# The Effects of Employment Uncertainty and Wealth Shocks on the Labor Supply and Claiming Behavior of Older American Workers*

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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 have increased the reliance that most (older) workers have on public social insurance programs, exactly at a time that public finances are suffering from a large drop in contributions. 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. We analyze the role of three intertwined factors in the recent evolution of work and retirement benefits claiming behavior in the United States; namely, higher unemployment uncertainty, higher unemployment benefits, and wealth shocks. We find that higher employment uncertainty reduces work and increases early claiming, while higher unemployment benefits mildly reduce work and reduce claiming at early ages. Finally, wealth shocks increase both early claiming and work. When all these factors are combined, the final outcome is a mild decline in labor supply and little variation in early claiming.

**JEL Codes:** J14, J26, J65
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# 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 years has become an additional source of financial pressure 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, between 2008 and 2010 the U.S. unemployment rate has doubled, and even now (with the recovery slowly taking hold in the U.S.) affects around 8% 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 painfully long time to level off. Additionally, in the U.S. households portfolios have suffered considerably through the recession: between 2007 and 2009 the average household wealth declined by around 20% (Bricker et al. 2011), and the more recent data from the Survey of Consumer Finances (SCF) shows that this decline is probably over 30% if we include 2010 in the calculation (See Glover et al. 2011, for a discussion of the macroeconomic implications of such declines in wealth). 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 years.

Thus, recent retirement trends in the U.S. can be understood as the result of three forces, the decrease in retirement savings account balances due to the financial crisis, increasing employment uncertainty due to the deteriorating labor market, and the increase penalty linked to early retirement benefits claiming resulting from the implementation of the reforms to the Social Security system starting in 2000. The first two forces could in

some sense be expected to partially offset each other, 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. The increase penalty for claiming early should, other things equal, delay claiming and possibly increase labor supply after the early retirement age. As noted, for example, by Coile and Levine (2010) it is hard to tell which one of these effects is going to dominate in terms of labor supply behavior, 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. 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 and can explicitly model the incentive structures for claiming retirement benefits.

We explicitly consider the participation decision 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 probabilities of becoming unemployed and re-employed after unemployment are ignored, the expected utility from work is overestimated and, hence, the probability of applying for benefits, especially at early ages, is underestimated.[1] This mechanism, as employment uncertainty has evolved over time, can explain part of the striking shift of benefits claim from the Normal Retirement Age to the Early Retirement Age in the United States. More importantly, it can also explain the fact that this early claiming has remained high even as the penalty for early retirement has become steeper with the increases in the Normal Retirement Age that started in the year 2000, and that will continue later in this decade.[2]

[1]Chan and Stevens (2004), and Coile and Levine (2007, 2010) discuss the importance of taking into account employment uncertainty when analyzing retirement programs, and Haaga and Johnson (2012) show the relationship between unemployment levels and claiming behavior, but all these authors do their analysis within a reduced form context in which there is little hope of disentangling the different effects at play, given that they do not explicitly model the behavior of the individuals or the incentives faced by them.

[2]The NRA will start to increase again in 2017 for the cohorts born after 1954, and will increase by 2 months for every younger cohort, until it reaches age 67 for all those born in 1960 or later.

The connection between labor supply and claiming requires that we pay special attention to the fairly complex Social Security incentives that affect the labor supply and benefit uptake behavior of individuals between the Early Retirement Age (ERA) and the maximum retirement age. These incentives, analyzed in detail in the Appendix and incorporated in our model, are especially involved between the early and Normal Retirement Ages (NRA), and include the Social Security Earnings Test (ET), which determines the maximum level of earnings that do not result in a benefit withholding for individuals who have claimed retirement benefits before the NRA, and the Actuarial Reduction Factor (ARF), which determines the permanent reduction in benefits that individuals face if they claim benefits early.[3]

The model used in this paper is closely related, and in important ways extends, those presented in Rust and Phelan (1997), Benítez-Silva et al. (2003 and 2011), and Benítez-Silva and Heiland (2007). Our model also shares a number of characteristics with the work of French (2005), Gustman and Steinmeier (2005), van der Klaauw and Wolpin (2008), Blau (2008), İmrohoroğlu and Kitao (2009b), Iskhakov (2010), French and Jones (2011) and Haan and Prowse (2012) 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).[4] These researchers are the first to explain in the U.S. context the trend towards early claiming, which has been documented using administrative micro data in Benítez-Silva and Yin (2009).[5]

However, even in those complex models developed in the last decade and a half, the authors ignore employment uncertainty, and assume a perfect control by the individual over its labor supply. We therefore contribute to this vast retirement literature by paying special attention to employment uncertainty and, even more importantly, its interplay with social insurance programs in the United States. By carefully modeling employment

[3]Notice that 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.

[4]Interestingly, while Rust and Phelan (1997) emphasize the importance of analyzing claiming and labor supply decisions separately, many researchers since have avoided tackling both, due, we believe, to the difficulty in matching the highly skewed distribution of claiming in the United States. Some recent work by İmrohoroğlu and Kitao (2009b), using the insights from Benítez-Silva and Heiland (2007, 2008), do analyze claiming behavior directly, and properly model the earnings test structure. The payoff is that they are also able to match the claiming behavior quite well. Their model is a General Equilibrium one, but does not account for unemployment uncertainty or wealth shocks.

[5]Leonesio (1990), Gustman and Steinmeier (1991), and Gruber and Orszag (2003) describe the correct features of the earnings test but do not study it in detail. Most of the other literature focuses on the taxation aspects of the earnings test, see for example, Friedberg (1998 and 2000), Baker and Benjamin (1999), and Votruba (2003). Coile et al. (2002), and Song and Manchester (2007a, and 2007b) focus their empirical work on the study of claiming behavior without analyzing it jointly with labor supply.

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 (and lower re-employment probabilities) 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 duration 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). One of the few existing research pieces about these 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 leisure and consumption decisions by workers. Moreover, we also include health status into the individual's utility function, and account for health uncertainties.

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 modeling 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). Our model is able to explain with great accuracy the following: (i) the strikingly high proportion of Americans who claim benefits exactly at the ERA; (ii) the fact that early claimants are predominately individuals who were not working before reaching the ERA; (iii) the increased hazard of applying for benefits at the NRA; (iv) the declining labor force participation at those same ages.

Additionally, we conclude that accounting for employment uncertainty (moving from no uncertainty to benchmark uncertainty, and then to high uncertainty) leads to higher early claiming and slightly lower labor force participation. Given the unemployment prob-

abilities we have calculated from the Current Population Survey (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%) as well as the drop in re-employment probabilities of between 10% and 20% depending on age and unemployment duration, observed in 2008-2009 compared with the historical 1986-2006 trend, leads to an increase in early claiming of 8.25%, and a decrease in labor force participation of as much as 9.3% (for age 62) and 7.94% on average between age 60 and 64.[6]

Finally, we analyze the effects of a sudden and unexpected drop in wealth balances (in line with the drops in household wealth reported in the SCF 2009) on retirement, keeping employment (and other sources of) uncertainty constant. This exercise 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 et al. (2009).[7] We find that negative wealth shocks have a positive and fairly large effect on labor supply (predicting an increase of around 10% of average working lives), and induce earlier benefits claiming. The labor supply effect we predict is somewhat larger than previously found, 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 about higher employment uncertainty and negative wealth shocks changing labor supply and claiming individual behavior, 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 analyzes the effects of wealth shocks on the key variables of interest. Section 6 concludes.

[6]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 more than twice that magnitude.

[7]A recent paper by Chai et al. (2011) presents a related life-cycle model of portfolio decisions with uncertain income. In that model the authors do not take employment uncertainty into account, and do not separately analyze labor supply and claiming decisions.

# 2 Recent 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.[8] 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 high levels, even with the implementation of the 1983 Amendments that penalize early claiming of benefits, and reward late claiming at a higher rate. In fact, as of the end of 2011, 76.85% of men and 81.68% of women claimed Social Security benefits before the NRA, compared to 36% and 59% in 1970, respectively.[9] 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 historical and current data on males 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 traditionally high eligibility ages of 62 and 65, and more recently 66, following the move towards a NRA of 66 for Americans born between 1943 and 1954, which comes as no surprise given the well established response to program incentives. Between 1994 and 2004, more than 55% of claimants have been taking their benefits at age 62 (between 48% and 52% in the 2006-2011 period, the drop in claiming at the earliest possible age is also documented in Haaga and Johnson 2012, using the SIPP), and between 17% and 23% wait for the normal age of retirement (between 12% and 26% in 2006-2011).[10] Notice also that 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.[11]

[8] 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.

