Universitat Pompeu Fabra, Barcelona GSE and FEDEA, sergi.jimenez@upf.edu

1 Introduction and Motivation

Developed countries share a considerable concern about the financial sustainability of their social insurance systems. The origin of these worries can be found on two well documented processes: an unfavorable demographic performance (see Diamond 2007, and Lutz et al. 2008), and a tendency towards reducing the age of retirement on those economies (see Gruber and Wise 1999 and 2004, and Fenge and Pestieau 2005). 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. Moreover, the economic turbulence and uncertainty of the last couple of years has become an additional source of financial pressures on governments as their tax revenues decline, while the reliance on their public systems is now more prominent than ever.

At the same time the current crisis has affected the labor market in ways not seen in a generation, with workers of all ages and in almost all occupations suffering an increase in the probability of losing their jobs and a decline in their re-employment probabilities, exactly at the time that their retirement portfolios where declining sharply. In fact, in the last two years the U.S. unemployment rate has doubled, and even now affects around 9% of the labor force after reaching 10% during 2010. Interestingly, in the largest European economies, which have traditionally suffered from higher unemployment rates, the increases have been more moderate, with the exception of Spain, where unemployment also more than doubled in this period and is taking a long time to level off. Additionally, in the U.S. households portfolios have suffered considerably through the recession, and between 2007 and 2009 the average household wealth decline by around 20% (Bricker et al. 2011). 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, but rarely have they analyzed the implications of employment uncertainty at the end of the working life at a time of negative wealth shocks. This is clearly more important now than ever given the large increases in uncertainty we have seen in the last couple of years.

Thus, recent retirement trends in the U.S. can be understood as the result of two forces, the decrease in retirement savings account balances due to the financial crisis, and increasing employment uncertainty due to the deteriorating labor market. These forces could be in some sense be described as opposite but actually hide some complexities due to the relationship between labor supply and claiming behavior. The drop in wealth balances is likely to induce workers to postpone retirement in the sense of working longer, and the second one is likely to induce them to claim benefits as early as possible and at the same time maybe withdraw from the labor force earlier. As noted, for example, by Coile and Levine (2010) it is hard to tell which one is going to dominate in terms of the effect on labor supply, and therefore it is imperative to be able to analyze the question in a setting (which we propose in this paper) in which we can keep one of these effects (uncertainties) constant to be able to provide a useful analysis.[1] The fact is that in the last few years we have seen both a trend towards higher labor force participation of older Americans somewhat slowed down by the crisis, as well as a consistent majority of Americans claiming benefits early, which supports the idea that there are complex effects at work that are worth analyzing within a framework that can separate claiming and labor supply decisions.

We explicitly consider the participation decision and job search activities of older individuals, accounting for employment uncertainty, by using a sequential decision structure. We consider 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 likelihood of returning to the labor market after a period of unemployment is low and the depreciation of expected retirement benefits is high, individuals will be more prone to choose to start receiving benefits as early as possible. Note that if the probability of becoming unemployed is ignored, the expected utility from work is overestimated and, hence, the probability of applying for benefits, especially at early ages, is underestimated. 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 the 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, are especially involved between the early and Normal 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 a benefit reduction for individuals who have claimed retirement benefits before the NRA, and the Actuarial

[1] Coile and Levine (2010) discuss it in the following terms "... it is difficult to know what impact the current economic crisis may have on retirement behavior. Decreases in retirement savings account balances and home equity reduce available income in retirement and may indeed lead some to stay in the workforce longer. At the same time, a weak labor market may lead to job losses and limit opportunities for older workers who are seeking jobs. Their only option may be to retire. Both delayed retirement for some and earlier retirement for others may result."

Reduction Factor (ARF), which determines the permanent reduction in benefits that individuals face if they claim benefits early. However, the role of the Earnings Test in the context of the adjustment of the ARF is not very well understood, or even known by many. We will show through our dynamic model that the appropriate modeling of these incentives is key in order to understand the claiming behavior of older Americans.

The model used in this paper is closely related to those presented in Rust and Phelan (1997), Benítez-Silva, Buchinsky, and Rust (2003 and 2011), 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), Blau (2008), and Iskhakov (2010), 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, 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 employment uncertainty, and assume a perfect control by the individual over its labor supply. The price to pay for not considering the employment uncertainty is that the expected utility from continue to work is overestimated, and the probability of claiming early or applying for disability benefits is underestimated. Chan and Stevens (2004), and Coile and Levine (2007, 2010) discuss the importance of taking into account employment 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 faced by them.

We therefore contribute to the vast retirement literature by paying special attention to employment uncertainty and, even more importantly, its interplay with social insurance programs in the United States. In fact, lack of consideration of employment uncertainty may lead to biased estimates of the effects of potential reforms of the pension system. By carefully modeling employment 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 older workers, whose productivity and grade of adequacy to new technologies tend to depreciate rapidly with time. Hence, if we ignore the firing risk of older workers, 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. Moreover, as it has been emphasized by García-Pérez (2006), the consideration of the likelihood of dismissal makes unemployed workers change their search behavior as their expected stage in unemployment is longer.

Our paper also contributes to the literature on search models by considering non-participation decisions in a non-stationary environment including the risk of dismissal. The possibility of non-participation in an otherwise standard search model was first analyzed in Pissarides (1976) and in Van den Berg (1990). More recently, Frijters and van der Klaauw (2006) estimate an structural, non-stationary search model with non-participation, where the state of inactivity (considered as an absorbing one) is unrelated to the economic conditions. Our analysis improves upon the former by considering the fundamental non-stationarity induced by age considerations, and upon the latter by providing a full economic description of the non-participation state (i.e., retirement). Furthermore, we include in this literature the risk of dismissal, and one of the few existing research about this issues is García Pérez and Sánchez-Martín (2010), where a search model with a full economic description of the non-participation state is developed. The main novelty of the present paper with respect to the latter is the explicit consideration of saving decisions by workers.

In this paper we provide a partial equilibrium simulation exercise using calibrated parameter values. Most of these calibrated parameters are the result of extensive reduced form econometric models which have explored in detail the descriptive properties of the data. Some other parameters like the discount factor and the relative risk aversion parameters are taken from recent studies using similar models (See, Gourinchas and Parker 2002, and French 2005). The model is able 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 is also able to replicate the increased hazard of applying for benefits at the NRA. The model 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 employment uncertainty and the level of unemployment benefits. Another important finding is that it is key to model uncertainty properly, otherwise claiming hazards at age 62 (65) are underestimated (overestimated) by as much as 10% (25%), labor supply at age 62 is overestimated by around 10%, and wealth accumulation in the 60s is also overestimated by almost 10% if employment uncertainty is ignored.

