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The Effects of Employment Uncertainty, Unemployment Insurance, and Wealth Shocks on the Retirement Behavior of Older Americans

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Abstract

Unemployment rates in developed countries 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, negative 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 relatively little variation in early claiming.

JEL Codes: J14, J26, J65
Keywords: Employment uncertainty, wealth shocks, retirement, labor supply, life-cycle models

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The recent 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 the probabilities of finding a job when unemployed, exactly at the time that their retirement portfolios where declining sharply. In fact, between 2008 and 2010 the U.S. unemployment rate doubled, and even now (with the recovery slowly taking hold in the U.S.) affects around 6% of the labor force after reaching 10% during 2010. In the largest European economies, which have traditionally suffered from higher unemployment rates, the increases were more moderate, with the exception of Spain, where unemployment also more than doubled in this period and is still taking a painfully long time to level off below 20%. Notice that in Europe in general the employment level is taking much longer to recover to pre-crisis level than in the United States, probably linked to a variety of reasons including very different labor market, monetary, exchange rate, and even fiscal policies during the crisis. Interestingly, only recently we see monetary policies in Europe mimicking moves we saw by the Federal Reserve a few years ago at the worse moments of the crisis, and increased pressures to reform the labor market to make it more flexible and responsive to government stimulus.

Additionally, in the U.S., households portfolios suffered considerably through the recession: between 2007 and 2009 the average household wealth declined by around 20 %, and the more recent data from the Survey of Consumer Finances (SCF) shows that this decline is closer to 30 % if we include 2010 in the calculation. 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 effects of both (unemployment and wealth) shocks on the labor supply and retirement benefits claiming decisions of older Americans.

A third policy ingredient of the great recession has been the extension of unemployment benefits with benefit duration rising from the usual 26 weeks to as long as 99 weeks. The US Federal government has implemented two unemployment insurance programs during the last six years: the Extended Benefits program and the Emergency Unemployment Compensation program. These two programmes have allowed unemployed workers to finance their search for jobs during quite a long period. We aim to analyze whether the retirement behavior of older workers have reacted to this new institutional environment.

In this complex context we analyze a retirement model in which individual face employment and wealth shock as well as social protection changes. We 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.

In more detail, we find that introducing employment uncertainty in the model increases early claiming and reduces labor force participation at older ages. We also demonstrate that early claiming provides self insurance against unemployment uncertainty, helping unemployed workers smooth their consumption. Along the same lines, we find that the (automatic) extension of unemployment benefits during recessions helps explain why we do not see more early claiming during bad economic times. Finally, we show that that, in general, wealth shocks result in higher labor force participation and earlier claiming. In fact the modeling of wealth shocks in the presence of employment uncertainty can explain why some previous research have found rather 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, more generous unemployment insurance, and negative wealth shocks have on labor supply and claiming, can explain why early claiming has remained 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.

Finally, our work has also implications for the Spanish case. In the Spanish case, accounting for unemployment and reemployment uncertainty, changes in unemployment subsidies, as well as wealth shocks can be of crucial importance to understand the retirement patterns observed during the great recession.

1 Introduction

The recent 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 the probabilities of finding a job when unemployed, exactly at the time that their retirement portfolios where declining sharply. In fact, between 2008 and 2010 the U.S. unemployment rate doubled, and even now (with the recovery slowly taking hold in the U.S.) affects around 6% of the labor force after reaching 10% during 2010.[1] 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 closer to 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).[2] 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 effects of both (unemployment and wealth) shocks on the labor supply and retirement benefits claiming decisions of older Americans.

One of the most important public responses to the crisis has been the extension of unemployment benefits with benefit duration rising from the usual 26 weeks to as long as 99 weeks (see Hagedorn et al, 2013). The US Federal government has implemented two unemployment insurance programs during the last six years: the Extended Benefits program and the Emergency Unemployment Compensation program.[3] These two programmes have allowed unemployed workers to finance their search for jobs during quite a long period. We aim to analyze whether the retirement behavior of older workers have reacted to this new institutional environment.

In fact, the recent retirement trends in the U.S., that is, older Americans' labor supply and benefits claiming decisions, can only be totally understood as the result of four forces taking part at the same time: (1) the **increased penalty linked to early claiming** for retirement benefits resulting from the implementation of the last reforms to the Social Security system; (2) the **increase in employment uncertainty** due to the deteriorating labor market; (3) the temporary **increase in the generosity of the unemployment insurance system**; and (4) the **decrease in retirement saving account balances** due to the financial crisis.

The increased penalty for claiming early should, other things equal, delay claiming and possibly increase labor supply after the Early Retirement Age (ERA). The drop in wealth

[1]Interestingly, in the largest European economies, which have traditionally suffered from higher unemployment rates, the increases were more moderate, with the exception of Spain, where unemployment also more than doubled in this period and is still taking a painfully long time to level off below 20%. Notice that in Europe in general the employment level is taking much longer to recover to pre-crisis level than in the United States, probably linked to a variety or reasons including very different labor market, monetary, exchange rate, and even fiscal policies during the crisis. Interestingly, only recently we see monetary policies in Europe mimicking moves we saw by the Federal Reserve a few years ago at the worse moments of the crisis, and increased pressures to reform the labor market to make it more flexible and responsive to government stimulus.

[2]Portfolios have recovered considerable ground during 2013 and 2014, but the uncertainty of possible unexpected fluctuations remains intact.

[3]See http://ows.doleta.gov/unemploy/extenben.asp and http://ows.doleta.gov/unemploy/supp_act.asp for more information about these two programmes.

balances is likely to induce workers to postpone retirement in the sense of working longer, and the increased employment uncertainty is likely to induce them to claim benefits as early as possible, and maybe withdraw from the labor force earlier. At the same time the increase in generosity of the unemployment insurance system might dampen these latter effects somewhat. Finally, employment uncertainty and the drop in retirement savings 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, as we will try to uncover. 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 analyze one of the effect while holding the rest constant.[4]

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 uncertainty, and the incentive structures for claiming retirement benefits.[5] This is why in this paper we explicitly consider the participation and benefits claiming decisions of older individuals, accounting for employment uncertainties (unemployment risk and re-employment probabilities), changes in unemployment insurance benefits, and modeling unexpected wealth shocks, by using a sequential decision structure.[6] We consider that older individuals make participation and claiming decisions comparing the utility they receive from retirement benefits today and possible withdrawal from the labor force, with the expected utility from continuing active in the labor market, where the latter could include receiving benefits while still working. Our key contribution is to model employment uncertainty (the probability of losing a job when employed, and the probability of finding a job if unemployed) and the complex incentive structure around the early and normal retirement ages in the presence of that uncertainty. The risk of unemployment (and the risk of not finding a job when unemployed) is very important for older workers, whose productivity and grade of adequacy to new technologies tend to deteriorate more rapidly than for younger workers. 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.[7]

It is worth mentioning that claiming behavior has been rarely emphasized by most re-

[4]The same conclusion is also present in Hurd and Rohwedder (2010) where the net effect of both unemployment and wealth shocks on retirement is said to be "an empirical matter".

[5]Burtless and Bosworth (2013) provide evidence that the trend towards higher participation of older workers is not restricted to the U.S., and has not slowed down with the great recession.

[6]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. 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.