[9] See the Annual Statistical Supplement to the Social Security Bulletin (2012 in progress), 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.

[10] It is important to clarify an accounting fact regarding how the claiming at age 65 and age 66 has been calculated in the aggregate statistics provided by the Social Security Administration. Notice that up to 2008 a very small proportion of individuals (less than 2%) were claiming at age 66, while in 2009 this proportion jumped to nearly 16% and has remained high hereafter. The reason for this is that starting that year everyone claiming after age 65 was considered to claim at age 66, and that includes the many individuals who claim exactly at their NRA which now for certain cohorts moved from 65 to 65 and some months and up to 66. The result of this accounting is that the peak at age 65 is on a quick decline in the aggregate statistics, while the age 66 peak is on the rise. This is part reflects a real shift in claiming behavior, but not as sudden and dramatic as the aggregate statistics suggest.

[11] Using the first seven waves of the Health and Retirement Study, we see that the claiming distribution

It is interesting to notice the rather anomalous claiming behavior in 2000, which resulted in a sizable 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 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 2010, 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 up to 2009, when again late claimers became again the high pension individuals. Between 2002 and 2009 benefits for late claimers dropped sharply, potentially because those individuals were 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 temporary 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.[12] The pattern of benefits we see since 2009 suggests later claiming by those with higher earnings histories, even if the proportions of those claiming after the NRA are very small so those numbers should be analyzed with caution. In any case, our dynamic model should be able to fit the cross-sectional evidence we observe, even if it is hard to match the changes since our model will commit to a particular set of parameters and rules, which reflect the state of the incentive structure after the year 2000.

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.[13]

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is quite similar to those reported, which is not surprising given that the Health and Retirement Study (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.

[12]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 as seem to be the case given the latest data.

[13]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. In that work the authors use a Public-Use microdata extract from the Master

In Table 2 we present the main stylized facts regarding labor supply of older workers, according to data from the CPS in the 1996-2010 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 62) in the 15 years we present here, which corroborates the aggregate evidence that labor force participation of older workers is on the rise.[14] We also find that the fraction of those not working increases substantially at age 62 and reaches 70% (in most years) after age 67. Finally, it is important to note that the 2008-2010 economic crisis has made the fraction of individuals not working to increase, specially at certain ages.

An interesting complement to the data shown in Table 2 are the unemployment rates for older individuals, which have been historically quite low. For example, for males 55 to 64 the unemployment rate was 3.3% in 1996 and 3% in 2006, but increased to 7.2% in 2009 and to 8% in 2010, only to decline to 5.9% as of August of 2012. These numbers are considerably lower than for prime-aged males. For males 65 and over the unemployment rates are almost identical. In the case of women 55 to 64 unemployment rates have also been historically around 3%, and also about doubled during the recession.

# 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 directly depends on consumption and leisure, and face some of the key incentives from social insurance programs, such as retirement incentives, and unemployment insurance. We formally ac-

Beneficiary Record, which has the advantage of allowing us to separate individuals who claim on their own histories of earnings (workers) from those who claim as dependents. However, that data is only available up to 2004. In any case, the claiming patterns we report in Table 1 are very much in line with those we find in the Public-Use microdata.

[14] Aggregate data from the Bureau of Labor Statistics on males, shows a similar and interesting picture. The share of males aged 55-64 in the labor force has increased from 65.5% percent in 1994 to 70% percent in August of 2012, after three decades of decline leading to the mid-1990s. Interestingly, the latter percentage has remained surprisingly stable through the tough labor market of the last 4 years. The increased participation 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% in the mid-1990s to around 23% in August of 2012.

knowledge 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 and their re-employment probabilities might be considerably lower.

## 3.1 Basic 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.

The model assumes that individuals are forward looking, and discount future periods at a constant rate $\beta$, assumed fixed in our calibration exercises, and equal to 0.965. Individuals can accumulate balances and receive a fixed interest rate, $\overline{r}$, of 2%.[15]

We solve the dynamic Life-Cycle model by backward induction, and by discretizing the space for the continuous state variables.[16] 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, $l_t$, consumption, $c_t$, and application for retirement benefits, $ssd_t$. We assume two possible values for this variable. If $ssd_t$ equals 1 the agent has initiated the receipt of benefits. If the individual has not filed for benefits or is not eligible then $ssd_t$ is equal to 0.

After age 70 it is assumed that all individuals have claimed benefits, and again only consumption and leisure choices are possible.[17] 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 working time spent non-working, assuming that a full-time job requires 2000 hours per year and

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

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

[17]This is consistent with the fact that beyond age 70, Social Security benefits are no longer increased as a result of delaying claiming, therefore individuals can only lose from claiming after age 70.

a part-time job requires 800 hours per year.

Our 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 and Re-employment uncertainty*: modeled following the empirical distributions using the CPS from 1989 to 2006 for the probabilities of being fired, and the NLSY79 and NLSY97 for the re-employment probabilities. We will also use the same data-sets on the 2008-2009 period to approximate the effect on employment transition probabilities of the current economic crisis.

The individual can choose voluntarily not to work (losing the right to receive unemployment benefits, but suffering the negative consequences of a spell out of work in terms of future wages and future retirement benefits), however given that we allow for employment uncertainty and therefore the possibility of losing a job (with probability $\delta$), it is quite important to model unemployment benefits.[18] In the United States, and until the current economic crisis, these benefits covered individuals during 26 weeks, and at a level of around 50% of their previous wage (Shaw and Stone 2012). The program is administered at the State level under Federal guidelines, and usually takes into account the earnings in the 52 weeks prior to the unemployment spell.

It is also important in our model to account for unemployment duration. Hence, in each period, unemployed (non-employed) individuals do search (which, in turn, is assumed to be costless) and have an age-specific and duration specific (for unemployment durations 1, 2 and 3+) probability $\lambda_t$ of receiving an offer. Individuals decide to accept or not the offer, so they can voluntary choose to be out of work. It is important to note that there is, at least, a period of unemployment after displacement.

Finally, we do not model the institutional details of private pension schemes or disability insurance. However, we do model private savings. We assume agents enjoy an initial level of assets in the first period, $a(0) = a_0$, and that they face borrowing constraints, $a(t) \geq 0$ for every $t \geq \tau$.

[18]We do not model severance payments here, given that in the United States this is a relatively minor issue, since there is no legally established level of severance pay the employers need to provide, and the standard two-weeks pay is not a function of tenure on the job, which is quite convenient to maintain the size of problem as small as possible. However, this consideration might be more important for certain occupations and other countries, which we hope to analyze in future work.

## 3.2 The model

As stated above, we assume that the individual's utility is given by

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

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 will use the same specification for $\phi$ as in Benítez-Silva, Buchinsky, and Rust (2011).[19] Hence, we will assume that the disutility of work increases with age, and is uniformly higher the worse one's 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. Moreover, the disutility of work will decrease with average wage. Thus, 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.

Finally, we also assume that there are no time or financial costs involved in applying for retirement benefits. The parameter $\gamma$ 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).

### 3.2.1 The value functions

Thus, the expected present discounted value of utility from age $t$ onward for an individual with state variables $(a, \overline{w}, ss, h, em)$ where $a$ stands for assets, and $em$ for employment state, is represented by the following two Bellman equations that correspond to the core of the model we are analyzing: the value of being employed, $V_1^t$, and the value of being unemployed, $V_0^t$.[20]

In this context, we first define the value of being employed, with $em = 1$ as follows:

$$\begin{aligned} V_1^t(a, \overline{w}, ss, h, em) &= \max_{c_t, l_t, ssd} u(c_t, l_t, h_t, t) + \\ &\quad \beta \left[ (1 - \delta_t) \; Emax \left( V_1^{t+1}(w_t), V_0^{t+1} \right) + \delta_t \; V_0^{t+1} \right] \end{aligned} \tag{2}$$

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

[20] We are not modeling here the decision of being out of the labor force. Hence, we should interpret the status of unemployment as being non-employed.

subject to,

$$a_{t+1} = (1+\overline{r})(a_t - c_t) + w_t(1-l_t) + I\{ssd=1\}P_t \tag{3}$$

Notice that individuals choose their consumption level, their leisure level and make their Social Security decision regarding claiming of Retirement benefits. The continuation value in the Bellman equation, with probability $1-\delta_t$, comes down to the labor supply choice next period between working at an expected wage and being voluntary unemployed ($vu=1$). However, with some probability $\delta_t$ they are not able to work next period and just obtain the utility of not working starting tomorrow. While in the notation above the utility of not working is the same regardless of whether it is the product of a voluntary choice or not, in reality and in the model, those who have chosen not to work do not receive unemployment benefits and therefore face a slightly different budget constraint in the future. In the budget constraint above, we can see that only those who decide to claim benefits, $I\{ssd=1\}$, will obtain a pension, $P_t$.