We then analyze the effects of a number of policy experiments and their interplay with 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 double digit increases in labor supply at certain ages, and an increase in the average working life of almost 2 years, as well as a move towards even earlier claiming) increases in the average wage used to compute retirement benefits for those that work in their 60s and beyond. Additionally, we conclude from our benchmark model as well as all the policy simulations, that accounting for uncertainty (moving from no uncertainty to regular uncertainty more clearly, and then to high uncertainty) leads to higher early claiming and slightly lower labor force participation. Given the unemployment probabilities we have calculated from the CPS, the 56% increase in unemployment probabilities around age 62 (going from an average 3.2% probability of losing their jobs in a given year to about 5%) that occurred in 2008-2009 compared with the historical 1986-2006 trend, leads to an increase in early claiming of 4%, and a decrease in labor force participation of 4.6%.[2]

Finally, we analyze the effects of a sudden and unexpected drop in wealth balances (inspired by the drops in household wealth reported in the SCF 2009) on retirement, keeping employment uncertainty constant. This effort is related to a number of empirical efforts trying to understand whether retirement behavior responds to business cycle fluctuations, as discussed for example in Hurd, Reti, and Rohwedder (2009). We find that negative wealth shocks have a positive and fairly large effect on labor supply (except exactly at the Early Retirement Age mark), and induce earlier benefits claiming. The labor supply effect we predict is somewhat larger than previously shown, in part due to the fact that most researchers have ignored the role of employment uncertainty over the business cycle, which comes to offset the effect of wealth shocks on labor supply, and biases wealth effects in standard reduced form models towards zero.

The combination of the effects we find that higher employment uncertainty and negative wealth shocks have on labor supply and claiming, can explain why early claiming has remained very high in the United States even as the early retirement penalties have increased substantially compared with previous periods, and why labor force participation has remained quite high for older workers even in the midst of the worse employment crisis in a generation.

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 simulation results, and Section 5 describes the policy experiments we propose and their budgetary consequences. Section 6 analyzes the effects of wealth shocks on the key variables of interest, and Section 7 concludes.

[2]While the responsiveness of claiming and labor supply to changes in unemployment probabilities might seem small given the large proportional jump in uncertainty during the latest recession, if analyzed from the point of view of employment uncertainty, the responsiveness is much larger. Notice that the historical probability of being (voluntary) employed (given employment in the previous period) was around 96.8% and it changed to around 94.95%. This means that a drop of only around 1.91% in employment probabilities, resulted in changes in claiming and labor supply of twice that magnitude.

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, around 60% of older Americans were claiming benefits at age 62, and it has stayed at 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, using data from Table 6.A4 of SSA's Statistical Supplement, 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 2005, almost 60% of claimants have been taking their benefits at age 62 (between 51% and 54% in the 2006-2009 period), and between 15% and 20% wait for the normal age of retirement (between 22% and 26% in 2006-2009). A majority of the remaining individuals claim at age 63 or 64, with a very small proportion claiming after the NRA. The latter is worth emphasizing given that the Delayed Retirement Credit increased by half a percentage point every two years during this period.[5]

It is interesting to notice the rather anomalous claiming behavior in 2000, which resulted in an increase in claiming at age 65, and a reduction of the proportion of individuals claiming at 62. This is driven by the large increase in new entitlements at age 65 and above in that year, very likely the product of the removal of the ET for those above

[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.

[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]Using the first seven waves of the Health and Retirement Study, we see that the claiming distribution is quite similar to those reported, which is not surprising given that the HRS cohort reached retirement claiming ages exactly in the period covered by Table 1. 55% of the HRS cohort claimed at 62, 12.32% at age 63, 8.48% at age 64, 16.71% at age 65, 3.41% at age 66, and 3.7% at age 67 or above. We do not use the HRS data as our benchmark in the discussion, because in a number of waves it is not possible to separate retirement claiming from other type of Social Security claiming, like disability benefits or survivor benefits.

the NRA, which made waiting to claim benefits because of a strong attachment to the labor force unnecessary. This conjecture is further supported by the evidence on benefits levels shown in the bottom panel of this table. It shows the trends in benefits received, in dollars of 2005, as a function of the age at which benefits where claimed. We see a clear break in the patterns after 2000, especially in terms of the benefit levels at the NRA and above. In 1999 and 2000 later claiming led to consistently larger benefits, while the maximum benefit has been systematically obtained by those claiming at 65 since then. It drops sharply for those claiming after 65, potentially because those individuals are now of a type trying to catch up to compensate for a low wage career, or a sketchy one. Our interpretation of this evidence is that the removal of the ET for those above the NRA had the effect of allowing people to claim benefits independently of their labor supply behavior, leading relatively well-off individuals, who before waited to claim to avoid the ET, to claim sooner. Those claiming after the NRA are now either individuals trying to catch up after relatively lower wage career profiles, or spouses claiming on their partner's earnings histories. Notice that the scheduled increases in the NRA are essentially bringing back the old ET for those above age 65, so the prediction is that a pre-ET-reform benefit level distribution is likely to emerge, at least in part, in the next years. It is important to emphasize that this table does not account for the actuarial reduction of benefits faced by individuals claiming before the NRA, or for the delayed retirement credit obtained by those after the NRA. In this research we are interested in the inflation-adjusted level of benefits actually received by claimers since this is what our dynamic model of retirement predicts.[6]

Table 2 is similar to Table 1 but now we are not using the Annual Statistical Supplement, but a Public-Use microdata extract from the Master Beneficiary Record. This public data provided by Social Security allows us to overcome a problem with the previous table; namely, that we could not separate individuals who claim on their own histories of earnings (workers) from those who claim as dependents. With the microdata we can do that, and in this new table we restrict attention to male workers, who represent the closest empirical counterpart of the agents in our dynamic model. The main difference with the trends shown in Table 1, which includes data for all individuals claiming, is that claiming is somehow lower at age 62 and larger at age 65-66. An additional difference between these two tables is that now the average benefits we show are adjusted by the Actuarial Reduction Factors and the Delayed Retirement Credit, which essentially mean that those benefit levels are now actuarially comparable and an approximation to the Primary Insurance Amount (PIA), instead of being in nominal terms like those in the

[6]It is clear that analyzing the role of (theoretically) actuarially fair adjustments is important to understand the importance of individual heterogeneity in claiming behavior. Benítez-Silva and Yin (2009) focus on this point, and find considerable individual heterogeneity in benefits receipt, especially for those above the NRA.

previous table. We have made the adjustments to show 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.

In Table 3 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. More aggregate data, that from BLS, shows a similar and very interesting picture, for both males and females. The labor force participation rate for older Americans has been growing since the mid 1990s. The share of males aged 55-64 in the labor force has increased from 65.5% percent in 1994 to 70.2% percent in 2009 after three decades of decline. This is mainly driven by males aged 60-64, for whom participation rates have risen from around 52% to around 61% during that period. Notice that these are exactly the individuals who become eligible to claim retirement benefits, and are claiming them predominantly early. At the same time, for males 65 and over the participation rate has also increased substantially, from close to 17% to around 22%. For females the participation rate has continuously increased in the last three decades, from around 40% in 1980 (48.9% in 1994) to 60% in 2009.

