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Abstract of the Dissertation

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The world has been going through one of worst economic recessions in history with severe job market downturns. In October 2009, the U.S. civilian unemployment rate reached a historical 10% and nearly 50% of the unemployed exhausted their 26-week regular Unemployment Insurance (UI) benefits and consequently, UI has been extended to 99 weeks. This dissertation examines the empirical facts of job displacement among the older American workers during the recent economic crisis, and studies their subsequent labor market and retirement decisions, with focus on the roles of government programs including UI and Social Security Old-Age Benefits (OA).

Job displacement is empirically shown to have both short term and long term negative effects on workers' future employment. While young and prime-aged workers usually increase labor supply to compensate for the drops in assets and incomes, it is ambiguous how older workers would response and whether premature retirement would follow. For workers who are approaching their retirement age when OA becomes available, both OA and UI could be claimed for that purpose. The extent to which they rely on these two programs is affected by factors including age, wealth, income profiles and the institutional details of UI and OA.

Using data from the Health and Retirement Study (HRS), I estimate a dynamic life-cycle utility maximization model with separate decisions on consumption/savings, labor market status and OA take-ups. With the structural model, I am able to isolate the effects of changes in UI coverage from changes in other relevant aspects including changes in the Normal Retirement Age (NRA), and analyze such effects in a deteriorating labor market. I conduct several experiments on UI generosities and evaluate the consequences on the mean individual as well as across the distributions of wealth and income. I find that in a severe labor market downturn, those who are on the lower end of wealth and income distributions are forced to claim OA early while the wealthier and high-income individuals typically postpone OA claiming to reduce early claiming penalties. However, with the extra help of a 99-week UI, some of the poor and low-income individuals can also afford to postpone OA claiming using UI as a stepping-stone. Specifically, among those who originally claim OA at an early 62 years old during a severe labor market downturn, 6.34% of the poorest individuals and 2.52% of the lowest-incomers postpone OA take-ups, resulting in slight increases in the average OA entitlement ages. However, the role of UI as a stepping stone is more prominent among those with high income profiles whose OA take-ups are postponed for almost a quarter year.

Dedication

To my parents, Jian Liu and Qinfang Zhang, whom I have been away from all these years and wish could have spent more time with. This dissertation would never have been done without your love and support.

To my husband, Shang Yang. You make everything possible.

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List of Abbreviations

AHEAD	the Study of Assets and Health Dynamics
AR(1)	first order auto regression
AIME	Average Indexed Monthly Earnings
BLS	Bureau of Labor Statistics
CBO	Congressional Budget Office
CODA	the Children of Depression (cohort)
CPS	Current Population Survey
DP	dynamic programming
DWS	Displaced Worker Supplement
ERA	Early Retirement Age
EB	Extended Benefits
EBB	the Early Baby Boomer (cohort)
EUC	the Emergency Unemployment Compensation program
HRS	Health and Retirement Study
i.i.d.	independent and identically distributed
MBB	the Mid Baby Boomer (cohort)
MSM	method of simulated moments
NRA	Normal Retirement Age
OA	Social Security Old-Age Benefits
OASDI	Old-Age, Survivors, and Disability Insurance program
O.L.F.	out of the labor force
PIA	Primary Insurance Amount
SS	Social Security
SSA	Social Security Administration
SSRB	Social Security Retirement Benefits
TUR	total unemployment rate
UI	Unemployment Insurance
WB	the War Baby (cohort)

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Chapter 1

People are separated from their jobs constantly, voluntarily or involuntarily. When the job losses are voluntary, it is most likely that there are follow-up plans. Involuntary job losses, on the other hand, are exogenous shocks that take people by surprise. What do they do after being displaced? How much do they rely on the extra help from Unemployment Insurance (UI)? While high job losses and low reemployment have been haunting this country ever since 2008, answers to these questions become significantly important. However, answers are far more difficulty to obtain when the job displacement takes place just a few years before workers' designated retirement. The ambiguity to this problem comes from the complicated Social Security Old-Age Benefits (OA), labor market and end-of-life uncertainties, and last but not least, changes in the current UI benefits as a result of the recent economic recession and labor market downturn, as well as changes in the Normal Retirement Age (NRA) for the cohort being affected. Modeling such a problem is extremely changeling.

While existing literature has extensively explored post job displacement behaviors, most of them are empirical and focused on the general population. A few of them employ a more costly structure model to explore the consequences among older workers, and only a handful of them consider both UI and OA as sources of income and discuss their roles in the decision-makings.

In my opinion, job displacement among the old is a very interesting and important matter, especially with the recent changes in both programs and the potential interactions between them. Interpretations of the solutions to this problem would benefit almost every developed country and some of the developing countries where the workforce is aging. Policies developed from the analysis of the problem would greatly benefit American's bankrupting Social Security system and the currently poorly-performed labor market.

The dissertation is organized as follows. After introducing and reviewing the literature in chapter 1, I present job displacement facts and the institutional details of relevant government programs in chapter 2. The benchmark model, solving and estimating strategies as well as the results are explained in chapter 3. In the same chapter, relevant UI policy analysis are conducted and results are analyzed. Finally, chapter 4 concludes.

1.1 Introduction and Background

People are constantly exposed to the risk of losing their jobs. In October 2009, unemployment rate reached a peaking of 10% in the United States. Although the economy has been recovering and unemployment is going down, more than 8% of the workforce was still out of a job at the end of 2012. There were 28,030 mass layoff events in 2009 and in 2012, more than 1.6 million workers filed for UI as a result of 17,080 mass layoffs.[1] In 2007, there were roughly 8 million new recipients of UI and the number soared to 14.4 million in 2009. 62% workers exhausted their regular 26 weeks UI in 2010 compared to 35% in 2007. Congressional Budget Office (CBO) estimates that UI benefits totaled $94 billion dollars in 2012 when the average unemployment rate was 8.3%, almost tripled compared to the $33 billion paid out in 2007 when the average unemployment rate was 4.5%. Additionally, in response to the severe job market downturn, most States have extended their UI coverages from 26 weeks to up to 99 weeks, through the Emergency Unemployment Compensation (EUC) program and extended benefits (EB) program. The three programs provided a total amount of over $520 billion benefits to the unemployed workers from 2007 to 2012.

When the job loss is voluntary, it is most likely that there are contingent plans. Involuntary job loss, on the other hand, is disruptive to people's career paths. What do they do after being displaced? The majority of the young and prime-aged workers are expected to be searching for new jobs to compensate losses wealth and income, and to continue to provide for themselves and/or their families. Very occasionally, they become long-discouraged workers, switch roles as bread winners with other family members, or even go back to school. For older workers workers, however, premature retirement could follow. According to March Current Population Survey (CPS), similar proportions of the prime-aged and older workers remained unemployed within three years after being displaced, while significantly less (around 10%) older displaced workers were employed and retirement was much higher among them (see table 8). I therefore ask the following questions: How do old displaced workers make decisions? Do government programs matter?

Although older workers are less likely than younger workers to become unemployed, those who do have a more difficult time finding jobs. Lahey

[1]Source: Bureau of Labor Statistics (BLS) News Release. Mass layoff numbers are from establishments which have at least 50 initial claims for UI filed against them during a 5-week period.

(2005) finds that workers younger than 50 are 42% more likely to be called for an interview than their 50 and above peers. Even when reemployed, older displaced workers suffer larger earnings losses. In 1996, 38.2% of the reemployed displaced workers aged 55 to 64 suffered an earnings loss of 20% or more, while less than 25% younger displaced workers did (O'Leary and Wandner, 2000). The situation was similar, if not worse during this recent recession. In 2010, 55% of the unemployed individuals aged 55 and above were out of jobs for 6 month or longer, compared to only 42% of the younger age group(Whittaker, 2013).

Nevertheless, a substantial percentage of the older displaced workers still choose to stay in the labor force searching for new jobs, with the financial support from their UI, and some of them do find one eventually. Better yet, for those who are eligible for claiming OA benefits,[2] both UI and OA can be utilized as replacements of the previous income during job search. Depending on the income profile, OA could be more attractive to some workers since it has much longer coverages and usually a higher benefit amount. That being said, penalty is associated with OA early claiming and it is invertible, while current regulations of UI eligibility, on the other hand, allow one to demonstrate on-going active job search by performing some job search activities without true intention to finding one. In this case, claiming UI may become a temporary strategy for the older displaced workers to survive through the economic hardship and delay OA claiming for a higher benefits, in the case of those who are not eligible yet, "a bridge" to walk on to the earliest eligibility (Palme and Svensson, 2004). When that happens, UI may provide no or little incentives to job search and people claim UI only because it is "free money'. With the two opposite motives, it is ambiguous to predict how changes in UI would affect work incentives and ultimately labor market outcomes. Plus, the retirement age was going through a change about the same time as the outburst of labor market downturn: Normal Retirement Age (NRA) stated to increase from 65 to 66 years old in 2009 for the affected cohort, who were born between 1943 and 1954. With a higher NRA, early claiming penalty increases and claiming early is less favorable. Therefore, with all the changes happening together, It is also not clear how OA claiming decisions would be affected, nor how each change would affect OA claiming.

[2]There are other retirement plans such as Individual Retirement Account (IRA), 401(k) and pensions could become available for the workers, but OA is the most commonly observed and has the largest coverage.

Not until the recent recession has displacement-induced retirement been emphasized along with other retirement incentives in the literature. Only a handful of empirical research papers take into account the interactions between UI and OA programs. While those empirical research provides evidences of associations between the weak labor market and retirement decisions, a structural model is able to preserve the rich details in UI and OA regulations and capture the interactions in-between the two programs. After being solved and estimated, it allows us to do experiments on the benefit details of UI and OA to examine consequent changes in motives and behavior responses, and the magnitudes of possible trade-offs between the two government programs.

The key question that I ask in this paper is how older workers react to job displacement and how much they rely on UI and OA when making such decisions. To answer the question, I incorporate working and claiming choices into a dynamic life-cycle model and consider both UI and OA as possible sources of incomes. I apply the model to a set of representative agents from the Health and Retirement Study (HRS) and obtain a set of optimal parameters using the Method of Simulated Moments (MSM), so that the weighted overall differences between the model and the data is minimized at the chosen moments. I then identify the impacts of UI on OA claim decisions and labor market outcomes. I conduct several policy experiments on UI generosities and compare them with the benchmark model which follows UI and OA policies at the time those HRS agents retired (around 2000). Not only do I analyze multiple retirement incentives of the mean individual, I also examine those incentives across the distribution of wealth and income, especially the lower-income and less wealthy individuals, who are more exposed and vulnerable to macroeconomic shocks and labor market downturns.

In my opinion, later-life job displacement is a very interesting and important matter, especially with the interactions between labor market decisions and retirement decisions. I believe that the solutions to this model and the policy experiments could help us better understand the working and claiming arrangement of older workers, and how UI and OA affect these arrangement. While workforce is aging in almost every developed country and some of the developing countries, further research on optimal policies developed from this research would help achieving policy targets such as increasing labor force participation among the older populations and delaying the timing of social retirement benefits (OA in the United States) payments.

1.2 A Literature Review

The research question in my dissertation concerns the following areas: job displacement and subsequent behavioral responses, labor market uncertainties and labor supply, retirement incentives and finally, UI and OA programs in the United States.

While the existing literature has extensively explored these areas separately, retirement incentives associated with job displacement and labor market shocks in general are greatly overlooked compared to other retirement incentives. Also, only a small body of the literature empirically study the roles of UI and OA in retirement and claiming decisions, taking into account the interactions between the two programs and with the influences from changes in macroeconomic environment. I therefore contribute to the existing literature by conducting a structural analysis of the problem and by examining the impacts of UI on the displaced workers when they are approaching OA eligibility age. With the estimated dynamic model, I am also able to isolate the behavioral responses to several policy changes of UI generosities, both for the mean individual and across the income and wealth distribution of those workers, from the changes in other aspects including OA and labor market performances.

1.2.1 Job Displacement

Job displacement has been shown to have negative effects on worker's future labor market decisions in the literature. First of all, decreases in labor supply and lower reemployment probabilities are often associated with job displacement (Stevens, 1995), and subsequent job losses are sometimes observed following job displacement (Fallick, 1996; Stevens, 1997). Secondly, empirical evidences of long-term earning losses are substantial and significant, especially for those who fail to avoid subsequent job losses. Stevens (1995, 1997) explore the long-term effect of job losses using the Panel Study of Income Dynamics and find that after 6 or more years later, earnings and wages fall by 9%, while workers who avoid additional displacements have earnings and wage losses between 1% and 4%. Stevens contributes such differences to certain pre-displacement characteristics and concludes that re-cumulating job tenure and re-investing job specific human capital to a stable new employer is one of best recovery methods. Moreover, Eliason and Storrie (2006) find that the long-run effect of job displacement could be "driven by

an increased sensitivity to subsequent macroeconomic shocks". Other papers that find similar negative impacts of job displacement include Topel (1990), Ruhm (1991) andJacobson et al. (1993).

Responses to job displacement have been studied mostly within the realm of classic labor supply theory featuring labor market uncertainties. However, it is empirically and theoretically controversial whether labor supply would decrease (called the discouraged-worker effect) primarily due to the scarring from involuntary job losses, or people actually work more to compensate for their financial losses and pre-cautiously in against potential future job losses (called the added-worker effect), which is sometimes also observed in the spouses of the displaced-workers. There are quite a few paper discovering the added-worker effect (Cullen and Gruber, 2000; Heckman and Macurdy, 1980), yet some other paper fail to find any empirical evidence (Gallipoli and Turner, 2009; Layard et al., 1980; Serneels, 2002).

Most of the research work on job displacement adopting a structural analysis method use a search-based labor supply model, the same model used in this dissertation. In job search models, labor supply decision-makings are formulated as a dynamic process of either accepting or rejecting offers arriving within the period, as opposed to the simple "to work, or to quit" situation. The details of job search model can vary, but almost always involve with a probability of getting a job offer before making the decisions on whether to take it or not. There is a gigantic body of literature that concern job search models. The earliest static search model was introduced by George Stigler (1961). The single-agent search problem without on-the-job search was discussed in McCall (1970) and Mortensen (1970) and the single-agent on-the-job search model in Burdett (1978). Later studies add more features to the model by introducing risk-aversion (Hall et al., 1979), consumption smoothing (Seater, 1977), assets accumulation (Browning et al., 1999), different unemployment transfers (Mortensen, 1977; Topel, 1983), non-participation (Frijters and van der Klaauw, 2004; Mortensen, 1986), borrowing constraints (Rendon, 2006), and even taxation benefits. Rogerson et al. (2005) provide an excellent literature survey on the theoretical aspects of job search models and I find that Mortensen (1986) a comprehensive yet effective model for me to build up on.

Last but not least, Farber (2003, 2007, 2011) use data from the Displaced Workers Survey (DWS), the same data used in the dissertation, to examine job losses and the consequences in the United States from as early as 1981, till the great recession from 2007 to 2009 during which time serious job

losses, very low reemployment rates, difficulties in finding full-time jobs, and substantial earnings losses are observed. Farber's work provides an insightful look into DWS and draws a general picture of the job displacement facts that would benefit all researchers within this field.

1.2.2 Job Displacement among Older Workers

Compared to job displacement among the general population, the literature concerning displacement among the working old is much smaller and mostly empirical. The majority of relevant research papers focus on the working arrangements of the old workers upon losing their (career) jobs, or compare them with the younger displaced peers. Only a handful of them take into the account of OA benefits and other government programs while modeling post displacement responses.

Couch (1998) was one of the first research papers discussing involuntary job losses among old workers, although his work was cited later by researches of health studies rather than economists. Chan and Stevens have conducted several research works on this subject, following their earlier research on general job displacement in 1995 and 1997. Chan and Stevens (1999) use the first three waves of HRS and find empirically large and lasting effects of late-career job loss on wages, assets, employment expectations, and actual employment. The research paper also discusses the gender differences in the re-valuation of work-retirement trade-offs following displacement of the career jobs. Their follow-up work (Chan and Stevens, 2001) estimates various hazard models of post-displacement reemployment probabilities using non-displacement old as a control group and showed a negative effect of job loss on future reemployment probabilities. Their estimation shows that the employment rate of displaced workers is 20% lower than the similar non-displaced counterpart, four years after job losses at age 55. Chan and Stevens (2004) continue the research path and focus on the retirement incentives induced by job displacement. They find significant increase in the probability of retirement after job displacement but only a small fraction of the increase in retirement and labor force participation decisions are the results of the displacement-altered retirement incentives including earnings, assets and pensions.

Ever since the discussion of displacement and premature retirement incentive in Chan and Stevens (2004), many researches have been conducted. Coile and Levine (2011, 2010) use data from CPS and find that during the current economic recession, there is no evidence of the weak labor market

and high unemployment affecting retirement decisions for workers between 55 and 61 years old, however, workers age 62 to 69 do retire earlier in responsible to high unemployment. Similar work with different focus is discussed in Benitez-Silva et al. (2011), which employs a structural analysis and incorporates both labor market uncertainties and OA claiming decisions upon job displacement events. They are able to match the claim and labor force participation behaviors "with great accuracy" in this research piece. Although UI and its interactions with OA is not the focus of their research, the modeling and estimation approaches used in the paper greatly benefit my research.

Another research direction of displacement-induced retirement is the possible roles of economic and industrial downturns. Hallberg (2011) finds that when displacement rate is high, people tend to transit to retirement more. He actually observes an increase in labor supply during the current economic crisis, which in a sense coincides with the findings in my dissertation. Some other researches do not agree with his findings. For example, Munnell et al. (2009a) find the proportion of older Americans being employed today is as high as the peak of last expansion, and they think of the result a product of "two opposing trends an increase in the labor force participation of older men and a decline in their job security relative to younger workers". Similar results are also obtained in Dorn and Sousa-Poza (2010) and Hurd and Rohwedder (2010).

Over all speaking, the majority of both theoretical and empirical research works on displacement induced retirement incentive are established based on the indirect influences of job displacement through changes in income, wealth and expectations.

Regarding search behavior and search outcomes among the older workers in general, Benitez-Silva and Ni (2010) find that labor market outcomes is strongly related to search activities among the old American workers, regardless of their health and other characteristics that may impair working abilities, a finding that holds true for younger workers too. However, many empirical findings suggest that older workers are less favorable in the labor market even though older workers are less likely to lose their jobs. It is primarily due to longer job tenures they have with their employers (Johnson and Mommaerts, 2011), once they are unemployed, employment opportunities for older workers are restricted especially in industries requiring intensive computer usages (Hirsch et al., 2000). Older workers are less likely to be called for an interview, and age discriminations do exist especially for females Lahey (2005). Also, old displaced workers are in general unemployed for a much

longer time than the younger workers (Whittaker, 2013), and even if they do find a job, their suffer greater learning losses (O'Leary and Wandner, 2000). The above reasons contribute to a higher percentage of discourage job-seekers among the old labor forces and the accelerated transitions to retirement (Maestas and Li, 2006).

1.2.3 Other Retirement Incentives

Unlike the "traditional" retirement incentives that have been extensively explored and well-established in literature, researchers started to analyze the effect of job displacement on retirement decisions not until recently. Compared to the latter, the former is more systematic and provides a better understanding on the modeling and interpretation of retirement decision-makings as well as OA claim decisions that later became separated from labor market decisions. The methodology and techniques that I borrowed from these retirement models are invaluable. Also, even though some of the incentives are not modeled in this dissertation, knowledges of them greatly helped me in laying out the agenda for future researches.

One of the earliest work is by Stock and Wise (1990) on the financial incentive of retirement, the incentive that is most widely discussed. In their model, the "option value" of work is introduced to a labor supply model in analyzing retirement incentives, and people continues to work only if the expected value of retirement in the further is higher than the value of retiring today. They bring a forward looking and dynamic decision-making concept to the classic life-cycle labor supply models used in retirement analysis. Ever since then, the financial incentive became one of the most studied retirement incentives and many other forms of financial incentive have been studied, even including the stock market performances (Coile and Levine, 2006). Dwyer and Mitchell (1999) and many other papers discuss retirement incentives rising from health conditions. Those researches find health problems to be the same important, if not the most important factors that influence retirement plans besides the economic variables. Also, access to health insurance is another retirement incentive that catches many attentions, especially as healthcare becomes more expensive over the years. These researches either treat age 65 as the turn point as people become eligible for Medicare (Gruber and Madrian, 1996), or attach labor supply to the employer sponsored health insurance (Blau and Gilleskie, 2008).

The dynamic model constructed by the pioneer work of Rust (1989) and

Rust and Phelan (1997) separates retirement as a labor market decision from OA claiming decisions, a ground-breaking retirement model for almost all the later research works that employ a structural method to build upon. Rust (1989) establishes a model of retirement whose structures are derived from various aspects of empirical evidences including multiple kinds of uncertainties, bequests, endogenous labor supply and saving decisions, health insurance and Social Security Disability Insurance, partial retirement, as well as multiple labor market transition options. Methods in solving this stochastic dynamic programming problem are explained in the second half of the paper. The discrete choice formation of retirement decision and the optimization method provided in this paper again became the foundation of not only dynamic programming problems in retirement, but many other complicated models in various fields in economics researches that call for sequential solving method. Rust and Phelan (1997) present numerical solutions and estimations of such a model for the first time, with labor supply and OA claiming as separated endogenous decisions. Their estimation results associate retirement behaviors with institutional details of OA rules especially among the individuals with lower incomes, shedding lights on many similar research works thereafter, including mine.

1.2.4 The Roles of Government Programs

Many researchers have explored the effects of public program on retirement decisions, among which OA is one of the most well studied programs. Burtless and Moffit (1984) find that the spike of record retirement (as from the labor market) at age 62 only appeared when the early retirement age (ERA) was introduced in 1961. Cuts in OA benefits (by increasing NRA from 65 to 66 years old in the 1983 reform) are found to be strongly associated with increase in labor supply of the affected cohort (Mastrobuoni, 2006), while a higher wealth in public pension is found to reduced the average retirement age with an elasticity of 0.15 (Hurd et al., 2012). Most of the analysis focus on the financial incentives where workers are liquidity constrained and cannot retire until 62 since before that they cannot borrow against OA benefits (Coile and Gruber, 2001).

UI, as a public program that is especially important for the unemployed workers, however, is not explored in the retirement context as much as OA. Nevertheless, general discussion of UI is well documented in the literature. Anderson and Meyer (1997) examine the determinants of UI take-up rates.

Hipple (1999) finds that the percentage of UI receipts rises as durations of unemployment increase and Krueger and Meyer (2002) find that an increase in UI benefits will lead an increase in the length of unemployment spells with an elasticity of 0.5. As for the current economic recession, Farber and Valletta (2013) use data from CPS 2000-2005 and 2007-2012 and find that as a result of UI coverage extension, there are "a small but statistically significant reduction in the unemployment exit rate and a small increase in the expected duration of unemployment". My research greatly benefits from the results and methodology of those researches.

There is only a handful of research works specifically addressing the role of UI in the retirement decision mechanism. Hamermesh (1982) makes an early empirical contribution to the literature of UI and retirement using a State level data and samples from the Retirement History Survey. Rebick (1994) uses time-series evidence for the US, Sweden and Japan to look at the effect of unemployment on the labor force participation rate and rate of OA benefits receipt for older workers. O'Leary and Wandner (2000) surveyed the nationwide and State-level UI programs in the US with comparison between younger and older workers. They find that older job seekers has a higher UI claim rate than general population but "shoulder a proportionately small share of the unemployment burden", and suggest aspects such as initial eligibility, continuing eligibility, wage replacement, and partial benefits of the UI program could effect the employment pattern of older workers. Other programs available to older workers are also examined in the paper.

Even fewer research works either take into account the interactions between the two program, or compare their influences. Hutchens (1999) studies the cases where OA early retirement benefits are used as an alternative UI and finds that an inefficiently high level of early retirements as a result. Several optimal policies are proposed. However, the analysis conducted are mostly from the perspective of OA and encouraging employment among the older workers, whereas my research more specifically addresses the situations of an economic depression with both high unemployment and high UI coverage. Hutchens and Jacobson (2002) examine the receipts of UI and OA at the time when law prevented people from claiming both, but the data they use were collected only in the State of Pennsylvania back in the 70s with no resemblance to current laws. Coile and Levine (2007) conclude that OA is more effective in compensating the income loss resulted from job displacement and UI plays only a minor role in delaying retirement. They apply a linear probability model and a probit model to HRS and find that older

workers rely on OA more than UI in their labor market decisions when they become OA eligible. They explain that it is because that generosity of UI has little effects on the take-up for older workers compared to younger ones. However, older worker do response more to UI generosity than young people in terms of duration of unemployment. Consistent results are found using matched March CPS data. However, it is not clear in their research why UI is less preferred than OA since claim early results in a deduction of benefits while UI is free-money, hence I do not entirely agree their more-effective conclusion. Another relevant yet different work is Hairault et al. (2009). They discuss the connection between UI and OA program from the perspective of optimal contract and welfare, using a game-theoretic based apporach.

In general, the majority of the literatures that consider both UI and OA as income sources of older workers against labor market uncertainties are empirical and fail to explicitly explain how UI affects retirement incentives and labor market outcomes through a structural model, which is exactly the focus and contribution of this dissertation.

1.3 My Contribution

The model I apply to my research question is based on the pioneer work of McCall (1970), Mortensen (1986) and Rust and Phelan (1997). It is similar to Rendon (2006) but with OA features similar to Benitez-Silva et al. (2011).

The structural model I have in this dissertation allows freedoms in controlling uncertainties in longevity and labor market outcomes, and almost all institutional details of UI and OA programs. I therefore contribute to the literature by analyzing the sole effects of changes in UI benefits (mostly by extending the coverage) on employment and retirement decisions. The policy experiments and analysis I conduct are tailored to the current economic recession where job losses are high and UI coverage is much longer. Lastly, not only are such effects analyzed for the mean individuals, they are analyzed across distributions of wealth and incomes, which allows further research on optimal policies to be performed.