[7]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.

searchers. Mainly, we believe, because of the difficulty that models have in explaining the large percentage of Americans who claim benefits as early as possible while still matching other behaviors. However, Social Security benefits are an important financial resource for older Americans, providing them on average with around $1,200 a month, and therefore very much determining the budget constraint of most older Americans. We believe that a realistic characterization of the key decisions made by older Americans requires researchers to pay special attention to the retirement benefits claiming decision, otherwise risking a major distortion of the incentive structure faced by individuals. Additionally, even in the complex retirement 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.

The calibration of the model we present allows us to explain with great accuracy the benefits claiming behavior of older Americans; namely, the strikingly high proportion of individuals who claims benefits exactly at the ERA. The model also matches well the fact that early claimants are predominantly individuals who were not working before reaching the ERA,[8] and as could be expected we find that this group had lower wealth and worse labor market prospects (e.g. lower wages in the period they last worked) than those who worked in the period before claiming, and also those who claim later. For those workers, early claiming of public pension benefits (access to their public pension wealth) provides self insurance against unemployment uncertainty and helps them smooth their consumption. We also find that the increase in the number of weeks that individuals can receive unemployment benefits that has been put into place in the United States during the last recession can explain why we have not seen an even higher proportion of individuals claiming benefits early.

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

Our model also does a good job in capturing the declining labor force participation at those same ages, and shows that both claiming and labor supply are responsive to the existence

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

of employment uncertainty and changes in the duration of unemployment insurance, typically observed during crisis (Hagedorn et al, 2013). Another important finding is that it is key to model uncertainty properly, otherwise, if employment uncertainty is ignored, claiming hazards at age 62 (65 and 66) are widely underestimated (overestimated) by as much as 17 percentage points (13 percentage points), labor supply is overestimated, and wealth accumulation at age 60-65 is underestimated by between 2% and 10% depending on age.

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).[9] We find that negative wealth shocks have a positive and fairly large effect on labor supply, 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 structure of the paper is the following. After presenting a quick overview of the recent literature and the basic stylized facts regarding retirement and claiming behavior in the U.S. in Section 2, we describe our Life-Cycle model formally and then more intuitively 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.

2 Retirement Overview: the literature and some stylized facts regarding retirement and labor supply

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.[10] 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 (mainly from the 1970s) the majority of Americans were claiming benefits at age 65, while in the 1980s and 1990s the peak started to move towards age 62. By the end of the 1990s, close to 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 2013, 69.47% of men and 75.83% of women claimed Social Security benefits before the NRA, compared to 36% and 59% in 1970, respectively.[11]

[9]A more 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.

[10]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.

[11]See the Annual Statistical Supplement to the Social Security Bulletin (2014), Table 6A4, and also the Social Security Bulletin, OASDI Monthly Statistics, 1970 - 2007. The latter statistics are no longer available but are

While Rust and Phelan (1997) emphasize the importance of analyzing and modeling claiming and labor supply decisions separately, and do so quite convincingly, many researchers since have avoided directly tackling or matching both, due, we believe, to the difficulty in fitting the highly skewed distribution of claiming in the United States. For example, van der Klaauw and Wolpin (2008) and Blau (2008) do not explicitly model the decision to claim benefits at the different ages, while French and Jones (2011) in principle do model it, but they decide not to include those decisions in the moment conditions when estimating the model, making it hard to tell whether their model matches the age distribution of claiming decisions. The decision to model the level of benefits received by individuals as an stochastic process instead of the product of optimizing choices by individuals, can be especially problematic when trying to predict the consequences of changes in the incentives structure since the predicted changes in benefit levels do not take into account the behavioral responses of individuals to the new structure, providing therefore erroneous predictions of benefit levels, and consequently of other choices. 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.

The model used in this paper is related, and in important ways extends by modeling employment and wealth uncertainties, 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). 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).[12]

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). In more recent work, 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.,

comparable to the ones given in the Statistical Supplement.

[12] 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.

retirement). The main novelty of the present paper with respect to the latest contributions to the search literature (García Pérez and Sánchez-Martín 2010), 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.

Before discussing the stylized facts our model will try to match, it is important to mention that given the nature of the methodology we will be using (discussed in detail in the next sections), our main purpose is to perform a kind of comparative statics analysis between the pre-crisis and the crisis period regarding, mainly, labor supply and claiming behavior. Showing how modeling certain features of the system is key to provide a good pre-crisis benchmark, and how modeling labor market and wealth uncertainties is essential to understand what we have seen during the crisis. Our purpose is not to match the time series evidence, but to match the age profile at particular points in time.

Table 1 shows, 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, and the levels of benefits increase with age as expected given the actuarial adjustments of benefits depending on claiming ages.[13] The claiming 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. This increase in the NRA comes with a higher penalty for early claiming, which for those claiming at age 62 has gone from 20% to 25%, and will further increase to 30% for those born in 1960 or later, who face an NRA of 67.

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).[14] 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.[15] 2012 shows a

[13]Appendix A discusses some interesting features of the data presented in the table focusing on the trend of benefits over the last couple of decades. 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.

[14]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. 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 in part reflects a real shift in claiming behavior, but not as sudden and dramatic as the aggregate statistics suggest.

[15]Using the first seven waves of the Health and Retirement Study, we see that the claiming distribution is quite similar to those reported, which is not surprising given that the 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.

sharp decline in claiming at age 62 to 44% (in 2013 this percentage increased a bit, in particular it reached 44.62%) and an increase in claiming at age 65 and 66. Our interpretation of these recent developments is that most likely we have to consider 2011 and 2012 (and clearly 2013) as post-crisis period, since the economy has started to recover quite robustly in this period, something corroborated by the lower unemployment rates, especially among older individuals, as discussed below. We believe that in terms of claiming and work the crisis period should be understood as the 2008-2010 period, and those are the benchmarks of our model once we account for the uncertainties present during the crisis.

In Table 2 we present the main stylized facts regarding labor supply of older males, according to data from the Current Population Survey (CPS) in the 1996-2012 period. Firstly, it is quite remarkable that the fraction of people working 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.[16] We also find that the unemployment rates for older individuals have been historically quite low. For example, for males 55 to 64 the unemployment rate was, on average, 3.3% in 1996 and 3% in 2006, but increased to 7.2% in 2009 and to 8% in 2010 (in fact nearly 9% in the first few months of 2010), only to decline to 6.3% as of December of 2012. These numbers are considerably lower than for prime-aged males. The distribution by age can be seen in the lower panel of Table 2.

Finally, in Figure 1 we can see the effect of the 2008-2010 economic crisis on labor market participation of older Americans. The percentage of older American males working during the last five years is larger than before 2008, specially for those aged 63 and over.

This changes in participation and labor supply are quite connected with the risk of dismissal, if employed, or with the likelihood of being re-employed, when an unemployed worker is looking for a new job. We have in Figures 2 and 3, the empirical patterns of these two important transition rates, which will be used in the calibration of our model, distinguishing again between the period before the 2008 crisis and afterwards. In Figure 2 we present the average of the empirical firing probabilities computed using the CPS data in the 1986-2006 period for the pre-crisis period, and the data on 2008-2009 for the crisis one. Notice the large increase in the probability of becoming unemployed at all ages seen in the economy during the worst period of the recession.[17]

The re-employment (offer arrival) probabilities shown in Figure 3 are based on NLSY79 and

[16] 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 70.7% percent in December 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 few years. The increased participation is mainly driven by males aged 60-64, for whom participation rates have risen from around 52% to 61.2% 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 23.5% in December of 2012. Leonesio et al. (2012) also analyze this phenomenon and concentrate on the effect that this has on the income of the elderly.