Our model relies heavily on a number of empirical specifications, for example regarding health uncertainty, and the evolution of average wages. For the former 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.

3 Methodology and the Dynamic Model

We solve and simulate an extended version of the Life-Cycle model, in which individuals maximize expected discounted life-time utility, which in this case depends on consumption and leisure, and individuals face some of the key incentives from social insurance programs, such as retirement incentives, and unemployment insurance. We formally acknowledge that individuals face several sources of uncertainty, including life-time, wage, health, and employment uncertainty. The latter is one of the keys of our model, since individuals know that as they grow old, and their productivity declines, the probability of losing their jobs might be increasing. This can have a sizable effect on how they assess the benefits provided by early retirement provisions, and even disability benefits.

3.1 Model description and assumptions

We assume that individuals maximize the expected discounted stream of future utility, where the per period utility function $u(c, l, h, t)$ depends on consumption c, leisure l, health status h, and age t. We specify a utility function for which more consumption is better than less, with agents expressing a moderate level of risk aversion. The flip side of utility of leisure is the disutility of work. We assume that this disutility is an increasing function of age. It is also higher for individuals who are in bad health and lower for individuals with higher human capital (measured by the average wage). In addition, we assume that the worse an individual's health is, the lower their overall level of utility is, holding everything else constant. Moreover, we assume that individuals obtain utility from bequeathing wealth to heirs after they die. 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 0.96. Individuals can accumulate balances and receive a fixed interest rate of 2%.[7]

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

[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.

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

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 model allows for four different sources of uncertainty: (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. We will also use data on the 2008-2009 period to approximate the effect on the employment transition probabilities of the current economic crisis.

Given that we allow for employment uncertainty and therefore the possibility of losing a job, 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 80% 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.

The *state* of an individual at any point during the life cycle can be summarized by five 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, $\overline{w}_t$. This 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 $P(\overline{w}_t)$.

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. Within a log-normal regression model, we follow Benítez-Silva, Buchinsky, and Rust (2011), such that:

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

The R^2 for this type of regression is very high, with an extremely small estimated standard error, resulting from the low variability of the $\{\overline{w}_t\}$ sequences. This is a key aspect of the model given the important computational simplification that allows us to accurately model the Social Security rules in our dynamic programming model with a minimal number of state variables.

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:

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

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 (2)). The factor of 0.8 here incorporates the assumption that the rate of pay working part-time 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 (1), rather than having to keep track of the entire earnings history in order to determine the 35 highest earnings years, which the AIE requires.

3.2 The model

We assume that the individual's utility is given by

$$u_t(c, l, h, t) = \frac{c^\gamma - 1}{\gamma} + \phi(t, h, \overline{w}) \log(l) - 2h, \tag{3}$$

where h denotes the health status and $\phi(t, h, \overline{w})$ 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).

The disutility of work increases with age, and is uniformly higher the worse one's

[9] Given the relatively small number of part-time workers at some ages, we had to aggregate across a wide range of ages. Interestingly the penalty decreases with age, likely due to self-selection. For individuals younger than 61 the penalty for part-time work is almost 40%, then decreases to about 25% for those between 61 and 64, and finally declines to around 20% for those 65 and older.

health is. If an individual is in good health, the disutility of work increases much more gradually with age compared to the poor health states. The disutility of work decreases with average wage. We postulate that high wage workers, especially highly educated professionals, have better working conditions than most lower wage blue collar workers, whose jobs are more likely to involve less pleasant, more repetitive, working conditions and a higher level of physical labor.

We assume that there are no time or financial costs involved in applying for retirement benefits. The parameter γ indexes the individual's level of risk aversion. As $\gamma \to 0$ the utility of consumption approaches $\log(c)$. We use $\gamma = -.37$, which corresponds to a moderate degree of risk aversion, i.e., implied behavior that is slightly more risk averse than that implied by logarithmic preferences. This specification has been used and discussed by Benítez-Silva, Buchinsky, and Rust (2003, 2011), and also in Benítez-Silva and Heiland (2007).

Thus, the expected present discounted value of utility from age t onward for an individual with state variables $(a, \overline{w}, ss)$ where a stands for assets, 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 probability of losing a job to a dynamic life cycle model of consumption, asset accumulation and retirement.

The value of being employed

$$\begin{aligned} V^t_{1,\tau}(a, \overline{w}, ss) &= \max_{c_t, \tau, ssd} U(c_t, L_{\tau,t}) + \\ & \quad \beta \left[(1-\delta)\ Emax\ (V^{t+1}_{1,\tau}(w_t), V^{t+1}_{1,\tau}(x)) + \delta\ V^{t+1}_{0,\tau}\right] \end{aligned} \tag{4}$$

subject to,

$$L_\tau = L(1 - I_\tau) + I_\tau$$

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

The value of being unemployed

$$V^t_{0,\tau}(a, \overline{w}, ss) = \max_{c_t, \tau, ssd} U(c_t, 1) + \beta\ Emax\ (V^{t+1}_{1,\tau}(x), V^{t+1}_{0,\tau}) \tag{6}$$

$$L_\tau = L(1 - I_\tau) + I_\tau$$

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

As explained before, unemployment benefits, b_t, are computed as a function of the average wage, with firing costs being the equivalent of two weeks pay, and unemployment benefits worth half of 80% of the previous period average wage. Thus, we define:

$$b_t = g(w_t, d_t) \tag{8}$$

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

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

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 (1), 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 (1). Note there is a potential

"Jensen's inequality" problem here due to the fact that we have substituted the conditional expectation of w_{t+1} into the next period value function V_{t+1} over w_{t+1} and aw_{t+1} jointly. However, the R^2 for the regression of aw_{t+1} on aw_t is virtually 1 with an extremely small estimated standard error $\hat{\sigma}$. Hence, in this case there is virtually no error resulting from substituting what is an essentially deterministic mapping determining aw_{t+1} from w_{t+1} and aw_t.

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 (2) 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.

- At least one job offer is received 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.

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

- The unemployment probability δ is a function of some characteristics of individuals like average wage and age, and given that it is logically also a function of the economic environment we use the higher empirical probabilities of the last couple of years to simulate the consequences for individuals of facing higher uncertainty.

- 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 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 the following. 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 4 presents our first set of results. We show four panels of results, with the first panel using a benchmark model without employment uncertainty, but with the appropriate characterization of the Earnings Test. As discussed in great detail in Benítez-Silva and Heiland (2007, 2008), and also in Benítez-Silva et al. (2009), most of the retirement literature has modeled the earnings test as a tax. However, this is incorrect, and distorts the incentive structure in the direction of making early claiming less attractive. This first panel shows that the claiming peaks are relatively close to what we see in the data, where our benchmark are the proportions from the Public-Use microdata for males. This result convinces us of the need to account for the full incentive structure to characterize optimal behavior in line with the empirical facts. The second panel presents our full model, in which we introduce employment uncertainty. The model improves further, and we now find a distribution of claiming ages very close 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 age 63 and 65 we see in the Public-Use microdata and the aggregate SSA data.