Chapter 2

Chapter 2 summarizes institutional details of the Unemployment Insurance (UI) and the Social Security Old-Age Benefits (OA) in the United States, two important factors that affect post job displacement decisions among the working old. UI and OA entitlement facts are presented from 1995 to the current labor market downturn for a better understand of the programs. The chapter also looks at both the Current Population Survey (CPS) and the Health and Retirement Study (HRS), and presents job displacement facts among the old American workers as well as retirement and OA take-up facts, upon which a structure model and further policy analysis are developed.

2.1 Unemployment Insurance in the United States

In the United States., UI programs are administrated independently by each State with guidelines established by Federal laws. There are three types of UI benefits provided[3]: the regular UI, Extended Benefits (EB) and the Emergency Unemployment Compensation (EUC). They share the same benefit structure yet provide different coverages. Unlike the regular UI, EB and EUC are enacted only under certain circumstances.

Most workers (81.9% of the civilian labor force in 2010) work in jobs where they contribute to the program and therefore are eligible for UI. Others, including self-employed individuals, employees of certain non-profit and government organizations and certain agricultural workers, are not eligible for the benefits discussed in this dissertation.

2.1.1 Regular Benefits

The regular UI program in United States was established by Social Security Act of 1935. It is funded through the State's UI payroll tax and the Federal UI payroll tax pays for the State's administrative expenses.

[3]Other types of UI that are not discussed within the realm this dissertation include: Disaster Unemployment Assistance, Unemployment Compensation for Federal Employees, Unemployment Compensation for Ex-service members, Trade Readjustment Allowances, Self-Employment Assistance and etc. These programs either provide benefits to very specific populations or become enacted under very specific circumstances.

Table 1: State-level UI Benefits. 2009 – 2010. In Current Dollars.

State	Replacement ratio 1	Replacement ratio 2	Min. WBA	Max. WBA	Ave. WBA	Ave. wkly wage
AK	0.335	0.308	$56-128	$370-442	$243.99	$792.87
AL	0.408	0.371	$45	$265	$211.37	$570.20
AR	0.512	0.493	$79	$441	$288.41	$584.66
AZ	0.391	0.332	$60	$240	$217.70	$655.57
CA	0.451	0.384	$40	$450	$317.00	$825.01
CO	0.502	0.462	$25	$443-487	$361.92	$784.03
CT	0.432	0.4	$15-30	$537-612	$319.68	$799.28
DC	0.405	0.334	$50	$359	$305.60	$914.04
DE	0.415	0.368	$20	$330	$257.11	$698.32
FL	0.402	0.338	$32	$275	$235.75	$696.97
GA	0.465	0.397	$44	$330	$273.20	$688.11
HI	0.555	0.49	$5	$559	$419.29	$855.04
IA	0.541	0.492	$56-67	$374-459	$305.23	$620.22
ID	0.488	0.451	$72	$334	$264.48	$586.53
IL	0.385	0.333	$51-77	$385-531	$276.79	$832.23
IN	0.53	0.475	$50	$390	$311.58	$655.43
KS	0.521	0.466	$109	$436	$337.15	$723.22
KY	0.503	0.477	$39	$415	$302.06	$632.67
LA	0.421	0.289	$10	$247	$219.54	$758.81
MA	0.462	0.438	$33-49	$629-943	$388.87	$888.27
MD	0.468	0.417	$25-65	$410	$313.23	$751.61
ME	0.507	0.469	$62-93	$356-534	$282.13	$601.48
MI	0.49	0.424	$117-147	$362	$297.47	$701.38
MN	0.474	0.445	$38	$377-585	$355.99	$800.45
MO	0.423	0.37	$35	$320	$251.25	$679.27
MS	0.412	0.367	$30	$235	$192.99	$525.99
MT	0.471	0.456	$125	$422	$274.39	$602.16
NC	0.511	0.496	$43	$505	$298.28	$601.39
ND	0.482	0.458	$43	$431	$313.81	$684.74
NE	0.446	0.413	$30	$318	$247.99	$599.79
NH	0.425	0.385	$32	$427	$280.39	$727.99

Continued on next page

Table 1 – continued from previous page

State	Replacement ratio 1	Replacement ratio 2	Min. WBA	Max. WBA	Ave. WBA	Ave. wkly wage
NJ	0.508	0.447	$87-100	$600	$386.74	$865.24
NM	0.562	0.51	$71-106.5	$426-526	$313.61	$615.46
NV	0.466	0.401	$16	$400	$325.96	$812.13
NY	0.42	0.348	$64	$405	$307.64	$882.83
OH	0.449	0.409	$106	$375-508	$290.60	$711.25
OK	0.507	0.467	$16	$430	$292.32	$625.71
OR	0.46	0.429	$115	$493	$302.31	$704.12
PA	0.536	0.496	$35-43	$564-572	$345.11	$696.39
RI	0.555	0.509	$68-118	$546-682	$371.40	$729.18
SC	0.452	0.412	$20	$326	$238.97	$579.75
SD	0.473	0.439	$28	$309	$265.72	$605.29
TN	0.407	0.356	$30	$275	$224.52	$630.22
TX	0.507	0.406	$59	$406	$324.85	$801.10
UT	0.504	0.479	$29	$451	$315.82	$659.90
VA	0.451	0.399	$54	$378	$292.74	$733.51
VT	0.503	0.474	$64	$425	$291.01	$613.87
WA	0.528	0.482	$133	$560	$397.49	$825.33
WI	0.47	0.422	$54	$363	$280.24	$663.47
WV	0.413	0.401	$24	$424	$257.18	$640.88
WY	0.505	0.473	$31	$438	$341.77	$721.99
US	**0.463**	**0.407**	—	—	**$303.43**	**$745.25**

Source: BLS, Oct. 2009 - Sep. 2010. Minimum and maximum UI effective in Jan. 2010.
Notes: WBA is claimants' weekly benefit amount.
Replacement Ratio 1 = Weighted Average of: WBA / (Normal Hourly Wage × 40 Hrs.)
Replacement Ratio 2 = Ratio of:
Weighted Average WBA/ Weighted Average (Normal Hourly Wage × 40 Hrs.

To be eligible for UI in most States, workers must have lost their job through no fault of their own (in most cases, because they were laid off) and must have had a consistent record of earnings during a base period (in most cases, the previous four or five quarters). Workers are also typically required to be "able to work, available to work, and actively seeking work", subject to other eligibility requirements by State laws.

The basic benefits covers 26 weeks in most States. Entitlement durations are slightly longer in very few States (up to 30 weeks in Massachusetts and up to 28 weeks in Montana) and shorter in another few states (20 weeks at maximum in Missouri, 23 weeks at maximum in Florida and 25 weeks in Illinois).

Generosity of the UI benefit amounts varies across States but the nationwide weekly benefits are typically about 50% of prior weekly earnings up to a State-specific cap. As of January 2010, the replacement rate ranged from as low as 33.2% in Arizona and 34.8% in NY, to as high as 49% in Hawaii and 49.6% in Pennsylvania, and the maximum weekly benefits ranged from $247 in Louisiana to $653 in Massachusetts and, in States that provide independent allowances, up to $979 (Massachusetts, with 13 dependents). Table 1 lists the State-specific UI benefits in together with the average weekly wage in the year of 2010, which has not changed much throughout the periods of time that this research covers. A national average replacement ratio can be calculated using table 1 and population of each State.

2.1.2 Extended Benefits

During periods of high unemployment, extended benefits are available to workers who have exhausted regular UI. There are two types of such benefits: EB and EUC. EB is fully funded by the Federal Government from its general revenues. EUC is currently fully funded by the Federal Government but normally funded 50/50 by States and the Federal Government. The amounts of UI benefits are the same for EB, EUC and the regular UI, only with different coverage durations.

EB has been in effect since 1970. The basic EB provides 13 additional weeks upon the exhaustion of regular UI, 7 additional weeks of benefits are provided when the unemployment rate is raising above 8%, resulting in a total of 20 additional weeks of coverage[4]. At times when unemployment rates is very high, EUC could be authorized under Federal law. During

[4]A "look back" method was adopted beginning in Dec. 2007, requiring that a State's

Table 2: UI Programs in the United States: Coverages and Requirements

Program	**Coverage (wks)**	**Requirements**
Regular UI	26	None, available in most states
EB	13	Basic, available in most States
	20	Available in some States
EUC	Tier 1: up to 20	None, available in every state
	Tier 2: up to 34	3-mo. seasonal adjusted TUR $\geq$ 6.0%
	Tier 3: up to 47	3-mo. seasonal adjusted TUR $\geq$ 7.0%
	Tier 4: up to 53	3-mo. seasonal adjusted TUR $\geq$ 9.0%

Notes:
[a] EB and EUC are granted upon the exhaustion of regular UI.
[b] TUR: total unemployment rate.

the recent economic recession, EUC08[5] was enacted, providing benefits to claimants who filed an initial claim effective on or after May 7, 2006. EUC provides additional 14 to 47 weeks of benefits depending on which of four "tiers" the State's unemployment rate belongs to. However, the number of weeks EUC benefits offered has been as high as 53 since 2009. The original EUC program expired at the end of 2012 and the 2012 American Taxpayer Relief Act reauthorization the program continue through Jan 2014.

As a matter of fact, the maximum coverage has increased from 26 weeks to a maximum of 99 weeks nowadays with 26 weeks regular UI, 20 weeks of EB and 53 weeks of EUC. Table 2 offers a comparison between the coverages of the three UI programs.

2.1.3 Entitlement Facts

The total benefits payments made by the three UI programs have increased substantially, from $2.5 billion in 1995 to nearly $80 billion (and $70 billion alone by EUC) in 2010. As TUR soared to its historical high of 10% in October 2009 and stayed above 9.5% till December 2010, total claimers of UI benefits reached its historical high as well, including 14 million regular

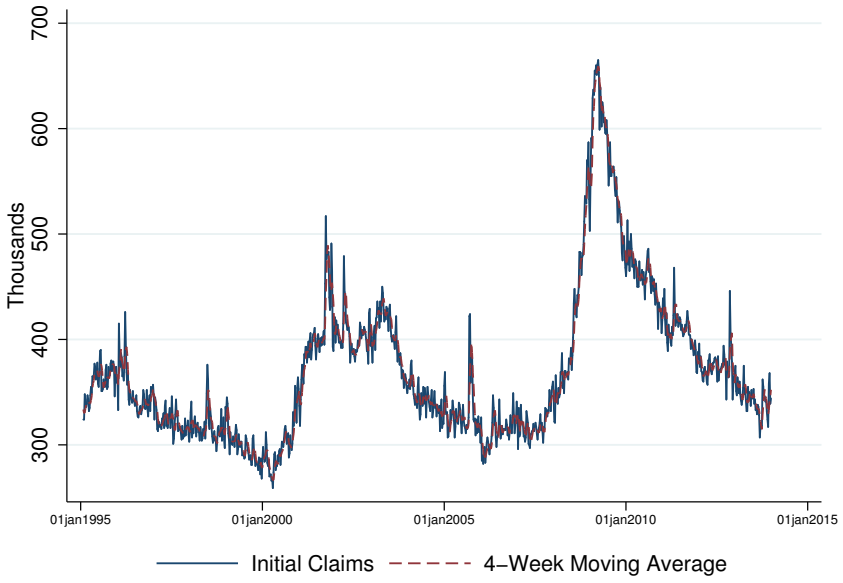
unemployment rate not only exceed the thresholds, but significantly higher than it was in the pervious period to be eligible for EB.

[5]EUC is used to refer EUC08 throughout the dissertation.

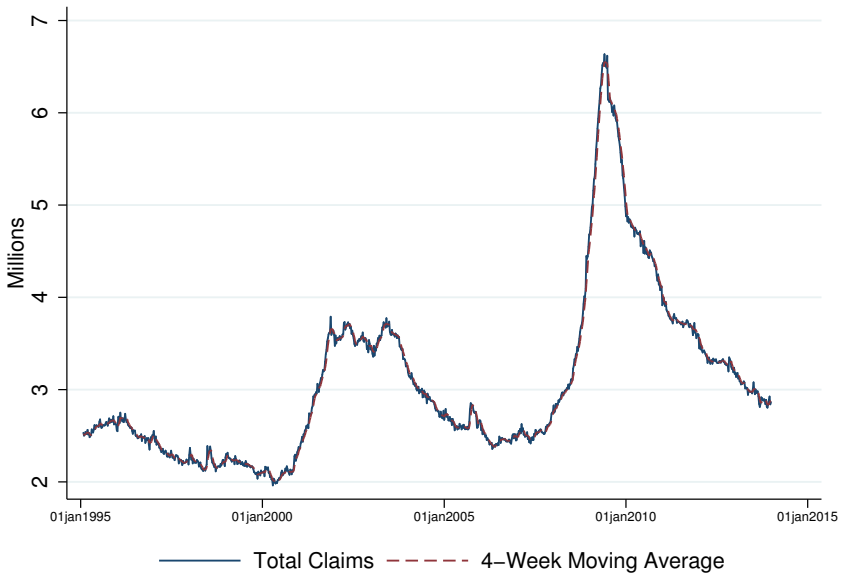
Table 3: Total Benefits Payments: UI, EB and EUC. 1995-2012.

Year	**UI**	**EB**	**EUC**
1995	2,317,858	75,295	—
1996	2,555,904	28,118	—
1997	2,788,888	26,792	—
1998	3,096,396	34,331	—
1999	3,238,737	16,924	—
2000	3,439,084	3,847	—
2001	3,348,504	3,924	—
2002	2,969,408	237,814	—
2003	1,782,369	367,778	—
2004	1,342,196	37,516	—
2005	1,360,682	8,848	—
2006	1,577,165	18,981	—
2007	1,857,230	-285	—
2008	1,752,330	44,169	7,895,238
2009	130,329	6,546,112	44,249,800
2010	85,148	9,015,073	70,212,916
2011	77,943	10,672,181	48,585,795
2012	107,706	2,901,931	—

Source: U.S. Department of Labor.
Notes: Total benefits paid are the benefit checks issued (plus or minus adjustments, such as reimbursement by nonprofit or government employers). Negative numbers are not errors.

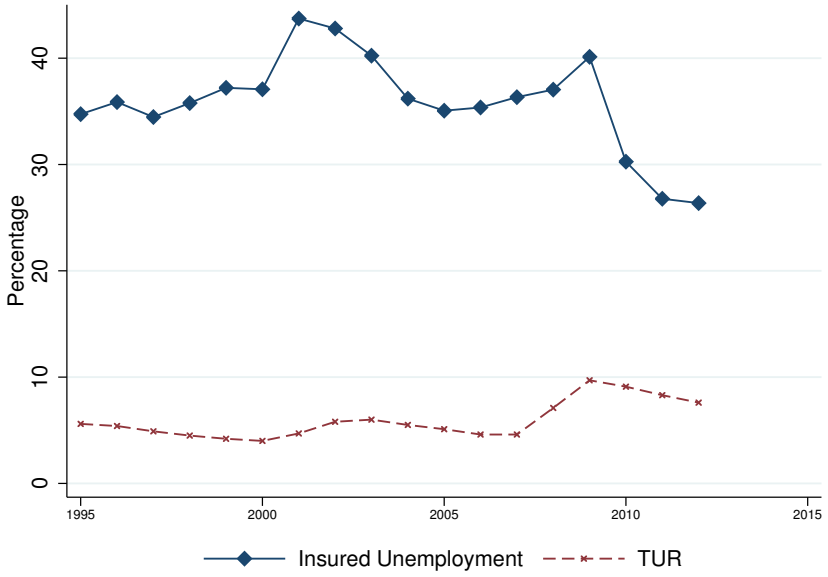


(a) Initial Claims

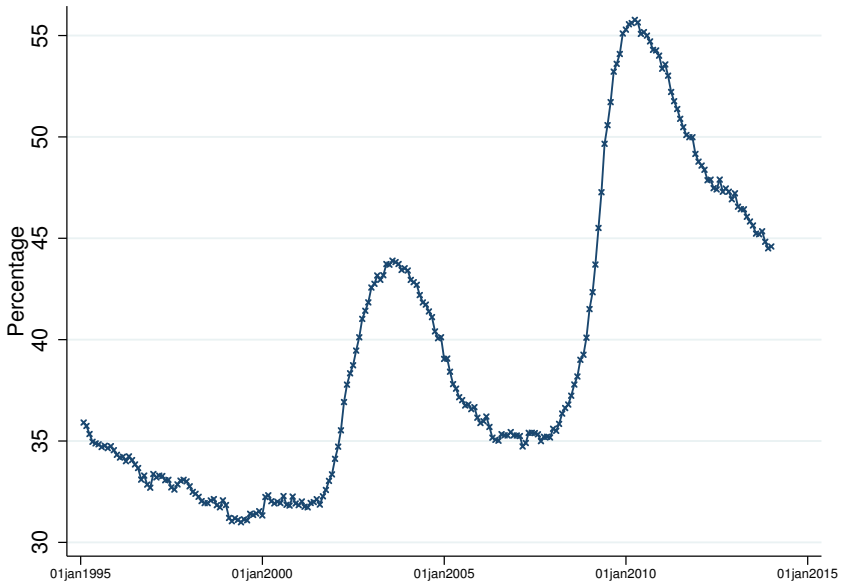


(b) Total Claims

Figure 1: Seasonally Adjusted UI Initial Claims and Total Claims. BLS Weekly Release. 1995-2012.



(a) Regular UI Insured as a Percent of Total Unemployment



(b) Regular UI Exhaustion Rate

Figure 2: Regular UI and TUR. BLS Weekly Release. 1995-2012.

UI initial claimers with an average weekly benefits of around $300, 2 million EB initial claimers and 6.5 million EUC initial claimers. In a single year of 2009, 7.5 million unemployed workers exhausted their regular UI benefits and more than 1 million exhausted their EB. With the maximum 53 additional benefits, 3.8 million exhausted their EUC, total weeks compensated were 203 million, 32million, 237 million for regular UI, EB and EUC respectively, within the single year of 2010. Nevertheless, around 35% of the unemployed workers were still covered during the recession and the numbers are turning good as the economy recovers.

Table 3 offers a comparison between the total payment provided by each program, while details are listed in table 26 – 28 in the appendix. Figure 1 presents initial claims and total claims of regular UI from 1995 to 2012, as well as a 4-week moving average that smooths out the volatility in the weekly initial claims data and assess trends. Figure 2 shows how the percentage of unemployed population among total unemployment and UI exhaustion rate changes from 1995 to 2012, in accompany with TUR. Note that regular UI insured percentages dropped significantly because of the high exhaustion rates and transitions to EB and EUC around that time. With high TUR and displacement, additional UI coverages were one of the most important sources of financial support, especially for the long-term unemployed workers whose unemployment lasted for at least 27 weeks and therefore exhausted their regular UI benefits.

Despite the potential solvency problem and financial burden resulted from the much longer UI coverage and increasing number of claimants, UI and other assistance programs are ranked by the Congressional Budget Office (CBO) as one of the most effective policies for job creation and economic growth (Elmendorf, 2011). It is estimated that each dollar of UI benefits generates $1.55 in new economic activity within the first year (Zandi, 2011), and about 750,000 jobs were boosted by UI during the most recent economic recession (Vroman, 2010).

2.2 Social Security Old-Age Benefits in the United States

Old-Age Benefits, also known as the Social Security Retirement Benefits (SSRB), is part of the Federal Old-Age, Survivors, and Disability Insurance (OASDI) program which provides benefits to eligible retirees, surviving

spouses and their dependents and disabled individuals. The OASDI program was established by the Federal Social Security Act of 1935 and it is funded by payroll taxes levied on employees, their employers, and the self-employed, subject to a maximum taxable income. Current OASDI tax rate is 12.4% and is split evenly between employers and employees.[6]

2.2.1 Eligibility and Benefit Structure

To be eligible for OA benefits, one must work and pay Social Security tax to earn "credits" toward Social Security. For those who were born in 1929 or later, 40 credits (10 years of work) are needed. The credits will remain on one's Social Security record during the time when one is not working and be accumulated until full once goes back to work.

Another two important concepts are the Early Retirement Age (ERA) and the Normal Retirement Age (NRA). ERA is the earliest age to receive OA benefits and NRA is the age when full amount of OA benefits are received. NRA depends on one's year of birth as documented in table 4, and ERA was introduced in 1961 and has been set at 62 years old since.

When claiming OA at NRA, the monthly benefits equal to Primary Insurance Amount (PIA). PIA is a piecewise liner function of the Average Indexed Monthly Earnings (AIME), it is also increasing and concave in AIME. AIME is calculated as the average indexed wages of one's 35 highest paid years. The calculation rules of PIA has been adjusted over the years. For the cohort discussed in this paper who reached their NRA mostly around 2000, PIA is calculated as 90% of the first \$680, 32% of AIME between \$681 and \$4100, and 15% of what is above \$4100. The brackets has increased over years and are significantly different from the current brackets.

Penalties occur if claim before NRA and benefits increase when claim after NRA unto 70 years old. Age-adjusted benefits levels are designed to be actuarially fair for take-up decisions at all ages. According to the current regulations, PIA is reduced by $5/9^{th}$ of 1% a month for the first 36 months preceding NRA, and $5/12^{th}$ of 1% a month beyond that, up to ERA, and increased by $2/3^{rd}$ of 1% a month up to 70 years old. Hence with a NRA of 65, claiming at ERA results in a deduction of 20% in PIA and claiming at age 70 increases the annual benefits level by 40%. With a NRA of 66,

[6]This tax rate has not changed since 1990, except for 2011 and 2012 when the OASDI tax rate on wages for employees and self-employed individuals was reduced from 6.2% to 4.2% and the combined tax rate was 10.4%.

Table 4: Birth Cohorts and NRA

Year of birth	NRA
1937 and prior	65
1938	65 and 2 months
1939	65 and 4 months
1940	65 and 6 months
1941	65 and 8 months
1942	65 and 10 months
1943-54	66
1955	66 and 2 months
1956	66 and 4 months
1957	66 and 6 months
1958	66 and 8 months
1959	66 and 10 months
1960 and later	67

Source: Social Security Administration (SSA).

claiming at ERA results in a deduction of 25% in PIA and claiming at age 70 increases the annual benefits level by 32%.

There is no minimum monthly OA benefit amount, although a monthly benefit of less than \$1 is not paid for administrative reasons. The maximum benefit depends on the age one retires. For instance, the per-month maximum benefit is $\$1,923$, $\$2,533$ and $\$3,350$ respectively when retiring at ERA, NRA and age 70 respectively in 2013.

An earnings test applies when someone is working while receiving benefits. Before 2000, earnings test applied to all ages.[7] After 2000, \$1 in benefits is deducted for each \$2 in earnings above the annual limit before NRA. When the NRA year is reached, OA benefits is reduced by \$1 for every \$3 one earns over an annual limit until the month of full retirement age. Once reaching NRA, one can keep working without reduction in the OA benefit amounts received.

[7]Refer to `http://www.ssa.gov/oact/cola/rtea.html` for details and the historical exempt amounts and ages.

2.2.2 Entitlement Facts

In 2012, 2.7 million of Americans filed for OA benefits with an average benefit amount of $1292.17. The number increased substantially compared with the start of the century whenonly 1.6 million were entitled OA with an average $796.90 monthly benefits (table 29, Appendix.). The total number of OA beneficiaries reached 18.5 million in 2012, making OA one of the most common and important sources of income among the retired old Americans.

The age structure of OA beneficiaries has changed quite a bit over the years (table 30, Appendix.), primarily due to the introduction of ERA in the 60's and decreased early claiming after 2000, especially during the current economic recession. Table 5 documents the changes in OA entitlement behaviors from 1995 to 2012. As can be seen from the table, average OA entitlement age stayed quite the same over the past two decades until the recent economic recession during which time significantly less people chose to claim benefits at the earliest possible age of 62. Considering that no major institutional reform took place during that time, the postponing entitlement decisions could be explained by the tight budget resulted from labor market downturn and the increased early claim penalties for the cohort with a NRA of 66. A change of UI coverage from 26 weeks to 99 weeks could also result in delayed OA take-ups because of the temporary bridge role of UI. However, as increases in UI coverage was accompanied by an increase in NRA, it is not certain how much or whether changes in UI contributed to changes in OA entitlement decisions, hence a structural analysis is employed to address this question later in chapter 3.

2.3 Job Displacement among Older American Workers

By the definition of Bureau of Labor Statistics (BLS), a displaced worker is someone at least 20 year old, with at least three years of tenure on a job (excepting temporary and seasonal jobs), who lost that job (without being recalled) due to slack work, abolition of a position or shift, or plant closing or relocation. It is agreed by all observers that displaced workers do not include those who are fired for cause.

Displaced workers are often in sectors and industries that suffer from changes in macroeconomic environment and government regulations in different times of history. Not only do they suffer losses finically right after losing the job, their reemployment probabilities and future incomes are very

Table 5: Old-Age Benefits Entitlement: Number, Average Age and Percentage Distribution by Age. Male. 1995-2012

			Percentage distribution by age						
Year	Num.(k)	Ave. age	62	63	64	65 to NRA	NRA	NRA to 69	70 and older
1995	916	63.7	55.90	8.28	11.90	. . .	17.91	4.54	1.59
1996	895	63.6	57.09	8.12	11.10	. . .	17.05	5.15	1.37
1997	904	63.7	57.39	7.50	11.02	. . .	16.93	5.34	1.70
1998	909	63.8	56.75	8.12	11.33	. . .	16.82	5.26	1.72
1999	940	63.7	56.41	8.35	11.21	. . .	16.93	5.38	1.72
2000	1115	64.1	46.95	6.88	10.61	. . .	22.91	11.17	1.47
2001	992	63.7	53.61	7.67	13.86	. . .	20.73	3.21	1.03
2002	1001	63.7	53.09	8.12	15.79	. . .	19.57	2.40	1.03
2003	969	63.6	56.00	7.81	14.93	4.19	13.24	3.05	0.68
2004	1010	63.6	56.71	8.00	12.51	5.86	13.08	3.04	0.68
2005	1061	63.6	56.53	8.11	10.81	8.11	12.61	3.04	0.79
2006	1057	63.8	51.88	8.76	10.47	11.04	13.42	3.53	1.02
2007	1075	64.0	48.24	8.42	10.58	13.77	13.65	3.64	1.02
2008	1200	64.0	48.46	7.98	9.58	15.28	14.14	3.65	0.91
2009	1452	64.0	50.69	8.24	8.47	13.39	14.53	3.89	0.80
2010	1387	64.1	48.97	9.54	7.93	12.18	15.52	4.71	1.03
2011	1340	64.0	47.92	8.33	8.68	11.92	16.55	5.44	1.27
2012	1419	64.2	43.92	7.67	7.91	13.58	19.13	6.14	1.65

Source: Social Security Administration.

likely to be affected negatively. Lastly, displaced workers tend to have lower education levels and are more attached to the sector in which they were previous employed. For older workers, prospects after involuntary job losses are even worse, especially during the current economic recession.