We now define the value of being unemployed, taking into account that the re-employment offer probabilities are a function of unemployment duration, which in the model we allow it to be one year, $em=0$, two years, $em=2$, or three or more years, $em=3$. This set up allows us to take into account two important issues: first the fact that re-employment offer probabilities are a declining function of unemployment duration (and age), and second the increased generosity of the unemployment insurance system during the recent recession. We define it as:

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

subject to,

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

Unemployed individuals, regardless they are voluntarily or non-voluntarily so, choose their consumption level, their leisure level and make their Social Security decision regarding claiming of Retirement Benefits when that choice is available. The continuation value has two parts: in case of not receiving an offer, with probability $1-\lambda_t(em)$, the individual obtains the utility of not working next period; in case of receiving an offer, with probability $\lambda_t(em)$, the continuation value comes down to the labor supply choice next period, which is a choice between working at the wage offer or continue unemployed

voluntarily.

Notice here that the budget constraint of an unemployed worker may have two income components: unemployment ($b_t$) and pension ($P_t$) benefits. As explained before, unemployment benefits are computed as a function of the average wage, $\overline{w}_t$, and of unemployment duration, $em$. Furthermore, these benefits are not available if the worker is voluntarily unemployed, $vu_t = 1$. Thus, we define:

$$b_t = \begin{cases} 0 & \text{if } vu_t = 1; \\ g(\overline{w}_t, em) & \text{otherwise.} \end{cases} \tag{6}$$

Finally, unemployment benefits are also a function of the employment state (unemployment duration) to allow the model to take into account the increase in the length of unemployment benefits during recessions. Unemployment benefits have gone from lasting only 26 weeks to lasting almost two years, and this is an important aspect affecting economic incentives at all ages, but especially for those facing retirement.

### 3.2.2 Computational details

The expected value function in each of the two key labor status consists of the conditional expectation of next period's value function, given the individual's current state $(a, \overline{w}, ss, h, em)$ and decisions $(c, l, ssd)$. We can denote it as $EV_{t+1}(a, \overline{w}, ss, h, em, c, l, ssd)$, and then write it in more detail as

$$\begin{aligned} EV_{t+1}(.) \;=\; & \int_{y'} \sum_{h'=0}^{2} \sum_{ss'=0}^{n} V_{t+1}(ap_{t+1}(a, \overline{w}, y', ss, ssd), \overline{w}p_{t+1}(\overline{w}, y'), ss', h') \\ & \times k_t(h'|h) g_t(ss'|a, \overline{w}, ss, h, ssd) f_t(y'|\overline{w}) dy', \end{aligned} \tag{7}$$

where the number of Social Security states, $n$, is eighteen, once we 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, $\overline{w}p_t(aw, y)$ is the Markovian updating rule that approximates Social Security's exact formula for updating an individual's average wage, $\overline{w}_t$, and $ap_t$ summarizes the law of motion for next period's level of assets, that is,

$$ap_t(a, \overline{w}, y, ss, ssd) = \overline{r}\left[a + y' - \tau(y', a) - c\right], \tag{8}$$

where $y'$ is the next period current income, $\tau(y, a)$ 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.

$f_t(y|\overline{w})$ is a log-normal distribution of current earnings, given current age $t$ and average wage $\overline{w}$, that is implied by (10) under the additional assumption of normality in $\eta_t$. The discrete conditional probability distributions $g_t(ss'|a, \overline{w}, ss, h, ssd)$ and $k_t(h'|h)$ reflect the transition probabilities in the Social Security and health states, respectively.

The individual's average wage, $\overline{w}_t$, 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:

$$\log(\overline{w}_{t+1}) = \gamma_1 + \gamma_2 \log(y_t) + \gamma_3 \log(\overline{w}_t) + \gamma_4 t + \gamma_5 t^2 + \epsilon_t. \tag{9}$$

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:

$$\log(y_{t+1}) = \alpha_1 + \alpha_2 \log(\overline{w}_t) + \alpha_3 t + \alpha_4 t^2 + \eta_t. \tag{10}$$

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 (10)). The factor of 0.8 here incorporates the assumption that the average 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.[21]

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 (9), rather than having to keep track of the entire earnings history in order to determine the 35 highest earnings years, which the AIE requires.

The $\overline{w}p_t$ function, derived from (9), is given by

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

where $\sigma$ is the estimated standard error in the regression (9). 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 $aw_t$.

## 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 to the data, like the proportion of individuals claiming at different ages, labor supply patterns, consumption patterns, their benefit levels, and 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 as well unanticipated changes in unemployment and re-employment probabilities, as well as wealth balances, 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 bellow 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.

Our model relies heavily on a number of empirical specifications, for example regarding health uncertainty, and the evolution of average wages. For the latter we use the first six

[21] Given the relatively small number of part-time workers at some ages, we had to aggregate across a wide range of ages.

waves of the HRS, which cover the 1992 to 2002 period of the US economy, mainly because of the possibility of having access to the restricted data on average wages resulting from the matches with the Social Security records of some of the HRS respondents. The way we approximate average wages was explained in the previous section. Regarding health uncertainty we use the NLSY79 for younger workers and the HRS for those 50 and older.

Regarding the unemployment risk, we use data to calibrate both the unemployment and the re-employment probabilities. The former is based on CPS data. We use the average of the empirical firing probabilities in the 1986-2006 period for our benchmark simulations, and the data on 2008-2009 for the exercises simulating the effect of the crisis. Figure 1 shows the benchmark unemployment probabilities as well as the probabilities we use in the model with high uncertainty. Notice the large increase in the probability of becoming unemployed at all ages seen in the economy during the worst period of the recession.

The re-employment (offer arrival) probabilities are based on NLSY79 and NLSY97 data. We use the monthly information regarding labor market status in all waves of the 1979 and the 1997 studies, in order to estimate the empirical exit rate from unemployment in the years leading to the great recession. It is also important to emphasize, regarding re-employment probabilities, that given that the observed probabilities are the product of both the probability of being offered a job and the probability of accepting it, we do not use data on re-employment probabilities for individuals over 50, since the observed probabilities are likely to be highly influenced by the very decisions we are trying to study. In practice, this means that we assume the re-employment probabilities for those over 50 are the same as for those between the ages of 41 and 50, allowing individuals in the model to decide their labor supply given those probabilities.[22] Regarding the modeling of the changes in re-employment uncertainty, we use the empirical hazards in the period 2008-2009 to calibrate the re-employment probabilities in the recessionary period. However, there is little information about these probabilities for individuals between 31 and 40 years of age in the National Longitudinal Surveys, so we average the probabilities of the younger (18 to 30) and older groups (41 to 50) to approximate the empirical probabilities of that group. On the other hand, some of the drops in re-employment observed in the data are surprisingly large, especially for older individuals, and likely the result of a combination of lower offer arrival rates and reductions in labor force participation due to the recession, leading us to decide to calibrate the drops in re-employment probabilities following the qualitative empirical results that show larger drops in re-employment for older individuals during the recession, as well as larger drops for those who were unemployed for longer

[22]It is not possible to separate in the data the probability of being offered a job and the probability of accepting it. We would like to measure only the first of these probabilities to introduce it in the model, but we observe the product of the two, which we believe that for younger individuals is a fairly acceptable measure of the first set of probabilities, but that is unlikely to be the case for older individuals.

periods.

Figure 2 shows the benchmark re-employment probabilities (before 2008) by age and unemployment duration as well as the new re-employment probabilities we use in the model with high uncertainty (2008-2009). Notice that during the recessionary period re-employment probabilities are assumed to be between 10% and 20% lower than during the benchmark period, with the larger drops assumed to happen among the older individuals and those unemployed for longer periods.

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

Tables 3 to 5 show the results of our key model specifications in which we introduce incrementally more realistic characterizations of employment uncertainty, and then the increases in uncertainty and unemployment benefits we have observed during the recent US recessionary period. The next section will focus on expanding these models to include the wealth shocks also observed during the recession.