[17] Gustman, Tabatabai, and Steinmeir (2015) use the HRS to compare the effects of the Great Recession on the participation of the younger HRS cohorts compared with the older cohorts at those same ages. They find sizable effects on participation, and emphasize the importance of modeling the expectations of individuals about future labor force participation.

NLSY97 data.[18] We use the monthly information regarding labor market status in these two data sets in order to estimate the empirical exit rate from unemployment in the years leading to the great recession. 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. We believe that these changes in labor supply are highly connected to the ones observed in both the firing and re-employment probabilities. This is why we are going to model this carefully within our dynamic model in order to study how all these changes affect individual decisions regarding retirement and labor supply.

Another component of the analysis has to do with the effects of the sharp decline in wealth balances due to the market decline that started in 2008. As reported in the SCF 2009 compared with the levels of 2007, and studied in Bricker et al. (2011), the average decline in net wealth in the two year period, 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, with younger families (with the head of the household younger than 35) and older families (with the head of the household older than 75) suffering declines above 20%, we will be simulating a surprise decline for all our agents and at all ages.

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 acknowledge that individuals face several sources of uncertainty, including life-time, wage, health, and employment uncertainty. The latter is one of the keys of our model, since individuals know that as they grow old, and their productivity declines, the probability of losing their jobs might be increasing and their probabilities of finding a new job when unemployed 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). This disutility formulation is relatively flexible, and while highly parameterized it does help us match the labor supply decisions better. Without

[18] The 1979 National Longitudinal Survey for Youth (NLSY) is a longitudinal project that follows the lives of a sample of 12,686 American youth born between 1957-64. The 1997 sample is composed of about 9,000 American youth born between 1980-84. Re-employment probabilities are computed by using the information for all individuals included in both waves that have been unemployed at least once during their working careers.

such a function is very difficult to match the declining participation of older individuals without resorting to even more heroic (regarding particular preferences or expectations) assumptions. While this could be seen as a weakness of our model, we believe it is just a realization of the fact that in reality declining labor supply is likely connected with a (potentially complex) process correlated with the variables we choose to include in this disutility formulation, 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 β, assumed fixed in our calibration exercises, and equal to 0.965. As discussed by many other researchers, even in estimation efforts, identification of the discount rate is quite a sensitive and complicated task. Our choice in this case is not innocuous since relatively small variations in this discount rate would lead to sizable changes in the claiming distribution of individuals, as well as their labor supply, which we interpret has having pinned it down quite well given the other assumptions made in the model. Individuals can accumulate balances and receive a fixed interest rate, $\overline{r}$, of 2%.[19]

We solve the dynamic Life-Cycle model by backward induction, and by discretizing the space for the continuous state variables.[20] The terminal age is 100 and the age when individuals are assumed to enter the labor force is 21.[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.[22] 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 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;

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

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

[21]Our decision to solve the problem starting at age 21 is based on the fact that we have reliable initial conditions for our key variables of interest, based on the information from the NLSY79. An alternative to this procedure would be to start at a later age, say age 50, and use the initial conditions found in the HRS for example. Given the fact that prior to age 62 the only decisions of our agents are consumption, savings, and labor supply, and the fact that the host of uncertainties vary much less before that age, the results shown are quite robust to this particular assumption. We consider a model that covers the whole life-cycle as more general, since it can provide a foundation for other research efforts that could potentially focus on other decisions and expectations present earlier in life, but that are out of the scope of our research. The fit of the model to the data for younger individuals is quite good, and while we have not included it in our analysis due to space and focus constraints, it is available from the authors upon request.

[22]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.

(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 δ), it is quite important to model unemployment benefits.[23] 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 λ_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.

We must emphasize that 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 (meaning that younger agents almost always accept job offers if they are unemployed), but that is unlikely to be the case for older individuals who have available to them the possibility of drawing from their Social Security wealth.

Finally, we do not model the institutional details of private pension schemes or disability insurance.[24] 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 $t \geq \tau$.

[23]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.

[24]Household debt is also absent from the model as a possible mechanism to explain the labor supply and claiming decisions of individuals, which have been found to be a possible explanation for delay claiming and higher participation in empirical exercises like those of Butrica and Karamcheva (2013).

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 ϕ as in Benítez-Silva, Buchinsky, and Rust (2011).[25] 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 γ indexes the individual's level of risk aversion. As $\gamma \to 0$ the utility of consumption approaches $\log(c)$. We use $\gamma = -.37$, which corresponds to a moderate degree of risk aversion, i.e., implied behavior that is slightly more risk averse than that implied by logarithmic preferences.[26]

3.2.1 The value functions

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.[27]

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

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

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

[25] 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.

[26] See Benítez-Silva, Buchinsky, and Rust (2003, 2011), and also in Benítez-Silva and Heiland (2007).

[27] 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.

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

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

subject to,

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

Unemployed individuals, regardless of whether they are voluntarily or non-voluntarily in that employment state, 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. 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

$$\begin{aligned} EV_{t+1}(.) \quad &= \quad \int_{y'} \sum_{h'=0}^{2} \sum_{ss'=0}^{n} \sum_{em'=0}^{3} V_{t+1}(ap_{t+1}(a, \overline{w}, y', ss, ssd), \overline{w}p_{t+1}(\overline{w}, y'), ss', h') \\ &\quad \times k_t(h'|h) g_t(ss'|a, \overline{w}, ss, h, ssd) q_t(em'|em, l) f_t(y'|\overline{w}) dy', \end{aligned} \tag{7}$$

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 η_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 transition between employment states is governed by the transition probabilities that affect those employed or unemployed and is a function of the previous state and the labor supply (leisure) decision, this is reflected in $q_t(em'|em, l)$.

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 construct:

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

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.[28]

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 σ 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.

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).

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

3.2.3 Solving and Simulating the Model: calibrating uncertainties in 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 below 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 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. This means that the sample we use is of around 8,000 individuals observed in the period mentioned. 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. In the case of the NSLY79 in most cases we have yearly information, but for the HRS the fact that the survey is every two years presents a considerable challenge. While many assumptions can be made about a yearly probability distribution such that is consistent with the actual data observed every two years, we have chosen to use the smoother biannual data to avoid a situation in which a number of key variables, especially labor supply, could change too much from year to year due to the assumption about how health evolves. We are therefore assuming that health only changes every two years. We can conjecture that thanks to this assumption the resulting simulations of labor supply, for example, would be smoother than if the transitions were yearly. It turns out that this smoothness seems to be present in the data so this helps us match the labor supply better. However, the results are very comparable with those of a model with yearly health transitions in which we assume that the probabilities evolve linearly over the two year period.

We will use the empirical distribution of unemployment and re-employment probabilities shown in Section 2. We have grouped these empirical distributions by 10-year age groups, starting at age 21. It is important to emphasize, however, that given that the observed re-employment probabilities are the product of both the probability of being offered a job and the probability of accepting it, we may have some problems trying to identify job offers arrival rates. This is why we do not directly use the available data on re-employment probabilities for individuals over 50, since the observed probabilities are likely to be highly influenced by the decisions we are trying to study.[29] 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. Implicitly we are assuming (although allowing our agents to deviate from this) that individuals younger than 50 on average accept an offer if given to them, while this is not the case for older workers for whom we do not impose the empirical re-employment probabilities for individuals their age.