This section presents stylized facts of job displacement from CPS and BLS monthly and quarterly releases, providing a base for structure modeling and analysis.

2.3.1 Stylized Displacement Facts

All the stylized facts in this section are selected from CPS January 2010 displaced workers supplement (DWS).

CPS is a monthly survey of about 50,000 households conducted by the Bureau of the Census for BLS. The survey has been conducted for more than 50 years. It is the primary source of information on the labor force characteristics of the U.S. population. The sample is scientifically selected to represent the civilian non- institutional population. Respondents are interviewed to obtain information about the employment status of each member of the household 15 years of age and older. Although CPS is not an ideal panel for my research, its broad sampling of all ages allow me to do a simple comparison between older and young populations.

DWS is a biannual survey that collects information on the displaced workers (on a three-year basis) that are participants of CPS conducted in January. January 2010 DWS refers to persons who had 3 or more years of tenure on a job that they had lost or left within the last 3 years (January 2007 and December 2009) because of plant or company closings or moves, insufficient work, or the abolishment of their positions or shifts.

Displaced Workers Characteristics

As shown in table 6, compared to their non-displaced peers, older displaced workers are more likely to be male, less likely to be married and less likely to have college or higher degrees. On average, they tend to have much lower family incomes than the non-displaced workers (workers with no displacement within the past three years and non-workers). However, those characteristics could be results of the selection process of labor market participation. The same goes for income, a characteristic that is highly associated with education and occupation.

Table 6: Workers Characteristics. Displaced and Non-displaced. 55 to 69 Years Old. 2007-2009.

	Displaced	**Non-displaced**
Male	60.62%	46.17%
Northeast	19.19%	20.85%
Midwest	23.03%	23.66%
South	29.62%	31.31%
West	28.16%	24.17%
Married	52.66%	58.97%
Widowed	2.33%	7.42%
Divorced	17.48%	12.81%
Never married	27.53%	20.80%
Less than high school	11.47%	12.07%
High school diploma	33.87%	30.57%
Some College	30.91%	27.71%
College degree	17.09%	19.27%
Master and above	6.66%	10.39%
Family income		
Less than 10,000	8.33%	5.92%
10,000 - 29,999	26.92%	22.06%
30,000 -49,999	23.33%	20.27%
50,000-99,999	28.76%	32.65%
100,000 or more	12.66%	19.10%

Source: CPS DWS January 2010.
Note: Data refer to persons who had 3 or more years of tenure on a job they had lost or left between January 2007 and December 2009 because of plant or company closings or moves, insufficient work, or the abolishment of their positions or shifts.

Moreover, older workers displaced between 2007 and 2009 are more likely to be in the following industries: construction (10.4% of the total displaced workers), retail trade (10.12% of the total displaced workers), professional and teaching (6.44% of the total displaced workers) and health care service (5.06% of the total displaced workers), a pattern that is shared among displaced workers of all ages during the same period of time.

Reason of Displacement

Reason of job displacement is one of the many factors that affect reemployment prospect, and therefore post-displacement decisions and outcomes. In January 2010 DWS, respondents are asked the question "Which of these specific reasons describes why you are no longer working at that job?"[8] Answers to this question are summarized in table 7, for different age groups and genders.

Table 7: Reasons of Displacement. Percentage Distribution. By Age Group. 2007-2009.

Age	Total	Plant Closed or Moved	Insufficient Work	Position or Shift Abolished
total, 20 years and over	6,864	24.85%	53%	22.14%
20 to 24 years	599	24.54%	61.44%	14.02%
25 to 39 years	2,483	24.45%	55.58%	19.98%
40 to 54 years	2,480	24.52%	51.81%	23.67%
55 to 69 years	1,208	26.41 %	46.36%	27.24%
70 years and over	94	25.09%	47.31%	27.60%

Source: CPS DWS January 2010.
Note: Data refer to persons who had 3 or more years of tenure on a job they had lost or left between January 2007 and December 2009 because of plant or company closings or moves, insufficient work, or the abolishment of their positions or shifts.

[8]There are six reasons to choose from: plant or company closed down or moved, insufficient work, position or shift abolished, seasonal job completed, self-operated business failed, and some other reason. In this dissertation, only the first three types of displaced workers are studied.

As seen from the table, in general, people of different ages do not perform much difference in terms of the reason being displaced except that older although older workers are more likely to be displaced because of abolished position or shift rather than insufficient work. The result holds true when controlling for characteristics such as gender and education.

Post Job Displacement Labor Market Status

According to the January 2010 CPS DWS release, 49% of the 6.9 million long-tenured (with 3 years or more tenure) displaced workers were reemployed, down from 67% for the prior survey released in January 2008. This is also the lowest reemployment rate on record for the entire DWS series, which began in 1984. [9]

While nearly people of all ages, genders and races participate in the labor market more actively than anytime in history, it is worth mentioning that different age groups are significantly different in terms of post-displacement labor market status. As shown in table 8, while about the same percentages of the displaced workers are unemployed and actively looking for a job among all age groups, those who are 55 years and older are less likely to be employed after displacement and more likely to become discouraged and drop out of the labor force compared to the younger age groups, regardless of their gender, the types of work they do and how long ago the displacement took place.[10]

Not only do the prospects of older displaced workers look less optimistic than their younger competitors, their reemployment rate is significantly lower than the general population, especially within the first two years of losing their jobs. For those aged between 50 and 69, the reemployment rate is only 32.17% within one year of job displacement. it increases to 44.01% within two years but still significantly less than the 54.09% working percentage among the general populations within that age range, and catches up not until after 3 years of displacement, considering the facts that more 40% of

[9]The numbers improved in the January 2012 DWS release. From January 2009 through December 2011, 6.1 million workers were displaced from jobs they had held for at least 3 years, the U.S. Bureau of Labor Statistics reported today, 56 % of workers displaced from 2009 - 2011 were reemployed at the time of the survey, up by 7 percentage points from the prior survey in January 2010.

[10]Although males display slightly smaller differences in general compared to females and differences are larger for the 70 and older when retirement becomes a common option.

Table 8: Post Displacement Labor Force Status. Percentage Distribution. By Age Group. 2007-2009.

	Number	Em-ployed	Unem-ployed	O.L.F. Total	O.L.F. Retired	O.L.F. Disabled	O.L.F. Other
Total, 20 and above	**80,783**						
24 and below		60.33	11.43	28.24	0.03	1.90	26.32
25-39		75.85	8.07	16.08	0.03	2.75	13.30
40-54		77.72	6.44	15.83	1.18	6.23	8.42
55-69		54.09	3.77	42.14	28.24	9.21	4.69
70 and above		9.84	0.59	89.56	84.68	3.37	1.50
Total, displaced	**6,864**						
24 and below		48.25	37.23	14.52	0.00	0.50	14.02
25-39		54.93	34.39	10.67	0.00	0.85	9.83
40-54		50.93	39.35	9.72	0.40	1.49	7.82
55-69		41.38	36.34	22.27	10.60	3.39	8.28
70 and above		18.09	26.60	55.32	43.62	2.13	9.57
Displaced in 2009	**3,440**						
24 and below		41.38	44.54	14.08	0.00	0.00	14.08
25-39		45.26	45.10	9.64	0.00	0.56	9.08
40-54		40.52	50.90	8.58	0.25	1.06	7.27
55-69		32.17	45.10	22.73	11.01	2.27	9.44
70 and above		14.63	41.46	43.90	36.59	2.44	4.88
Displaced in 2008	**2,114**						
24 and below		55.98	27.72	16.30	0.00	0.54	15.76
25-39		61.73	26.61	11.66	0.00	0.66	11.01
40-54		55.78	33.07	11.16	0.53	1.99	8.63
55-69		44.91	32.64	22.45	10.18	4.44	7.83
70 and above		19.35	22.58	58.06	48.39	0.00	9.68
Displaced in 2007	**1,119**						
24 and below		67.86	17.86	14.29	0.00	3.57	10.71
25-39		73.42	14.94	11.65	0.00	2.03	9.62
40-54		70.77	18.79	10.44	0.70	2.09	7.66
55-69		58.53	21.66	19.82	11.06	4.61	4.15
70 and above		20.00	5.00	75.00	55.00	5.00	15.00

Source: CPS DWS January 2010.
Note: Data refer to persons who had 3 or more years of tenure on a job they had lost or left between January 2007 and December 2009 because of plant or company closings or moves, insufficient work, or the abolishment of their positions or shifts.

the general population of that age are already inactive (mostly retired) in the labor market. Although it is difficult for older displaced workers to find a new job, a substantial percentage of them still decide to look for new jobs, hence unemployment rate is extremely high among them.

2.3.2 Stylized Unemployment Facts

American workers have been facing one of the worst performed labor market that the recent economic recession has to offer.

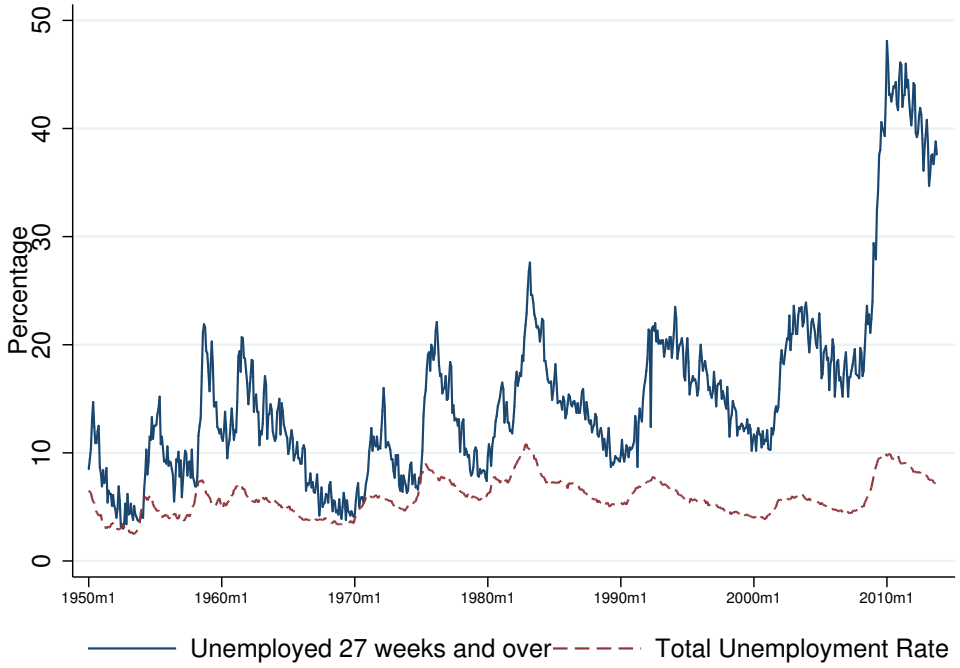


Figure 3: Persons Unemployed 27 Weeks and Over as Percent of Total Unemployment and Total Unemployment Rate. BLS. 1950-2013.

As shown in figure 3, more than 35% of the unemployed workers were unemployed for at least 27 weeks (beyond the 26 weeks of regular UI coverage) between 2008 and 2012. The proportion of long-term unemployed exceed 45% in 2010, a historical high that the U.S. economy has not witnessed since

1950[11]. It was not the first time an above-10-percent unemployment rate was observed in history, yet the worst time for potential job seekers. There was not a time when more than 30% of the unemployment out-lasted for UI coverage, so that the government had to enforce a UI with 99 weeks of coverage to support the workers through this difficult downturn.

Older workers have been experience the same difficulties in finding new jobs, if not worse. According to BLS statistics releases, in 2012, unemployment rate of those who are 55 to 64 years old was 5.9, much lower than the national average 8.1% and that among the prime-aged workers at 7.0%. However, the average unemployment duration for the older age group was 54.6 weeks and it took a median old job seeker 30.9 weeks to find a new jobs or otherwise get discouraged and drop out of the labor force, while the average unemployment duration of the entire labor force was 39.4 weeks and the median 19.3 weeks. 53.3% of the unemployed old were unemployed for 27 weeks and over, compared with the 41.1% national average. The same situation happened in 2010 when the labor market sank to the bottom, older workers are on average unemployed for 41.1 weeks (33.0 weeks for all civilian labor forces) and 54.2% unemployed for 27 weeks and over (43.2% for all civilian labor forces). Among the 2.1 million unemployed older workers, only 13.2% of them were reemployed within 5 weeks. The numbers are more or less consistent in other years, suggesting older workers have a more difficulty time in find a job, especially during labor market melt-downs.

[11]BLS Statistics of such dated back only to the 50s.

Chapter 3

The third chapter presents the benchmark structural model where decisions of the working old are optimized in a constrained utility maximization life-cycle framework. The model is then solved and estimated using data from the Health and Retirement Study (HRS) using a *FORTRAN* program. Policy analysis are performed. Consequences of a more generous UI policy in terms of coverage and benefit levels are analyzed, both for the mean individuals and across the distributions of wealth and income.

The structural model employed in this chapter helps understanding the decision-making mechanism by rationalizing the behaviors of the working old through the interactions of their motivation, constraints and the environment, an advantage that reduced-formed econometric models lack.

3.1 The Benchmark Model

In the benchmark model with finite horizon and discrete time, a representative agent maximizes his or her expected discounted life-time utility subject to his or her financial budgets, as well as uncertainties from the labor market and in life expectancy. The time unit is year.

One of the key attributes to the model is that Social Security Old-Age Benefits (OA) claim decisions are independent of the labor market decisions, and retirement is defined when the agent withdraws from the labor market, regardless of their claim status nor coming back decisions later on. Although it increases the state space and the choice space and adds computational complexity to modeling, it is crucial to the analysis of the problem. Retirement (withdrawal from the labor market) is modeled to be non-absorbing, which agrees with what can be observed from data where retirement is reversed quite often, especially within the first two years of one's initial retirement attempt. Meanwhile, OA claim decision is absorbing and non-reversible.[12] Additionally and as assumed in many similar models, the labor market is non-frictional and information is perfect so that matching is not an issue that the model should concern.

[12]The current regulations allow someone to revise OA under some circumstances. However, reversion rarely happens in real lives which is also suggested in the sample data used, not to mention that allowing such reversions would greatly complicates the model.

3.1.1 Utility and Budget Constraints

At age t, the separable additive period utility U_t is the summation of consumption from consumption $u_c(.)$, disutility of work $l^i(.)$ and a bequest-like residual $v_t(.)$. I assume CRRA for $u(.)$ and $v(.)$ with $1/\gamma$ as the elasticity of substitution. Leisure is the disutility of work and depends on the labor market status, and it is assumed to be an an increasing function of age t, that is, leisure is more appreciated at an older age.

The bequest-like residual is specified in (4). Similarly to the realization of a classic bequest, the agent dies at a mortality rate of m_t and leaves his or her total assets at the end of that period (or at the beginning of the next period) to the children generation. However, the bequest factor k_{bq} is bounded between 0 and 1 in a classic bequest motive, with 0 as the agent being completely selfish and indifferent toward the wellbeing of the next generation and 1 as the agent being completely altruistic. The residual term used in this model, on the other hand, captures various motives in addition to pure bequest incentive. Those incentives include precautions savings for healthcare and housing which are important aspects in life-cycle models in order to properly model end-of-life behaviors, just like bequest. Since exploring those incentives are not the main purpose of the model, all relevant incentives are summarized in a single residual term for efficiency's sake. As a result, k_{bq} does not have an obvious upper bound although a lower bound of 0 still applies. Also, the same risk-aversion parameter γ is assumed for the residual term. That is, inter-temporarily, the agent values a dollars spent on consumption the same way as a dollar saved up in the bank, regardless of the future purpose of the savings.

$$U_t = u_c(c_t) + l^i(t) + v_t(a_{t+1}) \tag{1}$$

$$u_c(c_t) = \frac{c_t^{1-\gamma} - 1}{1-\gamma} \tag{2}$$

$$l^i(t) = \delta_1^i + \delta_2^i \log(t), i \in \{w, nw\} \tag{3}$$

$$v_t(a_{t+1}) = k_{bq} m_t \frac{a_{t+1}^{1-\gamma} - 1}{1-\gamma}, k_{bq} \geq 0 \tag{4}$$

Since working full-time and part-time are not distinguished in the model, time is not of the essence and the only binding constraint is the budget constraint. Let y_t be the period income from the labor market, it equals the working wage w_t if one is working, or it equals one's UI benefits b_t if qualifications of UI receipts are met. Outside the labor market, the agent could be receiving a retirement benefits rb_t if he is at least 62 years old (ERA) and chooses to $(oa = 1)$. Let c_t be the period consumption, the net assets a_t is then accumulated over time with a fixed interest rate r. Without borrowing[13], the budget constraint can be written as:

$$a_{t+1} = \big(a_t + y_t + rb_t\{oa = 1\} - c_t\big)\big(1 + r\big), \forall t \in (0, T) \tag{5}$$

$$a_{t+1} \geq 0, \forall t \in (0, T) \tag{6}$$

3.1.2 Wage Evolution

Working wage w_t is received only when the agent is working and remains constant for the same job. There is no wage growth over time nor tenure[14]:

$$w_t = w_{t-1} \tag{7}$$

When not working, one receives job offer $\tilde{w}_t$ that is a decreasing function of age t. Additionally, I assume the error term ϵ_t is independent and identically distributed (*i.i.d.*) and follows a log normal distribution. There is no punishment on the length of unemployment durations. Wage distribution is assumed to be homogenous across all individuals.[15]

[13]The natural borrowing limit or another borrowing limit can be modeled as well, however, considering that the agents in the model are fairly old and not as active in the borrowing market as their younger peers as indicated in the data, including one more parameter to solve and estimate would only contribute to the computational time and complexity without adding more accuracy in modeling the problem.

[14]Statistics from both CPS and HRS shows that for workers in their late 50s and 60s, wage growth is typically very slow, as opposed to young and prime age workers.

[15]While heterogeneities do exist across education levels, industries, regions of residences and etc, those characteristics are not the emphasis of the model and incorporating them will case significant increase in computational times. Moreover, job turnover among older workers are relatively low and data suggest that new wages are rather determined by age, instead of the previous wages which are determined by those unattended characteristics.

Therefore, [16]

$$\log(\tilde{w}_t) = \rho \log(t) + \log(\epsilon_t) \tag{11}$$

$$\log(\epsilon_t) \sim N(\mu, \sigma^2) \tag{12}$$

3.1.3 Unemployment Benefits

The benchmark model follows all the institutional details of the current Unemployment Insurance (UI) program as presented in section 2.1.

The agent qualifies for an UI benefit payment only when he is involuntarily separated from the job and enters unemployment afterwards, hence UI is not granted when the quitting is voluntarily. Also, UI is only available up to the maximum coverage periods $\bar{N}_b$. At time t, the amount of UI benefits depends on the last worked-on wage $\hat{w}_t$, and a replacement ratio of ζ and a maximum payable amount $\bar{B}$ apply. Let du_t be the duration of UI receipt at time t, UI benefit level b_t can be determined using the following equation:

[16] Alternatively and as employed by a handful of previous studies, it can be assumed that when not working, one receives job offer $\tilde{w}_t$ that follows an AR(1) process on the last observed working wage $\hat{w}_{t-1}$. Additionally, the same assumptions that the error term ϵ_t is *i.i.d.* across time and a standard normal and that no punishment is placed on unemployment durations hold. As a result, the wage offer $\tilde{w}_t$ and its conditional and unconditional mean could be written as:

$$\tilde{w}_t = (1-\rho)\mu + \rho\hat{w}_{t-1} + \sigma\epsilon_t \tag{8}$$

$$\tilde{w}_t \sim N((1-\rho)\mu + \rho\hat{w}_{t-1}, \sigma^2) \tag{9}$$

$$\tilde{w}_t \sim N(\mu, \frac{\sigma^2}{1-\rho^2}) \tag{10}$$

Both assumptions are tested using the same benchmark model. While the alternative AR(1) assumption is able to produce a smooth wage profile and therefore average wage (OA benefits) profile, it fails to capture the rapid decreases in the mean working wages and wage offers as the workers age. Also, the sample HRS data used in my dissertation display a weak correlation between the new jobs and the previous jobs, especially under the circumstances of involuntary job separations and longer gaps. The original assumption, on the other hand, captures the decreasing wage trend and reduces the computational time and effort, with the smooth wage profile being achieved to some extent as a result of the endogenous decisions of the workers.

$$b_t = \begin{cases} \min(\zeta \hat{w}_t, \bar{B}) & \text{, if } du_t \leq \bar{N}_b \\ 0 & \text{, if } du_t > \bar{N}_b \end{cases} \tag{13}$$

Note that in the benchmark, $\bar{N}_b$ is 26 weeks (or 0.5 periods in the annual model), therefore those who receive UI benefits last period are not entitled to UI receipt this period. However, a state variable du_t is still assigned and kept track of so that the model can allow UI coverage to be extended to more than 52 weeks (or 1 period in the annual model) for the purpose of policy analysis.

Also, without the geographic code being available at the time, I use the national averages for both ζ and $\bar{B}$ even if these two parameters are varied across different States. The weighted averages are calculated using state-specific values of ζ and $\bar{B}$ as listed in table 1 and state-specific workforce sizes. As a result, the average replacement rate is 0.5 and the average maximum weekly UI benefit amount is \$600.

3.1.4 Retirement Benefits

In this model, the only type of retirement benefits considered is OA benefits, the most commonly available retirement benefits in the United States. It has many more beneficiaries compared to 401K and other private pensions. Also, it is more challenging to model OA and policy-wise, OA offers more insights and fits the purpose of my research better.

Calculations of OA benefits follow the current laws and regulations as presented in section 2.2 except for the Average Indexed Monthly Earnings (AIME). In practice, AIME is calculated as the average of the indexed wages from an individual's 35 highest paid years. In this model, however, it is impractical to keep track of an individual's entire earning profile or to keep replacing the lowest wage (including zero wages) each period if a higher wage is observed. Also, since HRS only records informations of up to five previous jobs upon the respondents' entry in the survey when they are in their late 40s or early 50s, the complete wage profile is not available for use. As a result, approximation is used. The current average wage $\bar{w}_t$ is specified as a linear function of the previous average wage $\bar{w}_{t-1}$ and the current non-zero working wage w_t. It is important to point out that zero wages are excluded when computing the average wages for two reasons. First of all, the majority

of the agents in this model have already worked 40 quarters by the age of 55 and including zero wages is essentially replacing the previous positive wages, a directly contradiction to the OA calculation rule. Secondly, it would raise possible bias when the agents strategically accept extremely lower offers instead of remaining unemployed and waiting for a better offer to come, so that consequent lower retirement benefits resulted from the replacement of zero wages can be avoided. Logarithm wages are used in implementations.

$$\log(\bar{w}_t) = \kappa_0 + \kappa_1 \log(\bar{w}_{t-1}) + \kappa_2 \log(w_t), w_t > 0 \tag{14}$$

Meanwhile, I assume that the logarithm of initial average wage $\bar{w}_0$ is a deviation from the logarithm of initial observed wage w_0, so that it is consistent with the above assumption in $\bar{w}_t$. w_0 is obtained as initial conditions from the sample HRS data.

$$\log(\bar{w}_0) = \log(w_0) + log(\epsilon_0), w_t > 0 \tag{15}$$

$$\log(\epsilon_0) \sim N(\mu_0, \sigma_0^2) \tag{16}$$

Let PIA_t be the unadjusted retirement benefit amount granted if claim OA at age t, it is then calculated as a piece-wise linear function of average wage $\bar{w}_t$ at age t, upon the satisfactions of OA eligibility. Note that both PIA_t and $\bar{w}_t$ are monthly measurements and need to be converted to annual measurement before using. Benefit structures used in equation (17) are excerpted from year 2000 when most of the respondents started to retire in the sample.

$$\text{PIA}_t = \begin{cases} 0.9 * \bar{w}_t & \text{, if } \bar{w}_t \leq 680 \\ 0.9 * 680 + 0.32 * (\bar{w}_t - 680) & \text{, if } 680 < \bar{w}_t \leq 4100 \\ 0.9 * 680 + 0.32 * (4100 - 680) + 0.15 * (\bar{w}_t - 4100) & \text{, if } \bar{w}_t > 4100 \end{cases} \tag{17}$$

The actual retirement benefits rb_t received is adjusted by OA claiming age as shown in table 9. After age adjustment, for those who are working while receive OA benefits before NRA, earnings test applies. UI benefits receipts are not subject to earnings test.

Table 9: Age Adjustment on OA Benefits: the Benchmark Model

OA take-up age	**Age adjusted** rb_t
62	80.0% * PIA_t
63	86.7% * PIA_t
64	93.3% * PIA_t
65	100% * PIA_t
66	108% * PIA_t
67	116% * PIA_t
68	124% * PIA_t
69	132% * PIA_t
70	140% * PIA_t

3.1.5 Labor Market Transitions

In the benchmark model, there are two labor market status: working and not working. Correspondingly, there are four types of transitions: from working to not working, from not working to working, from working to working and from not working to not working.