Table 3 presents our first set of results. We show four panels of simulations, with the first panel using a benchmark model without employment uncertainty, but with the appropriate characterization of the Earnings Test and the early retirement actuarial adjustments. 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 qualitatively in line with what we see in the data, where our benchmark are the aggregate proportions for males we show in Table 1, but quantitatively the peak at 62 is too low and the peak at 65 is too high. 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 very close to the males in the data, and we also capture the peaks at age 63, 65, and 66 that we see in 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 (Gustman and Steinmeier 2005) or hard to test beliefs about the future. Regarding labor supply, the qualitative results show a declining labor supply at older ages, and quantitatively

the model does a good job, considering the difficulty in matching the part-time choices without labor demand considerations.[23] The proportion of individuals working increases slightly at age 66 and 67 mainly due to the phasing-out and eventual disappearance of the earnings test.

It is important to highlight that the proper consideration of employment (and reemployment) uncertainty is correcting relevant biases in predicted labor supply and claiming behavior. For example, comparing the first and the second panels in Table 3 we can see that by not considering such uncertainty when solving the model we would be biasing upwards the work of individuals in their 60s, with the first model being very far from the empirical evidence presented in Table 2. With respect to claiming, the bias due to not considering employment uncertainty is even more important: claiming at 65 is around 20 percentage points higher than the prediction under our benchmark case (Model 2 in Table 3). 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 in qualitative terms (meaning in terms of the profile) 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 path for wealth after reaching a peak around age 50. Notice also the effect that increases in employment uncertainty have on wealth accumulation, with wealth

[23]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 2, 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.

reflecting a precautionary motive when uncertainty increases.

It is worth emphasizing that the wealth averages shown in the last column of Table 3 hide a much richer relationship between wealth accumulation and claiming. If we focus in the regular uncertainty case (lower employment uncertainty and higher reemployment probabilities), and for example in the average wealth at age 61, which is just around $92,000 in Model 2 of Table 3, 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 $69,584, while for those who end up claiming at age 63 is $95,960, and the levels for claimants at ages 64 to 66 are $118,913, $110,566, and $125,136, 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. Thus, conditional on surviving to the next period and accounting for a discount factor equal to 0.965, obtaining the return on their expected Social Security benefits offered by the actuarial adjustment can be optimal. 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 $87,190, around $23,000 less than what they had accumulated by age 61.[24] 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.[25]

In the third panel of Table 3 we simulate the effect of an increase in the unemployment risk, leaving re-employment probabilities at their benchmark levels (as in second panel). As explained above, we accomplish this by using the average of the empirical probabilities from the 2008 and 2009 CPS, in the case of the firing probability, but leaving the re-employment at their pre-crisis levels. This panel shows that, first, the proportion of those claiming early goes up from 50.05% to 51.96% at age 62, and, second, the pro-

[24]Quite surprisingly, these results regarding the wealth holdings of early vs. late claimers is at odds with the results in İnmohoroğlu and Kitao (2009b) who find that less wealthy individuals claim later. Given how correlated early claiming is with bad health, previous unemployment, and lower longevity, in our model and the data, we believe our result is more intuitive. Additionally, our findings are very much in line with those of Gustman and Steinmeier (2005) in a related model. The two models are quite different since they do not have unemployment uncertainty or wage uncertainty, but they introduce uncertain health care costs. However, both models do replicate quite well the claiming behavior.

[25]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 (well over 60%) compared with the data.

portion of those not working at age 62 goes up to nearly 48%, instead of the 45.8% of the benchmark. Finally, wealth accumulation decreases by between 4.5% and 7.2% for those age 50 and above (depending on age) as we increase uncertainty to the level of the 2008-2009 period. However, the benefit levels and consumption levels are quite similar, which means that individuals have adjusted through life-cycle decisions to this new more uncertain environment. In terms of the consequences at earlier ages, we can observe that non-participation goes up under the new more uncertain environment, which should not be very surprising.

In the last panel of Table 3, which we label Model 4, we present the results of combining higher employment uncertainty and lower re-employment uncertainty. The new re-employment probabilities come from the from the 2008-2009 years in the NLY79 and NLSY97, depending on age. The implications for both claiming and work are quite clear: claiming at age 62 increases further up to 54.18% and work gets reduced by around 2 percentage points across all ages with respect to Model 3, and about 4 percentage points with respect to Model 2, where the latter translates into an average reduction of labor supply of around 8%. Additionally, consumption and wealth levels are considerably reduced, which is not surprising given the effect that increased re-employment uncertainty has on the length of working lives and the possibility to consume and save.

## 4.1 The role of unemployment benefits

In 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. In model 5 we assume unemployment benefits are doubled which can be understood as going from 26 weeks to 52 weeks. In the benchmark model, we model unemployment benefits as 25% of the average wage, as a proxy for previous wages, and taking into account that half a year of benefits replaces around half of what unemployment benefits usually replace in terms of weekly benefits. When simulating the increase in unemployment benefits during the crisis we increase this replacement rate to 50%. Our results show that implementing a more generous unemployment benefits system significantly reduces claiming of retirement benefits at age 62 (by 1.96 percentage points, down to 52.22%), mainly due to a lower claiming from non-employment, but increases claiming at age 65 and 66, and slightly increases average consumption during retirement ages, and especially increases wealth accumulation. Labor supply is reduced slightly, especially after age 61. Finally, in model 6 we assume that UB are given for 99 weeks, which coincides with the maximum extension of UB allowed for during recessions (Mayer and Levine, 2010). The effects on claiming from unemployment

are stronger than in the former case. Claiming at age 62 is further reduced (by 4.35 percentage points, down to 49.83%) and consequently increased at ages 64 to 66. Furthermore, work during retirement ages is further reduced, and consumption and wealth accumulation are increased substantially. Notice that the results from this table allow us to isolate the effect of the increased generosity of the unemployment insurance system, so it does not get confounded if we were to move directly, for example, from model 3 to model 6.

Table 5 presents hazard rates of claiming at different ages and by employment status. The table shows the differences in the claiming behavior by labor force status (work, no-work) and by the duration of the unemployment spell (one, two and three or more years). We find, first, that only a small percentage of those working at age 61 claimed benefits at the ERA, while that is much more common for those not working at age 61, and pervasive among those not working for long periods. Second, in all models, claiming at age 62 increases with the duration of the unemployment spell. For example in the benchmark case, it increases from 21.43 (work) to 30.42 (one year unemployed), 57.26 (two years) and 94.16 percent (three or more years). Third, for all unemployment tenures, claiming at 62 decreases with the generosity of the unemployment insurance program Alternatively, claiming at age 65 increases with tenure in unemployment, except for the 99 weeks of benefits scenario, in which the claiming from work and the claiming from one year of unemployment are very similar, very likely because those enjoying a second year of benefits have a lower incentive to claim benefits than at other ages, except at age 65 which is almost like the hazard for those claiming from work.

Figure 3 presents graphically the main findings regarding the effect of increasing UI generosity on claiming by employment status and unemployment duration. The top two panels clearly show that the early claiming hazard from work and from one year of unemployment is small and not very affected by the generosity of the UB system. However, the claiming hazard from work is much higher at age 65. On the other hand, the bottom panels show that the effect of UB extension on claiming of the long term unemployed is substantial. Since we are providing them with income support they are deciding to delay claiming to avoid one or two years of early retirement penalties. Thus our results demonstrate that increasing UB generosity during recessions may substantially alter the retirement behavior of older workers.

In terms of the average working life predicted for the different models, as could be expected, we get that it declines as we move from Model 1 to Model 4, that is, as we introduce employment uncertainty. In the model without employment uncertainty the average working life is 39.07 years, while in model 2 drops by 6.37% to 36.57 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 in Model 3 is 35.16, and further

decreases once we take into account the lower re-employment probabilities in Model 4, with an average working life in that model of 33.66 years. The introduction of higher unemployment benefits in Model 5, further shortens the working life to 33.41 years in the case of the one year unemployment benefits, and to 33.08 years in the case of two years of benefits.

# 5 Wealth Shocks and Employment Uncertainty

Table 6 shows the effects on labor supply and claiming behavior of simulating wealth shocks in order to provide an additional discussion of the likely effects of the economic downturn that happened during, especially, 2008 and 2009. We provide three different scenarios regarding 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 two sets of columns in the table should be compared with the first two panels of Table 3, but the third set of columns in this table is to be compared with Model 4 in Table 3.

The first 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, work becomes much more attractive at all ages, specially when uncertainty is present in the model. In some cases the percentage point increase in labor force participation is well into the double digits, especially for the benchmark and the higher levels of uncertainty, and even for individuals age 60 to 61 the effect is between 5 and 10 percentage points. Secondly, the bad shock pushes a large proportion of individuals towards drawing as early as possible from their Social Security benefits. Claiming at age 62 increases between 11 (in case of mild employment uncertainty) and 8 percentage points (in case of higher employment uncertainty), evidencing that higher employment uncertainty partially offsets the effect of wealth shocks. 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. Notice that these effects are present even in the absence of employment uncertainty.