Regarding how to model the unexpected wealth declines, we will be simulating a surprise decline of 10% in two consecutive years. For example, the labor supply and claiming simulations of a 62 year old will be the result of simulating a surprise decline in wealth of 10% when the individual was 61 and again when he was 62, with no further declines afterwards (or before those ages). Then, the behavior of the 63 year old is the result of seeing a decline when he was 62 and 63, and so on.

3.3 How employment uncertainty is connected with claiming behavior: an intuitive discussion

It is natural for the reader to ask what are the particular mechanisms that connect the decision of individuals to claim benefits early and the key contributions of our modeling strategy, namely, the modeling of employment uncertainty (including the generosity of the unemployment insurance system) and the careful modeling of the incentives of the Social Security system between the ERA and the NRA.

To clarify this issue is useful to think about what happens in a model where individuals have perfect control of their labor supply, meaning that they cannot get fired and can always find a job if they have not worked during a given period. In that case individuals take the possibility of working next period and beyond as given, and therefore the continuation value in their value functions are overestimated compared with a case in which under some probability, work would not be available and at least one period out of work would be happening. This overestimation could lead to a more sketchy optimal labor supply function, since deciding not to work in a period has no consequences for the future except through a potentially lower future Social Security retirement benefit, and the resulting leisure boost could compensate this possible loss. On the other hand, the same overestimation could lead to not valuing as interesting enough the early claiming of benefits since labor income is always an alternative that the individual controls perfectly, and then the gains in retirement benefits obtained with every year of delay in claiming push individuals to work too much around retirement ages.

Additionally, the lack of existence of bad years in terms of earnings, due to the absence of unemployment, leads to wealth accumulations that are too high, making again early claiming a less interesting option, since thanks to the wealth accumulated, individuals can afford, in consumption terms, to even work less and still enjoy the large increases in retirement benefits

[29] Gustman, Tabatabai, and Steinmeier (2015) describe using the HRS, employment uncertainty of different cohorts when in their 50s, focusing on those who suffered the Great Recession while in that age group. Those data are the product of both the uncertainties faced by individuals and the very decisions we want to study, and therefore are not ideal for our purposes. The authors do recognize the importance of modeling expectations if we want to understand their decision making process.

that come with the delay in claiming.

What all this means is that a model without labor market uncertainties obscures the complex trade-offs that occur around retirement age, a period in which not only the usual tension between consumption and leisure is present, but also agents see how their budget constraints can be affected in a radical fashion by gaining access to their public pension wealth, and they can further be affected by the fact that the income they receive from Social Security can be a function of their earnings in the labor market. It is key to understand that in the U.S. Social Security income can be complemented, after the early retirement age, by labor income. Therefore, early claimants can maintain the option of staying or going back to the labor force while protecting themselves against labor market uncertainties. Interestingly, the set up of the Earnings Test provisions fosters this insurance-like behavior, since the withholdings of benefits to those working above certain wage levels are not permanent (they are not a tax), and are returned in the form of higher benefits once the individual reaches the NRA.

This reasoning can be summarized by the following statement: "I am more likely to claim early because I am afraid I might get fired and lose some resources in the future, but if I do not get fired there is no harm done because I will recover my withheld Social Security benefits when I get to reach the NRA". Furthermore, if the early claimant decides to return or continue to work it might be that thanks to the yearly recalculation of benefits his or her Social Security wealth would further increase. These two effects, either directly (in the case of the earnings test provision) or indirectly (in the case of recalculation) reduce the penalty incurred by individuals when they choose early retirement, making early claiming less costly when reaching the ERA (and any age before the NRA), explaining further why so many individuals claim early especially from unemployment. This means that while nominally I am giving up a sizable percentage of benefits by claiming early (as much as 30% for those cohorts with NRA equal to 67), this could be rational even beyond longevity and preference characterizations, because individuals use early claiming as an insurance in the labor market. This is true even if they actually claim and stop working, because they know that if they were to come back to work, the benefits withheld through the Earnings Test would not be lost, and some additional gain might be waiting for them thanks to the recalculation of benefits that Social Security perform in order to use only the highest 35 years of earnings.

What this intuitive discussion comes to show, is that not modeling uncertainties, and not properly modeling the Earnings Test could lead to sizable biases in understanding the trade-offs faced by individuals around retirement ages and result in claiming behavior that postpones retirement, where the latter is understood both as receiving benefits and leaving the labor force.

4 Simulation Results

Table 3 shows first the results of two specifications (models 1 and 2) in which we introduce incrementally more realistic characterizations of employment uncertainty in the pre-crisis context. On top of these specifications we add, in three stages (models 3, 4 and 5, respectively) the increases in uncertainty (higher unemployment risk, lower re-employment probabilities and, finally, higher 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.

4.1 Pre-crisis scenarios

The first panel of Table 3 (Model 1) presents the pre-crisis benchmark model without employment uncertainty, but with the appropriate characterization of the Earnings Test and the early retirement actuarial adjustments.[30] This 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 peaks at 65 and 66 are too high. The second panel presents our full model, in which we introduce employment uncertainty calibrated to the pre-crisis scenario, characterized by low unemployment risk (probability of losing a job) and high reemployment probabilities (probability of finding a new job if unemployed). The model improves further, and we now find a distribution of claiming ages much closer to the data reported by the U.S. Social Security Administration. In particular, we capture the sharp peak at age 62, with a simulated percentage very close to the males in the data before 2008, and we also capture the peaks at age 63, 65, and 66 that we see in the aggregate SSA data. The comparison of Models 1 and 2 make it clear that by ignoring employment uncertainty we make early claiming less attractive.

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 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.[31] The proportion of individuals working increases slightly at age 67 and 68 likely because of the disappearance of the earnings test at those ages.

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

[30] 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.

[31] The model includes a part-time labor supply choice and we assume that agents can freely choose to work part-time or full-time, which is not likely to be realistic and leads to a relative interest in part-time work once agents reach the ages in which labor supply is more costly in utility terms. Interestingly, a fairly stable (across time and across older ages) proportion of individuals actually works part-time, but since we do not model, or know much about, 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 as much. 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.

important: claiming at 65 is around 14 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 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. 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 eventually 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.[32] These findings are somewhat sensitive to the

[32]Quite surprisingly, these results regarding the wealth holdings of early vs. late claimers is at odds with the results in İmrohoroğlu 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 in 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

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.[33]

4.2 Crisis scenarios

In the third panel of Table 3 (crisis scenario 1) we simulate the effect of an increase in the unemployment risk, leaving re-employment probabilities and unemployment benefits at their benchmark levels (as in the second panel). As explained in section 3.3, 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 (probability of finding a job when unemployed) at their pre-crisis levels. Notice that we model all these crisis scenarios as a surprise for individuals of all ages who did not expect this sudden increase in unemployment risk (and lower re-employment in the next scenario). As it is probably intuitive, the results show, first, that the proportion of those claiming early goes up from 48.26% to 50.61% at age 62, and, second, that the proportion of those not working at age 62 goes up to nearly 48%, instead of the 45.5% of the benchmark. Finally, wealth accumulation decreases by between 3.2% and 7.1% 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 had enough with the adjustments thorough leisure and claiming to respond to this more uncertain environment.

In the fourth panel of Table 3, which we label Model 4 (crisis scenario 2), we present the results of combining higher probabilities of becoming unemployed and lower probabilities of finding a job when unemployed but leaving unemployment benefits at their benchmark level. The new re-employment probabilities come from the the 2008-2009 years in the NLY79 and NLSY97, depending on age. Under this scenario 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.