The Assumptions

According to the definitions of BLS[17], for those who are not working, there are the unemployed who are or have been actively searching for jobs and there are those who are just out of the labor force (O.L.F.). The benchmark model, however, does not separate those two groups, for three reasons. First of all, with non-absorbing retirement (the same as withdrawal from the labor market) being one of the key characteristics of the model, those who opt out of the labor market can receive job offers and make a return just like the unemployed individuals and there is no strong evidence suggesting significant differences between the probabilities of them receiving jobs offers nor returning. More importantly, the survey data are too vague to differentiate between those two status, which is a common issue existing in many other similar data sets. Even though instead of relying on the self-reported labor force status, additional questions about searching activities can be used to

[17]See Appendix: Definitions and Concepts.

identify one's true labor market status, the information collected are often self-contradictory and identification issues predominates unless searching intensities are modeled too, which presents another challenge to solving and estimating the model. Last but not least, in this model with yearly time unit, the 55 years plus agents frequently become discouraged after actively searching (being unemployed) for a few months and they stop looking within the same year. Unless a quarterly or monthly model is established, which is computationally more changeling and also calls for somewhat questionable de-aggregations in many variables, it is almost impossible to model the change of status within the period.

Nevertheless I do separate those who are laid off to become jobless from those who voluntarily quit their jobs by only allowing the displaced agents to claim UI. Also, I assume that there is no on-the-job search hence no switch directly from job to job which accommodates the target age group and reduces computation intensities considerably.

The Transitions

For an agent who is working at age t, there is a probability of θ_t that he or she is displaced from the job, and when that happens, the agent stays out of a job for the rest of the period and receives a 26 week unemployment benefits. He or she can choose not to continue to work at the same wage by quitting and therefore not eligible for the receipt of UI. If the agent is not working at t, there is a probability of λ_t that an offer arrives should he or she choose to accept or not. The wage of the offer is determined by the process introduced in section 3.1.2. When no offer arrives, he or she stays not working by default.

Modeling and estimating θ_t and λ_t in together with all other parameters can bring some identification issues. In a nutshell, θ_t and λ_t are exogenous to the model and if treated endogenously, it is difficultly to separate them from the acceptance decision-process. Therefore, I construct from March CPS (1990-2013) the actual involuntary job separation rates and job finding rates, and use them as upper and lower bounds in estimating θ_t and λ_t, respectively. Numerically, both θ_t and λ_t are specified as a function of age t as below:

$$\theta_t = \frac{1}{1 + \exp(-\theta_1 - \theta_2 t)} \tag{18}$$

$$\lambda_t = \frac{1}{1 + \exp(-\lambda_1 - \lambda_2 t)} \tag{19}$$

3.1.6 Bellman Equations

As can be seen from the above, the benchmark model can be formulated as a dynamic programming (DP) problem so that the multi-period maximization problem is broken into relatively simpler steps at different points in time. When solving and estimating the DP problem, it requires keeping track of how the decision situation is evolving over time. Table 10 specifies the state variables (the endogenous situations), control variables (the decisions) and exogenous shocks (the environment) in this problem.

Table 10: The DP Problem: States, Controls and Exogenous Shocks

	Variables
States	Age (t)
	Labor market status (dla)
	Asset (a)
	Average wage ($\bar{w}$)
	OA receipt (oa)
	Workers: current working wage (w)
	Non-workers: last observed wage ($\hat{w}$)
	Non-workers: duration of UI receipts (du)
Controls	Next period's assets (a')
	Labor market decisions (dla')
	OA claim decision(oa')
Exogenous shocks	Mortality (p_s)
	Layoffs (θ)
	Arrival of job offers (λ)

Let V_1 and V_2 be the values for working and not working, respectively. Note that $t' = t + 1$ by default, and the following bellman equations hold:

$$V_1(t, a, w, \bar{w}, oa) = \max_{a', dla', oa'} \Bigg\{ u(t, c, l, bq) + p_s \beta \Big[\theta V_2(t', a', \hat{w}', \bar{w}', oa', du') + (1 - \theta) \max \big\{ V_1'(t', a', w', \bar{w}', oa), V_2(t', a', \hat{w}', \bar{w}', oa', du') \big\} \Big] \Bigg\}$$

subject to,

$$\big(a + w - c + rb[oa = 1]\big)\big(1 + r\big) = a' \tag{20}$$

$$V_2(t, a, \hat{w}, \bar{w}, oa, du) = \max_{a', dla', oa'} \Bigg\{ u(t, c, l, bq) + p_s \beta \Big[(1 - \lambda) V_2(t', a', \hat{w}', \bar{w}', oa', du') + \lambda \max \Big\{ \int_w V_1'(t', a', w', \bar{w}', oa)\, dw, V_2(t', a', \hat{w}', \bar{w}', oa', du') \Big\} \Big] \Bigg\}$$

subject to,

$$\big(a + b[du \leq \bar{N}_b] - c + rb[oa = 1]\big)\big(1 + r\big) = a' \tag{21}$$

3.2 Solving the Model

Backward induction is used in solving the above bellman equations. Since no closed-form solutions can be obtained, the mode is discretized and solved numerically with value function iteration, using a computer program written in *FORTRAN*.

To implement the algorithm, variables are firstly discretized using lower bound and upper bound obtained by data, as shown in table 11. The maximization problem is then solved inter-temporally, starting from the last period of life to the first period, in reverse orders. Also, all events of uncertainties and interests earned happen at the beginning of each period, so are the decision-makings.

Table 11: The DP Problem: Model Discretization

Parameter		**Value**
a_{min}	Assets lower bound	1000
a_{max}	Assets upper bound	650,000
w_{min}	Wage lower bound	5000
w_{max}	Wage upper bound	105,000
rb_{min}	OA benefits lower bound	100
rb_{max}	OA benefits bound	30,000
N_a	Grid points: assets discretization	42
N_w	Grid points: wage discretization	26
N_{rb}	Grid points: OA benefits discretization	24

Start off by solving the step-by-step problem at age T[18]. It is the last period anyone will survive in the model and everyone dies with certainty at the beginning of age $T+1$. Meanwhile, labor market uncertainties such as layoffs and offers strike. Three decisions are to be made: asset decision (a_{T+1}), labor market decision (dla_T) and OA claim decision (oa_T). Under extreme cases when the bequest factor k_{bq} equals zero, the agent is completely selfish and does not care about the next generation, a_{T+1} is optimized at zero. On the contrary, when k_{bq} equals the upper bound (or 1 as in the classic bequest framework), the agent is completely selfishness in which case the he or she consumes only the minimum consumption level allowed and leaves all wealth (accumulated assets at the beginning of age T plus all incomes during T) to the descendants. For k_{bq} that is between zero and the upper bound, instead of maximizing by obtaining the first order condition of the objective function, value function iteration algorithm is used to find the optimality. That is, at age T, given the value of all the state variables, calculate the utility levels associated with different sets of choices that are either discretized (a_{T+1}) or are discrete themselves (dla_T and oa_T). For uncertainties that are yet to happen, expected values are used. The set of choices that delivers the highest utility is the optimal choice set, or the "policy" for that particular set of states, and that highest utility value (value of the optimized objective function) is stored in $V_1(T,.)$ or $V_2(T,.)$ accordingly, depending on whether the agent is working or not at the beginning of age T. $V_1(T,.)$ and $V_2(T,.)$

[18] $T = 100$ in the benchmark model.

are arrays whose dimensions agree with the number of state variables and the number of values each state variable can take. Repeat the above process for all the possible combination of the state variables until all components of $V_1(T,.)$ and $V_2(T,.)$ are filled for age T.

Next, move backwards to age $T-1$ where a mortality rate of m_{T-1} in together with exogenous labor market shocks occur. The optimal "policy" is consisted of the three decisions the same as at age T by comparing the value of the utility levels resulted from each alternative set of choices and picking the highest. Only this time, the value of the objective function is the summation of today's utility and the discounted expected utility (calculated using $V_1(T,.)$ and $V_2(T,.)$) of tomorrow at age T that has already been optimized. Hence the only relevant choices are today's with tomorrow's choices already being taken care of by the previous step. That is how the multi-period DP problem is broken down into simpler inter-temporary problems. Finally, results are stored in $V_1(T-1,.)$ and $V_2(T-1,.)$ for the working and non-working agents, respectively.

The same algorithm is implemented till $V_1(.)$ and $V_2(.)$ are filled for all ages considered in the model, and "policy" rules are obtained for combinations of the states including age. The benchmark model is hence solved, numerically. The value functions $V_1(.)$ and $V_2(.)$ as well as the "policy" rules are what I use to simulate and estimate the benchmark model later on.

3.3 The Data

Before the model can be used for real policy analysis, it must be applied to a set of real people and proven to be well-fitting. That is, to estimate the model by finding a set of optimal parameters so that behaviors predated by the model match behaviors of the actual people in life. I use HRS for estimation, a good quality representative panel dataset that fits the needs and purpose of the model. Specifically, RAND contributed HRS data (version L) is used as the main panel for obtaining general information such as identification number, birth and death, enter and exit, interview status and etc, mainly for selecting the sample. Most of the time-variant variables used in the model, including wealth, income, OA claiming and labor market behaviors, are directly extracted from individual RAND contributed Fat Files (1992-2010, wave 1 to wave 10) and merged to the main panel.

3.3.1 The Health and Retirement Study

HRS is a large-scale longitudinal panel study conducted by the University of Michigan, and supported by the National Institute on Aging and SSA. It explores the labor force participation and health transitions that individuals undergo toward the end of their work lives and in the years that follow, and helps explain the antecedents and consequences of retirement. Since its launch in 1992, HRS surveys more than $22,000$ Americans over the age of 50 on a biannual basis.

Unlike most survey studies, HRS includes new cohorts over time when they reach the due age, and six such birth cohorts (sub-sample groups) have been surveyed in HRS: the original 1992 HRS cohort; the 1993 Study of Assets and Health Dynamics (AHEAD) cohort; the Children of Depression (CODA) and War Baby (WB) cohorts entering the sample in 1998 when the original HRS and AHEAD studies merged; and the Early Baby Boomer (EBB) cohort entering the sample in 2004; and finally, Mid Baby Boomer (MBB) cohort entering the sample in 2010.

HRS collects information about income, work, assets, pension plans, retirement expectations, health insurance, health expenditure, disability, physical health and functioning, cognitive functioning and health care expenditures of the representative respondents. The rich and in-depth information it has collected and the panel nature of the data set fit the purpose of this research.

3.3.2 Selecting the Sample

Two birth cohorts are used: those who were born before 1940 and those who were born between 1940 and 1954. According to SSA and as explained earlier in section 2.2, those who were born in and prior to 1937 have a NRA of 65 years and 0 months. NRA is then increased by 2 month for each year born later till 1942. Those born between 1943 and 1954 have a NRA of 66 years and 0 months. With most of the variables unavailable on a monthly or quarterly basis, an annual model is adopted and NRA is rounded. The following assumptions hold: any OA take-up happening during the first half of the year is considered to be the decision made at the beginning of that same year, and OA take-up during the second half of the year is the decision made at the beginning of the next year. Hence, in this model, the first cohort is assumed to have a NRA of 65 and the second cohort is assumed to have

Table 12: Sample HRS Descriptive Statistics ($N = 2,639$)

Demographics	
Male	52.56%
White/caucasian	85.26%
Black/aferican american	11.25%
Less than high-school	16.02%
GED	5.84%
High-school graduate	35.94%
Some college	22.58%
College graduate and above	19.62%
Northestern	16.57%
Midwest	26.67%
South	40.36%
West	16.40%
Birth cohort	
NRA of 65	59.19%
NRA of 66	40.81%
Panel starting age	
55	28.87%
56	30.35%
57	12.54%
58	11.37%
59 and above	16.87%
Years in the Panel	
5 to 8	4.93%
9 to 11	20.34%
12 to 14	42.30%
15 to 16	32.43%

Source: HRS sample, selected from HRS 1992 - 2010.

a NRA of 66. Particularly, the birth cohort with a NRA of 65 is used to estimate the benchmark model where their retirement process completed in full (up until 68 years old) before 2008 when UI coverage was still 26 weeks[19].

In addition to being selective about the NRA, to avoid modeling OA eligibility, I exclude those who have worked less than 10 years (40 quarters) at the age of 61 from the sample, which is less that 5%. Also, I drop the disabled population considering that disability may impair working ability and therefore working decisions. Meanwhile, I restrict the starting age and exit age and require the final eligible sample to be staying in the panel for at least 6 consecutive years[20]. Other sample selection rules apply, including those at the far end of wealth and income distributions. Those with too much inconsistent or invalid information recorded and cannot be recovered from answers to other survey questions are also carefully examined and ruled out.

As a result, I have a relatively small but still convincing sample of $2,639$ agents. Table 12 presents the descriptive statistics of the HRS sample. As can be seen from the table, the sample is representative with 52.56% male, 85.26% white and 78.14% with at least a high school diploma. Geographically, 40.36% of the sample live in south which is relatively concentrate but consistent with HRS sampling. Meanwhile, around 60% of the respondents start to be observed when they are 55 or 56 years old, and about 75% of the respondents stay in the sample for 12 years or more, which offers comparable moments that the dynamic model can be matched with.

3.3.3 Stylized Facts of the Sample

Table 13 and table 14 present the detailed OA claim and labor market facts of the sample cohort whose NRA is 65. The facts are consistent with what can be observed in data sets other than HRS[21]: There are two spikes with respect to OA claiming age distribution, one at age 62 (ERA) when almost half of the eligible population make a claim and the other at age 65 (NRA) when more than 20% decide to claim. At the same time, labor

[19]Estimation has also been done using both cohorts by solving the benchmark model twice with different NRA's, some shared general parameters and other cohort specific parameters. However, for the purpose of analyzing the effects of UI coverage change from 26 weeks to 99 weeks, only results from the single cohort with NRA of 65 is presented.

[20]Not necessarily 3 consecutive waves as long as the gaps can be filled up.

[21]For example, CPS and the public-used and summarized data released by SSA.

Table 13: Sample HRS Old-Age Benefits Claiming Facts (NRA=65)

OA claim age	**N(%)**	**Mean**	**Min**	**Max**
Non-claimants, total	**96**	—	—	—
Claimants, total	**1466**	**9970.22**	**433.81**	**28375.78**
62	49.32%	9162.77	433.81	28375.78
63	14.12%	9386.23	952.26	23838.28
64	8.66%	10401.81	583.40	18281.37
65	22.10%	11457.27	449.22	26150.63
66	4.37%	11948.36	641.74	23336.04
67 and above	1.43%	11944.31	1496.98	19765.56
Male claimants,total	**778**	**11369.46**	**433.81**	**26150.63**
62	48.33%	10680.37	433.81	25084.53
63	13.88%	10755.16	1488.40	23838.28
64	8.87%	11468.14	851.76	18281.37
65	22.75%	12685.03	1120.13	26150.63
66	4.63%	13037.60	641.74	23336.04
67 and above	1.54%	13512.98	1496.98	19765.56
Female claimants,total	**688**	**8387.942**	**449.22**	**28375.78**
62	50.44%	7518.34	1240.34	28375.78
63	14.39%	7892.86	952.26	18052.26
64	8.34%	9133.26	583.40	17942.69
65	21.37%	9978.93	449.22	25917.21
66	4.07%	10547.91	1277.55	19160.55
67 and above	1.39%	9852.76	2023.05	18530.22

Notes:

[a] Sample selected from HRS 1992 - 2010, wave 1 - wave 10.

[b] All measurements are in 2000 dollars.

Table 14: Sample HRS Labor Market Facts (NRA=65)

Age	**Work**	**Non-work**	**Stop working**	**reemploy**	**Ave. wage**
55	92.67%	7.33%	—	—	32602.41
56	88.99%	11.01%	4.39%	34.21%	31658.97
57	87.06%	12.94%	4.76%	34.65%	31868.59
58	84.26%	15.74%	5.24%	26.26%	31863.67
59	82.16%	17.84%	5.55%	23.14%	30414.06
60	77.07%	22.93%	8.63%	14.44%	30653.06
61	73.68%	26.32%	9.31%	15.38%	30170.30
62	64.10%	35.90%	16.93%	10.80%	30030.59
63	52.33%	47.67%	25.21%	12.22%	28223.87
64	46.30%	53.70%	21.34%	10.22%	27751.59
65	40.74%	59.26%	24.46%	11.50%	25218.29
66	33.94%	66.06%	31.57%	9.68%	24656.31
67	33.31%	66.69%	23.89%	11.94%	22169.07
68	29.45%	70.55%	29.67%	8.75%	21859.96
69	30.00%	70.00%	23.71%	11.85%	21502.06
70	27.10%	72.90%	31.58%	9.07%	21611.99

Notes:

[a] Sample selected from HRS 1992 - 2010, wave 1 - wave 10.

[b] All measurements are in 2000 dollars.

supply decreases dramatically when OA early eligibility is reached at 62, and less than 30% of the sample agents are working after age 67. Decreases in labor force participation can also be seen from the increasing working to non-working transitions and the decreasing reemployment rates. Moreover, average working wage decreases substantially from $32,602 at age 55 to $21,612 at age 70, a significant drop that is more than 35%.

Also, note that claiming OA benefits does not necessarily indicate retirement from labor market. A same-person comparison between these two ages indicates that the two event could be independent: while 66.40% of the respondents are claiming OA while retired, 6.21% are retired with OA benefits and 9.97% are active in the labor market while receiving OA benefits. In fact, people typically make OA claiming decisions years ahead of withdrawing from the labor market, which can be seen from the differences between the average OA entitlement age and the average self-reported retirement age.

The age at the beginning of the wave that a respondent was first reported retired (including partially retired) is summarized in table 15. The mean age is 70.5 years old, and more than 50% of the respondents first reported themselves to be retirement after 70, among whom 50% were at least 77 years old and 25% were 83 years or older.[22]

Table 15: Sample HRS Retirement Facts: Age Retirement First Reported

	Age Group	**%**
No Retirement Reported (27.39%)		
Retirement Reported (72.61%)	Below 50	4.33%
	50-61	18.37%
	62-64	8.24%
	65-69	14.76%
	70 and above	54.32%

Source: HRS Sample. 1992 - 2010.

[22]Late-retirement behavior is overstated in this context since the statistics are obtained by taking the age at the beginning of a wave when a respondent first reported retirement and retirement could occur in between that wave and the one before. There are 8.26% of the respondents who were retirement at wave 1 but statistics do not change much by excluding them.

When follow the same respondents through all the waves they participated, the data shows a little less than 10% of the retirees revoke the retirement and came back to the labor market to either work (part time or full time) or to search for jobs. More than half of the return decisions were made within 2 years (1 wave) after the initial retirement decisions, and nearly 90% made within 6 years (3 waves). Among the returnees, more than half went back to the labor market for full time work, the rest part time work, and very returned to be unemployed and searching for new jobs. The distribution is fairly stable regardless of the timing of when to return to the labor market.

Table 16: Sample HRS Retirement Facts: Post Retirement Return Decisions

Return Decisions		%
Absorbing retirement (90.62%)		
Return after initial retirement (9.38%)	Return within 2 years	50.32%
	Return within 4 years	78.11%
	Return within 6 years	88.98%
	Return within 10 years	91.17%
	Return within 18 years	100.00%
	Full Time Work	56.03%
	Part Time Work	39.75%
	Unemployment(Searching)	4.21%

Source: HRS Sample. 1992 - 2010.

3.3.4 Current Population Survey

In addition to HRS, two sets of variables are constructed from CPS March Supplement (1990-2010): the age-specific lay-off rates and the age-specific reemployment rates, which are utilized to bound the estimation of the displacement rate (θ_t) and the offer arrive rate (λ_t) parameters respectively, with $\pm 50\%$ intervals. Note that without access to geo-code, the aggregate nationwide numbers are used.

Since the numbers of the 55 years and older can be quite noisy, primarily due to the small number of that age group participating in the labor force and very frequent turn-over of them, I approximate the two rates using data from the 40 to 55 years old age group. That is, rates of the 40 years old from data are used in approximation to the rates of the 55 years old in the model, rates of the 41 years old are used to approximate the rates of the 56 years old, and finally, rates of the 55 years old are used to approximate the rates of the 70 years old and above.

3.4 Estimating the Model

Different results are produced when different parameter values are used in the benchmark model. Estimation refers to the process during which a set of optimal parameters are obtained so that the behaviors predicted by the model are consistent with decisions of the real agents in life. In addition to solving the model as explained in section 3.2 , simulating the model is also part of the estimation process.

3.4.1 Simulating the Model

Unlike solving the model that starts from the last period and moves backwards, simulating takes forward motion where initial conditions are either assumed or taken from the data, and optimal decisions are made as time goes by upon the realization of various events, using the value functions $V_1(.)$ and $V_1(.)$ and the "policy" obtained earlier.

Start the simulation with $t = T_0$: obtain the initial conditions including assets, labor market status, most recent wage and UI receipt status from the data and calculate the average wage using formula (11) and (12). Generate sequences of random numbers for the realization of the four types of uncertainties: death, displacement, offers and wages of offers. Store the sequences in vectors for repeated uses.

At age T_0, the agent wakes up in the morning and all the uncertain events become certain. Firstly, death could happen and if it does, simulation ends. In case of survival, displacement could happen for a working agent, or an offer could arrive with certain wage if the agent is not working at T_0. Whether or not those events happen depends on the sequences of random numbers generate earlier and the value of relevant parameters. After all the uncertainties are realized, the agent makes the optimal decisions on labor

market status, consumption and OA claiming, knowing how much he or she can make during T_0 from working, UI and OA. While life at age $T_0 + 1$ and after remains uncertain, the agent has perfect information on the probabilities of each event happening and knows the value of his or her future when optimal decisions are made based on the expectations of those events from $V_1(T_0 + 1, .)$ and $V_1(T_0 + 1, .)$. Therefore, decisions at age T_0 are optimized when comparing different values of utility at T_0 from different choice sets, a process that is very similar as if $V_1(T_0, .)$ and $V_2(T_0, .)$ were calculated when solving the model, except that there are no uncertainties involving as of age T_0 since the agent known exactly whether the events happen or not at the very beginning of T_0.

Repeat the above process till death occurs or otherwise the maximum age allowed in the model is reached, and one simulation is completed. Ideally, the model should be simulated multiple time for each agent in the sample so that the Law of Large Numbers[23] holds. That is, take initial conditions of the first agent, simulate the model for a certain amount of times, move to the second agent with the same procedure, and repeat till the last agent in the sample are simulated.

In this dissertation, 100 simulations are conducted for initial conditions taken from each agent in the sample simulated and Monte Carlo integration is used when comparing the model with the data.

[23]Suppose that an experiment is performed to obtain the value of the random variable X and this experiment is repeated N times in an $i.i.d$ fashion, N independent copies of the random variable can be obtained, written as X_1,X_2,X_3,...,X_N. The random variables X_i have the same probability distribution, and therefore the same means and variance. The Law of Large Numbers states that the empirical average of X_i is very close to the true mean of X_i at a high probability if N is large enough:

$$Pr\left(\left|\frac{X_1 + ... + X_N}{N} - \mu\right| \geq \epsilon\right) \leq \frac{\sigma^2}{N\epsilon^2} \tag{22}$$

with

$$E(X_i) = \mu,\ varX_i = \sigma^2, i = 1, ..., N \tag{23}$$

Particularly, when $N \to \infty$, the right hand side of equation (22) goes to zero.

3.4.2 Estimation Strategy

The model is estimated using Method of Simulated Moments (MSM) introduced by McFadden (1989) and Pakes and Pollard (1989), and also in Gourinchas and Parker (2002).

To implement, generate an array of random numbers whose dimension is $4 \times N_{obs} \times N_{sim}$: 4 being the types of uncertainties the model embraces (mortality, displacement, offers and wages of offers), N_{obs} being the number of agents (observation) in the sample, and N_{sim} being the number of simulation conducted for each agent. Store the array for repeated uses each time a new set of parameters are tested for goodness of fit.

Next, simulate the model using initial conditions obtained from the data at age 55 with algorithm explained in section 3.4.1, calculate the moment statistics from the simulation results and compare them with the data. Repeat the process with different sets of parameters, however, using the same array of random numbers generated at the beginning of estimation for consistency. The optimal set of parameters is the one that minimizes the weighted sum of distance between the real moments and moments produced by the model. More specifically, Powell's conjugate direction method[24] is applied in searching and obtaining the optimal set of parameters to achieve the minimization of the weighted sum of differences.

Let x_i be the i^{th} moment observed in data, $\hat{x_i}$ the corresponding moment predicted by the model and ω_i the weight of that moment, then $\mathbb{F}_{MSM}$ is the sum of weighted differences of all N moments and the objective function to be minimized:

$$\mathbb{F}_{MSM} = \sum_{i=1}^{N} \omega_i \frac{(x_i - \hat{x_i})^2}{\hat{x_i}} \tag{24}$$

[24]This method employes a bi-directional search along each search vector (in turn) to minimize the objective function. During each iteration, it writes the new position as a linear combination of the search vectors. The new displacement vector then becomes a new search vector, and is added to the end of the search vector list, while deleting the search vector that contributed most to the new direction. The algorithm iterates until no significant improvement can be made or otherwise the preset maximum number of iteration is reached.

Table 17: Benchmark Estimation: Moments Selected in MSM

Moments	**Quantiles/Values**	**Periods**
Continuous Choice Distribution		
Assets	4	17 (age 55 to age 71)
Working wage	5	17 (age 55 to age 71)
OA benefit level (by age)	5	5 (age 62 to age 66)
OA benefit level (overall)	5	—
Discrete Choice Distribution		
Labor market status	2	17 (age 55 to age 71)
Labor market transitions	4	16 (age 56 to age 71)
OA take-up decisions (by age)	5	—
OA take-up decisions (overall)	2	—
Averages		
Average assets	—	17 (age 55 to age 71)
Average wage	—	17 (age 55 to age 71)
Average OA benefits (by age)	—	5 (age 62 to age 66)
Average OA benefits (overall)	—	—

Note: 71 is the maximum age observed in data.

Table 17 presents the statistics selected (the components of the objective function specified above) in SMM estimation. It also reports the number of quantiles used for continuous choice variables and the number of values used for discrete choice variables in constructing the choice distributions, as well as the number of periods when those choices are took into account. Monte Carlo integration is adopted for the averages. As shown in the table, five wage quantiles, five OA benefits quantiles and four assets quantiles are used in matching the choice distributions of the continuous choices. "Zero-one" values are used for OA take-up decisions and as for labor market outcomes, there are two status (working and not working) and therefore four transitions[25]. Also note that, OA take-ups and benefit levels are only matched up

[25]Those four types of transitions are, by definition: from working to not working, from not working to working, from working to working and from not working to not working. When calculating, however, only the first two transitions are included in calculating the weighted difference as the latter two are just their complements.

to 66 years old, and claiming behaviors beyond that is not taken into account, consistent with the conventions of the majority of the retirement literature. Other than that, all the choice variables are matched from 55 years old to 71 years old, the maximum observed age in the sample data. Equal weights are used except for OA statistics where significantly less number of the entries would have entered equation (24) if it was not for the adjusted weights.