The second scenario shows the consequences of the accumulated wealth effect (of around 20%) of the crisis following the findings from the SCF 2009. Interestingly, the results show an slightly stronger labor supply effect, especially at older ages, which in turn leads to a milder claiming effect than in the previous case. Still in the case of higher uncertainty the increase in early claiming is substantial with respect to the case presented in Model 4 in which wealth balances were not affected. The third scenario compounds the effect of the 20% wealth decline with the increase in unemployment benefits to the 99 weeks mark. In this case, the only relevant results are those with high uncertainty, and we see that the labor supply and claiming effects are similar to those of the previous panel, with somewhat of a small decline in labor supply and a small decline in early claiming.

In terms of length of working lives, in Scenario 1 we find that the average working life in the case of high uncertainty increases by about 3 years to 36.54, with respect to Model 4, and by about four years in the case of Scenario 2 to about 37.56 years of work experience, when the wealth decline is of about 20%. The length in the working life remains at about the same level once we introduce the longer unemployment benefits.

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 et al. (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.

One additional conclusion from Table 6 has to do with the fact that the changes in labor supply are much stronger at age 60 than at age 62, regardless of the level of unemployment

uncertainty. This is important to emphasize because it might seem, if we just look at one panel at a time (including most of the results in Table 3) that there is nothing too special about age 62, even though is the Early Retirement Age. We can see that thanks to the fact that benefits are available, the labor supply response can be more subdued so individuals can smooth the changes in their behavior, reflecting the clear heterogeneity across ages due to the fact that the incentive structures, and therefore the budget constraints, at different ages are very different. The structural dynamic model accounts for this heterogeneity in incentive structures, and allows us to uncover the different responses by age to wealth and uncertainty changes.

# 6 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 financial and retirement portfolios. These events likely increase the reliance that most older workers have, and 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 (like the large proportion of early retirement claimants, and the fact that most of them had a period out of work before claiming), 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%), we find that the implied elasticity of these two individual decisions with respect to this uncertainty is between 0.1 and 0.2.

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 A. 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, or by getting their checks withheld because of earnings above the Earnings Test thresholds.[26] 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.[27] 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.[28] 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), the MBA equals the PIA. If an individual decides to begin receiving benefits before the NRA and exits the labor force or stays below the earnings limit, her MBA is reduced by up to 25%, assuming a NRA of 66. Under the current regulation of the OA program, the monthly benefit amount received upon first claiming benefits depends on the age (month) of initiation of Social Security benefits, in the following way,

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

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

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

[27] Given a NRA of 66, which is 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.

[28] As of 2012 this maximum is $110,000.

actuarial reduction will reach 30 percent as the NRA increases to 67 over the next few years (see SSA-S 2005, p.18).[29]

## 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.[30] 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

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

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 "full" $MBA$.[31] 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

[29]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)

[30]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.

[31]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 was rarely discussed in any publication up to a couple of years ago.

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.[32] 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.[33] 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.[34]

# Appendix B: Unemployment insurance in the US

During the last recession the U.S. unemployment rate rose to record high levels (from 4.4 in October 2006 to 10.0 in percent in October 2010). In parallel the fraction of long term unemployed (more than 6 months) increased from 1-2 percent in 2006 to 4 percent in 2009-2010, and they represented about of 35 percent of the unemployed in 2009/2010 (Mayer and Levine 2010).

## Description of the Program

Unemployment Insurance (UI) was created in the U.S. in 1935 under President Roosevelt, and each State operates its own program but must follow certain federal rules, since the U.S. Department of Labor oversees the program. Most workers in the United States, nearly 82 percent of the civilian labor force in 2010, work in jobs in which they are eligible for UI. The amount and duration of the weekly unemployment benefits are based on a worker's prior wages and length of employment. Employers pay taxes into a special fund based on the unemployment and benefits-payment experience of their own work force. The federal government also assesses an unemployment insurance tax of its own on employers. States hope that surplus funds built up during prosperous times can carry them through economic downturns, but they can borrow from the federal government or boost tax rates if their funds run low. States must lengthen the

[32] 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).

[33] 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).

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

duration of benefits when unemployment rises and remains above a pre-set "trigger" level. The federal government may also permit a further extension of the benefits payment period when unemployment climbs during a recession, paying for the extension out of general federal revenues or levying a special tax on employers. Whether to extend jobless-pay benefits frequently becomes a political issue since any extension boosts federal spending and may lead to tax increases.

## Eligibility

Workers must meet the State requirements for wages earned or time worked during an established period of time referred to as a "base period." There are two basic eligibility conditions:

1. In most States, this is usually the first four out of the last five completed calendar quarters prior to the time that your claim is filed.

2. Unemployment state must be involuntary and through no fault of the part of the workers (determined under State law).

## Benefits

In general, benefits are based on a percentage (about 50% of earnings, according to diverse state formulas) of an individual's earnings over a recent 52-week period - up to a State maximum amount. The average weekly benefits during 2010 and 2011 were around $300, and the benefits are capped at a maximum that varies widely by State, with Mississippi having a maximum of $235 while Massachusetts has a maximum of $653 (See Shaw and Stone 2012). About 1/4 of states provide from U.S.$1 to U.S.$95 a week for each child and sometimes for other dependents, which increases the maximum families can receive. The benefit is payable after a one week waiting period in most states for up to 26 weeks, according to the state. Federal law provides up to 13 additional weeks in states with high unemployment, and some States provide additional benefits for specific purposes.

Extended Benefits (EB) are available to workers who have exhausted regular unemployment insurance benefits during periods of high unemployment. The basic Extended Benefits program provides up to 13 additional weeks of benefits when a State is experiencing high unemployment. Some States have also enacted a voluntary program to pay up to 7 additional weeks (20 weeks maximum) of Extended Benefits during periods of extremely high unemployment.

Under certain circumstances and also in periods of high unemployment, benefits can be extended, under various programs, up to 99 weeks. For example, the extended unemployment compensation (EUC) program, a federally financed program, was enacted in June 2008. It was extended four times in 2008-09. States can opt to pay the EUC before EB, and all but one follow this sequencing.[35]

[35]The American Recovery and Reinvestment Act of February 2009 includes provisions that affect all three tiers of UI benefits. For example, an extra $25 for each week of compensation is added for recipients of all three tiers of benefits. In short, UI benefits have been widely accessible and more generous in the current downturn than in previous recessions.

Table A.1. Key Parametrizations of the Model

| Parameter | Value | Use | Source |
|---|---|---|---|
| $\beta$ | 0.965 | Discount Factor | Calibration |
| $\gamma$ | -0.37 | Risk Aversion | Utility Function Eq. (1) |
| Leisure of a FT Worker | 0.54 | Leisure | Utility Function Eq. (1) |
| 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 | 1$ on the $ | Age 21 to 60 | CPS 1986-2009 |
| Part-time Penalty 2 | 0.65 on the $ | Age 61 to 64 | CPS 1986-2009 |
| Part-time Penalty 3 | 0.55 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. Males. Annual Statistical Supplement

| **Age** | **1994** | **1996** | **1998**[a] | **2000** | **2002** | **2004** | **2006** | **2008** | **2009** | **2010** | **2011** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **62** | 0.554 | 0.571 | 0.567 | 0.469 | 0.531 | 0.552 | 0.5184 | 0.4849 | 0.5046 | 0.49 | 0.48 |
| **63** | 0.083 | 0.0815 | 0.0808 | 0.0689 | 0.0807 | 0.0836 | 0.0872 | 0.0802 | 0.0816 | 0.095 | 0.0831 |
| **64** | 0.129 | 0.111 | 0.1135 | 0.106 | 0.1574 | 0.1145 | 0.1042 | 0.0965 | 0.0841 | 0.079 | 0.0867 |
| **65** | 0.176 | 0.171 | 0.168 | 0.228 | 0.1961 | 0.2107 | 0.2548 | 0.2997 | 0.1476 | 0.12 | 0.1195 |
| **66** | 0.02 | 0.023 | 0.024 | 0.048 | 0.0103 | 0.012 | 0.0112 | 0.0171 | 0.1579 | 0.18 | 0.1919 |
| **67** | 0.01 | 0.013 | 0.0133 | 0.027 | 0.006 | 0.0064 | 0.006 | 0.007 | 0.008 | 0.012 | 0.0145 |
| **68+** | 0.027 | 0.028 | 0.0322 | 0.05 | 0.017 | 0.0193 | 0.0178 | 0.0158 | 0.016 | 0.019 | 0.025 |
| Claimants[b] | 817 | 782 | 794 | 987 | 874 | 894 | 945 | 928 | 1,052 | 1,276 | 1,159 |
| | | | | | Average benefits in $ of 2010 | | | | | | |
| **62** | 1,064 | 1,052 | 1,094 | 1,167 | 1,201 | 1,193 | 1,166 | 1,189 | 1,189 | 1,163 | 1,142 |
| **63** | 1,150 | 1,220 | 1,187 | 1,241 | 1,303 | 1,300 | 1,320 | 1,295 | 1,320 | 1,317 | 1,301 |
| **64** | 1,272 | 1,292 | 1,285 | 1,322 | 1,436 | 1,426 | 1,424 | 1,370 | 1,388 | 1,375 | 1,392 |
| **65** | 1,357 | 1,383 | 1,382 | 1,468 | 1,556 | 1,605 | 1,675 | 1,707 | 1,586 | 1,545 | 1,551 |
| **66** | 1,280 | 1,273 | 1,231 | 1,513 | 1,059 | 1,189 | 1,314 | 1,583 | 1,906 | 1,771 | 1,778 |
| **67** | 1,260 | 1,363 | 1,274 | 1,605 | 1,008 | 1,079 | 1,140 | 1,513 | 1,663 | 1,711 | 1,756 |