4.3 The role of unemployment benefits

The last panel of Table 3 shows model 5 (crisis benchmark), with the results of combining the increases in employment uncertainties with an increase in unemployment benefits (also modeled as unexpected), which is in fact what has happened in the last years due to the recession, with the extended benefits provision at the Federal level, and the State level supplementations (see

models do replicate quite well the claiming behavior.

[33]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.

appendix B for details of the UB U.S. insurance system). 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), which has been in place in most states until December 2013. The main results are not surprising since we see the U.S. moving in the "European direction," of additional protection for those unemployed: work is further reduced and claiming postponed, exactly as it is found for Spain in Garcia Pérez and Sánchez Martin (2010). The effects on claiming are quite strong with claiming seeing a reduction from the levels in Model 4, going down to 48.64%, which is quite similar to what we observe in Model 2, our benchmark in a pre-crisis setting. Furthermore, work during retirement ages is further reduced, and consumption and wealth accumulation are increased substantially, compared with Model 4 or Model 3. 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 5. These later results suggest that we would have seen even more early claiming if it were not for the increase in unemployment benefits, even in the presence of the higher penalties for claiming retirement early.

In Figure 4 we plot the hazard rates of claiming at different ages and by employment status, as well as the the effect of increasing UI generosity on claiming by employment status and unemployment duration. We show the differences in the claiming behavior by labor force status (work, no-work), duration of the unemployment spell (one, two and three or more years) and duration of the benefits (Model 4, 26 weeks vs. Model 5, 99 weeks). 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 both of the models shown, claiming at age 62 increases with the duration of the unemployment spell. For example, for Model 4, it increases from 18.85 (work) to 29.48 (one year unemployed), 56.55 (two years) and 94.19 percent (three or more years). Third, for all unemployment tenures, claiming at ages 62 and 63 decreases with the generosity of the unemployment insurance program. Alternatively, claiming at age 66 increases with tenure in unemployment, except for the 99 weeks of benefits scenario, in which the claiming from work and the claiming from two years 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.

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 (and, thus, moving the U.S. benefit system in an European direction) 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 38.83 years, while in model 2 drops by 6.25% to 36.404 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 35.026, 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 33.54 years. The introduction of higher unemployment benefits in Model 5, further shortens the working life to 33.08 years in the case of two years of benefits.

5 Wealth Shocks and Employment Uncertainty

Table 4 shows the effects on labor supply and claiming behavior of simulating wealth shocks in order to provide an additional (and even more realistic) discussion of the likely effects of the economic downturn that happened during, especially, 2008 and 2009. Notice that we are assuming individuals could not predict these events, and therefore the analysis we present should be understood as age by age (shown for ages 60 and above) 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 (instantaneous) consumption and savings decisions. We provide the results for each employment uncertainty level, which means the results in the table should be compared with the appropriate panels of Table 3, which are also included in the table for ease of comparison.

The table reports the simulated effects of a surprise decline in wealth of 20%, modeled as two consecutive declines of 10%. This is in line with the implied 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 of 10% in two consecutive years, as explained earlier.

The effects of this substantial wealth decline are that first of all, work becomes much more attractive at all ages, specially when uncertainty is present in the model. In some cases the percentage increase in labor force participation is well into the double digits, especially for the benchmark and the higher levels of uncertainty. Secondly, the bad shock pushes a larger proportion of individuals towards drawing early from their Social Security benefits. Claiming at age 62 increases around 2 percentage points, 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% in two consecutive years, instead of accumulating at the fixed interest rate they have taken as given.[34] It seems that agents then choose to draw

[34]Given the fact that wealth balances have somewhat recovered on average in the last couple of years or so, it is even more natural to model this as a temporary phenomenon that surprises individuals. Our main interest is to analyze how this decline in wealth interacts with the claiming and labor supply choices around retirement ages.

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 (Model 1 and the corresponding panel accounting for the wealth shock).

The last column in the table, labeled Model 6, compounds the effect of the 20% wealth decline (spread over two periods) with the increase in unemployment benefits to the 99 weeks mark under the high uncertainty (higher firing probabilities and lower probabilities of finding jobs) scenarios. We see that the labor supply and claiming effects are fairly strong, with sizable effects on the labor supply of those 64 and 65 years old, and an increase in early claiming for all ages up to and including the Normal Retirement Age. Notice that thanks to modeling the wealth shock, the claiming distribution is more in line with the data in terms of not seeing such a large proportion of individuals waiting to age 67 to claim benefits, which suggests that this is an important modeling element to understand the behavior of recent cohorts of older Americans who in spite of facing larger penalties for early retirement and higher rewards from delaying beyond the Normal Retirement Age, they continue to prefer to claim before the Normal Retirement Age. In terms of length of working lives, under this scenario, it goes up a bit to about 33.3 years of work experience.

These wealth effects while not too large are non-trivial, and are somewhat 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 are very 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 in the presence of higher unemployment benefits, 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.

Figure 5 provides an overall summary of our simulation results to emphasize our take-home points. First of all, our model predicts quite well the overall behavior of Older Americans regarding labor supply and claiming behavior. We see the declining labor supply around the age at which Social Security retirement benefits become available, and the predominance of early retirement regarding take-up of retirement benefits. Furthermore, the graph shows how the crisis of the last few years have impacted the two key decisions made by Older Americans, making labor supply decline because of the presence of high labor market uncertainties, but less than could be predicted solely based on the evolution of the labor market, due to the decline in wealth balances which has pushed up labor supply. On the other hand, the presence of those uncertainties has maintained early claiming as the preferred option for Older Americans even in a period in which the penalties for early retirement as well as longevity have increased (See Society of Actuaries 2014, which indicate a substantial increase in longevity in the last decade and a half among Americans who reach age 65.) The latter, suggests that delaying claiming is in principle more likely to be optimal for a higher proportion of individuals, other things equal.

6 Conclusions

The world economy has gone 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 the probabilities of finding new jobs, and a considerable loss of the value of their financial and retirement portfolios, even after a recovery in the value of those portfolios in the last couple of years. 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 suggests 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.

Another important result from our model is the fact that modeling claiming and work separately allows us to show that early claiming provides self insurance against unemployment uncertainty, helping unemployed workers smooth their consumption. Along the same lines, we find that the (automatic) extension of unemployment benefits during recessions helps explain why we do not see more early claiming during bad economic times.

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 rather 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, more generous unemployment insurance, and negative wealth shocks have on labor supply and claiming, can explain why early claiming has remained 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.[35] 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.[36] 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.[37] 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 actuarial reduction will reach 30 percent as the NRA increases to 67 over the next few years (see SSA-S 2005, p.18).[38]

[35] 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.

[36] 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.

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

[38] 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)

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.[39] To illustrate this feature of the system, suppose the NRA is 66 years, and an individual claims benefits at age 62 and n months, where $n < 48$, receives checks for x months where $(n + x < 48)$, and suspends receiving checks after that until she turns 66 (after which she retires for good). In this case she receives x checks of

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

After turning 66, her MBA will be permanently increased to

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

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

Earnings Test

The Earnings Test limit defines the maximum amount of income from work that a beneficiary who claims benefits before the NRA under OASI may earn while still receiving the "full" MBA.[40] Earnings above the limit are taxed at a rate of 50 percent for beneficiaries between age 62 and the January of the year in which they reach the NRA, and 33 percent from January of that year until the month they reach the NRA (SSA-S 2005, p.19; SSA-S 2005, Table 2.A18). For the latter period, the earnings limit is higher, $34,680, compared with $14,160 for the earlier period as of 2010. Starting in 2000, the Earnings Test was eliminated for individuals over the NRA.