To estimate more efficiently, the parameters are separated into different groups according to how they fit into the model and estimated in batches. For example, the parameters relevant to the labor market uncertainties would be estimated first until a decent result is obtained. The parameters relevant to utility would proceed and so on and so forth. After the small test-runs, the final estimation including all the parameters is conducted. Meanwhile, as the order of the parameters to estimate is of the essence to Powell's conjugate direction method when search for new parameters to narrow down the differences in (24), a separate subroutine is written to re-order the inputs of parameters each time an estimation is attempted. I do find that by first estimating the parameters that the model is more sensitive to, both the results and the computational time are improved.

3.4.3 Estimation Results

Optimized parameter values are presented in table 18. Except the first 4 parameters that are calibrated, all the remaining 15 parameters are estimated simultaneously using MSM.

As can be see from the table, both displacement rates and offer arrival rates are decreased functions of age, consistent with what is suggested in data. Parameters within the utility specification, both β and γ are within the rational range of risk aversion, and δ_1 and δ_2 indicate positive leisure from not working and increased preferences toward not working as aging, consistent with the literature. The bequest factor k_{bq} is 2.959, suggesting that the residual does capture a lot more saving incentives in addition to the mere bequest motive, which would otherwise results in a k_{bq} that is less than 1. Parameters within the wage specifications suggest that the averages of wages being offered to the older workers decrease significantly over age and the big variance of the offers are in line with the fact that working wages after 55 years old are distributed very unevenly. Also, standard errors are reasonable and multicollinearity is excluded. Overall speaking, the estimated results of all 15 parameters are rational and agree with the data and literature.

Table 18: Benchmark Estimation: Model Parameterization

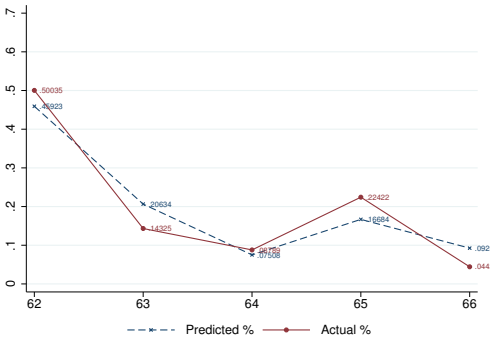
Parameter		**Value**	**Source**
r	interest rate	0.02	Calibration
ζ	weekly UI replacement rate	0.5	BLS
$\bar{B}$	weekly maximum UI	600	BLS
$\bar{N}_b$	maximum weeks of UI coverage	26	BLS
θ_1	displacement rate	7.991 (0.00329)	Estimation
θ_2	displacement rate	-0.014 (0.00396)	Estimation
λ_1	offer arrival rate	1.003 (0.00013)	Estimation
λ_2	offer arrival rate	-0.050 (0.00271)	Estimation
β	discount rate	0.959 (0.00164)	Estimation
γ	utility function	1.628 (0.00219)	Estimation
δ_1	leisure	0.003 (0.000005)	Estimation
δ_2	leisure	0.0002 (0.00005)	Estimation
k_{bq}	bequest factor	2.959 (0.02051)	Estimation
κ_0	average wage evolution	-0.043 (0.00042)	Estimation
κ_1	average wage evolution	0.971 (0.00010)	Estimation
κ_2	average wage evolution	0.028 (0.000007)	Estimation
ρ_t	log wage offer distribution	-5.281 (0.00536)	Estimation
μ	log wage offer distribution	20.211 (0.11497)	Estimation
σ	log wage offer distribution	0.353 (0.00003)	Estimation

Notes:
[a] Estimation of parameters in the displacement rate and the offer arrival rate (θ_1, θ_2, λ_1 and λ_2) are bounded by the actual layoff rates and job finding rates obtained from March CPS (1990-2010) for the corresponding yet younger cohort between 40 and 55 years old.
[b] Standard errors of the estimation are shown in parentheses.

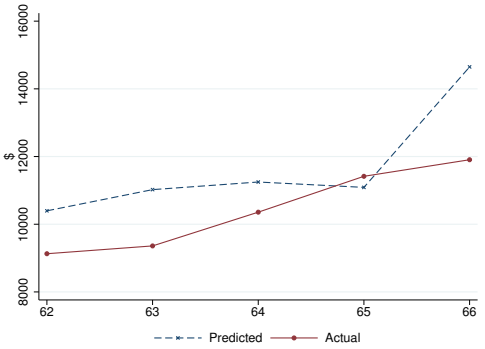
Figure 4 presents a comparison between the predicted and real behavior of the agents in various aspects.

For OA take-up distributions (figure 4. a-b), the benchmark model does a fairly good job in capturing the spike at age 62 where more than 50% of the population make early OA claims. Although the second spike at age 65 (the NRA) is slightly less underestimated, it can be improved in the future by including Medicare, which is traditionally used to capture the high incentive of OA claiming at 65 when employer sponsored health insurance becomes less important as Medicare goes alive. As for the OA benefits receipts, the model is able to reproduce a benefit profile that is increasing over age. OA benefit amounts are over-estimated at age 66 which is also associated with the mismatch of OA claiming due to the lack of Medicare modeling. Considering that only less than 25% of population claim their OA benefits during that time, the overestimation is of less concern.

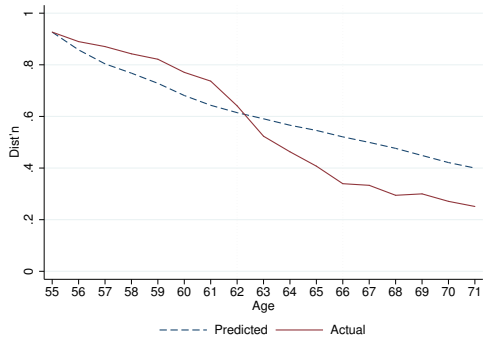
For labor market behaviors (figure 4. c-f), the benchmark model reproduces the major trends of labor supplies among the working old, by recreating the decreased labor force participation rates, observed average working wages and job finding probabilities. Note that in most job-search models and models with similar settings, wages are typically increasing over time due to the increasing selectiveness of the agents while this model produces otherwise for two obvious reasons: market offers a lower price for older workers and the older a worker is, the more he or she values leisure. A third less obvious reason is that as the wealthier and higher-income workers start to retire, those who still choose to stay in the market tend to have lower wealth and income profiles. However, withdraws from the labor market are slightly underestimated and labor force participation is over estimated, especially after age 62, which could be explained by not modeling health condition. While disabled population are excluded from the sample, less severe health problems could still impair working abilities and working decisions, causing the mis-match between data and model. On the other hand, health shocks are still the biggest uncertainties that the old concern the most and with steady streams of cash inflow from OA and without concerning their health issues, people have no strong incentive to save for possible medical expenditure and consequently, labor supply motives are reduced. Even though modeling bequest motive as a residual term helps to capture some of the factors that are not current in the model, it is not enough to fill the gap and future work on modeling health uncertainties is necessary.



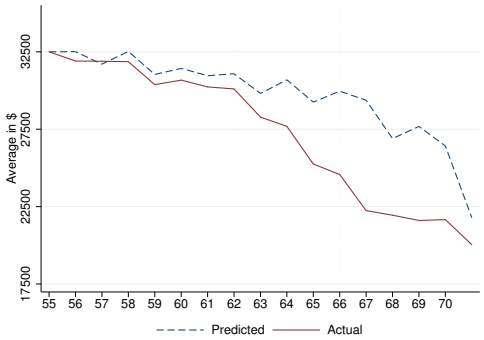
(a) OA Take-up Age Distribution



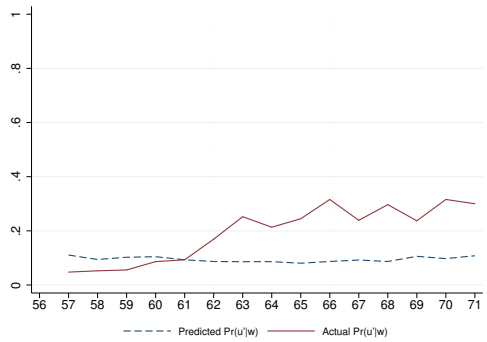
(b) Average OA Level by Take-up Age



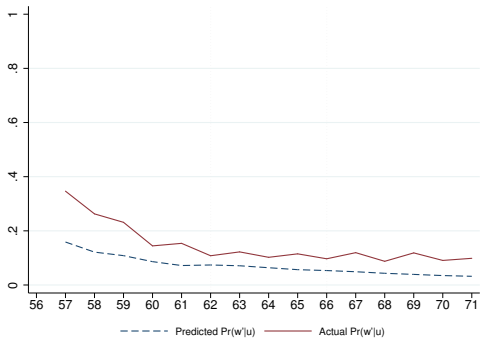
(c) Labor Force Participation



(d) Average Accepted Wages



(e) Job Transitions: Stop Working



(f) Job Transitions: Job Finding

Figure 4: The Benchmark Model: Estimation Results

Overall speaking, the estimated benchmark model is able to reproduce most of the stylized facts from the data including the early OA claiming peak at age 62 , decreases in labor supply and decreasing average wages, which provides a solid foundation for policy analysis.

3.4.4 Sensitivity Analysis

A sensitivity analysis is conducted to test how the model responses to changes in parameter values, that is, how a 10% change in parameter values will lead to changes in the behaviors of the benchmark model. Sensitivities are examined for all parameters except the UI coverage parameter $\bar{N}_b$ since the annual model in this dissertation would not be able to capture an increases of 2.6 weeks in UI coverages. Table 19 displays changes in OA claiming decisions from age 62 to 66 with 65 as NRA and changes in assets, consumptions, wages and working decisions in selected ages.

As can be seen from the table, the benchmark model is quite sensitive to γ, β and κ_1, slightly sensitive to κ_2 and μ_t, and reasonably sensitive to all other parameters, indicating that preferences toward risk (as in γ) and today-tomorrow tradeoffs (as in β) are important in the decision makings. Also, κ_1 and κ_2 are largely determined by the current regulation in calculating OA benefit levels, therefore a 10% change yields large deviations from the benchmark. As for μ_t, it represents the mean of the error terms in logarithm wage specifications which explains the relatively high elasticity. Overall speaking, the benchmark model behaves well when testing for sensitivity.

3.5 Behavioral Responses to Job Displacement

For the purpose of my research, I target the workers who are displaced at age 61 just before early OA eligibility at 62, so that both government programs can be collected as financial sources under the benchmark UI coverage of 26 weeks. It is an approach sharing some similarity with an impulse response study that is common to macroeconomics researches, but different in the sense that the impulse (displacement) is not imposed on everyone in the model, instead, I divide the sample into subgroups based on whether they are affected by the impulse (displacement). Figure 5 demonstrates the responses and how UI and OA are utilized, and UI exhaustion rates across distribution of wealth and income are presented in figure 6.

Table 19: Benchmark Model Sensitivity Analysis

	r	ζ	$\bar{B}$	θ_1	θ_2	λ_1	λ_2	γ	β
OA									
62	1.01%	0.90%	0.00%	-0.44%	0.08%	-0.25%	0.36%	-29.29%	-9.54%
63	0.05%	0.05%	0.00%	0.56%	0.56%	1.26%	-0.05%	79.93%	13.55%
64	-3.14%	-3.14%	0.00%	1.57%	-1.70%	-1.96%	-0.65%	66.23%	-6.81%
65	-5.03%	-4.58%	0.00%	-0.09%	-0.27%	0.00%	-2.25%	-23.63%	1.17%
66	2.73%	2.73%	0.00%	0.00%	0.11%	0.22%	1.20%	-32.10%	29.37%
Assets									
58	0.32%	0.32%	0.00%	0.01%	-0.01%	0.01%	0.01%	0.21%	8.78%
62	2.04%	2.04%	0.00%	-0.01%	0.00%	0.21%	0.19%	-25.02%	47.85%
66	2.67%	2.67%	0.00%	-0.07%	0.01%	-0.20%	-0.23%	-60.55%	90.67%
Wage									
58	-0.04%	-0.04%	-0.07%	-0.07%	-0.07%	-0.09%	-0.02%	-11.11%	-1.38%
62	-0.12%	-0.12%	-0.15%	-0.06%	-0.05%	-0.10%	-0.24%	-72.30%	-3.18%
66	0.18%	0.18%	0.15%	0.17%	0.24%	-0.01%	0.95%	-73.59%	-2.91%
% Work									
58	-0.22%	-0.21%	0.00%	0.00%	0.01%	0.10%	-0.29%	-45.55%	5.58%
62	0.07%	0.07%	0.00%	0.88%	-0.08%	0.10%	-0.38%	-94.82%	13.08%
66	0.16%	0.16%	0.00%	-0.04%	-0.02%	0.29%	-1.01%	-97.34%	30.38%
Stop Work									
58	0.32%	0.32%	0.00%	0.11%	0.00%	0.00%	0.21%	367.73%	-20.98%
62	4.05%	4.97%	0.00%	1.16%	0.92%	1.27%	-0.35%	803.58%	-8.32%
66	13.26%	-1.29%	0.00%	-0.12%	-0.12%	1.29%	-0.94%	127.70%	-1.06%

(Cont.)

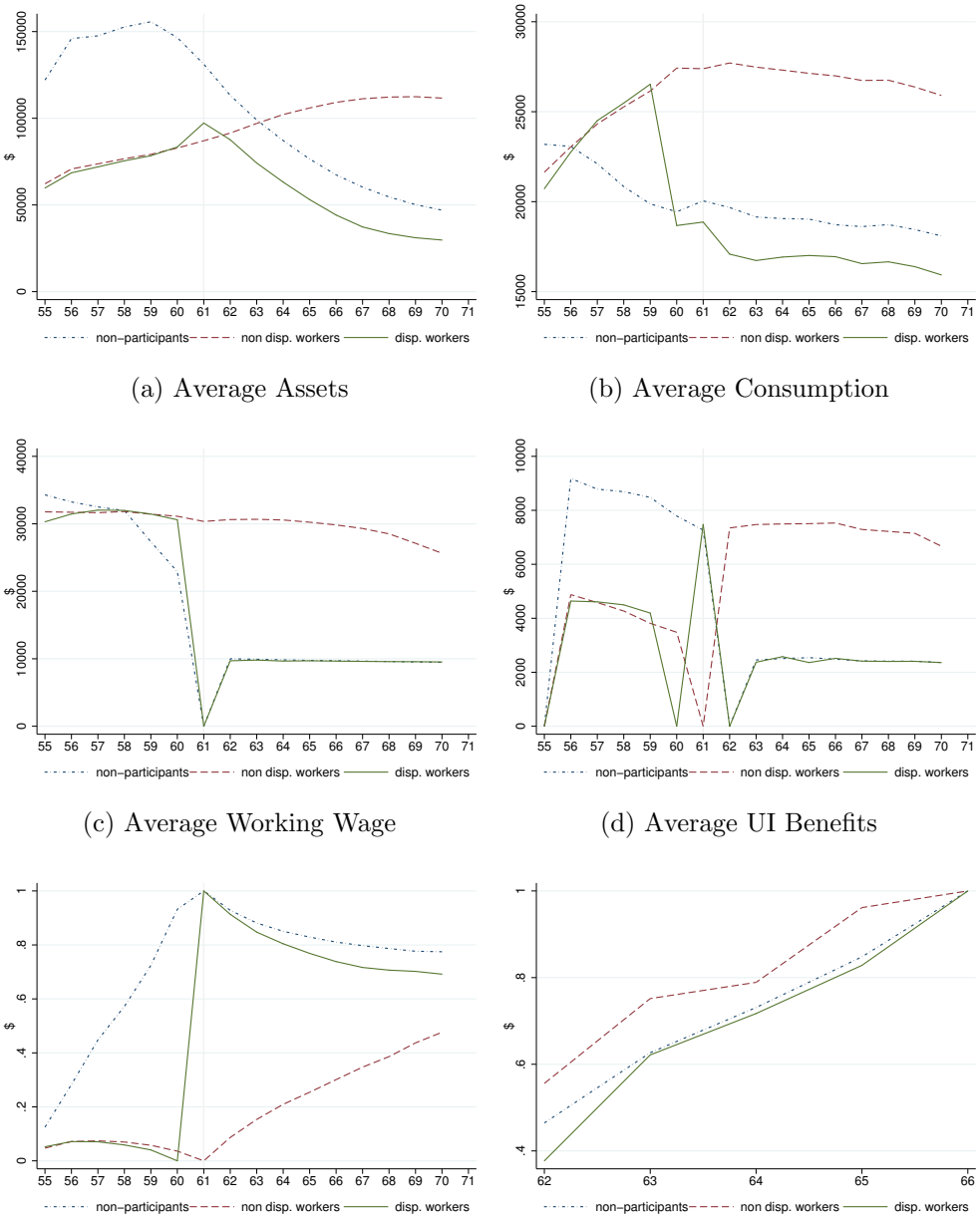
	δ_1	δ_2	k_{bq}	κ_0	κ_1	κ_2	ρ_t	μ	σ
OA									
62	-0.17%	0.38%	2.18%	4.76%	58.95%	-48.87%	0.73%	-1.34%	-0.63%
63	0.15%	0.91%	-1.01%	-3.64%	-49.85%	3.24%	1.72%	16.99%	0.96%
64	4.97%	-3.27%	-7.20%	-1.44%	-66.75%	23.43%	6.15%	-17.80%	-1.57%
65	-9.61%	-2.07%	-4.67%	-9.88%	-65.05%	130.64%	-12.49%	-1.08%	-0.54%
66	7.97%	0.98%	1.20%	-8.19%	-94.32%	93.67%	2.18%	-13.10%	6.33%
Assets									
58	0.08%	0.04%	0.10%	-0.02%	-3.40%	-0.64%	0.15%	-2.27%	0.00%
62	0.75%	0.09%	0.74%	0.22%	-16.20%	-2.33%	0.39%	-6.68%	0.01%
66	-0.19%	0.15%	0.74%	0.14%	-0.21%	-14.84%	-0.45%	5.24%	0.08%
Wage									
58	-0.10%	-0.07%	-0.07%	-0.01%	-0.62%	-0.01%	-0.24%	3.08%	-0.05%
62	0.71%	-0.05%	-0.19%	-0.03%	3.53%	0.64%	0.05%	9.85%	-0.03%
66	2.81%	0.31%	-0.03%	0.16%	51.63%	1.67%	1.17%	9.10%	0.29%
% Work									
58	-1.85%	-0.01%	0.00%	-0.49%	2.23%	1.76%	-0.10%	-2.55%	0.00%
62	-3.85%	-0.16%	0.21%	-1.11%	-12.87%	1.70%	-2.83%	5.45%	0.03%
66	-6.25%	-0.12%	0.52%	0.72%	-68.15%	-6.27%	-4.17%	28.84%	0.64%
Stop Work									
58	9.37%	0.00%	-0.11%	-1.06%	-7.35%	-7.99%	0.43%	20.34%	0.11%
62	7.28%	1.16%	-0.12%	2.54%	357.23%	8.67%	10.75%	41.50%	0.46%
66	10.33%	1.41%	-1.17%	-4.23%	261.15%	24.88%	0.70%	-9.86%	0.59%

Notes: The table allows parameter values to increase by 10% and records changes in key moments compared with the benchmark

Figure 5 summarizes responses to job displacement among three subgroups: displaced workers who lose their jobs at the beginning of age 61, non-participants who mostly choose not to work at the beginning of age 61 and non-displaced workers who are working at 62 either by finding a new job or continuing the old job from age 60. Behaviors in prior to 61 are also plotted on the same graphs for a more complete comparison.

As can be seen from the figure, the non-participates have distinctively different wealth and labor supply profiles from the other two subgroups. The non-participates take about 25% of the entire population, for the age being analyzed, and given the large offer arrival rates and small displacement rates across time, it is highly unlikely that they are long-term discouraged workers with no job offers, instead, there is a high probability that they are non-participates by choice. Overall speaking, the non-participants are more likely to be retreating from the labor market earlier and staying outside the labor market when 65 years or older, while the participants (displaced and non-displaced works) have a more consistent working history prior to OA claiming and are more likely stay in the labor market much longer thereafter. Also, non-participants are on average wealthier than the participants which partially explains why they could afford not working while still being able to maintain relatively high consumption levels. Being relatively wealthier and higher in income (seen both from working wages and average UI benefits) in prior to the withdraws from the labor force, they are able to afford not working and claim OA a lot later than the rest of the population. However, consumption of theirs is adjusted accordingly and is much lower compared to the non-displaced working population (still, higher than the displaced workers). Their utility maximization is achieved more through leisure, rather than high consumption.

On the other hand, for those who do participate, job displacement has negative effects on both future wages and future reemployment probabilities. Consequently, displaced workers adjust to job losses by cutting down consumption and living on earlier savings. After exhausting the 26 weeks UI at 62 (as shown in figure 5 (d) from the kinks at age 62), reemployment rate increases dramatically when offers – sometimes not that desirable – are taken and because they could not afford to be very selective, average working wages are low and remain lower than those who are not displaced even after almost ten years after displacement takes place. As a matter of fact, UI and OA are hardly life-savers for those displaced working old: UI is quickly running out and early OA take-ups are not observed, primarily due to the early claim



(a) Average Assets

(b) Average Consumption

(c) Average Working Wage

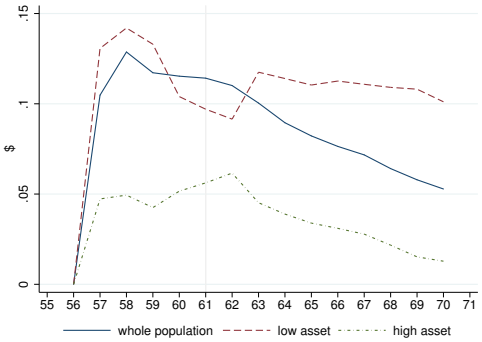
(d) Average UI Benefits

(e) Labor Force Participation: Not Working

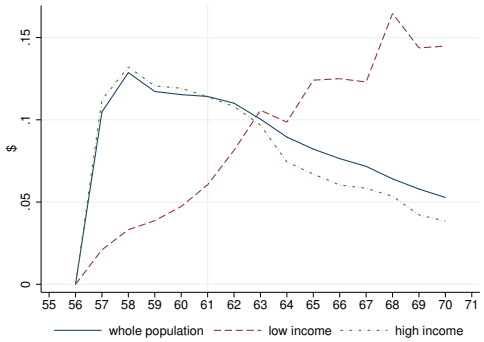
(f) Receiving OA Benefits

Figure 5: Responses to Job Displacement at Age 61: Benchmark

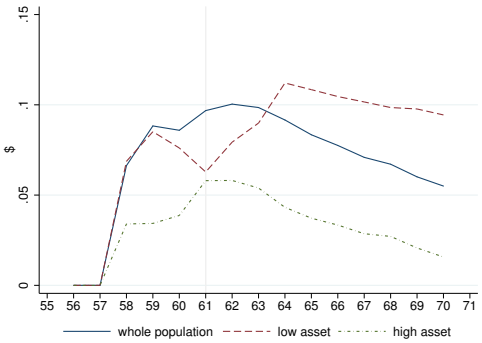
Note: Responses are obtained from the benchmark model. Non-participants are those who are not working at 61 by choice (quit or continue not to work). Non-displaced workers are those working at 61 (continue to work or newly employed). UI lasts for 26 weeks (half a year).



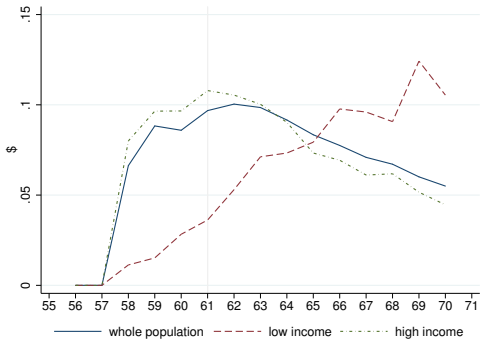
(a) Benchmark: Across Wealth



(b) Benchmark: Across Income



(c) Extended UI: Across Wealth



(d) Extended UI: Across Income

Figure 6: UI Exhaustion Across Wealth and Income Distributions: Benchmark and Extended UI.

Note: UI exhaustion is measured as the percentage of the job seekers who exhaust UI for the 1^{st} time, obtained from the benchmark model for the lowest and highest quantiles in asset levels and labor market incomes. Benchmark UI covers 26 weeks of the unemployment duration while extended UI has a coverage of 99 weeks.

penalties. Recovery from job losses at such a late age is slow and gradual, and by the age of 68, the differences in wages, labor force participation, assets and consumption are still significant compared to their non-displaced peers. The well-beings of those workers are harmed by the sudden eruption of their careers at a late age. Lastly, although the wage profile of displaced workers is very similar to the that of the participants whose working history is inconsistent as well, they consume a lot less and are less wealthier. Working more but consuming less, they are not as better-off as the non-participants either.

Meanwhile, as shown in figure 6, UI benefits are typically exhausted faster among those who are relatively poor and with lower incomes, regardless of the coverage. Also, an extended 99-week UI is associated with less exhaustion, although the difference is less than the difference in coverages. Note that in this figure, extension of UI coverage is pure without the accompany of higher displacement risks. While most poor and low-income individuals tend to claim OA early, once displaced, there is a large chance that they could not afford to do so, or to switch to OA even when UI is exhausted, mainly for two reasons: first of all, early claim will result in a large and permanent penalty in OA benefits and secondly, displacement disrupts their plans and without knowing whether or not a new job can be attained or how much the new job will pay, claiming early with reduced OA benefits is hardly the wisest choice. This is also empirically true when early OA are sometimes less preferred than other government programs and loans. Nevertheless, UI would not be extended if displacement did not reach a certain level, hence pure extension of UI coverage is experimental. More realistic policy analysis on extended UI coverages are conducted in the next section.