*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: Labor Supply Facts (CPS, 1996-2010)

| full-time | 1996 | 1998 | 2000 | 2002 | 2004 | 2006 | 2008 | 2010 |
|---|---|---|---|---|---|---|---|---|
| 60 | 56.27 | 50.63 | 54.56 | 52.79 | 54.87 | 56.64 | 55.40 | 50.23 |
| 61 | 51.17 | 50.80 | 57.67 | 48.02 | 52.05 | 54.46 | 52.77 | 54.31 |
| 62 | 39.95 | 41.10 | 39.93 | 39.09 | 41.94 | 44.45 | 43.73 | 41.23 |
| 63 | 30.09 | 31.39 | 31.32 | 32.88 | 37.45 | 39.76 | 40.03 | 40.31 |
| 64 | 23.81 | 26.08 | 30.78 | 30.32 | 30.31 | 32.87 | 35.79 | 34.36 |
| 65 | 21.48 | 18.06 | 23.20 | 23.47 | 23.14 | 26.05 | 27.47 | 25.66 |
| 66 | 15.65 | 15.42 | 22.98 | 19.20 | 20.41 | 20.47 | 23.16 | 22.37 |
| 67 | 12.66 | 12.52 | 15.76 | 16.94 | 17.70 | 15.61 | 23.22 | 21.78 |
| part-time | 1996 | 1998 | 2000 | 2002 | 2004 | 2006 | 2008 | 2010 |
| 60 | 10.73 | 12.91 | 10.34 | 11.19 | 11.79 | 11.27 | 12.01 | 12.71 |
| 61 | 12.38 | 12.76 | 11.03 | 12.16 | 10.96 | 11.14 | 10.80 | 9.76 |
| 62 | 11.28 | 13.35 | 12.14 | 13.61 | 10.86 | 12.59 | 12.70 | 13.40 |
| 63 | 15.28 | 14.66 | 12.76 | 13.32 | 12.98 | 13.87 | 12.21 | 13.20 |
| 64 | 13.12 | 10.69 | 13.95 | 14.91 | 12.30 | 12.70 | 12.70 | 12.68 |
| 65 | 14.68 | 14.30 | 13.65 | 13.95 | 13.74 | 13.95 | 13.94 | 11.46 |
| 66 | 16.66 | 12.34 | 13.32 | 13.74 | 12.35 | 14.74 | 12.57 | 13.54 |
| 67 | 14.61 | 12.04 | 15.04 | 14.06 | 11.53 | 12.45 | 11.13 | 12.28 |
| no work | 1996 | 1998 | 2000 | 2002 | 2004 | 2006 | 2008 | 2010 |
| 60 | 33.00 | 36.47 | 35.10 | 36.02 | 33.33 | 32.09 | 32.58 | 37.05 |
| 61 | 36.44 | 36.44 | 31.30 | 39.82 | 36.99 | 34.41 | 36.43 | 35.93 |
| 62 | 48.77 | 45.54 | 47.93 | 47.30 | 47.20 | 42.96 | 43.57 | 45.37 |
| 63 | 54.63 | 53.94 | 55.92 | 53.80 | 49.57 | 46.36 | 47.76 | 46.49 |
| 64 | 63.07 | 63.22 | 55.28 | 54.76 | 57.38 | 54.42 | 51.51 | 52.96 |
| 65 | 63.84 | 67.63 | 63.15 | 62.58 | 63.12 | 60.00 | 58.58 | 62.88 |
| 66 | 67.70 | 72.24 | 63.70 | 67.06 | 67.24 | 64.79 | 64.26 | 64.09 |
| 67 | 72.73 | 75.45 | 69.20 | 69.01 | 70.77 | 71.94 | 65.65 | 65.94 |