Individuals who continue or reenter employment after claiming Social Security benefits before the NRA, and whose earning power or hours constraints are such that their income from work is around or below the earnings limit, are mailed their full monthly check from Social Security and are locked-in at the reduced benefit rate permanently. Those with earnings above the limit will not receive checks from Social Security for some months and thereby adjust their ARF.[41] 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

[39] 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.

[40] 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.

[41] 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).

that calendar year exceed the Earnings Test limit due to high earnings before claiming.[42] 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.[43]

Retirement Claiming and Retirement Benefit Levels: 1994-2012

When studying Table 1 in more detail, 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 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.[44] 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 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.

As discussed in Section 2, 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. It is clear, however, 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 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.

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 percent in October 2010). In parallel the fraction of long term unemployed (more than 6

[42]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).

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

[44]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.

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 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.[45] In short, UI benefits have been widely accessible and more generous in the current downturn than in previous recessions.

[45] 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.

Table A.1. Key Parameterizations of the Model

Parameter	Value	Use	Source
β	0.965	Discount Factor	Calibration
γ	-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 detail in the text.

Table 1: US Social Security Claiming. Males. Annual Statistical Supplement

Age	1994	1998[a]	2000	2002	2004	2006	2008	2009	2010	2011	2012
62	0.554	0.567	0.469	0.531	0.552	0.5184	0.4849	0.5046	0.49	0.48	0.439
63	0.083	0.0808	0.0689	0.0807	0.0836	0.0872	0.0802	0.0816	0.095	0.0831	0.076
64	0.129	0.1135	0.106	0.1574	0.1145	0.1042	0.0965	0.0841	0.079	0.0867	0.079
65	0.176	0.168	0.228	0.1961	0.2107	0.2548	0.2997	0.1476	0.12	0.1195	0.135
66	0.02	0.024	0.048	0.0103	0.012	0.0112	0.0171	0.1579	0.18	0.1919	0.221
67	0.01	0.0133	0.027	0.006	0.0064	0.006	0.007	0.008	0.012	0.0145	0.016
68+	0.027	0.0322	0.05	0.017	0.0193	0.0178	0.0158	0.016	0.019	0.025	0.031
Claimants[b]	817	794	987	874	894	945	928	1,052	1,276	1,159	1,201
			Average benefits in $ of 2010								
62	1,064	1,094	1,167	1,201	1,193	1,166	1,189	1,189	1,163	1,142	1,108
63	1,150	1,187	1,241	1,303	1,300	1,320	1,295	1,320	1,317	1,301	1,279
64	1,272	1,285	1,322	1,436	1,426	1,424	1,370	1,388	1,375	1,392	1,364
65	1,357	1,382	1,468	1,556	1,605	1,675	1,707	1,586	1,545	1,551	1,561
66	1,280	1,231	1,513	1,059	1,189	1,314	1,583	1,906	1,771	1,778	1,823
67	1,260	1,274	1,605	1,008	1,079	1,140	1,513	1,663	1,711	1,756	1,776

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, 1996-2012)

working	1996	1998	2000	2002	2004	2006	2008	2010	2012
60	67.00	63.53	67.42	63.98	66.67	67.91	67.42	62.95	66.18
61	63.56	63.56	63.57	60.18	63.01	65.59	63.57	64.07	63.98
62	51.23	54.46	56.43	52.70	52.80	57.04	56.43	54.63	56.40
63	45.37	46.06	52.24	46.20	50.43	53.64	52.24	53.51	52.18
64	36.93	36.78	48.49	45.24	42.62	45.58	48.49	47.04	45.74
65	36.16	32.37	41.42	37.42	36.88	40.00	41.42	37.12	41.66
66	32.30	27.76	35.74	32.94	32.76	35.21	35.74	35.91	38.67
67	27.27	24.55	34.35	30.99	29.23	28.06	34.35	34.06	35.38
unemployed	1996	1998	2000	2002	2004	2006	2008	2010	2012
60	3.64	2.82	4.39	3.64	2.70	2.01	2.82	6.18	5.04
61	3.11	2.67	1.18	3.44	3.13	1.55	2.88	3.69	5.97
62	2.24	2.71	1.50	3.39	2.02	0.85	1.66	4.80	3.34
63	0.68	1.28	2.19	2.75	1.43	1.62	2.24	4.01	3.59
64	2.06	1.44	1.15	1.59	1.85	1.05	1.92	4.70	3.52
65	1.41	0.67	1.94	0.46	1.42	1.17	2.49	3.42	3.14
66	0.95	1.65	1.68	1.34	2.35	1.37	1.72	2.30	1.93
67	0.89	0.67	0.92	0.68	2.31	2.00	1.97	3.87	2.70

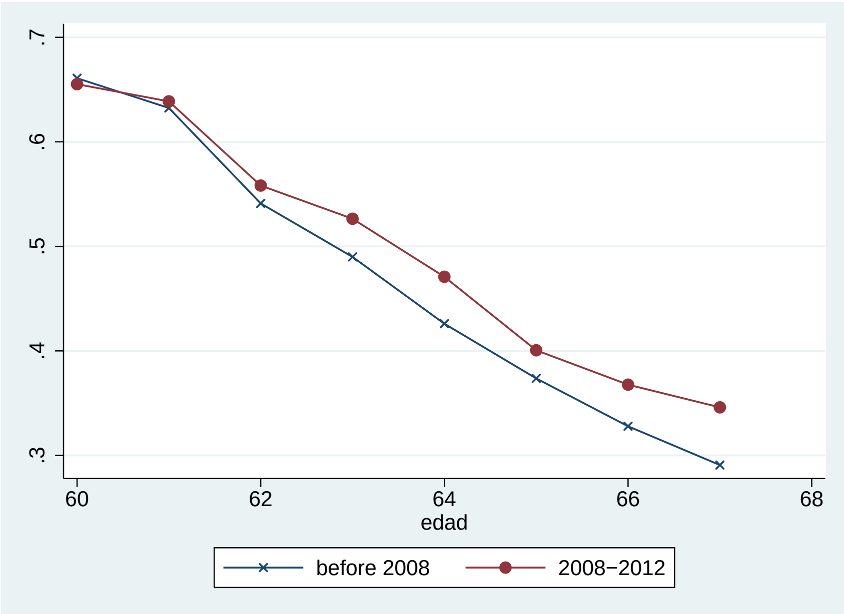

Figure 1: Labor Supply: percentage of working males by age (CPS, 1996-2012)