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 or hard to test beliefs about the future. Regarding labor supply, the qualitative results show a declining labor supply at older ages, especially at age 62 and then at age 63 and 64. The proportion of individuals working increases at age 65 and 66 mainly due to the phasing-out and eventual disappearance of the earnings test.[10]

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 4 we can see that by not considering such uncertainty when solving the model we would be biasing downwards by 7.3% and 8.1%, respectively, the work decision of workers of age 63 and 64. On the contrary, we would be predicting a 7.8% larger work percentage among those aged 62. With respect to claiming, the bias due to not considering employment uncertainty is even more important: claiming at 65 is 24.2% bigger than the prediction under our benchmark case (Model 2 in Table 4). 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 aggregate Social Security data, giving 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, however, our model does not predict a significant decline in consumption around retirement (although a small decline is observed), as widely documented in the empirical literature. The latter is likely the result of our simplified structure which does not account for the complexities involved in the consumption decisions around the time of retirement as presented, for example, in Aguiar and Hurst (2005). We do not consider this a serious drawback of our model given the difficulty of finding data which could allow us to identify the different consumption objectives of older individuals. The last column also provides the average wealth level of individuals at different ages, and we can see the declining simulated wealth, which becomes steeper after age 63. Notice also the effect that increases in employment uncertainty have on wealth accumulation, with wealth monotonically declining at all ages when uncertainty increases.

It is worth emphasizing that the wealth averages shown in the last column of Table 4 hide a much richer relationship between wealth accumulation and claiming. If we focus

[10]The model does include a part-time labor supply choice and we assume that agents can freely choose to work part-time of full-time, which is not likely to be realistic and leads to a growing interest in part-time work once agents reach the ages in which labor supply is more costly in utility terms. As we saw in Table 3, a fairly stable (across time and across older ages) proportion of individuals actually works part-time, but since we do not model the mechanism that explains why some individuals might or might not receive part-time offers we have chosen not to modify the model in an ad-hoc way to match this proportion. We have experimented with a model in which individuals can only choose whether to work full-time or not to work at all, and in that case the proportion of those working at older ages does not increase. However, in such a model early claiming is much less attractive, suggesting a connection between access to flexible labor supply and the decision to draw retirement benefits.

in the regular uncertainty case, and for example in the average wealth at age 61, which is just below \$103,000 in Model 2 of Table 4, we should emphasize that the average wealth level varies tremendously depending on whether those individuals eventually claim at age 62 or higher. For example, the average wealth level at age 61 for individuals who claim at age 62 is \$66,845, while for those who end up claiming at age 63 is \$96,482, and the levels for claimants at ages 64 to 66 are \$134,433, \$164,669, and \$173,736, respectively. Interestingly, those who claim later end up consuming a lot of that wealth as they take advantage of the guaranteed (if they survive) adjustment factors offered by Social Security. This should not be very surprising in the model given that we are assuming that individuals obtain only a fixed 2% interest rate on savings, so conditional on surviving to the next period and accounting for a discount factor β, which is equal to 0.96, obtaining the return on their expected Social Security benefits offered by the actuarial adjustment can be optimal and therefore wealth de-accumulation can be a good strategy for some individuals. This is exemplified by the fact that by the time they actually claim, those who claim at age 65, have on average wealth level of \$111,562, around \$50,000 less than what they had accumulated by age 61. These findings are somewhat sensitive to the assumptions regarding the interest rate and the discount factor, and are difficult to compare with the data due to the fact that we do not have housing in our model, which represents the large majority of the savings of individuals at older ages.[11]

In the third panel of Table 4 we simulate the effect of an increase in the unemployment probabilities. We accomplish this by using the average of the empirical probabilities from the 2008 and 2009 CPS, while in the benchmark simulations we were using the average of the 1986 to 2006 period. Figure 1 shows the benchmark unemployment probabilities as well as the new probabilities we use in the model. Notice the large increase in the probability of becoming unemployed at all ages seen in the economy in the last couple of years. From our results we confirm that this increase in unemployment probabilities affect both claiming and labor supply. First, the proportion of those claiming early goes up from 47% to 49% at age 62, and the proportion of those not working at age 62 goes up to nearly 52%, instead of the 50% of the benchmark. The wealth accumulation decreases by between 4% and 6% (depending on age) as we introduce uncertainty in the model, and by further 3% as we increase uncertainty to the level of the 2008-2009 period. However, the benefit levels and consumption levels are hardly affected, which means that individuals have adjusted through life-cycle decisions to this new more uncertain

[11]If for example, we increase the interest rate to 4% the level of wealth accumulation increases by around 50% when individuals reach the 60s. However, the difference between the level accumulated, by age 61, by those who claim at 62 and those that claim at 65 is much smaller with this higher interest rate, which is what we could expect given the trade-offs faced by the agents in the model. Notice, however, that this higher (real) interest rate leads to a claiming hazard at the ERA that is too high (over 60%) compared with the data.

environment. We do not show the consequences at earlier ages, but we can report that, for example, non-participation goes up under the new environment by between 2% and 3% when the individuals are in their 40s and 50s.

In Figure 2 we highlight another important finding from our model. The claiming behavior is strongly correlated with the employment state of individuals in the period before they claim benefits, with a very high proportion (around 82%) of those not working at age 61 eventually claiming at age 62, while this proportion drops to around 30% for those working at age 61.[12] Furthermore, the effect of increasing employment uncertainty is quite relevant for those who claim benefits from non-work: claiming increases by 15% at age 63 and about 10% at age 64 when such uncertainty is larger. The effect is also important, although a bit lower, among those who claim directly from work (11% at age 63 and 9.6% at age 64). A final important remark is that we find almost the same differential claiming behavior when we distinguish between those with good and bad health. Claiming among the latter is much more concentrated at the ERA, around 87% (basically comparable to the level from non-work) than among the former (27.7%). Hence, it seems that those in bad economic or health condition take advantage of the first available retirement age to permanently exit from the labor market and enjoy their retirement benefits.

In the last panel of Table 4 we present the results of combining the increase in employment uncertainty with an increase in unemployment benefits, which is in fact what has happened in the last couple of years due to the recession, with the extended benefits provision at the Federal level, and the State level supplementations. We assume unemployment benefits are doubled which can be understood as going from 26 weeks to 52 weeks. We originally modeled an 80% approximate replacement rate on the average wage as a proxy for recent wages, and therefore a full year of benefits would replace 80% of the average wage. Making a more generous unemployment benefits system reduces significantly claiming of benefits at age 62 (mainly due to a lower claiming from non-employment) but increases claiming at age 65, and slightly increases consumption during retirement, while higher employment uncertainty increases non-participation after age 62, and slightly affects also consumption and wealth level during retirement. The effects on consumption and wealth should not be surprising given the more generous system during periods of unemployment. We conclude therefore that an increase in unemployment benefits justified by a likely increase in the likelihood in unemployment, has effects on claiming and labor supply, but if we assume that this comes as a surprise to individuals

[12] Using waves 1 and 2 of the HRS, so that we can unequivocally distinguish claiming retirement benefits from other Social Security benefits (something not possible in subsequent waves), we found that the empirical counterparts of these transitions are 63.25% and 31.8%, which we consider quite close given the difficulty in matching not only the unconditional proportion of claimants (which we do quite closely), but also their previous related states.

of all ages, the effects are modest.[13]

In terms of the average working life predicted for the different models, as could be expected, declines as we move from Model 1 to Model 4 as we introduce uncertainty. In the model without employment uncertainty the average working life is 37.6 years, while in model 2 drops by 3.6% to 36.28 years. Once we take into account the high uncertainty of the last few years the drop in the working life increases, and the average working life we simulate is 35.3 years. The introduction of higher unemployment benefits further shortens the working life to 34.6 years, a drop of 8% in the working life of the average individual with respect to the model without uncertainty, or more than 3 years.