3.6 Unemployment Insurance Policy Analysis

To conduct policy analysis on changes in UI coverage from 26 weeks to 99 weeks that is currently effective during the recent economic recession, I set the benchmark with optimized parameters obtained earlier for the birth cohort with a NRA of 65, and compare it with the simulated results of various UI policies that I propose. For each policy and the experiment, I examine the consequent changes in OA claiming and labor market behaviors. I present the comparitive results not only for the mean agent, but across the income and wealth distribution of the population.

UI is a form of social insurance. Workers make contribution to the system to insure again future job losses. For the currently displaced workers, it

serves as a financial cushion in smoothing consumption by partially replacing income losses. The program affects labor supply in multiple ways. On one hand, UI motivates job search by requiring benefit recipients to do so. On the other hand, it provides dis-incentives for them to accept job offers that are less desirable and results in longer unemployment spells. In the case of older displaced workers, the direction towards which labor supply would response to changes in UI policy is further complicated by the interactions between UI and OA, as stated previously. The benefit level of UI is regulated by Federal and State laws and additional benefits are only available during times of high unemployment as the recent 2007-2009 great recession with a historical unemployment rate of 10% and displaced workers can receive up to 73 weeks of extend UI provided by the EB and EUC programs, resulting in a total UI coverage of 99 weeks as of January 1^{st}, 2014. Therefore, it would only be realistic to analyze a UI policy change with labor market downturn, during which time either displacement rates are high or job offer rates are low, or both exist.

To isolate the effect of the combined effects of changes in UI and the labor market, there are four scenarios I am going to examine: labor market downturn without changes in UI policy, extended UI without labor market downturn, labor market downturn with extended UI and lastly, labor market downturn with increased UI benefits.

Meanwhile, regardless of the effective policy change in 2008, it is difficult to do a before-and-after policy analysis using data from HRS. For one thing, the extended benefits EB and EUC depend on State-specific unemployment rates. Hence it is hardly convincing to conduct such an analysis using only the national average figures, without detailed geographic information of the respondents. And even with geocode access, the before-and-after method is beyond feasible level because it would require the after UI coverages to be adjusted according to the unemployment rates in different districts so that it is consistent EUC regulations. For another thing, only one wave of the HRS data (wave 11 in 2010) was released since the outburst of unemployment in 2008. What is even worse, for the birth cohort whose early OA claiming decisions were made around 2008, the sample size is extremely small and the complete OA claim distribution between age 62 and age 66 could not be observed. Therefore, my strategy in analyzing the UI policy changes is by performing one pure policy experiment and several policy analysis of real scenarios.

Results of the experiment and analysis in comparison with the benchmark model are presented in table 20 - table 22 across wealth and income distributions. Table 23 is a summary of the average OA take-up ages in the benchmark and all scenarios analyzed. Additionally, table 31 in the appendix compares behaviors of those subgroups in the benchmark, as in absolute values instead of comparative percentages. Table 32 and table 33 present the comparative statistics of those at the top of income and wealth distributions.

I find that those who are on the lower ends of wealth and income distributions are in general less sensitive to policy changes. I also find that even though a more generous UI policy helps in times of labor market downturn, the negative effects resulted from high displacement rates overcomes increases in UI and workers are on average worse off, in which case even if the additional UI benefits do a better job in protecting workers against unemployment shocks and can potentially encourage labor supply, the poorly performed labor market pushes the labor supply toward the opposite direction. Finally, in a severe labor market downturn, those who are on the lower end of wealth and distributions are forced to claim OA early while the wealthier and high-income individuals typically postpone OA claiming. However, with the extra help of a 99-week UI, more poor and lower-in-income individuals can also afford to postpone OA claiming using UI as a stepping-stone, although not for a very long time, so that early claiming penalties can be reduced. The "bridge" role of extended UI is more prominent among the wealthy and high-income individuals.

3.6.1 Several Notes on Constructing the Analysis

There are a few important notes I would like to address on how the policy analysis in this section are constructed before presenting the results, in order to understand and inteprete the final results.

First of all, it is easily to see from the benchmark behaviors (table 31) and comparative statistics (table 21 and table 22) that, in this model with no heritage from the father generation, lower assets are often associated with lower income and that explains why they almost always have very similar patterns. The same applies to the wealthy and high-income individuals.

Secondly, those who are at the tops of wealth and income behave very different from those who are at the bottoms as shown in table 31. For example, wealthiest individuals work significant less compared to the least wealthy and lowest-in-income individuals who keep working even after claiming OA.

Thirdly, there are quite a few discrepancies in the comparative statistics for those who are at the highest quantile of wealth and income, especially OA claiming outcomes. It is because that wealth and income are log distributed with extremely long tails, so the number of individuals at the top quantile is small, unlike those who are at the bottom quantile. Worse still, significantly less percentages of the wealthiest and highest-incomers are OA claimers at 62, making the headcount even smaller. Hence, mean individuals who are also wealthier and higher in income should also be referred to whenever the counterparts of the poor and the low income individuals are called. That is also the reason why table 32 and table 33 are listed in the appendix, despite the useful insights they provide.

Fourthly, high displacements are often accompanied by low job finding rates and they both can affect labor market outcomes – the unemployment rate. As the requirement of extended UI is only imposed on unemployment, and a 99-week of UI coverage requires a 10% unemployment rate – which is the outcome, there are several ways to achieve it. An extremely low job finding rate, or a high displacement rate, or the combination of the two can all be used. In this dissertation, only high displacement is used.

Last but certainly not the least, in all of the scenarios analyzed in this section, beliefs about the parameters are changed forever, that is, labor market downturns last till death and so do changes in UI generosities. It is quite different than the alternative approach where the labor market deterioration will eventually end after certain years. There are two reasons why the former approached is adopted. First of all, unlike other economic crisis, people's expectation on the market getting well soon is low. Secondly, while information on how long UI will remain 99 weeks is valid, there is no survey asking questions such as "How long do you think this bad economy will end?" or "Do you expect unemployment to drop to the normal range within 5 years?". Without data, it is difficult to decide when the beliefs can be changed back, and wrong assumptions would be even worse. However, it would be interesting and fruitful possibly, to conduct a number of experiments on different expected durations of such a downturn. Optimal policy proposals could be benefitting from comparing the results of those experiments.

Table 20: Policy Analysis: Mean Individuals. Changes from the Benchmark (NRA = 65).

Age	Wk.	Stop wk.	Re-emp	A	C	Wage	UI	Claim	OA
Experiment: UI extended from 26 to 99 weeks without labor market deterioration									
59	-0.02%	-1.08%	-0.29%	-1945.42	1228.95	108.16	8092.13	—	—
60	-0.27%	-0.66%	0.15%	-2033.72	1104.24	134.12	8062.03	—	—
61	-0.15%	-0.51%	-0.32%	-2187.70	842.62	239.29	7750.31	—	—
62	0.06%	-0.46%	-0.51%	-1958.34	944.98	284.06	7822.07	-2.71%	114.11
63	0.26%	-0.39%	-0.54%	-1914.11	916.90	197.99	7718.52	1.35%	-270.53
64	0.39%	-0.44%	-0.54%	-1865.39	720.85	78.09	7576.11	-0.15%	-247.63
65	0.55%	-0.17%	-0.47%	-1737.14	714.92	49.90	7446.62	0.88%	99.70
66	0.80%	-0.24%	-0.76%	-1574.82	824.72	39.25	7292.62	0.64%	121.20
67	0.86%	-0.12%	-0.41%	-1458.28	852.10	93.32	7227.14	—	—
Scenario 1: Labor market downturn with a 10% displacement rate									
59	-3.97%	-0.17%	2.05%	1467.65	-1487.77	-337.65	-61.61	—	—
60	-4.93%	-0.29%	2.66%	1480.76	-1516.70	-361.11	-79.52	—	—
61	-6.05%	-0.10%	2.91%	1366.61	-1493.27	-471.06	-92.02	—	—
62	-6.79%	0.12%	2.77%	873.18	-1525.34	-751.96	-46.46	-2.01%	-117.68
63	-7.48%	0.23%	3.10%	-106.66	-1531.57	-1006.82	-229.00	0.18%	8.22
64	-7.96%	0.28%	3.06%	-1396.10	-1602.73	-1344.32	-237.03	2.04%	581.71
65	-8.35%	0.19%	2.94%	-2699.78	-1532.58	-1600.52	-390.29	-1.82%	92.35
66	-8.41%	0.31%	2.65%	-4363.35	-1610.79	-1817.39	-440.91	1.62%	115.15
67	-8.33%	0.30%	2.55%	-5839.42	-1660.92	-2177.09	-378.46	—	—
Scenario 2: Labor market downturn with extended UI from 26 weeks to 99 weeks									
59	-3.83%	-1.24%	1.70%	195.9	-155.31	-124.69	8077.3	—	—
60	-5.08%	-0.95%	2.76%	398.41	-322.88	-161.04	7954.89	—	—
61	-6.06%	-0.62%	2.49%	453.52	-573.26	-175.33	7625.8	—	—
62	-6.80%	-0.29%	2.51%	545.19	-587.54	-395.47	7731.38	-5.11%	104.01
63	-7.19%	-0.20%	2.30%	-84.62	-666.67	-701	7512.04	2.49%	-360.38
64	-7.49%	-0.23%	2.21%	-927.75	-766.6	-1140.67	7199.93	1.59%	345.83
65	-7.66%	0.04%	2.21%	-1929.46	-707.51	-1433.28	6910.42	-1.39%	296.71
66	-7.55%	0.11%	1.92%	-3304.76	-663.34	-1730.68	6521.1	2.43%	345.36
67	-7.54%	0.24%	2.36%	-4675.35	-742.79	-1964.07	6448.38	—	—
Scenario 3: Labor market downturn with increased UI benefit amount (same as scenario 2)									
59	-3.72%	-0.94%	1.71%	1191.63	-237.75	-161.96	23339.22	—	—
60	-4.80%	-0.62%	2.62%	1552.13	-355.79	-193.05	22224.06	—	—
61	-5.88%	-0.41%	2.66%	1804.82	-546.53	-252.31	22243.73	—	—
62	-6.51%	-0.03%	2.44%	1946.86	-641.24	-512.33	22096.23	-4.14%	145.31
63	-6.97%	-0.05%	2.43%	1375.09	-764.50	-797.95	21040.42	1.41%	-16.02
64	-7.37%	-0.07%	2.46%	519.79	-667.87	-1204.37	20716.62	2.65%	138.96
65	-7.59%	0.15%	2.39%	-642.56	-612.43	-1484.98	19536.39	-2.92%	176.72
66	-7.34%	0.46%	1.93%	-2338.52	-733.26	-1844.54	19218.17	3.02%	266.19
67	-7.37%	0.32%	2.45%	-3805.65	-778.99	-2105.64	18381.94	—	—

Notes:

[a] All statistics are calculated as the changes (dollars and percentages) from the benchmark model.

[b] Work percentages and average consumption are both calculated for the survivors. Average wage is for the survived workers. Claim age is the age starting receive OA, and as percentage of the total who ever claimed between age 62 and 66.

Table 21: Policy Analysis: Least Wealthy Individuals. Changes from the Benchmark (NRA = 65).

Age	Wk.	Stop wk.	Re-emp	A	C	Wage	UI	Claim	OA
Experiment: UI extended from 26 to 99 weeks without labor market deterioration									
59	-0.31%	-2.29%	0.80%	-660.12	895.97	598.93	4218.55	—	—
60	-0.47%	-2.42%	0.02%	-1255.55	904.66	513.29	4265.84	—	—
61	-0.78%	-3.08%	0.00%	-1566.74	758.83	516.60	4771.80	—	—
62	-0.75%	-2.04%	-0.23%	-252.31	418.70	493.61	4676.72	-3.77%	174.42
63	-0.77%	-1.73%	-0.23%	-1026.56	705.33	484.74	4716.49	3.10%	49.06
64	-0.96%	-1.88%	-0.14%	-2749.36	303.92	503.18	4594.51	-0.46%	-257.20
65	-0.93%	-1.24%	-0.19%	-3649.46	507.85	481.11	4649.81	-1.11%	-40.16
66	-1.14%	-1.56%	-0.03%	-5530.75	678.11	487.04	4458.45	2.26%	-582.08
67	-1.18%	-1.45%	-0.18%	-7028.68	561.53	483.82	4390.38	—	—
Scenario 1: Labor market downturn with a 10% displacement rate									
59	-3.07%	-0.22%	1.42%	-20.42	-1231.58	-502.69	-36.95	—	—
60	-4.10%	-0.23%	2.56%	259.71	-1294.01	-468.29	-119.11	—	—
61	-5.24%	-0.34%	2.88%	552.28	-1026.07	-551.79	-93.53	—	—
62	-5.66%	0.94%	2.66%	361.40	-1282.90	-723.43	-110.08	3.35%	-15.24
63	-6.12%	0.58%	2.78%	529.64	-1212.84	-835.65	-231.54	0.58%	59.91
64	-6.34%	0.80%	2.62%	548.84	-1225.12	-961.16	-265.75	0.61%	137.05
65	-6.43%	0.93%	2.49%	541.34	-759.15	-1096.88	-208.30	-5.11%	-269.66
66	-6.63%	0.80%	2.59%	-480.69	-1051.30	-1192.78	-310.42	0.57%	-332.60
67	-6.90%	0.39%	2.58%	-1217.02	-1342.97	-1243.26	-317.59	—	—
Scenario 2: Labor market downturn with extended UI from 26 weeks to 99 weeks									
59	-3.26%	-2.77%	2.32%	-490.96	-69.19	64.02	3977.00	—	—
60	-4.59%	-2.95%	2.58%	-454.61	-182.55	19.33	4005.82	—	—
61	-6.13%	-3.56%	2.86%	-381.58	-300.97	-47.80	4531.81	—	—
62	-6.48%	-1.40%	2.24%	-175.02	-650.51	-241.33	4444.73	-2.99%	257.11
63	-6.86%	-1.26%	2.31%	-232.97	-345.86	-380.16	4333.03	5.66%	164.22
64	-7.34%	-1.17%	2.43%	-540.61	-818.13	-504.43	4113.84	0.11%	-114.83
65	-7.35%	-0.05%	2.32%	-612.30	-449.90	-665.44	4166.08	-5.91%	-237.37
66	-7.74%	-0.53%	2.57%	-1867.15	-702.80	-757.25	3843.35	3.15%	-580.20
67	-7.85%	-0.13%	2.46%	-2759.91	-1185.21	-854.64	3750.70	—	—
Scenario 3: Labor market downturn with increased UI benefit amount (same as scenario 2)									
59	-1.54%	0.43%	2.27%	-529.38	220.16	341.12	11500.77	—	—
60	-3.40%	-1.60%	2.60%	-109.05	224.51	281.50	13171.58	—	—
61	-4.70%	-2.05%	2.44%	367.73	247.15	139.59	13008.70	—	—
62	-5.01%	0.42%	2.17%	574.68	-384.40	-97.60	13065.89	0.08%	309.95
63	-5.65%	0.02%	2.58%	638.55	-453.93	-229.76	12290.21	4.36%	466.01
64	-6.06%	0.17%	2.47%	576.56	-597.30	-376.40	12256.70	3.63%	555.78
65	-6.30%	0.62%	2.48%	597.74	-96.85	-528.44	11682.06	-11.67%	-478.82
66	-6.24%	1.39%	2.45%	-1300.39	-892.46	-693.96	11281.15	3.61%	-914.77
67	-6.29%	0.68%	2.27%	-2287.16	-1185.46	-808.06	10686.42	—	—

Notes:

[a] All statistics are calculated as the changes (dollars and percentages) from the benchmark model.

[b] Statistics are displayed for the lowest quantile in assets as of age 59. Work percentages and average consumption are both calculated for the survivors. Average wage is for the survived workers. Claim age is the age starting receive OA, and as percentage of the total who ever claimed between age 62 and 66.

Table 22: Policy Analysis: Lowest-income Individuals. Changes from the Benchmark (NRA = 65).

Age	Wk.	Stop wk.	Re-emp.	A	C.	Wage	UI	Claim	OA
Experiment: UI extended from 26 to 99 weeks without labor market deterioration									
59	-0.81%	-0.62%	0.23%	280.00	135.37	25.64	1531.14	—	—
60	-0.54%	0.17%	0.12%	210.03	258.14	46.95	1610.38	—	—
61	-0.25%	0.08%	-0.17%	69.36	120.07	50.09	1751.85	—	—
62	0.41%	-0.58%	-1.17%	108.06	199.59	66.99	1779.21	-0.74%	-32.03
63	0.43%	-0.22%	-0.28%	150.57	330.48	81.30	1942.88	-0.41%	51.33
64	-0.01%	-0.65%	0.17%	89.10	344.52	78.11	1944.59	1.41%	16.07
65	-0.31%	-0.47%	0.22%	70.02	335.64	75.53	1953.44	-0.20%	7.90
66	-0.43%	-0.51%	0.05%	59.09	312.42	70.71	1976.91	-0.07%	-67.59
67	-0.42%	-0.49%	-0.01%	72.84	380.44	67.04	1958.68	—	—
Scenario 1: Labor market downturn with a 10% displacement rate									
59	1.37%	0.64%	-2.15%	663.60	-694.62	-41.80	34.91	—	—
60	-0.06%	0.74%	1.80%	1278.78	-279.05	-54.92	-14.05	—	—
61	-2.51%	-0.09%	3.77%	1536.56	-60.28	-8.17	-52.37	—	—
62	-3.84%	-0.40%	2.78%	1475.69	-191.72	-18.46	2.52	1.15%	-37.30
63	-5.00%	-0.48%	2.97%	1399.04	-160.03	-13.07	1.66	-0.29%	75.19
64	-6.27%	0.30%	3.90%	1199.64	-190.37	17.28	10.30	-1.19%	2.98
65	-6.30%	0.46%	2.54%	885.95	-624.76	36.77	13.62	0.15%	-28.97
66	-5.58%	2.07%	2.17%	995.24	-307.71	45.59	-21.39	0.19%	32.05
67	-5.78%	0.25%	2.50%	849.96	-303.20	38.19	51.64	—	—
Scenario 2: Labor market downturn with extended UI from 26 weeks to 99 weeks									
59	-1.15%	0.22%	0.02%	1142.58	-11.08	-5.15	1537.89	—	—
60	-1.95%	0.12%	2.03%	1186.80	-45.43	15.44	1598.30	—	—
61	-3.72%	-0.05%	3.65%	1288.67	63.28	74.49	1702.37	—	—
62	-3.24%	0.25%	0.99%	1243.62	188.51	74.18	1788.10	-1.37%	-69.62
63	-4.59%	-0.67%	2.91%	1083.83	110.08	72.10	1952.58	0.56%	42.70
64	-5.35%	-0.41%	2.64%	921.81	-31.04	71.81	1983.66	0.82%	28.53
65	-5.71%	0.38%	2.60%	909.69	-5.25	92.11	1973.18	-0.09%	-339.47
66	-5.70%	0.76%	2.31%	855.70	-37.95	105.09	1959.35	0.08%	54.08
67	-6.11%	-0.10%	2.71%	839.93	16.49	88.96	1955.92	—	—
Scenario 3: Labor market downturn with increased UI benefit amount (same as scenario 2)									
59	0.53%	0.68%	-1.91%	-64964.18	-233.62	-31.63	4956.31	—	—
60	-0.66%	0.59%	1.95%	-59279.15	-86.98	-34.73	5029.17	—	—
61	-3.35%	-0.44%	4.23%	-52570.39	111.75	13.77	5196.76	—	—
62	-2.96%	-0.25%	0.67%	-47752.16	118.96	-1.33	5906.77	-0.36%	-98.08
63	-4.41%	-0.43%	3.05%	-44465.28	166.37	7.77	5689.87	-2.00%	69.47
64	-5.62%	-0.15%	3.35%	-41394.48	211.74	39.64	5816.37	1.51%	22.05
65	-6.06%	0.12%	2.70%	-39326.05	142.09	55.37	5821.31	0.31%	39.62
66	-5.64%	1.57%	2.27%	-37633.92	47.01	70.17	5698.91	0.53%	185.27
67	-5.94%	0.13%	2.62%	-35731.13	105.30	64.41	5839.28	—	—

Notes:

[a] All statistics are calculated as the changes (dollars and percentages) from the benchmark model.

[b] Statistics are displayed for the lowest quantile in average incomes as of age 59. Work percentages and average consumption are both calculated for the survivors. Average wage is for the survived workers. Claim age is the age starting receive OA, and as percentage of the total who ever claimed between age 62 and 66.

Table 23: Policy Analysis: Average OA Take-up Age (NRA = 65).

Subgroups	Benchmark averages	Changes from benchmark (in month) Experiment	Scen. 1	Scen. 2	Scen. 3
Mean	63.22	0.82	0.71	1.42	1.60
Least wealthy	63.15	1.10	-1.35	0.24	-1.00
Wealthiest	64.35	-0.78	2.70	0.53	0.78
Lowest-income	62.76	0.11	-0.10	0.27	0.41
Highest-income	63.09	0.48	1.78	2.45	2.42

Note: The benchmark average OA take-up age is in years and all other statistics are calculated as the changes from the benchmark model in months.

3.6.2 Isolated Effects of Extended Coverages

Extended UI is only available during periods of high unemployment. That being said, it is very common to have lags existing since policy changes in UI can only occur after such labor market deterioration lasting for a certain amount of time, not to mention that it is time consuming to establish the relevant regulations. Therefore, it is important for us to understand how they would separately affect labor market outcomes and OA decisions.

To start, an experiment is conducted by extending UI from 26 weeks to 99 weeks without imposing a high displacement rate in the labor market so that the pure effects of UI coverage change is examined. To implement, the annual UI benefit amount doubles and the it lasts for two periods, resulting in a new UI that is four times as generous. As observed in almost all subgroups and the mean individuals, with a higher UI, job seekers are more selective, their reservation wages increase and so do accepted working wages, and reemployment decreases accordingly, all expected as in the literature. However, the changes in behaviors are very small, primary due to the fact that displacement rate is low in the experiment. As a result, changes in in UI coverage only affect the expectations of the working individuals lightly and a small proportion of non-working individuals that are displaced. Those who are not working by voluntary quitting their jobs are not affected because of the UI eligibility requirement. Consumptions are increased, indicating increases in the confidence in future when job losses are better protected. Nevertheless, the extended UI does not have much influences overall, and especially on the least wealthy individuals. Regardless of the extra protection from UI, they need to save for further by accepting job offers to keep working. After all, UI

is nothing more than an insurance and provides benefits only to the involuntary job losers and only up to 50% of their previous wages. Therefore, it is very rare for people to make active changes in their current situations except for the possible involvement of a less precautions savings plan, knowing that their future is more secure in case they lose their jobs.

3.6.3 Isolated Effects of Labor Market Downturns

The isolated effects of a labor market downturn is analyzed in scenario 1, where the labor market deteriorates but changes in UI policy fail to follow. In this scenario, the isolated effects of a labor market downturn is examined. In order to be comparable to the effective 99 extended UI policy where both EB and all 4 tiers of ETC requirements[26] need to be satisfied, a 10% displacement rate is imposed.

As can be seen from the comparison results, the less wealthy and low-income individuals have a profile that is distinctively different from their wealthy and high-income peers of the same age. Firstly, employment is directly compromised due to high displacement. However, in comparison to the individuals with higher income and assets, the less wealthy and low-income individuals work more and because they do not have enough assets to live upon, they cannot afford to take a break after being displaced, even if it means accepting lower job offers, as shown in table 21 where the drops in average is especially significant for the least wealthy individuals[27]. Not to mention the motive-of-precaution that drives the differences in their savings decisions even apart: the poor save more and the rich do not. In the meantime, substantial decreases in consumption are observed, another way for them to survive the bad economy. Secondly, less wealthy and low-income individuals react quite differently in terms of OA claiming decisions, in contrast to the individuals in nicer conditions. Without additional UI and certainly no savings acting as buffers, they tend to make early OA claim, and in that case, OA serves as an alternative UI, regardless of the large penally imposed on early claiming. Richer and those with a better-paid job would try to cut back early claiming in the bad economy (and consequently reduce early claiming penalties) by using their stock of wealth first.

[26] Details are explained in section 2.1.2.

[27] It is less obvious for the individuals within the lowest quantile of income since they are already at the bottom and cannot reach further down in this model, where wage is bounded (non-negative) and discretized.

To conclude, poorly performed labor market will affect OA take-ups. In general, it encourages early OA claiming among those with low incomes and less savings, because steady income streams are especially appreciated during depressions even counting in substantial early claim penalties. Meanwhile, it discourages early OA claiming among the high-incomers and the wealthy by an average of 1.78 and 2.70 months respectively (see table 23), simply because they can afford to do so and a steady and less-punished OA is much more appreciated. Also, it forces lower income and less wealthy workers to accept lower wages just to make ends meet. The entire population suffers from lower consumptions levels. Such a labor market downturn like the one we have had during the past few years are deadly.

3.6.4 Joint Effects of Extended Coverages and Labor Market Downturns

Both scenario 2 and 3 reflect the influences of UI policy changes during the times of when labor market is not performing well (the same as in scenario 1, where a 10% displacement rate is imposed). The extents to which UI benefit amounts increase are the same in these two scenarios, but implemented with different approaches: In scenario 2, a UI policy change is established by extending UI from 26 weeks to 99 weeks, in accordance with the current effective policy. In scenario 3, a UI policy change is in effect by keeping the 26-week coverage and increasing the UI benefit amount to an equal level as one with 99 weeks of coverage, i.e., increasing both UI replacement rate and maximum weekly benefit amount by around four times[28] while displaced workers are entitled to such benefits for 26 weeks.

As can be seen from the comparative statistics, although a more generous UI helps in alleviating difficulties resulted from the high displacement rate, the latter still dominates, especially in terms of labor market behaviors and the reductions in consumption and savings. A UI that pays four times as much as before does not deliver a lot of help, surely not with so many job losses and surely not with no expectation that any of these are going to be well in the near future[29]. Less wealthy and low income individuals still face severe financial situations when displaced and therefore have to keep working even by accepting lower offers, especially when UI is or about to exhaust. In one sentence, the same story as told in scenario 1, only slightly alleviated.