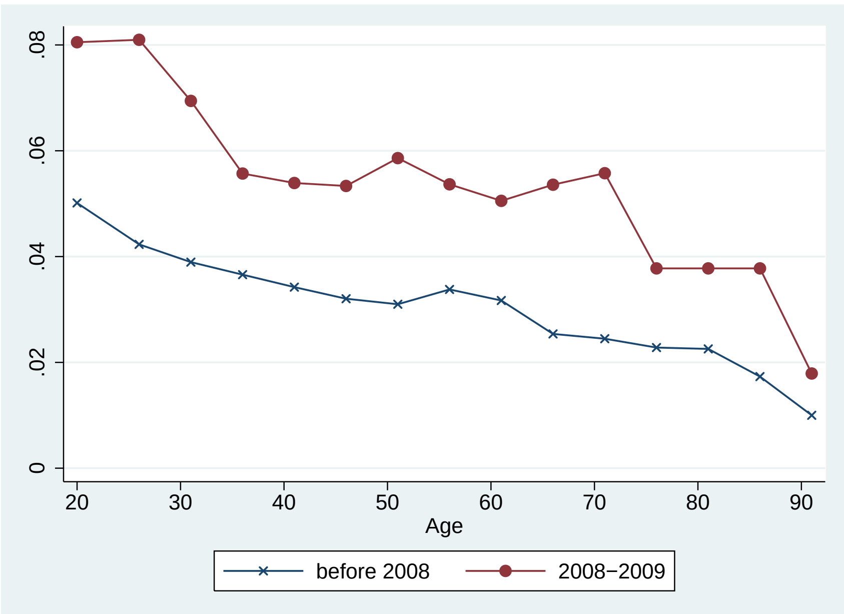

Figure 2: Heterogeneous Unemployment Probabilities (CPS, 1989-2009)

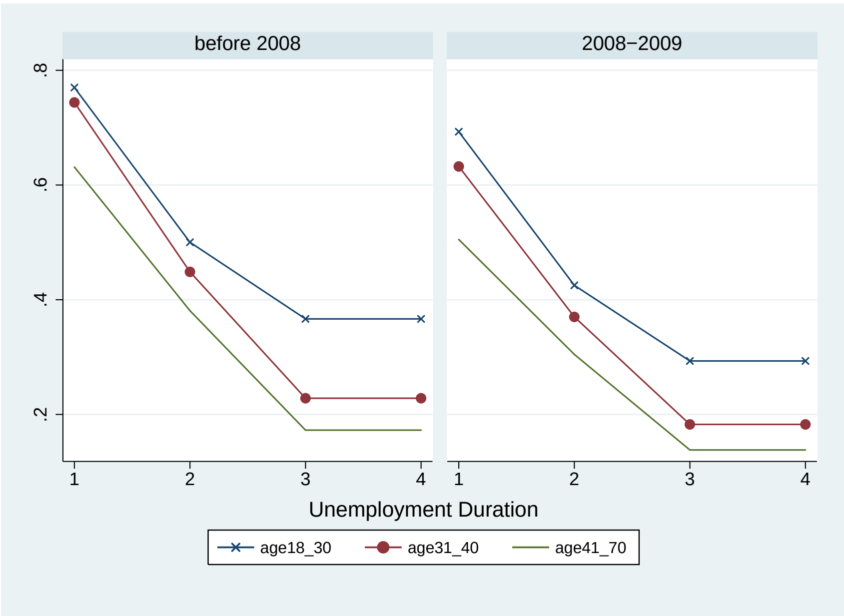

Figure 3: Heterogeneous Reemployment Probabilities (NLSY79 and NLSY97)

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 50	9,212	7,855 (85.27%)	—	—	1,880	96,434
Age 60	8,331	5,995 (71.96%)	—	—	1,949	89,443
Age 61	8,205	5,560 (67.76%)	—	—	1,970	84,619
Age 62	8,055	5,254 (65.22%)	2,378(30.95%)	1,051	1,948	78,474
Age 63	7,883	4,933 (62.57%)	497(6.47%)	1,203	1,941	75,929
Age 64	7,726	4,717 (61.05%)	508(6.61%)	1,272	1,940	73,079
Age 65	7,555	2,637 (34.90%)	1,899(24.72%)	1,337	1,940	70,214
Age 66	7,357	2,928 (39.79%)	1,642(21.37%)	1,444	1,896	65,047
Age 67	7,152	3,763 (52.61%)	728(9.47%)	1,548	2,004	64,004
Age 68	6,959	3,901 (56.06%)	31(0.4%)	1,688	1,956	64,671
			Model 2: ET with ARF and low unemployment risk and high re-reemployment (pre-crisis Benchmark)			
Age 50	9,212	7,205 (78.21%)	—	—	1,810	125,599
Age 60	8,331	4,644 (55.74%)	—	—	1,891	99,846
Age 61	8,205	4,501 (54.86%)	—	—	1,879	92,171
Age 62	8,055	4,391 (54.51%)	3,736(48.26%)	867	1,849	84,234
Age 63	7,883	4,106 (52.09%)	554(7.16%)	940	1,828	81,399
Age 64	7,726	3,547 (45.91%)	329(4.25%)	1,171	1,832	78,677
Age 65	7,555	2,416 (31.98%)	837(10.81%)	1,278	1,826	74,417
Age 66	7,357	2,210 (30.04%)	731(9.44%)	1,364	1,795	68,961
Age 67	7,152	2,181 (30.49%)	1,508(19.48%)	1,556	1,776	64,949
Age 68	6,959	2,352 (33.79%)	46(0.59%)	1,755	1,790	63,958
			Model 3: model 2 with high unemployment risk and high re-employment (crisis scenario 1)			
Age 50	9,212	6,906 (74.97%)	—	—	1,734	119,911
Age 60	8,331	4,452 (53.44%)	—	—	1,837	93,747
Age 61	8,205	4,315 (52.59%)	—	—	1,829	86,073
Age 62	8,055	4,198 (52.11%)	3,928(50.61%)	865	1,803	78,119
Age 63	7,883	4,009 (50.85%)	603(7.77%)	937	1,781	75,417
Age 64	7,726	3,545 (45.88%)	352(4.53%)	1,156	1,780	73,192
Age 65	7,555	2,558 (33.86%)	868(11.18%)	1,266	1,778	69,796
Age 66	7,357	2,251 (30.59%)	741(9.55%)	1,358	1,755	65,703
Age 67	7,152	2,260 (31.59%)	1,237(15.94%)	1,550	1,741	62,551
Age 68	6,959	2,328 (33.45%)	32(0.41%)	1,753	1,749	61,906
			Model 4: model 2 with high unemployment risk and lower re-Employment (crisis scenario 2)			
Age 50	9,212	6,542 (71.01%)	—	—	1,640	113,511
Age 60	8,331	4,219 (50.64%)	—	—	1,756	87,786
Age 61	8,205	4,084 (49.77%)	—	—	1,761	80,209
Age 62	8,055	3,967 (49.25%)	4,137(54.18%)	881	1,737	72,165
Age 63	7,883	3,766 (47.90%)	593(7.61%)	940	1,727	69,788
Age 64	7,726	3,360 (43.49%)	350(4.49%)	1,165	1,722	67,722
Age 65	7,555	2,499 (33.08%)	827(10.62%)	1,263	1,718	64,684
Age 66	7,357	2,082 (28.29%)	746(9.58%)	1,351	1,696	61,199
Age 67	7,152	2,109 (29.48%)	1,108(14.22%)	1,541	1,683	58,435
Age 68	6,959	2,131 (30.62%)	28(0.36%)	1,749	1,689	57,852
			Model 5: model 4 with 99 weeks of unemployment benefits (crisis Benchmark)			
Age 50	9,212	6,401 (69.48%)	—	—	1,702	121,150
Age 60	8,331	4,162 (49.95%)	—	—	1,825	95,312
Age 61	8,205	4,035 (49.18%)	—	—	1,812	87,598
Age 62	8,055	3,921 (48.68%)	3,772(48.64%)	890	1,783	79,707
Age 63	7,883	3,667 (46.64%)	525(6.77%)	958	1,772	77,021
Age 64	7,726	3,143 (40.68%)	388(5.00%)	1,190	1,769	74,461
Age 65	7,555	2,116 (28.00%)	846(10.91%)	1,273	1,769	70,770
Age 66	7,357	1,802 (24.49%)	749(9.66%)	1,382	1,771	66,501
Age 67	7,152	1,830 (25.59%)	1,343(17.32%)	1,533	1,754	63,432
Age 68	6,959	1,884 (27.07%)	131(1.69%)	1,731	1,757	62,569