5 Policy Experiments and Employment Uncertainty

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 different levels of employment uncertainty, and discuss the likely effect on the public accounts.

Table 5 presents the simulation results of four different policy experiments, with a further breakdown of the consequences by different levels of employment uncertainty. The leftmost set of results down the panels shows the simulations of the policy experiments when employment uncertainty is not present, the middle set of panels shows the results under the benchmark uncertainty (which uses the unemployment probabilities for the 1986-2006 period), and the rightmost set of panels show the results for the high uncertainty cases (using the unemployment probabilities for the 2008-2009 period).

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 employers who will see as an opportunity to hire these workers. We should compare these results with those from the first three panels of Table 4 depending on the level of uncertainty assumed. We can see that the proportion of workers is slightly higher under this scenario for all the ages shown, and that the proportion of individuals claiming early is slightly lower, but a higher proportion claims before the Full Retirement Age. The benefits level is very similar, and consumption a bit higher. Notice that the increases in uncertainty lead to earlier claiming (increase of about 2 percentage points when going from no uncertainty to regular uncertainty, and another percentage point as we simulate the high uncertainty case), small declines in labor supply in the early and

[13] If we assume it is not a surprise, so individuals can inter-temporally adjust to this increased uncertainty the effects are even smaller.

late 60s (2.5 percentage points lower participation rates at age 62 as regular uncertainty is considered), and slight increases in the mid 60s, responding in part to shorter careers due to the increases in employment uncertainty. 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. 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. Even with all these differences our findings are qualitatively consistent with theirs (especially if we consider that we only reduce the Social Security tax by 50% and still allow updates in the average wage), something quite reassuring. Quantitatively, we find that the average working life increases only by about 2.5 months (with respect to the benchmark model with standard uncertainty, which predicts an average working life of about 36.28 years) with the reform we propose.

The second set of panels in Table 5 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. We can see that the proportion of workers is much higher under this scenario for all the ages shown but in particular for ages 62 to 65 where we see very large effects on labor supply. For example, the proportion of individuals working at age 62 goes from 50% in the benchmark model to more than 65% under the new policy and benchmark uncertainty. The effect is even more dramatic for ages 63 and 64, where the proportion of workers goes from around 32% to between 48% and 68%, depending on the level of uncertainty. 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. In terms of the average length of the working life, the increase is quite substantial, and we estimate it to be around 21 months with respect to the benchmark model with standard uncertainty. Also, the proportion of individuals claiming at age 62 is much higher than in the benchmark simulations (increases by about 20% to around 54% of individuals claiming at the ERA), and a higher proportion claims before the Full Retirement Age. Analyzing the results for this policy experiment across uncertainty levels we see a slight trend towards earlier claiming as the uncertainty increases and a uniform, but very small, decline in participation across ages.

The third set of panels in Table 5 shows the consequences of a complete elimination of the earnings test at all ages, similar 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 at age 62 goes up sharply, compared with the benchmark model (regardless of the level of uncertainty studied) and also with the two other policy experiments. However, labor supply is not affected in such a dramatic fashion, although the labor force participation rates are considerably lower at age 62, and considerably higher afterwards. The average length of the working career goes up by about 2.84 months compared with the benchmark model with standard uncertainty.

The last set of results of Table 5 shows the consequences of increasing the Normal Retirement Age to 69. The most clear consequence of this policy change is twofold. On the one hand, to delay retirement claiming considerably, with a sharp decline in those claiming at age 62 (of around 20% regardless of the level of uncertainty simulated), and increasing considerably those claiming after age 65. On the other hand we have also a sharply increasing labor supply at ages 62 and 63, and lowering it from age 64 to 66. The average length of a working life goes up by around 8.28 months, with respect to the benchmark model with standard uncertainty, which is quite substantial. The consequences of increasing uncertainty in this case are rather small, except for some small age-dependent variation in claiming behavior and labor supply. 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 the retirement benefit by 8% for every year that the individuals delayed claiming beyond the NRA (66 in the previous panels).

5.1 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. 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 5, 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 based as well as the Social Security Taxes collected, given that the increase in labor supply is quite substantial for this policy as shown in Table 5.

6 Wealth Shocks and Employment Uncertainty

Table 7 shows the effects on labor supply and claiming behavior of simulating wealth shocks in order to provide some discussion of the likely effects of the economic downturn that happened during, especially, 2008 and 2009. We provide three different scenarios of surprise wealth shocks. Notice that we are assuming individuals could not predict these events, and therefore the analysis we present should be understood as age by age instantaneous effects on the two key variables of interest. This means individuals in these simulations are not able to adjust intertemporally to the new scenario but can only respond with the choices available to them, mainly labor supply and claiming of retirement benefits, but also their consumption and savings decisions. As in Table 5, we provide the results for each scenario and each employment uncertainty level. This means the first set of columns in the table should be compared with the first panel of Table 4, and the second set of columns with the second panel, and the same for the third. The first scenario proposes a mild wealth shock, in which the rate of return on savings goes down from the assumed fixed rate of 2% to 1%. Again, this 50% decline in the rate on return on savings happens as a surprise for individuals of all ages. This shock sharply increases labor supply for individuals ages 63 to 65, while for the rest of the ages the effect is also positive but quite small. Regarding claiming, the effect is to make early claiming more appealing, with a higher proportion of individuals claiming at age 62 and 63 (with increases of 3 to 5 percentage points), and much smaller proportions claiming at older ages. The effects are quite similar across the uncertainty categories.