[28]To be accurate, 3.81 times (99 weeks / 26 weeks).

[29]See section 3.6.1 for detailed explanations.

However, with the additional help from extended UI coverage, a different pattern in OA claiming behaviors can be observed. On average, 3.1% of the early-claimer-of-62 decide to postpone OA take-ups for at least 1 year, 6.34% for the poorest population and 2.52% among those with the lowest incomes – the power of UI as a stepping stone to avoid early OA claiming penalties. Note how the poor and low-incomer are now claiming OA even later compared to the benchmark? That is the help from a 99-week UI. Nevertheless, the postponing does not last very long, for many reason. For one thing, the poor and low-incomers tend to work more as aging and the a larger proportion of them are therefore affected by high displacement and higher UI coverage. Secondly, the additional UI benefits they get are not enough to cover all expenses as UI is calculated as a percentage of the previous wage so in the sense of absolute values, the extra money is not quite helping. Thirdly, they already benefit from deferring OA for one year and the reductions in early claiming penalty are much less. Being on the edge of desperation, OA is more steady and pays more than UI and they can always claim both OA (now with lower penalty) and UI at the same time. Still a sad situation, but at least better than before with only 26 weeks coverage from UI. Note that the stepping-stone role of UI is fuller utilized among the wealthy and high income individuals when making decisions on deferring their OA take-ups. As can be seen from table 23, those with the highest income profiles are able to defer OA claiming by nearly a quarter of a year, using extra help from the extend UI.

It is also worth mentioning that, from the welfare point of view, with additional UI, consumption deduction decreases, workers are therefore better off compared with a 26-week UI. Also, even though the second and third scenario provide the same amount of total UI benefits that a displaced worker can collect in one unemployment spell, consequences of these two polices are quite different. The differences could be raised for several reasons. One of which is that in this annual model, a lump-sum UI granted within the same period is almost guaranteed: a displaced worker automatically receives such a UI in the exact period he or she loses the job. Since only one event happens in a certain period, there is no offer and hence no acceptance decisions within that same period. The 99-week UI, on the other hand, requires a worker to remain unemployed for two consecutive periods without accepting any job offer. Therefore, although the potential benefits these two UI can provide in total are the same, they do not equal even with savings, and an annual model certainly is not the best environment to analyze such differences.

Chapter 4

For older workers, job displacement is not only associated with lower reemployment probabilities and income losses, but also changes in retirement plans. Two government programs are playing important roles in the decision-makings: Unemployment Insurance (UI) and Social Security Old-Age Benefits (OA). With different benefit structures and eligibility requirements, both programs can be utilized against drops in income and wealth resulted from involuntary job separations, and both can affect retirement and labor supply incentives and outcomes.

The current economic recession was one of the worst downturns United States has witness since the 50s, with high unemployments and low reemployments. It was not the first time an above-10-percent unemployment rate was observed in history, yet there has not been a single time when more than 30% of the unemployment out-lasted for the basic 26-week UI coverage. It is the one of the darkest times for job seekers and the government had to enforce a UI with 99 weeks of coverage in 2008 to support the workers through the difficulties. Around the same time, Normal Retirement Age (NRA) increased from 65 to 66 years old for the affected cohort. Consequently, OA take-ups are delayed, especially take-ups at age 62 – the Early Retirement Age (ERA). With changes in the institutional details of both government programs and worse still, the labor market, the problem is further complicated. So far, the mechanism has not been well studied within a structural framework, where there are more freedoms in policy analysis and better controlling of the environment.

Using the dynamic life-cycle model constructed and estimated in this dissertation, I am able conduct several policy analysis for the cohort with a NRA of 65 years old and use the results to mimic the more complex situation the economy has experienced during the recent recession, for the cohort with a NRA of 66 years old. I find that even though a more generous UI policy helps in times of labor market downturn, the negative effects resulted from high displacement rates still dominate, in which case even if the additional UI benefits do a better job in protecting workers against unemployment shocks and can potentially encourage labor supply, the poorly performed labor market pushes the labor supply toward the opposite direction. I also find that in a severe labor market downturn such as the recent one, those who are at

the bottom of income and wealth distributions are forced to claim OA early, while the wealthier and high-income individuals tend to postpone OA claiming for as long as nearly 3 months and survive the hardship by cutting their consumption levels and eating off their savings. However, with the extra help from a 99-week UI benefit, some of the poor and low-income individuals can also afford to postpone OA claiming at ERA using UI as a stepping-stone so that early claiming penalties can be reduced. For example, 6.34% of the poorest elders who used to claim OA at age 62 decide to wait and the same happens to 2.52% of those with extremely low incomes. Such changes in OA take-up behaviors result in 1.6 months and 0.37 months delays in their average OA take-up ages. These are the joint efforts of a labor market downturn and a UI policy change, independent of changes in the NRA and hence OA benefit generosities.

The mechanism and results explained in this structure model can help us to better understand OA claiming and retirement incentives during the recent economic recession. It also provides a foundation for further research on optimal UI policy designs and has important implications for our aging society at this time, when high unemployment is still looming along this nation's recovery path and when the governments is still making every effect in adjusting UI policies to mend the broken economy.

Appendix: Definitions and Concepts

BLS's definitions are adopted for the following concepts used in the paper:

Job Displacement: A displaced worker is someone at least 20 year old, with at least three years of tenure on a job (excepting temporary and seasonal jobs), who lost that job (without being recalled) due to slack work, abolition of a position or shift, or plant closing or relocation.

Employed persons refer to 16 years and over in the civilian noninstitutional population who, during the reference week, (a) did any work at all (at least 1 hour) as paid employees; worked in their own business, profession, or on their own farm, or worked 15 hours or more as unpaid workers in an enterprise operated by a member of the family; and (b) all those who were not working but who had jobs or businesses from which they were temporarily absent because of vacation, illness, bad weather, child care problems, maternity or paternity leave, labor-management dispute, job training, or other family or personal reasons, whether or not they were paid for the time off or were seeking other jobs. Each employed person is counted only once, even if he or she holds more than one job. Excluded are persons whose only activity consisted of work around their own house (painting, repairing, or own home housework) or volunteer work for religious, charitable, and other organizations.

Unemployed persons refer to those aged 16 years and older who had no employment during the reference week, were available for work, except for temporary illness, and had made specific efforts to find employment sometime during the 4-week period ending with the reference week. Persons who were waiting to be recalled to a job from which they had been laid off need not have been looking for work to be classified as unemployed.

Not in the labor force includes persons aged 16 years and older in the civilian non-institutional population who are neither employed nor unemployed in accordance with the definitions contained in this glossary. Information is collected on their desire for and availability for work, job search activity in the prior year, and reasons for not currently searching.

Appendix: Figures and Tables

Table 24: Seasonal Adjusted Unemployment Rate. Civilian Labor Force. 16 Years and Above. 2004 - 2013.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2004	5.7	5.6	5.8	5.6	5.6	5.6	5.5	5.4	5.4	5.5	5.4	5.4
2005	5.3	5.4	5.2	5.2	5.1	5.0	5.0	4.9	5.0	5.0	5.0	4.9
2006	4.7	4.8	4.7	4.7	4.6	4.6	4.7	4.7	4.5	4.4	4.5	4.4
2007	4.6	4.5	4.4	4.5	4.4	4.6	4.7	4.6	4.7	4.7	4.7	5.0
2008	5.0	4.9	5.1	5.0	5.4	5.6	5.8	6.1	6.1	6.5	6.8	7.3
2009	7.8	8.3	8.7	9.0	9.4	9.5	9.5	9.6	9.8	10.0	9.9	9.9
2010	9.7	9.8	9.9	9.9	9.6	9.4	9.5	9.5	9.5	9.5	9.8	9.4
2011	9.1	9.0	9.0	9.1	9.0	9.1	9.0	9.0	9.0	8.8	8.6	8.5
2012	8.2	8.3	8.2	8.2	8.2	8.2	8.2	8.1	7.8	7.8	7.8	7.9
2013	7.9	7.7	7.5	7.5	7.5	7.5	7.3	7.2	7.2	7.2	7.0	6.7

Source: BLS.

Table 25: Seasonal Adjusted Civilian Labor Force Participation Rate. In Percentages.16 Years and Above. 2004 - 2013.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2004	66.1	66.0	66.0	65.9	66.0	66.1	66.1	66.0	65.8	65.9	66.0	65.9
2005	65.8	65.9	65.9	66.1	66.1	66.1	66.1	66.2	66.1	66.1	66.0	66.0
2006	66.0	66.1	66.2	66.1	66.1	66.2	66.1	66.2	66.1	66.2	66.3	66.4
2007	66.4	66.3	66.2	65.9	66.0	66.0	66.0	65.8	66.0	65.8	66.0	66.0
2008	66.2	66.0	66.1	65.9	66.1	66.1	66.1	66.1	66.0	66.0	65.9	65.8
2009	65.7	65.8	65.6	65.7	65.7	65.7	65.5	65.4	65.1	65.0	65.0	64.6
2010	64.8	64.9	64.9	65.2	64.9	64.6	64.6	64.7	64.6	64.4	64.6	64.3
2011	64.2	64.2	64.2	64.2	64.2	64.0	64.0	64.1	64.2	64.1	64.1	64.0
2012	63.7	63.9	63.8	63.7	63.8	63.8	63.7	63.5	63.6	63.7	63.6	63.6
2013	63.6	63.5	63.3	63.4	63.4	63.5	63.4	63.2	63.2	62.8	63.0	62.8

Source: BLS.

Table 26: Federal-State Regular UI. Summary Financial and Claims Data. 1995-2012.

Year	Total payments (in thousands)	Num. first payments	Wks compen. (total)	Num. claimants exhausting benefits	Ave. wkly. benefits	Ave. duration (acutal)
1995	20,122,189	8,035,229	118,344,208	2,661,773	187.29	14.7
1996	20,634,904	7,989,615	118,970,010	2,738,963	189.45	14.9
1997	18,605,353	7,325,279	106,590,203	2,484,911	192.76	14.6
1998	18,433,293	7,331,890	101,377,206	2,266,356	200.29	13.8
1999	19,260,936	6,951,210	100,555,806	2,300,128	211.75	14.5
2000	19,441,159	7,033,133	96,007,342	2,143,989	221.01	13.7
2001	30,402,857	9,877,448	136,338,414	2,827,089	238.07	13.8
2002	40,383,144	10,092,569	166,284,570	4,421,750	256.79	16.5
2003	39,063,133	9,935,108	163,202,859	4,416,574	261.67	16.4
2004	32,319,580	8,368,623	135,132,839	3,531,535	262.5	16.1
2005	29,260,295	7,917,294	121,170,797	2,855,810	266.62	15.3
2006	27,960,228	7,350,734	112,078,157	2,676,729	277.2	15.2
2007	30,524,891	7,642,400	116,330,490	2,670,579	287.73	15.2
2008	40,675,305	10,059,554	149,550,916	3,425,068	297.1	14.9
2009	75,823,946	14,172,822	266,046,305	7,530,212	308.73	18.8
2010	53,843,013	10,726,566	203,148,596	6,365,048	299.31	18.9
2011	43,240,710	9,474,531	165,543,426	4,837,275	295.79	17.5
2012	39,757,125	8,661,577	147,644,807	4,227,891	302.67	17

Source: U.S. Department of Labor.

Table 27: Federal-State EB. Summary Financial and Claims Data. 1995-2012.

Year	Total payments (in thousands)	Num. first payments	Wks compen. (total)	Num. claimants exhausting benefits	Ave. wkly. benefits	Ave. duration (acutal)
1995	75,295	68,854	708,968	43,297	106.65	10.3
1996	28,118	31,923	270,425	11,048	106.55	8.5
1997	26,792	32,048	264,854	10,229	103.77	8.3
1998	34,331	45,437	330,944	8,831	104.3	7.3
1999	16,924	14,587	146,779	5,875	120.06	10.1
2000	3,847	5,370	28,293	1,090	182.24	5.3
2001	3,924	5,216	16,260	1,066	304.74	3.3
2002	237,814	84,075	573,770	25,176	282.13	6.8
2003	367,778	120,357	1,156,155	70,813	284.09	9.6
2004	37,516	34,221	159,889	7,603	258.68	4.7
2005	8,848	9,609	50,451	1,211	183.07	5.3
2006	18,981	35,294	114,793	324	163.66	3.3
2007	-285	37	126	5	242	3
2008	44,169	28,371	130,644	2,385	267	5
2009	6,546,112	1,577,624	23,090,963	892,693	283	15
2010	9,015,073	2,293,083	31,785,632	1,376,670	295	14
2011	10,672,181	1,916,597	33,991,938	1,729,233	302	18
2012	2,901,931	629,878	9,967,322	539,365	303.83	15.8

Source: U.S. Department of Labor.

Table 28: Federal EUC. Summary Financial and Claims Data. 1995-2012.

Year	Total payments (in thousands)	Num. first payments	Wks compen. (total)	Num. claimants exhausting benefits	Ave. wkly. benefits
2008	7,895,238	2,575,955	27,998,339	613,390	281.99
2009	44,249,800	6,565,319	150,625,512	0	293.77
2010	70,212,916	5,447,634	237,278,775	3,818,985	295.91
2011	48,585,795	3,976,230	167,177,470	2,825,656	290.62

Source: U.S. Department of Labor.

Table 29: OA Entitlements. Number and Average Monthly Benefits for Retired Workers, by Age and Sex.

Age	Total		Men		Women	
	Number	Benefit	Number	Benefit	Number	Benefit
			2000			
Total	**1,677,600**	**$796.90**	**940,100**	**$936.80**	**737,500**	**$618.60**
62 - 64	1,148,300	752.00	623,800	896.70	524,500	580.00
62	869,700	729.90	463,600	877.40	406,100	561.40
63	118,600	792.30	68,400	915.80	50,200	623.90
64	160,000	842.70	91,800	980.00	68,200	658.00
65 - 69	496,400	892.00	301,900	1,010.70	194,500	707.70
65	424,200	882.80	257,600	1,003.20	166,600	696.50
Disability conversions	193,000	815.90	118,400	940.30	74,600	618.60
New entitlements	231,200	938.60	139,200	1,056.80	92,000	759.70
66	28,900	933.00	19,900	1,026.90	9,000	725.30
67	17,000	962.80	9,300	1,089.90	7,700	809.40
68	14,200	921.50	8,600	1,032.10	5,600	751.70
69	12,100	983.00	6,500	1,114.60	5,600	830.30
70 - 74	25,600	1,012.20	12,400	1,211.90	13,200	824.60
75 orolder	7,300	626.80	2,000	557.10	5,300	653.00
			2012			
Total	**2,735,007**	**$1,292.17**	**1,418,571**	**$1,473.73**	**1,316,436**	**$1,096.52**
62 - 64	1,462,012	1,075.06	715,310	1,225.91	746,702	930.56
62	1,086,120	1,024.35	528,047	1,166.92	558,073	889.45
63	182,363	1,188.15	91,952	1,347.20	90,411	1,026.39
64	193,529	1,253.13	95,311	1,435.71	98,218	1,075.95
65 - 69	1,224,678	1,536.02	683,756	1,722.11	540,922	1,300.79
65	312,821	1,458.86	163,126	1,643.57	149,695	1,257.58
66	841,434	1,549.92	483,331	1,733.09	358,103	1,302.70
Disability conversions	401,871	1,333.42	216,890	1,504.45	184,981	1,132.88
New entitlements	439,563	1,747.86	266,441	1,919.21	173,122	1,484.15
67	34,164	1,679.13	19,256	1,869.52	14,908	1,433.21
68	19,822	1,695.68	10,107	1,922.73	9,715	1,459.46
69	16,437	1,802.69	7,936	2,054.16	8,501	1,567.94
70 - 74	42,810	1,806.00	16,998	2,039.04	25,812	1,652.55
75 orolder	5,507	708.54	2,507	610.27	3,000	790.67

Source: SSA Annual Statistics Supplement. 2000 & 2012.

Table 30: OA Beneficiaries. Number (thousands), Average Age, and Percentage Distribution, by Sex and Age. 1940-2012. Selected Years.

Year	N	Ave. age	Percentage distribution						
			Total	62 - 64	65 - 69	70 - 74	75 - 79	80 - 84	85 or older
					Men				
1940	99	68.8	100.0	. . .	74.4	17.4	6.4	1.6	0.2
1950	1,469	72.2	100.0	. . .	39.1	33.7	20.2	5.9	1.2
1960	5,217	73.2	100.0	. . .	33.8	33.1	21.1	9.0	3.1
1970	7,688	72.6	100.0	7.5	30.1	26.9	19.6	10.6	5.3
1980	10,461	72.2	100.0	9.5	32.1	25.8	16.9	9.5	6.1
1995	13,915	72.9	100.0	9.5	28.0	26.1	18.3	11.1	7.0
1996	14,012	73.1	100.0	9.2	27.6	25.8	18.9	11.3	7.2
1997	14,126	73.2	100.0	9.0	27.2	25.8	19.2	11.4	7.4
1998	14,206	73.3	100.0	9.0	26.6	25.6	19.5	11.6	7.6
1999	14,329	73.3	100.0	9.1	26.4	25.2	19.8	11.7	7.8
2000	14,772	73.2	100.0	9.0	27.6	24.6	19.3	11.7	7.8
2001	14,930	73.3	100.0	8.9	27.6	24.3	19.1	12.1	7.9
2002	15,070	73.3	100.0	8.8	27.9	24.0	19.1	12.4	7.8
2003	15,254	73.3	100.0	8.7	27.9	23.5	19.0	12.6	8.2
2004	15,438	73.4	100.0	8.9	27.7	23.4	18.8	12.8	8.4
2005	15,654	73.4	100.0	9.1	27.4	23.2	18.7	12.8	8.7
2006	15,869	73.5	100.0	9.0	27.5	23.2	18.5	12.8	9.1
2007	16,112	73.5	100.0	8.5	27.8	23.3	18.3	12.8	9.3
2008	16,456	73.5	100.0	8.3	28.0	23.6	17.9	12.7	9.5
2009	17,067	73.4	100.0	9.1	28.2	23.3	17.5	12.4	9.6
2010	17,582	73.4	100.0	9.7	28.0	23.3	17.1	12.2	9.6
2011	18,043	73.4	100.0	9.4	28.3	23.6	17.0	12.0	9.7
2012	18,560	73.4	100.0	8.6	28.8	24.3	16.9	11.8	9.7
					Women				
1940	13	68.1	100.0	. . .	82.6	12.8	3.9	0.6	0.1
1950	302	71.1	100.0	. . .	48.4	32.9	15.0	3.2	0.5
1960	2,845	71.0	100.0	12.6	36.3	29.0	15.0	5.6	1.6
1970	5,661	72.0	100.0	11.5	30.1	25.4	18.7	10.0	4.4
1980	9,101	72.6	100.0	11.2	29.2	24.2	17.1	10.6	7.7
1995	12,757	74.3	100.0	8.8	24.0	23.2	18.5	13.5	11.9
1996	12,887	74.4	100.0	8.7	23.6	22.9	18.8	13.7	12.2
1997	13,155	74.5	100.0	8.6	23.2	23.0	19.0	13.8	12.5
1998	13,304	74.6	100.0	8.7	22.8	22.8	19.0	13.9	12.8
1999	13,453	74.6	100.0	8.8	22.8	22.3	19.3	13.8	13.0
2000	13,734	74.6	100.0	8.9	23.4	21.9	19.1	13.8	13.0
2001	13,912	74.6	100.0	8.9	23.6	21.6	18.8	13.9	13.1
2002	14,096	74.6	100.0	8.8	23.9	21.3	18.7	14.0	13.3
2003	14,294	74.5	100.0	8.8	24.3	21.0	18.5	14.0	13.4
2004	14,534	74.5	100.0	9.0	24.4	20.9	18.1	14.1	13.4
2005	14,821	74.5	100.0	9.4	24.4	20.8	17.8	14.1	13.5
2006	15,107	74.5	100.0	9.4	24.8	20.9	17.5	13.9	13.7
2007	15,416	74.5	100.0	9.0	25.3	21.1	17.2	13.7	13.8
2008	15,818	74.4	100.0	8.9	25.8	21.5	16.7	13.5	13.7
2009	16,447	74.2	100.0	9.6	26.1	21.4	16.3	12.9	13.6
2010	17,011	74.1	100.0	10.2	26.0	21.5	16.1	12.6	13.5
2011	17,557	74.1	100.0	10.0	26.5	21.9	16.0	12.2	13.4
2012	18,161	74.0	100.0	9.3	27.1	22.6	15.9	11.9	13.2

Source: SSA Annual Statistics Supplement. 2012.

Table 31: Policy Analysis: Benchmark Statistics (NRA = 65). Across Wealth and Income Distributions.

Age	% Wk.	Stop wk.	Re-emp	A	C	Wage	UI	Claim	OA
				Least wealthy individuals					
59	84.28%	36.45%	3.21%	15003.94	13447.85	17196.6	3132.79	—	—
60	82.58%	29.97%	5.92%	16122.03	13961.82	17275.49	4290.34	—	—
61	79.71%	25.59%	7.75%	16894.49	14568.92	16977.28	4200.12	—	—
62	75.57%	20.58%	9.88%	16420.73	15749.72	16889.77	4271.5	48.45%	9406.59
63	73.70%	19.53%	8.25%	17637.18	15905.29	16538.13	4203.04	16.48%	8346.97
64	72.56%	17.80%	7.49%	19195.93	16142.65	16092.58	4217.94	6.89%	7091.75
65	71.34%	16.35%	7.39%	20382.38	16225.07	15690.78	4011.21	27.59%	9990.21
66	70.35%	15.34%	7.14%	23241.02	17032.16	15273.59	3999.26	0.58%	11971.88
67	69.34%	14.79%	7.18%	24986.14	17395.93	14919.16	3801.47	—	—
				Wealthiest individuals					
59	48.09%	0.35%	19.09%	300129.41	36274.63	45438.84	11135.79	—	—
60	37.90%	0.25%	21.90%	293813.94	35577.09	47705.51	10169.68	—	—
61	32.08%	0.29%	16.40%	282040.28	35350.85	47905.39	10949.2	—	—
62	28.12%	0.19%	12.69%	267475.06	34796.55	48152.68	10743.56	28.78%	13093.75
63	25.52%	0.31%	9.89%	252656.52	33721.86	48429.48	10795.64	7.93%	14408.94
64	23.93%	0.27%	7.09%	237841.41	33468.85	48098.75	11212.86	0.87%	19599.93
65	22.04%	0.32%	8.76%	222059.67	32965.09	47970.48	11209.19	24.38%	2780.91
66	19.42%	0.22%	12.29%	207415.16	32310.88	47868.88	11025.44	38.04%	11834.59
67	14.68%	0.25%	25.11%	194598.23	32070.78	49292.87	11266.28	—	—
				Lowest-income individuals					
59	53.82%	21.95%	18.59%	75799.44	11068.88	6644.29	1575.58	—	—
60	54.39%	20.72%	13.00%	70108.02	10915.85	7076.9	1696.17	—	—
61	60.29%	21.63%	6.94%	63535.12	10852.98	7302.97	1782.84	—	—
62	63.95%	22.11%	7.37%	58390.55	10519.43	7408.22	1912.61	54.79%	3193.08
63	67.85%	23.50%	6.33%	54846.24	10214.59	7530.68	1898.15	15.85%	3469.89
64	69.75%	21.73%	6.80%	52419.81	10813.59	7629.06	1924.7	28.45%	4660.22
65	71.13%	20.65%	6.40%	50384.91	10916.77	7676.98	1912.51	0.40%	3119.94
66	72.12%	20.87%	6.40%	48318.5	10637.57	7736.25	1909.95	0.51%	2448.84
67	72.41%	22.35%	7.53%	46514.18	10677.75	7787.85	1889.06	—	—
				Highest-income individuals					
59	74.16%	4.35%	6.86%	124952.53	29284.08	39005.15	10848.5	—	—
60	70.07%	3.06%	6.53%	125673.9	29683.75	38990.64	10446.15	—	—
61	65.79%	1.82%	7.44%	125935.47	30041.11	38721.87	10354.91	—	—
62	61.58%	2.22%	7.46%	124266.2	30068.3	38452.67	10031.72	48.39%	15086.59
63	58.00%	2.29%	7.11%	123777.39	29652.27	38236.67	10109.7	24.11%	16434
64	54.31%	1.92%	7.69%	123771.62	29397.77	38140.41	10090.28	10.09%	17583.13
65	50.83%	1.51%	7.59%	123095.55	29091.43	37939.87	9967.96	5.10%	16485.51
66	46.59%	1.19%	9.47%	121573.59	28602.66	37963.5	9659.08	12.31%	18359.83
67	41.90%	1.00%	11.27%	119678.97	28214.8	38051.29	9130.96	—	—

Notes: Statistics are displayed for the lowest and highest quantile in aOAets and average incomes as of age 59. Work percentages and average consumption are both calculated for the survivors. Average wage is for the survived workers. Claim age is the age starting receive OA, and as percentage of the total who ever claimed between age 62 and 66. All statistics are from benchmark model with a NRA of 65.

Table 32: Policy Analysis: Wealthiest Individuals. Changes from the Benchmark (NRA = 65).