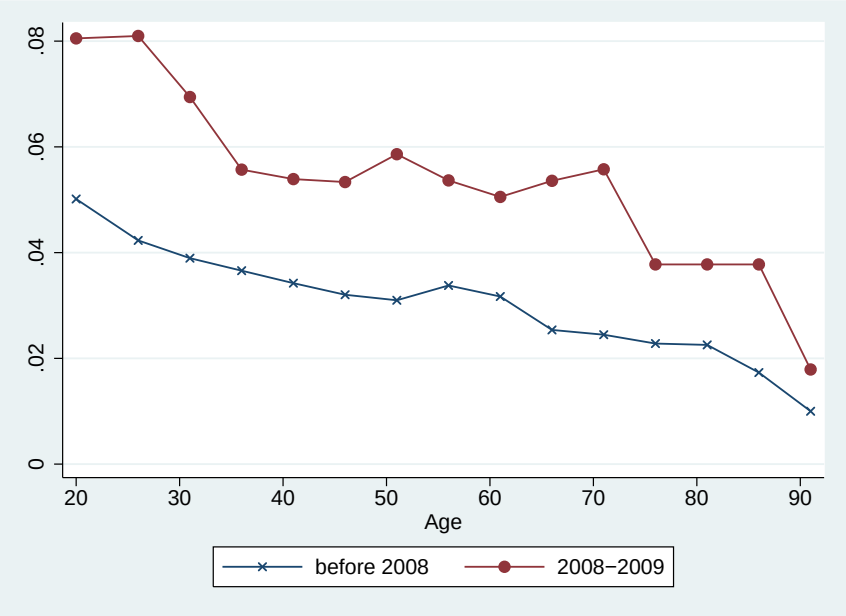


Figure 1: Heterogeneous Unemployment Probabilities

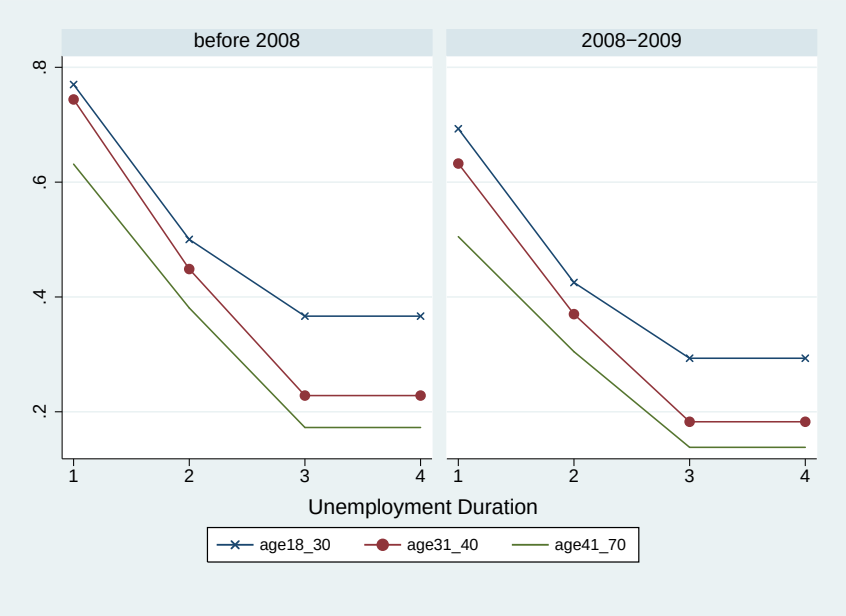


Figure 2: Heterogeneous Reemployment Probabilities

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

| Ages | Survivors | Work[a] | Claimers[b] | Benefits ($) | Consum. ($) | Wealth ($) |
|---|---|---|---|---|---|---|
| **Model 1: Earnings Test with ARF Adjustments. No Uncertainty** | | | | | | |
| Age 30 | 9,852 | 9,091 (92.27%) | — | — | 1,371 | 37,768 |
| Age 40 | 9,603 | 8,565 (89.19%) | — | — | 1,651 | 51,021 |
| Age 50 | 9,212 | 7,856 (85.28%) | — | — | 1,880 | 96,392 |
| Age 60 | 8,331 | 5,987 (71.86%) | — | — | 1,951 | 89,253 |
| Age 61 | 8,205 | 5,558 (67.73%) | — | — | 1,973 | 84,360 |
| Age 62 | 8,055 | 5,227 (64.89%) | 2,405(31.12%) | 1,051 | 1,951 | 78,162 |
| Age 63 | 7,883 | 4,751 (60.26%) | 559(7.23%) | 1,207 | 1,947 | 75,521 |
| Age 64 | 7,726 | 4,017 (51.99%) | 734(9.49%) | 1,281 | 1,939 | 72,118 |
| Age 65 | 7,555 | 2,612 (34.57%) | 2,663(34.46%) | 1,351 | 1,903 | 67,425 |
| Age 66 | 7,357 | 3,771 (51.25%) | 1,366(17.67%) | 1,403 | 1,956 | 64,390 |
| Age 67 | 7,152 | 4,369 (61.08%) | 0(0%) | — | 1,962 | 65,911 |
| Age 68 | 6,959 | 4,058 (58.31%) | 0(0%) | — | 1,933 | 67,036 |
| **Model 2 (Benchmark): ET with ARF Adjustments and Employment Uncertainty** | | | | | | |
| Age 30 | 9,852 | 9,241 (93.79%) | — | — | 1,224 | 54,177 |
| Age 40 | 9,603 | 8,747 (91.08%) | — | — | 1,516 | 83,283 |
| Age 50 | 9,212 | 7,205 (78.21%) | — | — | 1,810 | 125,549 |
| Age 60 | 8,331 | 4,644 (55.74%) | — | — | 1,893 | 99,580 |
| Age 61 | 8,205 | 4,502 (54.86%) | — | — | 1,884 | 91,871 |
| Age 62 | 8,055 | 4,366 (54.2%) | 3,902(50.05%) | 843 | 1,857 | 83,888 |
| Age 63 | 7,883 | 4,092 (51.91%) | 562(7.2%) | 933 | 1,835 | 80,957 |
| Age 64 | 7,726 | 3,425 (44.33%) | 398(5.1%) | 1,161 | 1,831 | 78,158 |
| Age 65 | 7,555 | 2,406 (31.84%) | 1,144(14.67%) | 1,280 | 1,820 | 73,686 |
| Age 66 | 7,357 | 2,488 (33.81%) | 1,790(22.96%) | 1,406 | 1,802 | 69,046 |
| Age 67 | 7,152 | 2,764 (38.64%) | 0(0%) | — | 1,795 | 68,791 |
| Age 68 | 6,959 | 2,643 (37.97%) | 0(0%) | — | 1,792 | 68,068 |
| **Model 3: Benchmark Model with Higher Employment Uncertainty** | | | | | | |
| Age 30 | 9,852 | 8,740 (88.71%) | — | — | 1,179 | 52,560 |
| Age 40 | 9,603 | 8,451 (88.00%) | — | — | 1,464 | 79,877 |
| Age 50 | 9,212 | 6,905 (74.96%) | — | — | 1,735 | 119,869 |
| Age 60 | 8,331 | 4,452 (53.44%) | — | — | 1,839 | 93,514 |
| Age 61 | 8,205 | 4,317 (52.61%) | — | — | 1,832 | 85,805 |
| Age 62 | 8,055 | 4,189 (52.00%) | 4,060(51.96%) | 848 | 1,808 | 77,817 |
| Age 63 | 7,883 | 3,999 (50.73%) | 629(8.05%) | 909 | 1,787 | 75,073 |
| Age 64 | 7,726 | 3,451 (44.66%) | 408(5.22%) | 1,148 | 1,781 | 72,805 |
| Age 65 | 7,555 | 2,497 (33.05%) | 1,136(14.54%) | 1,268 | 1,775 | 69,229 |
| Age 66 | 7,357 | 2,498 (33.95%) | 1,580(20.22%) | 1,394 | 1,759 | 65,652 |
| Age 67 | 7,152 | 2,731 (38.18%) | 0(0%) | — | 1,754 | 65,591 |
| Age 68 | 6,959 | 2,562 (36.81%) | 0(0%) | — | 1,748 | 65,117 |
| **Model 4: Benchmark Model with Higher Employment Uncertainty and Lower Re-Employment** | | | | | | |
| Age 30 | 9,852 | 8,529 (86.57%) | — | — | 1,154 | 51,827 |
| Age 40 | 9,603 | 8,117 (84.52%) | — | — | 1,409 | 77,231 |
| Age 50 | 9,212 | 6,542 (71.01%) | — | — | 1,640 | 113,473 |
| Age 60 | 8,331 | 4,219 (50.64%) | — | — | 1,758 | 87,582 |
| Age 61 | 8,205 | 4,085 (49.79%) | — | — | 1,764 | 79,967 |
| Age 62 | 8,055 | 3,960 (49.16%) | 4,247(54.18%) | 865 | 1,742 | 71,886 |
| Age 63 | 7,883 | 3,763 (47.73%) | 617(7.87%) | 920 | 1,727 | 69,459 |
| Age 64 | 7,726 | 3,289 (42.57%) | 395(5.04%) | 1,155 | 1,722 | 67,347 |
| Age 65 | 7,555 | 2,415 (31.96%) | 1,115(14.22%) | 1,267 | 1,714 | 64,195 |
| Age 66 | 7,357 | 2,309 (31.38%) | 1,464(18.67%) | 1,383 | 1,699 | 61,173 |
| Age 67 | 7,152 | 2,492 (34.84%) | 0(0%) | — | 1,695 | 61,186 |
| Age 68 | 6,959 | 2,336 (33.57%) | 0(0%) | — | 1,688 | 60,685 |

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

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

| Ages | Survivors | Work[a] | Claimers[b] | Benefits ($) | Consum. ($) | Wealth ($) |
|---|---|---|---|---|---|---|
| **Model 5: Model 4 with one year unemployment benefits** | | | | | | |
| Age 30 | 9,852 | 8,523 (86.51%) | — | — | 1,176 | 53,689 |
| Age 40 | 9,603 | 8,102 (84.37%) | — | — | 1,432 | 80,228 |
| Age 50 | 9,212 | 6,473 (70.27%) | — | — | 1,670 | 117,204 |
| Age 60 | 8,331 | 4,203 (50.45%) | — | — | 1,778 | 90,695 |
| Age 61 | 8,205 | 4,063 (49.51%) | — | — | 1,781 | 83,126 |
| Age 62 | 8,055 | 3,930 (48.79%) | 4,089(52.22%) | 872 | 1,758 | 75,093 |
| Age 63 | 7,883 | 3,712 (47.08%) | 584(7.46%) | 909 | 1,745 | 72,522 |
| Age 64 | 7,726 | 3,133 (40.55%) | 444(5.67%) | 1,171 | 1,745 | 70,171 |
| Age 65 | 7,555 | 2,241 (29.66%) | 1,075(13.73%) | 1,273 | 1,731 | 66,460 |
| Age 66 | 7,357 | 2,189 (29.75%) | 1,637(20.91%) | 1,393 | 1,715 | 62,812 |
| Age 67 | 7,152 | 2,375 (33.21%) | 0(0%) | — | 1,714 | 62,622 |
| Age 68 | 6,959 | 2,244 (32.25%) | 0(0%) | — | 1,712 | 61,966 |
| **Model 6: Model 4 with 99 weeks of unemployment benefits** | | | | | | |
| Age 30 | 9,852 | 8,521 (86.49%) | — | — | 1,191 | 54,840 |
| Age 40 | 9,603 | 8,086 (84.20%) | — | — | 1,450 | 82,353 |
| Age 50 | 9,212 | 6,400 (69.47%) | — | — | 1,702 | 121,107 |
| Age 60 | 8,331 | 4,162 (49.95%) | — | — | 1,827 | 95,089 |
| Age 61 | 8,205 | 4,034 (49.16%) | — | — | 1,814 | 87,337 |
| Age 62 | 8,055 | 3,905 (48.47%) | 3,894(49.83%) | 873 | 1,790 | 79,407 |
| Age 63 | 7,883 | 3,667 (46.52%) | 556(7.11%) | 936 | 1,778 | 76,639 |
| Age 64 | 7,726 | 3,015 (39.02%) | 474(6.96%) | 1,197 | 1,773 | 74,066 |
| Age 65 | 7,555 | 2,092 (27.69%) | 1,343(17.18%) | 1,294 | 1,793 | 70,158 |
| Age 66 | 7,357 | 2,095 (28.47%) | 1,548(19.8%) | 1,385 | 1,783 | 66,957 |
| Age 67 | 7,152 | 2,284 (31.93%) | 0(0%) | — | 1,769 | 67,255 |
| Age 68 | 6,959 | 2,134 (30.66%) | 0(0%) | — | 1,755 | 66,533 |