The second scenario reports the simulated effects of a surprise decline in wealth of 10%. This is in line with the implied yearly declines in wealth levels during the economic crisis, as reported in the SCF 2009 compared with the levels of 2007. As Bricker et al. (2011) discuss, the average decline in net wealth in the two year period between the two SCF surveys, was around 19%, and the decline in median wealth was around 23%. While they explain that this decline was not uniform across families and across ages, we are simulating a surprise decline for all our agents and at all ages. The effects of this substantial wealth decline are very clear. First of all, the claiming distribution becomes much more skewed with more than 3 out of 4 individuals deciding to claim exactly at the early retirement age, and most of the rest claiming just one year later, at age 63. Given our previous finding regarding how early claiming is very much linked with relatively lower accumulation of resources, the bad shock pushes a large proportion of individuals towards drawing as early as possible from their Social Security benefits. Regarding labor supply the effect is very large and positive for all ages except age 62. In some cases the percentage point increase in labor force participation is well into the double digits, and even for individuals age 60 to 61 the effect is between 4 and 5 percentage points. The only decline in participation happens exactly at age 62, mainly due to the 50% increase in claiming hazard at that age, which results in a large labor supply response.

Remember, that the reported effect is the instantaneous age effect, so in this case it has to be understood as the predicted response of those age 62 when they discovered their savings declined by 10% instead of accumulating at the fixed interest rate they have taken as given. It seems that agents then choose to draw from their benefits, and enjoy some leisure. In any case, overwhelmingly, the surprise wealth shocks results in more work and more early claiming, and again this is quite similar across uncertainty levels.

The last scenario shows the consequences of the accumulated wealth effect (of around 20%) of the crisis following the findings from the SCF 2009. The simulations are qualitatively similar to those of Scenario 2 but quantitatively amplified, so individuals claim even earlier, with around 82% now claiming at the early retirement age, and with labor force participation responding even more sharply, with the age 62 decline predicted to be much smaller in this case.

In terms of length of working lives, in Scenario 2 we find that the average working life in the case of standard uncertainty increases by about 3 years to 39.38, with respect to the benchmark model, and by about four years in the case of Scenario 3 to about 40 years of work experience, when the wealth decline is of about 20%. These wealth effects are quite large, and are apparently at odds with the results on the relationship between wealth changes and retirement by the research of Hurd, Reti, and Rohwedder (2009) and Hurd and Reti (2001). They estimate that the response to wealth changes is small. Our results, when taken together with our findings on the drop in labor supply due to increases in employment uncertainty, suggest that previous research that did not take into account that during recessions wealth declines while employment uncertainty increases, interpret small behavioral changes to financial crisis (or financial booms) as suggesting that wealth effects are small. Once we model both employment uncertainty and unanticipated wealth changes, we can observe that those two effects somewhat offset each other, which would predict, for any reduced form analysis of labor supply responses, smaller wealth effects than if they were to happen in a stable employment environment. Our findings are more in line with the work of Cheng and French (2000), and Coronado and Perozek (2004) which find larger labor supply effects due to the fact that their empirical design allowed them to better control for unobserved factors driving wealth accumulation and their labor market responses. This brings home the point of why the modeling effort we have undertaken in this paper is a worthy enterprise.

We have also performed budgetary calculations similar to those of the previous section, and for example, in the second scenario we find that taxes and benefits received are quite similar to the benchmark, with only slight decreases in income taxes paid and slight increases in Social Security taxes paid by agents under the surprised wealth shock scenario.

7 Conclusions

The world economy has gone and it is still going through one of its worse periods in recent memory. Unemployment rates around the developed world have reached very high levels, and workers of all ages and in almost all occupations have seen an increase in the probability of losing their jobs, a decline in their re-employment probabilities, and a considerable loss of the value of their retirement portfolios. These events likely increase the reliance that most older workers will have on public social insurance programs, exactly at a time that public finances are suffering from the drop in contributions, in a demographic environment that suggest life expectancies will continue to increase.

All this means that 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 from the sky rocketing costs of health care, increased longevity, declining fertility and growing immigration. Our paper is a step in this direction by providing a model that accounts 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 does a good job in matching important (and rather elusive) features of the data, and 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 employment uncertainty in the model increases early claiming and reduces labor force participation at older ages. Furthermore, in the exercise where we analyze the effects of increasing employment uncertainty (going from an average 3.2% probability of losing their jobs in a given year to about 5%), leads to an implied elasticity of these two individual decisions with respect to unemployment uncertainty of around 0.1. We also find that labor supply at older ages is very 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. The model also allows us to simulate the effects of large drops in financial wealth balances, similar to those experimented by families during the recession. We find that, in general, wealth shocks result in higher labor force participation and earlier claiming, and we also find that the modeling of wealth shocks in the presence of employment uncertainty can explain why some previous research have found small labor supply effects (especially around retirement) of unexpected wealth changes.

Therefore, our findings indicate that the combination of the effects that higher employment uncertainty and negative wealth shocks have on labor supply and claiming, can explain why early claiming has remained very high in the United States even as the early retirement penalties have increased substantially compared with previous periods, and why labor force participation has remained quite high for older workers even in the midst of the worse employment crisis in a generation.

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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.[14] 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.[15] 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.[16] 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

[14]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, Diamond, Gruber, and Jousten (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.

[15]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.

[16]As of 2010 this maximum is $106,800.

continues to receive benefits, her MBA_t is permanently reduced. The Actuarial Reduction 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).[17]

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.[18] 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

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

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

[17] 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)

[18] 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.[19] 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, \$34,680, compared with \$14,160 for the earlier period as of 2010. 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.[20] 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.[21] 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.[22]

[19] 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.

[20] 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).

[21] 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).

[22] 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	0.96	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	94,200	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	0.61 on the $	Age 21 to 60	CPS 1986-2009
Part-time Penalty 2	0.75 on the $	Age 61 to 64	CPS 1986-2009
Part-time Penalty 3	0.8 on the $	Age 65+	CPS 1986-2009

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

Table 1: US Social Security Claiming facts. Annual Statistical Supplement (in $ of 2005)

Age	**1994**	**1996**	**1998**[a]	**2000**	**2002**	**2004**	**2005**	**2006**	**2008**	**2009**
62	0.5886	0.6008	0.5833	0.5171	0.5602	0.5753	0.5664	0.5384	0.5131	0.5316
63	0.0789	0.0746	0.0801	0.0671	0.0777	0.0810	0.0830	0.0857	0.0788	0.0777
64	0.1212	0.1080	0.1077	0.1045	0.1484	0.1094	0.0993	0.1047	0.0988	0.0828
65	0.1566	0.1568	0.1557	0.1959	0.1724	0.1862	0.1975	0.2232	0.2608	0.1376
66	0.0182	0.0199	0.0210	0.0392	0.0096	0.0122	0.0130	0.0111	0.0159	0.1351
67-69	0.0230	0.0256	0.0286	0.0550	0.0152	0.0177	0.0188	0.0190	0.0166	0.0202
70+	0.0128	0.0140	0.0232	0.0208	0.0161	0.0178	0.0205	0.0179	0.0160	0.0147
Claimants[b]	1,444.5	1,396.1	1,441.3	1,758.9	1,595.5	1,680.3	1,793.5	1,771.8	2,010.9	2,416.5
					Average benefits					
62	788.58	785.31	815.35	864.56	892.58	888.31	881.9	877.98	904.6	911.79
63	882.14	942.89	907.85	960.51	1,002.8	996.66	986.9	1,009.4	1003.3	1,032.0
64	981.51	997.16	1,001.7	1,020.4	1,119.8	1,102.0	1,089.8	1,088.6	1,048.5	1,072.8
65	1,083.9	1,087.8	1,088.0	1,184.5	1,239.2	1,270.9	1,298.3	1,335.0	1,363.6	1,260.0
66	1,022.4	1,033.0	1,030.4	1,247.6	881.73	981.26	1,052.2	1,087.1	1,279.7	1,545.6
67	1,027.8	1,071.4	1,050.2	1,285.7	873.48	933.59	1,010.4	1,012.4	1,233.2	1,318.1

Notes: [a] The percentages do not coincide with those reported in the Statistical Supplements since we have not counted the 120,000 widows who were converted in these years from widow benefits to retirement benefits. [b] In thousands of claimers. Does not include disability conversions at the NRA.