Age	Wk.	Stop wk.	Re-emp	A	C	Wage	UI	Claim	OA
Experiment: UI extended from 26 to 99 weeks without labor market deterioration									
59	-0.44%	0.02%	-0.90%	724.06	293.89	-2075.36	10837.28	—	—
60	-0.89%	0.02%	1.22%	373.09	612.05	-2416.84	10749.72	—	—
61	0.14%	-0.02%	-2.32%	-461.84	384.29	-1739.68	9253.38	—	—
62	1.42%	0.04%	-3.95%	-553.72	416.16	-1681.43	10314.14	-1.29%	-172.57
63	1.59%	0.03%	-0.98%	-132.18	318.71	-2420.61	10283.78	0.67%	-145.11
64	0.35%	0.03%	4.22%	376.59	430.03	-2103.25	9914.41	-0.77%	-924.04
65	0.81%	-0.01%	-1.94%	207.39	315.53	-2345.52	10331.60	0.54%	408.83
66	1.37%	0.09%	-2.62%	283.28	468.86	-2631.24	10642.35	0.84%	-438.31
67	1.42%	0.03%	-1.85%	454.72	528.25	-2324.53	10215.64	—	—
Scenario 1: Labor market downturn with a 10% displacement rate									
59	-3.42%	0.01%	2.77%	366.59	-1171.83	-58.20	26.85	—	—
60	-3.76%	0.00%	2.81%	118.15	-943.71	82.64	-25.65	—	—
61	-4.33%	-0.02%	3.44%	-638.69	-813.97	173.82	-38.77	—	—
62	-4.28%	0.02%	1.84%	-1775.81	-866.95	-307.55	198.15	-5.16%	-65.57
63	-4.79%	0.03%	4.04%	-3337.57	-935.02	-84.89	10.37	-1.97%	-193.83
64	-5.27%	-0.01%	3.99%	-5168.41	-957.54	-827.27	150.05	1.21%	-2284.77
65	-5.11%	0.00%	1.77%	-7307.33	-994.84	-1700.77	-194.65	1.62%	652.07
66	-4.76%	0.02%	1.71%	-9557.57	-897.41	-535.85	-549.70	4.30%	149.15
67	-3.94%	0.00%	2.68%	-11239.68	-926.37	-1508.14	-100.62	—	—
Scenario 2: Labor market downturn with extended UI from 26 weeks to 99 weeks									
59	-0.56%	0.11%	-0.98%	-925.79	437.75	-905.93	10655.87	—	—
60	-2.35%	0.09%	4.13%	-407.41	226.46	-815.49	10745.40	—	—
61	-1.81%	0.01%	-0.38%	-421.09	151.88	-439.35	9736.93	—	—
62	-1.75%	0.03%	0.51%	-264.18	81.13	-179.07	10902.04	-2.13%	-112.53
63	-1.47%	0.03%	-0.30%	-204.58	58.66	-702.24	10980.21	1.28%	106.29
64	-2.69%	0.02%	5.55%	-157.71	286.06	-989.21	10851.29	-0.60%	-4124.31
65	-2.45%	0.02%	0.17%	-1133.12	120.39	-1453.11	11019.01	0.82%	1210.63
66	-2.13%	0.14%	0.44%	-1935.99	213.64	-1502.52	10648.28	0.62%	-152.03
67	-1.37%	0.03%	-1.09%	-2755.57	116.76	-969.66	10365.93	—	—
Scenario 3: Labor market downturn with increased UI benefit amount (same as scenario 2)									
59	-1.11%	0.16%	-1.07%	-1635.19	90.48	-988.12	32114.74	—	—
60	-1.91%	0.07%	2.39%	-870.22	56.05	-988.47	29884.51	—	—
61	-2.39%	0.02%	2.21%	-823.56	42.63	-227.57	31972.74	—	—
62	-1.93%	0.05%	-0.46%	-883.34	69.39	-334.25	33027.07	-2.33%	-158.37
63	-1.60%	0.05%	-0.34%	-1013.47	-26.45	-898.55	32461.74	1.32%	34.37
64	-2.79%	0.02%	5.47%	-1127.71	152.49	-1175.68	33439.87	-0.66%	-3588.21
65	-2.79%	0.02%	1.33%	-2096.62	-47.47	-1258.97	32639.72	0.87%	1788.96
66	-2.21%	0.15%	-0.65%	-2995.71	-29.62	-1704.65	31796.49	0.81%	157.58
67	-1.47%	0.06%	-0.88%	-3624.00	-70.24	-1737.09	32611.25	—	—

Notes:

[a] All statistics are calculated as the changes (dollars and percentages) from the benchmark model.

[b] Statistics are displayed for the highest quantile in assets as of age 59. Work percentages and average consumption are both calculated for the survivors. Average wage is for the survived workers. Claim age is the age starting receive OA, and as percentage of the total who ever claimed between age 62 and 66.

Table 33: Policy Analysis: Highest-income Individuals. Changes from the Benchmark (NRA = 65).

Age	Wk.	Stop wk.	Re-emp.	A	C.	Wage	UI	Claim	OA
Experiment: UI extended from 26 to 99 weeks without labor market deterioration									
59	0.45%	-0.51%	-0.36%	-5876.01	1370.33	-331.17	10371.24	—	—
60	0.25%	-0.32%	0.18%	-6136.39	1100.02	-343.49	10309.77	—	—
61	0.38%	-0.19%	-0.31%	-6215.95	802.37	-204.51	9890.81	—	—
62	0.47%	-0.37%	-0.37%	-5911.93	945.53	-32.47	9753.86	-0.80%	-31.85
63	0.51%	-0.33%	-0.33%	-5728.40	850.60	-33.55	9423.09	-0.50%	-4.15
64	0.22%	-0.25%	0.21%	-5595.10	831.75	7.94	9331.42	-0.76%	-63.08
65	0.33%	-0.14%	-0.35%	-5676.56	621.02	-49.72	9264.64	0.87%	473.81
66	0.68%	-0.07%	-0.84%	-5503.29	692.92	-192.36	9156.84	1.17%	-109.92
67	0.91%	0.00%	-0.70%	-5337.59	687.87	-192.08	9185.33	—	—
Scenario 1: Labor market downturn with a 10% displacement rate									
59	-4.09%	-0.29%	2.00%	2253.60	-1746.04	172.73	-134.52	—	—
60	-5.05%	-0.17%	2.33%	2472.26	-1765.86	69.43	-47.77	—	—
61	-6.28%	-0.10%	2.65%	2410.96	-1680.29	9.15	-205.25	—	—
62	-7.27%	-0.14%	2.54%	1844.35	-1582.49	-120.41	-69.52	-5.04%	102.49
63	-8.22%	-0.03%	2.89%	527.73	-1666.73	-264.70	-107.49	-1.55%	84.32
64	-8.91%	-0.11%	2.76%	-1200.00	-1784.62	-427.39	-79.73	4.12%	-601.58
65	-9.44%	-0.11%	2.77%	-2878.57	-1726.60	-570.35	-217.30	1.08%	53.60
66	-9.50%	-0.08%	2.38%	-4806.85	-1737.03	-554.64	-70.99	1.38%	195.46
67	-9.62%	-0.05%	3.29%	-6586.07	-1795.05	-638.95	-57.28	—	—
Scenario 2: Labor market downturn with extended UI from 26 weeks to 99 weeks									
59	-3.09%	-0.86%	1.36%	-2648.42	-188.18	-375.33	10197.40	—	—
60	-4.49%	-0.51%	2.70%	-2461.94	-420.80	-477.88	10168.14	—	—
61	-5.52%	-0.28%	2.15%	-2442.59	-736.16	-422.88	9623.45	—	—
62	-6.64%	-0.53%	2.36%	-2381.32	-868.34	-286.62	9450.23	-5.78%	57.29
63	-7.51%	-0.37%	2.35%	-2923.02	-1011.45	-410.98	9276.80	-1.57%	39.94
64	-8.37%	-0.33%	2.72%	-3954.42	-924.33	-590.04	9327.38	2.64%	-528.69
65	-8.80%	-0.24%	2.22%	-5455.60	-1024.99	-740.31	9197.71	2.15%	667.43
66	-8.68%	-0.09%	1.73%	-7030.23	-918.18	-1011.71	9005.82	2.56%	285.04
67	-8.74%	-0.01%	2.83%	-8680.45	-967.32	-935.47	8945.75	—	—
Scenario 3: Labor market downturn with increased UI benefit amount (same as scenario 2)									
59	-3.04%	-0.72%	1.38%	-1754.51	-489.96	-611.47	30978.58	—	—
60	-4.41%	-0.36%	2.69%	-1300.37	-679.52	-735.33	30103.75	—	—
61	-5.46%	-0.21%	2.19%	-1061.48	-928.33	-671.67	29044.42	—	—
62	-6.44%	-0.49%	2.14%	-938.93	-985.19	-597.74	28462.33	-5.87%	65.85
63	-7.28%	-0.48%	2.17%	-1565.17	-1106.50	-724.08	28870.40	-1.60%	38.62
64	-8.10%	-0.40%	2.52%	-2784.88	-946.98	-922.15	28942.64	2.73%	-497.65
65	-8.53%	-0.27%	2.15%	-4413.87	-1024.64	-1065.60	28200.62	2.03%	631.70
66	-8.25%	-0.10%	1.26%	-6220.91	-941.07	-1407.18	27839.48	2.70%	341.23
67	-8.51%	-0.08%	3.09%	-7970.31	-933.49	-1310.04	26149.44	—	—

Notes:

[a] All statistics are calculated as the changes (dollars and percentages) from the benchmark model.

[b] Statistics are displayed for the highest quantile in average incomes as of age 59. Work percentages and average consumption are both calculated for the survivors. Average wage is for the survived workers. Claim age is the age starting receive OA, and as percentage of the total who ever claimed between age 62 and 66.

References

Alvarez, F. and Shimer, R. (2008). Search and rest unemployment. Working Papers 13772, National Bureau of Economic Research.

Anderson, P. M. and Meyer, B. D. (1997). Unemployment Insurance takeup rates and the after-tax value of benefits. *The Quarterly Journal of Economics*, 112(3):pp. 913–937.

Ashenfelter, O. (2005). Unemployment as disequilibrium in a model of aggregate labor supply. *Econometrica*, 48(3):547–564.

Bellman, R. E. (1957). *Dynamic Programming*. Princeton University Press, Princeton, NJ, 2003 republished edition.

Benitez-Silva, H., Garcia-Perez, J. I., and Jimenez-Martin, S. (2011). The effects of employment uncertainty and wealth shocks on the labor supply and claiming behavior of older american workers. Working papers, Stony Brook University, Department of Economics.

Benitez-Silva, H. and Heiland, F. (2005). Early claiming of Social Security benefits and labor supply behavior of older americans. Working Papers 05-05, Stony Brook University, Department of Economics.

Benitez-Silva, H. and Heiland, F. (2007). The Social Security earnings test and work incentives. *Journal of Policy Analysis and Management*, 26(3):527–555.

Benitez-Silva, H. and Ni, H. (2010). Job search behavior of older Americans. Working papers, Stony Brook University, Department of Economics.

Blau, D. M. and Gilleskie, D. B. (2008). The role of retiree health insurance in the employment behavior of older men. *International Economic Review*, 49(2):475–514.

Browning, M., Crossley, T., and Smith, E. (1999). Asset accumulation and short term employment. Manuscript, University of Essex, Mimeo.

Burdett, K. (1978). A theory of employee job search and quit rates. *American Economic Review*, 68(1):212–220.

Burtless, G. and Moffit, R. (1984). The effect of Social Security benefits on the labor supply of the aged. In Aaron, H. and Burtless, G., editors, *Retirement and Economic Behavior*, pages 135–175. Brookings Institution, Washington.

CBO (2012). Unemployment Insurance in the wake of the recent recession. Report, The Congressional Budget Office.

Chan, S. and Stevens, A. H. (1999). Employment and retirement following a late-career job loss. *American Economic Review*, 89(2):211–216.

Chan, S. and Stevens, A. H. (2001). Job loss and employment patterns of older workers. *Journal of Labor Economics*, 19(2):484–521.

Chan, S. and Stevens, A. H. (2004). How does job loss affect the timing of retirement? *The B.E Journal of Economic Analysis & Policy*, 3(1):1–26.

Chan, S. and Stevens, A. H. (2011). Retirement incentives and expectations. Working Papers 8082, National Bureau of Economic Research.

Coile, C. and Levine, P. B. (2011). The market crash and mass layoffs: How the current economic crisis may affect retirement. *The B.E Journal of Economic Analysis & Policy*, 11(1):1–42.

Coile, C. C. and Gruber, J. (2001). Social Security incentives for retirement. In Wise, D. A., editor, *Themes in the Economics of Aging*, pages 311–354. University of Chicago Press.

Coile, C. C. and Levine, P. B. (2006). Bulls, bears, and retirement behavior. *Industrial and Labor Relations Review*, 59(3):408–429.

Coile, C. C. and Levine, P. B. (2007). Labor market shocks and retirement: Do government programs matter? *Journal of Public Economics*, 91(10):1902–1919.

Coile, C. C. and Levine, P. B. (2010). Reconsidering retirement: How losses and layoffs affect older workers. Manuscript, Wellesley College.

Couch, K. A. (1998). Late life job displacement. *The Gerontologist*, 38(1):7–17.

Cullen, J. B. and Gruber, J. (2000). Does Unemployment Insurance crowd out spousal labor supply? *Journal of Labor Economics*, 18(3):546–72.

DORN, D. and SOUSA-POZA, A. (2005). Early retirement: Free choice or forced decision? Working Papers NO. 1542, CESifo.

Dorn, D. and Sousa-Poza, A. (2010). 'Voluntary' and 'involuntary' early retirement: An international analysis. *Applied Economics*, 42(4):427–438.

Dreyfus, S. (2002). Richard Bellman on the birth of dynamic programming. *Operations Research*, 50(2):48–51.

Dwyer, D. S. and Mitchell, O. S. (1999). Health problems as determinants of retirement: Are self-rated measures endogenous? *Journal of Health Economics*, 18(2):173 – 193.

Elder, T. E. (2000). Reemployment patterns of displaced older workers. Manuscript, Northwestern University.

Eliason, M. and Storrie, D. (2006). Lasting or latent scars? Swedish evidence on the long-term effects of job displacement. *Journal of Labor Economics*, 24(4).

Elmendorf, D. (2011). Policies for increasing economic growth and employment in 2012 and 2013. Testimony before the Senate Budget Committee, Congressional Budget Office.

Employment and Training Administration (2001-2013). Comparison of state Unemployment Insurance laws. Technical report, U.S. Department of Labor.

Esteban-Pretel, J. and Fujimoto, J. (2011). Life-cycle labor search with stochastic match quality. Manuscript.

Fallick, B. C. (1996). A review of the recent empirical literature on displaced workers. *Industrial and Labor Relations Review*, 50(1):5–16.

Farber, H. S. (2003). Job loss in the United States, 1981-2001. Technical Report 471, Princeton University.

Farber, H. S. (2007). Job loss and the decline in job security in the United States. Working Papers 520, Princeton University.

Farber, H. S. (2011). Job loss in the great recession: Historial perspective from the displaced workers survey, 1984-2010. Working papers, National Bureau of Economic Research.

Farber, H. S. and Valletta, R. G. (2013). Do extended Unemployment Benefits lengthen unemployment spells? evidence from recent cycles in the u.s. labor market. Working Papers 2013-09, Federal Reserve Bank of San Francisco.

French, E. (2005). The effects of health, wealth, and wages on labour supply and retirement behaviour. *The Review of Economic Studies*, 72(2):395–427.

Frijters, P. and van der Klaauw, B. (2004). Job search with nonparticipation. *IZA Discussion Paper*, DP(1407).

Gallipoli, G. and Turner, L. (2009). Household responses to individual shocks: Disability and labour supply. CLSSRN Working Papers 2009-32, Vancouver School of Economics.

Garcia-Perez, J. I. (2006). Job separation in a non-stationary search model: a structural estimation to evaluate alternative Unemployment Insurance systems. *Journal of Applied Econometrics*, 21(2):245–272.

Gourinchas, P.-O. and Parker, J. A. (2002). Consumption over the life cycle. *Econometrica*, 70(1):47–89.

Gruber, J. and Madrian, B. C. (1996). Health insurance and early retirement: Evidence from the availability of continuation coverage. In *Advances in the Economics of Aging*, NBER Chapters, pages 115–146. National Bureau of Economic Research.

Hairault, J.-O., Langot, F., Menard, S., and Sopraseuth, T. (2009). Optimal Unemployment Insurance for older workers. *Journal of Public Economics*, 96:509–519.

Hall, J. R., Lippman, S. A., and McCall, J. J. (1979). Expected utility maximizing job search. In *Studies in the Economics of Search*, pages 133–156. North-Holland.

Hallberg, D. (2011). Economic fluctuations and retirement of older employees. *LABOUR*, 25(3):287–307.

Hamermesh, D. S. (1982). Unemployment Insurance and the older American. *Journal of Policy Analysis and Management*, 2(1):137–138.

Heckman, J. J. and Macurdy, T. E. (1980). A life cycle model of female labor supply. *Review of Economics Studies*, XLVII:47–74.

Hipple, S. (1999). Worker displacement in the mid-1990s. *Monthly Labor Review*, 122:15–32.

Hirsch, B. T., Macpherson, D. A., and Hardy, M. A. (2000). Occupational age structure and access for older workers. *Industrial and Labor Relations Review*, 53(3):401–418.

Honig, M. (1998). Married women's retirement expectations: Do pensions and Social Security matter? *American Economic Review*, 88(2):202–206.

Hurd, M. D. (1989). Mortality risk and bequest. *Econometrica*, 57(4):779–813.

Hurd, M. D., Michaud, P.-C., and Rohwedder, S. (2012). The displacement effect of public pensions on the accumulation of financial assets. *Fiscal Studies*, 33(1):107–128.

Hurd, M. D. and Rohwedder, S. (2010). The effects of the economic crisis on the older population. Working Papers WP 2010-231, University of Michigan Retirement Research Center.

Hutchens, R. (1999). Social Security benefits and employer behavior: Evaluating Social Security early retirement benefits as a form of Unemployment Insurance. *International Economic Review*, 40(3):pp. 659–678.

Hutchens, R. and Jacobson, L. (2002). Unemployment Insurance and older workers: Pennsylvania 1970-1994. Unpublished Manuscript.

Ichino, A., Schwerdt, G., Winter-Ebmer, R., and Zweimüllera, J. (2007). Too old to work, too young to retire? Working Papers IZA DP No. 3110, IZA.

Jacobson, L. S., LaLonde, R. J., and Sullivan, D. G. (1993). Earnings losses of displaced workers. *The American Economic Review*, 83(4):pp. 685–709.

Johnson, R. W. and Mommaerts, C. (2011). Age differences in job displacement, job search, and reemployment. Technical Report CRR WP 2011-3, Center for Retirement Research at Boston College.

Kletzer, L. G. (1998). Job displacement. *Journal of Economic Perspectives*, 12(1):115–136.

Krueger, A. B. and Meyer, B. D. (2002). Labor supply effects of social insurance. In Auerbach, A. J. and Feldstein, M., editors, *Handbook of Public Economics*, volume 4 of *Handbook of Public Economics*, chapter 33, pages 2327–2392. Elsevier.

Kyyrä, T. and Wilke, R. A. (2005). Reduction in the long-term unemployment of the elderly: A success story from finland. Manuscript.

Lahey, J. (2005). Do older workers face discrimination? Issue Brief 33, Center for Retirement Research at Boston College, Boston, MA.

Layard, R., Barton, M., and Zabalza, A. (1980). Married women's participation and hours. *Econometrica*, 47(185):51–72.

Levine, P. B. (2005). Unemployment Insurance over the business cycle: Does it meet the needs of less-skilled workers? Working Paper Series 05-11, National Poverty Center.

Ljungqvist, L. and Sargent, T. (2004). *Recursive Macroeconomic Theory*. MIT Press.

Maestas, N. and Li, X. (2006). Discouraged workers? job search outcomes of older workers. Working Papers WP 2006-133, University of Michigan Retirement Research Center.

Mastrobuoni, G. (2006). Labor supply effects of the recent Social Security benefit cuts: Empirical estimates using cohort discontinuities. Working Papers 66, Princeton University, Department of Economics, Center for Economic Policy Studies.

McCall, J. J. (1970). Economics of information and job search. *The Quarterly Journal of Economics*, 84(1):113–26.

McFadden, D. (1989). A method of simulated moments for estimation of discrete response models without numerical integration. *Econometrica*, 57(5):995–1026.

Mitchell, O. S. and Phillips, J. W. R. (2012). Retirement in Japan and the United States: Cross-national comparisons using the Japanese Study of Aging and Retirement (JSTAR) and the U.S. Health and Retirement Study (HRS). Working papers, University of Michigan Retirement Research Center.

Mortensen, D. T. (1970). A theory of wage and employment dynamics. *Microeconomic Foundations of Employment and Inflation Theory*, pages 124–166.

Mortensen, D. T. (1977). Unemployment Insurance and job search decisions. *Industrial and Labor Relations Review*, 30(4):505–517.

Mortensen, D. T. (1986). Job search and labor market analysis. In Ashenfelter, O. and Layard, R., editors, *Handbook of Labor Economics*, volume II, chapter 15. Elsevier Science Publishers.

Munnell, A. H., Muldoon, D., and Sass, S. A. (2009a). Recessions and older workers. Working Papers 9-2, Center For Retirement Research at Boston College.

Munnell, A. H., Sass, S. A., Soto, M., and Zhivan, N. A. (2006). Has the displacement of older workers increased? Prepared for the 8th Annual Joint Conference of the Retirement Research Consortium, enter for Retirement Research at Boston College.

Munnell, A. H., Sass, S. A., and Zhivan, N. A. (2009b). Why are older workers at greater risk of displacement? Center for Retirement Research at Boston College, Brief.

O'Leary, C. J. (2006). State UI job search rules and reempolyment services. *Monthly Labor Review*, 129(6):27–37.

O'Leary, C. J. and Wandner, S. A. (2000). Unemployment Compensation and older workers. Working Papers 00-61, Upjohn Institute.

Oreopoulos, P., Page, M., and Stevens, A. H. (2008). The intergenerational effects of worker displacement. *Journal of Labor Economics*, 26(3):455–500.

Pakes, A. and Pollard, D. (1989). Simulation and the asymptotics of optimization estimators. *Econometrica*, 57(5):1027–1057.

Palme, M. and Svensson, I. (2004). Income security programs and retirement in Sweden. In *Social Security Programs and Retirement around the World: Micro-Estimation*, NBER Chapters, pages 579–642. National Bureau of Economic Research.

Pérez, J. I. G. and Martín, A. R. S. (2007). Social Security and the search behaviour of workers approaching retirement. Working Paper Series WP ECON 08.03, University Pablo de Olavide.

Perez, J. I. G. and Martin, A. R. S. (2008). Social Security and the search behaviour of workers approaching retirement. Working Papers 08.03, Universidad Pablo de Olavide, Department of Economics.

Powell, M. (1964). An efficient method for finding the minimum of a function of several variables without calculating derivatives. *Computer Journal*, 7(2):155–162.

Rebick, M. E. (1994). Social Security and older workers' labor market responsiveness: The United States, Japan, and Sweden. In *Social Protection versus Economic Flexibility: Is There a Trade-Off?*, NBER Chapters, pages 189–222. National Bureau of Economic Research.

Rendon, S. (2006). Job search and asset accumulation under borrowing constraints. *International Economics Review*, 47(1).

Rogerson, R., Shimer, R., and Wright, R. (2005). Search-theoretic models of the labor market: A survey. *Journal of Economic Literature*, XLIII:959–988.

Ruhm, C. (1991). Are workers permanently scarred by job displacement? *American Economic Review*, 81:319–324.

Ruhm, C. J. (1990). Bridge jobs and partial retirement. *Journal of Labor Economics*, 8(4):482–501.

Rust, J. (1989). A dynamic programming model of retirement behavior. In Wise, D. A., editor, *The Economics of Aging*, chapter 12, pages 359–404. University of Chicago Press.

Rust, J. and Phelan, C. (1997). How Social Security and Medicare affect retirement behavior in a world of incomplete markets. *Econometrica*, 65(4):781–831.

Seater, J. (1977). A unified model of consumption, labor supply and job search. *Journal of Economic Theory*, 14:349–372.

Serneels, P. (2002). The added worker effect and intrahousehold aspects of unemployment. Economics Series Working Papers WPS/2002-14, University of Oxford, Department of Economics.

Servais, M. A. (June 2004). An elementary cookbook of data management using HRS data with SPSS, SAS and Stata examples. Technical report, Survey Research Center, Institute for Social Research, University of Michigan, Ann Arbor.

Servais, M. A. (June 2004 (Updated June 2010)). Overview of HRS public data files for cross-sectional and longitudinal analysis. Technical report, Survey Research Center, Institute for Social Research, University of Michigan, Ann Arbor.

Shimer, R. (2007). Reassessing the ins and outs of unemployment. Working Papers 13421, National Bureau of Economic Research.

Stephens, M. J. (2002). Worker displacement and the added worker effect. *Journal of Labor Economics*, 20(3).

Stevens, A. H. (1995). Long-term effects of job displacement: Evidence from the panel study of income dynamics. Working papers, National Bureau of Economic Research.

Stevens, A. H. (1997). Persistent effects of job displacement: The importance of multiple job losses. *Journal of Labor Economics*, 15(1):165–188.

Stigler, G. (1961). The economics of information. *Journal of Political Economy*, 69:213–225.

Stock, J. and Wise, D. A. (1990). Pensions, the option value of work, and retirement. *Econometrica*, 58(5):1151–80.

Stokey, N., Lucas, R. E., and Prescott, E. (1989). *Recursive Methods in Economic Dynamics*. Harvard University Press.

Tatsiramos, K. (2007). The effect of job displacement on the transitions to employment and early retirement for older workers in four European countries. *IZA Discussion Paper*, DP(3069).

Topel, R. (1983). On layoffs and Unemployment Insurance. *American Economic Review*, 73:541–559.

Topel, R. (1990). Specific capital and unemployment: measureing the cost and consequences of job loss. *Carnegie-Rochester conference series on public policy*, 33:181–214.

van den Berg, G. J. (1990). Search behaviour, transitions to non-participation and the duration of unemployment. *The Economic Journal*, 100(402):842–865.

Vroman, W. (2010). The role of Unemployment Insurance as an automatic stabilizer during a recession. The Urban Institute.

Whittaker, J. M. (2007). Unemployment and older workers. Report RL32757, Congressional Research Service.

Whittaker, J. M. (2013). Expediting the return to work: Approaches in the unemployment compensation program. Report R43044, Congressional Research Service.

Zandi, M. (2011). Doing infrastructure the right way. Moody's Analytics.