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

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

| Ages | From Work | From No Work-1year[a] | From No Work-2years[b] | From No Work-3+years[c] |
|---|---|---|---|---|
| | **Model 4: Higher Employment Uncertainty and Lower Re-employment with 26 weeks of UB** | | | |
| Age 62 | 21.43% | 30.42% | 57.26% | 94.16% |
| Age 63 | 8.42% | 23.23% | 52.58% | 94.27% |
| Age 64 | 6.84% | 15.29% | 62.98% | 89.25% |
| Age 65 | 49.44% | 17.76% | 37.31% | 78.72% |
| Age 66 | 100% | 100% | 100% | 100% |
| | **Model 5: Higher Employment Uncertainty and Lower Re-employment with One year of UB** | | | |
| Age 62 | 18.85% | 24.41% | 49.71% | 93.42% |
| Age 63 | 6.89% | 21.34% | 45.49% | 81.09% |
| Age 64 | 6.78% | 15.83% | 46.59% | 90.47% |
| Age 65 | 47.31% | 15.77% | 28.32% | 72.84% |
| Age 66 | 100% | 100% | 100% | 100% |
| | **Model 6: Higher Employment Uncertainty and Lower Re-employment with 99 weeks of UB** | | | |
| Age 62 | 17.38% | 16.20% | 35.01% | 90.82% |
| Age 63 | 5.73% | 17.28% | 31.12% | 64.75% |
| Age 64 | 6.18% | 14.85% | 33.16% | 72.18% |
| Age 65 | 47.03% | 42.67% | 28.86% | 70.06% |
| Age 66 | 100% | 100% | 100% | 100% |

*Notes:* [a] Out of work for a year. [b] Out of work for two years. [c] Out of work for three years or more.

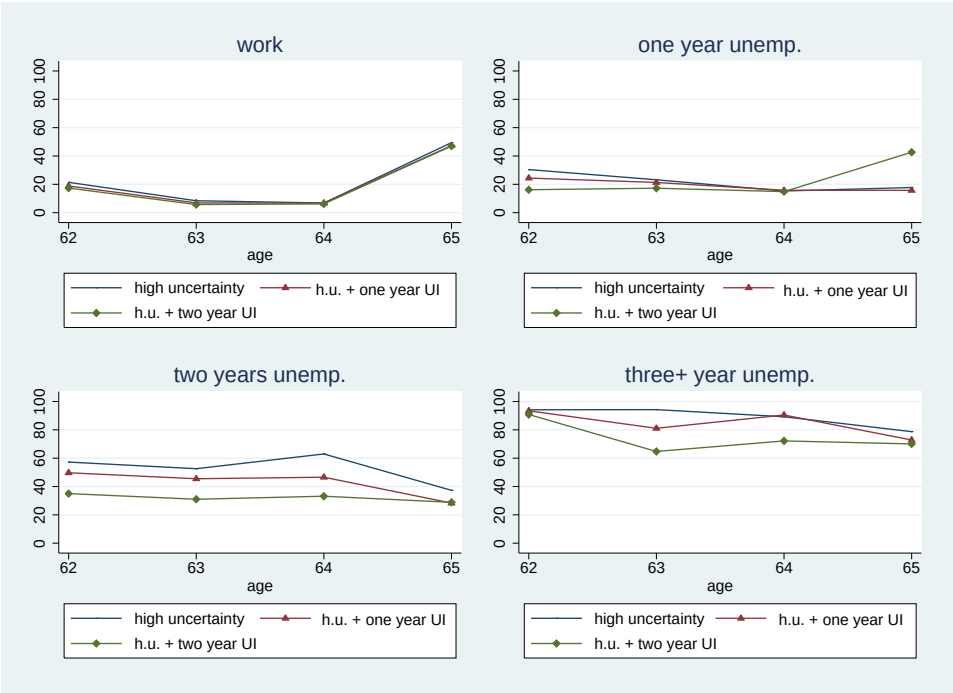


Figure 3: Claiming by duration of the unemployment spell

Table 6: Wealth Shocks. 10,000 Simulations of the Dynamic Model

| | No Uncertainty | | Benchmark Uncertainty | | High Uncertainty | |
|---|---|---|---|---|---|---|
| **Ages** | **Work**[a] | **Claiming**[b] | **Work** | **Claiming** | **Work** | **Claiming** |
| | | | **Comparison Percentages from Table 3** | | | |
| | **Model 1** | | **Model 2** | | **Model 4** | |
| Age 60 | 71.86% | — | 55.74% | — | 50.64% | — |
| Age 61 | 67.73% | — | 54.86% | — | 49.79% | — |
| Age 62 | 64.89% | 31.12% | 54.2% | 50.05% | 49.16% | 54.18% |
| Age 63 | 60.26% | 7.23% | 51.91% | 7.2% | 47.73% | 7.87% |
| Age 64 | 51.99% | 9.49% | 44.33% | 5.1% | 42.57% | 5.04% |
| Age 65 | 34.57% | 34.46% | 31.84% | 14.67% | 31.96% | 14.22% |
| Age 66 | 51.25% | 17.67% | 33.81% | 22.96% | 31.38% | 18.67% |
| Age 67 | 61.08% | 0% | 38.64% | 0% | 34.84% | 0% |
| Age 68 | 58.31% | 0% | 37.97% | 0% | 33.57% | 0% |
| | | | **Scenario 1: 10% Decline in Wealth for all uncertainty levels** | | | |
| Age 60 | 79.27% | — | 65.03% | — | 59.68% | — |
| Age 61 | 72.85% | — | 58.63% | — | 53.53% | — |
| Age 62 | 65.85% | 37.49% | 57.64% | 61.26% | 52.28% | 62.2% |
| Age 63 | 68.52% | 4.68% | 57.81% | 11.21% | 52.11% | 10.76% |
| Age 64 | 63.9% | 9.15% | 57.21% | 4.17% | 51.41% | 4.27% |
| Age 65 | 48.55% | 44.12% | 56.76% | 19.42% | 50.85% | 18.84% |
| Age 66 | 65.36% | 4.54% | 54.53% | 3.92% | 48.33% | 3.85% |
| Age 67 | 66.49% | 0% | 53.65% | 0% | 47.17% | 0% |
| Age 68 | 63.78% | 0% | 51.91% | 0% | 45.31% | 0% |
| | | | **Scenario 2: 20% Decline in Wealth for all uncertainty levels** | | | |
| Age 60 | 83.59% | — | 73.75% | — | 67.23% | — |
| Age 61 | 74.88% | — | 62.47% | — | 56.61% | — |
| Age 62 | 66.33% | 38.22% | 59.98% | 55.71% | 54.10% | 58.67% |
| Age 63 | 69.04% | 4.78% | 60.18% | 10.37% | 53.86% | 9.88% |
| Age 64 | 66.26% | 9.69% | 58.80% | 4.72% | 52.73% | 4.91% |
| Age 65 | 56.49% | 44.9% | 58.24% | 26.47% | 52.14% | 24.02% |
| Age 66 | 67.63% | 2.38% | 57.11% | 2.73% | 50.51% | 2.51% |
| Age 67 | 66.52% | 0% | 55.54% | 0% | 48.83% | 0% |
| Age 68 | 64.93% | 0% | 54.02% | 0% | 47.16% | 0% |
| | | | **Scenario 3: 20% Decline in Wealth and 99 weeks of UB** | | | |
| Age 60 | — | — | — | — | 65.61% | — |
| Age 61 | — | — | — | — | 55.94% | — |
| Age 62 | — | — | — | — | 53.78% | 58.22% |
| Age 63 | — | — | — | — | 53.42% | 9.95% |
| Age 64 | — | — | — | — | 52.35% | 4.83% |
| Age 65 | — | — | — | — | 51.92% | 24.21% |
| Age 66 | — | — | — | — | 50.40% | 2.78% |
| Age 67 | — | — | — | — | 48.56% | 0% |
| Age 68 | — | — | — | — | 46.53% | 0% |

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