Table 2: 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.

Table 3: 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

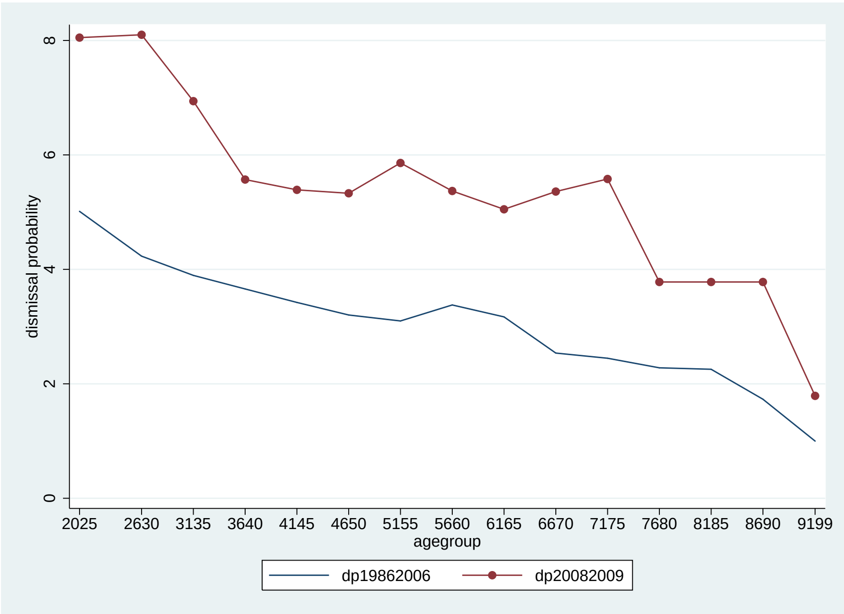

Figure 1: Heterogeneous Unemployment Probabilities

Table 4: 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	5,812 (69.8%)	—	—	1,985	114,319
Age 61	8,205	5,760 (70.2%)	—	—	2,009	109,551
Age 62	8,055	4,400 (54.6%)	3,466 (44.19%)	997	2,022	104,086
Age 63	7,883	2,634 (33.4%)	1,287 (16.4%)	1,115	2,032	100,158
Age 64	7,726	2,713 (35.1%)	964 (12.3%)	1,270	2,028	91,312
Age 65	7,555	3,363 (44.5%)	1,812 (23.1%)	1,392	1,944	82,098
Age 66	7,357	4,783 (65%)	313 (3.99%)	1,484	1,956	78,923
			Model 2 (Benchmark): ET with ARF Adjustments and Employment Uncertainty			
Age 60	8,331	5,625 (67.5%)	—	—	1,957	107,576
Age 61	8,205	5,560 (67.77%)	—	—	1,984	102,953
Age 62	8,055	4,081 (50.67%)	3,726(47.33%)	999	1,999	97,571
Age 63	7,883	2,559 (32.46%)	1,437(18.25%)	1,115	2,005	93,695
Age 64	7,726	2,924 (37.85%)	1,042(13.24%)	1,273	1,986	85,589
Age 65	7,555	3,659 (48.43%)	1,463(18.6%)	1,397	1,927	78,244
Age 66	7,357	4,753 (64.61%)	203(2.58%)	1,477	1,946	76,135
			Model 3: Benchmark Model with Higher Employment Uncertainty			
Age 60	8,331	5,528 (66.35%)	—	—	1,941	104,440
Age 61	8,205	5,441 (66.31%)	—	—	1,968	99,866
Age 62	8,055	3,895 (48.35%)	3,891(49.2%)	1,003	1,983	94,583
Age 63	7,883	2,595 (32.91%)	1,548(19.61%)	1,155	1,986	90,789
Age 64	7,726	3,055 (39.54%)	1,035(13.11%)	1,273	1,971	83,555
Age 65	7,555	3,772 (49.92%)	1,253(15.87%)	1,398	1,921	77,199
Age 66	7,357	4,632 (62.96%)	167(2.11%)	1,475	1,938	75,498
			Model 4: Benchmark Model with Higher Employment Uncertainty and Higher Unemployment Benefits			
Age 60	8,331	5,500 (66%)	—	—	2,019	114,842
Age 61	8,205	5,406 (65.89%)	—	—	2,043	110,265
Age 62	8,055	3,967 (49.25%)	3,291 (42%)	998	2,051	105,100
Age 63	7,883	2,298 (29.15%)	1,283 (16.37%)	1,154	2,059	100,829
Age 64	7,726	2,419 (31.3%)	1,080 (13.78%)	1,259	2,049	92,153
Age 65	7,555	3,128 (41.4%)	1,786 (22.79%)	1,389	1,973	83,645
Age 66	7,357	4,402 (59.83%)	395 (5.04%)	1,473	1,990	81,117

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.