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

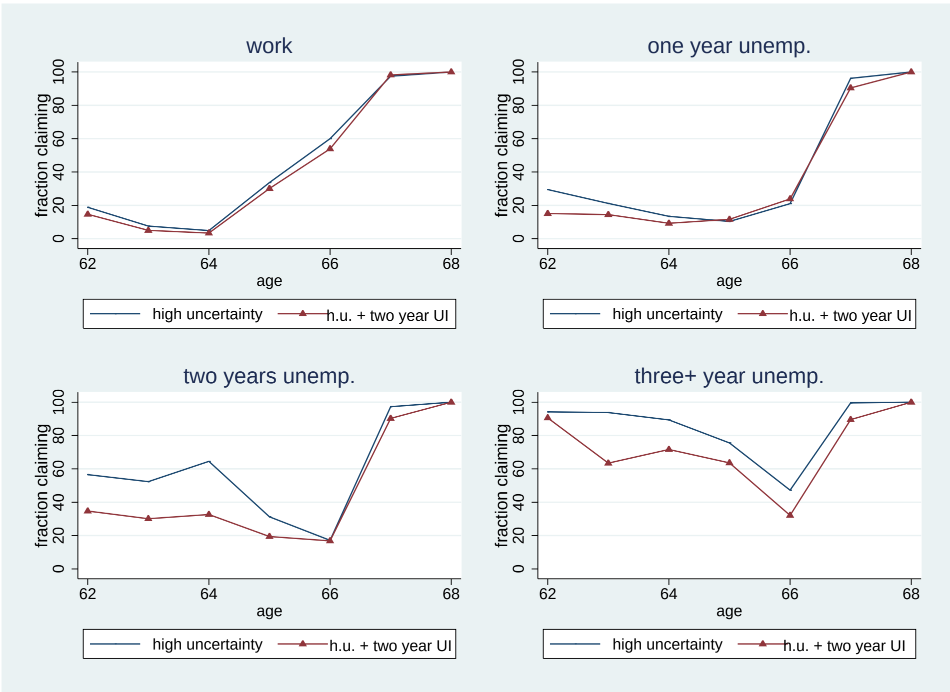

Figure 4: Claiming by duration of the unemployment spell and duration of unemployment benefits

Table 4: Wealth Shocks. 10,000 Simulations of the Dynamic Model

	No Uncertainty		**Benchmark Uncertainty**		**High Uncertainty**		**HU and High UB**	
Ages	**Work**[a]	**Claiming**[b]	**Work**	**Cl.**	**Work**	**Cl.**	**Work**	**Cl.**
			Comparison Percentages from Table 3					
	Model 1 No uncertainty		**Model 2 Pre-crisis Benchmark Low Une+High Reemp**		**Model 4 crisis scenario 2 High Une+Low Reemp**		**Model 5 Crisis Benchmark + 99 weeks UB**	
Age 60	71.96%	—	55.74%	—	50.64%	—	49.96%	—
Age 61	67.76%	—	54.86%	—	49.77%	—	49.17%	—
Age 62	65.23%	30.95%	54.51%	48.26%	49.25%	53.11%	48.68%	48.65%
Age 63	62.58%	6.47%	52.09%	7.16%	47.90%	7.61%	46.64%	6.77%
Age 64	61.05%	6.61%	45.91%	4.25%	43.49%	4.49%	40.68%	5.00%
Age 65	34.90%	24.72%	31.98%	10.81%	33.08%	10.62%	28.00%	10.91%
Age 66	39.79%	21.37%	30.04%	9.44%	28.29%	9.58%	24.49%	9.66%
Age 67	52.61%	9.47%	30.49%	19.48%	29.49%	14.22%	25.59%	17.32%
Age 68	56.06%	0.40%	33.79%	0.59%	30.62%	0.36%	27.07%	1.69%
			+ 20% Decline in Wealth for all uncertainty levels					
							Model 6 Crisis Benchmark + wealth Shock	
Age 60	73.26%	—	55.93%	—	51.01%	—	50.13%	—
Age 61	68.77%	—	54.88%	—	49.78%	—	49.20%	—
Age 62	63.21%	35.94%	54.58%	50.06%	49.27%	55.75%	48.76%	52.06%
Age 63	63.18%	10.78%	54.20%	9.63%	48.83%	9.73%	48.34%	9.68%
Age 64	57.45%	12.68%	52.42%	6.13%	47.61%	5.59%	46.64%	6.76%
Age 65	36.67%	24.87%	36.54%	17.14%	36.14%	14.53%	40.68%	14.12%
Age 66	39.05%	14.42%	32.03%	13.86%	29.74%	11.67%	26.28%	12.45%
Age 67	46.92%	1.29%	32.04%	3.17%	30.84%	2.72%	27.03%	4.9%
Age 68	54.28%	0.01%	34.30%	0.002%	31.51%	0.007%	27.78%	0.03%

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

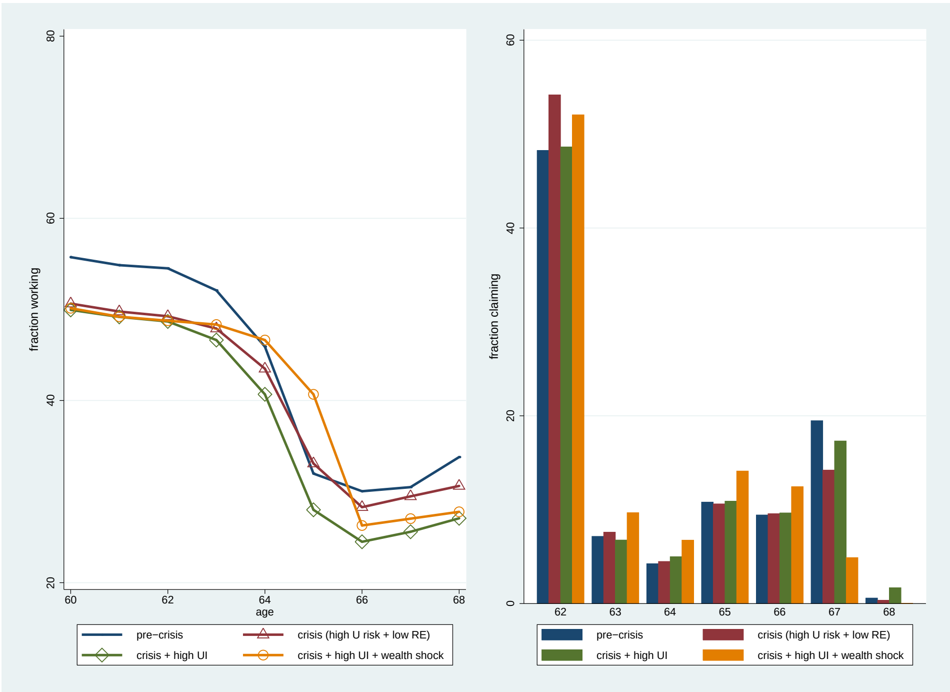

Figure 5: Work and Claiming under different scenarios

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