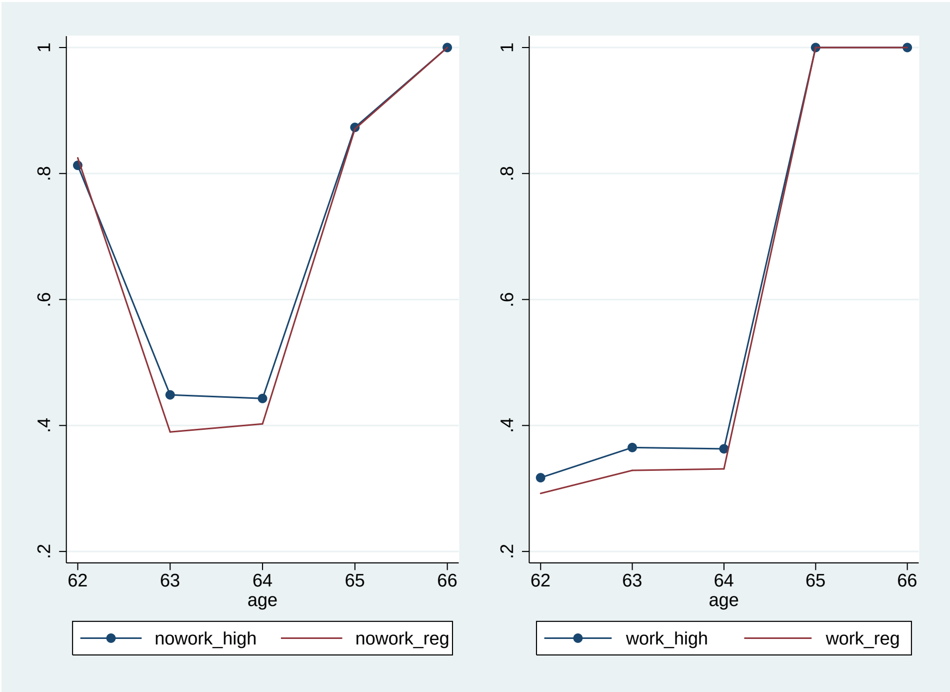

Figure 2: Claiming and Previous Employment

Table 5: Policy Experiments. 10,000 Simulations of the Dynamic Model

	No Uncertainty		**Benchmark Uncertainty**		**High Uncertainty**	
Ages	**Work**[a]	**Claiming**[b]	**Work**	**Claiming**	**Work**	**Claiming**
			Experiment 1: Lower Social Security Taxes for those 60+			
Age 60	69.98%	—	67.77%	—	66.51%	—
Age 61	70.19%	—	67.74%	—	67.52%	—
Age 62	59%	42.76%	56.47%	45.14%	54.84%	46.39%
Age 63	36.92%	20.07%	34.62%	22.44%	34.01%	24.52%
Age 64	37.57%	13.24%	39.89%	13.62%	41.39%	13.51%
Age 65	47.45%	20.44%	50.43%	16.82%	52.16%	14.08%
Age 66	65.89%	3.47%	65.5%	1.97%	63.71%	1.48%
Age 67	67.06%	0%	65%	0%	63.06%	0%
			Experiment 2: Higher Average Wage for those working at 60+			
Age 60	70.18%	—	67.98%	—	66.76%	—
Age 61	70.1%	—	67.74%	—	66.19%	—
Age 62	66.85%	53.51%	65.08%	54.07%	63.76%	54.63%
Age 63	68.62%	8.47%	66.22%	9.18%	64.86%	9.92%
Age 64	53.4%	23.1%	49.4%	24.79%	48.68%	24.34%
Age 65	55.66%	14.58%	56.52%	11.83%	55.66%	16.27%
Age 66	67.79%	0.34%	66.22%	0.14%	64.16%	1.14%
Age 67	67.99%	0%	66.15%	0%	63.91%	0%
			Experiment 3: Removal of the Earnings Test			
Age 60	69.78%	—	67.53%	—	66.38%	—
Age 61	70.2%	—	67.76%	—	66.31%	—
Age 62	47.11%	58.3%	42.53%	62.26%	39.6%	65.07%
Age 63	41.63%	10.76%	41.93%	11.76%	42.58%	12.46%
Age 64	41.81%	9.56%	44.88%	10.12%	46.76%	9.46%
Age 65	49.62%	18.3%	52.91%	14.21%	54.12%	11.69%
Age 66	65.71%	3.06%	65.27%	1.65%	63.46%	1.31%
Age 67	66.54%	0%	64.88%	0%	62.57%	0%
			Experiment 4: Normal Retirement Age set to 69			
Age 60	69.73%	—	67.48%	—	66.23%	—
Age 61	70.14%	—	67.65%	—	66.14%	—
Age 62	61.58%	38.97%	59.85%	39.36%	58.47%	40.79%
Age 63	54.97%	11.42%	50.53%	14.37%	49.29%	15.79%
Age 64	40.62%	14.3%	39.15%	15.9%	39.64%	15.98%
Age 65	40.89%	9.46%	42.71%	9.66%	44.29%	9.03%
Age 66	45.49%	10.93%	49.16%	9.97%	49.76%	9.49%
Age 67	54.57%	10.8%	57.03%	9.13%	56.96%	7.62%
Age 68	64.39%	4.12%	64.22%	1.59%	62.52%	1.28%
Age 69	63.92%	0%	62.88%	0%	61.17%	0%

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

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	134,444	134,883	144,566	134,715	136,116
Std. of Income Taxes	59,409	59,660	67,510	59,968	60,260
PV of Soc. Sec. Taxes Paid	43,171	41,844	45,585	43,240	43,609
Std. of Soc. Sec. Taxes	15,005	14,360	17,030	15,090	15,122
PV of Benefits Received	67,515	67,533	67,518	67,545	55,126
Std. of Benefits Received	50,589	50,574	53,598	49,750	43,221

Notes: Averages of 10,000 simulations, discounted to the initial period, assuming an interest rate of 2%, as in the model.

Table 7: Wealth Shocks. 10,000 Simulations of the Dynamic Model

	No Uncertainty		**Benchmark Uncertainty**		**High Uncertainty**	
Ages	**Work**[a]	**Claiming**[b]	**Work**	**Claiming**	**Work**	**Claiming**
			Scenario 1: Lower Interest on Savings			
Age 60	70.12%	—	67.99%	—	66.74%	—
Age 61	70.52%	—	67.85%	—	66.21%	—
Age 62	54.78%	47.14%	49.85%	51.02%	47.11%	53.34%
Age 63	36.03%	21.02%	35.58%	23.08%	35.79%	23.58%
Age 64	41.41%	11.92%	44.96%	12.92%	46.38%	12.43%
Age 65	51.21%	17.6%	55.75%	11.87%	56.47%	9.84%
Age 66	66.71%	2.31%	66.07%	1.1%	64.39%	0.81%
Age 67	67.66%	0%	65.6%	0%	63.06%	0%
			Scenario 2: 10% Decline in Wealth			
Age 60	74.06%	—	72.12%	—	70.45%	—
Age 61	75.13%	—	72.05%	—	70.20%	—
Age 62	37.32%	76.5%	36.36%	76.62%	36.54%	75.95%
Age 63	47.15%	22.77%	45.45%	22.9%	43.84%	23.52%
Age 64	68.16%	0.7%	66.2%	0.44%	64.78%	0.49%
Age 65	69.23%	0.01%	67.07%	0.03%	65.61%	0.02%
Age 66	69%	0%	67.37%	0%	65.32%	0%
Age 67	69.04%	0%	67.24%	0%	65.03%	0%
			Scenario 3: 20% Decline in Wealth			
Age 60	78.73%	—	76.19%	—	74.36%	—
Age 61	77.78%	—	74.64%	—	72.78%	—
Age 62	42.88%	81.98%	42.85%	81.78%	42.82%	81.99%
Age 63	52.09%	17.5%	49.85%	17.94%	49.13%	17.7%
Age 64	68.30%	0.5%	66.35%	0.2%	64.94%	0.28%
Age 65	69.25%	0%	67.09%	0.01%	65.64%	0.01%
Age 66	68.99%	0%	67.35%	0%	65.29%	0%
Age 67	69.08%	0%	67.36%	0%	65.16%	0%

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

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