Retirement Expectations Formation Using the Health and Retirement Study*

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June, 2002

Preliminary, Please do not cite without permission

Abstract

This paper examines how a wide array of factors (household and individual level financial, health and other taste shifter characteristics) influence retirement plans over time and how uncertainty affects the strategies that individuals use to plan their retirement years. Using panel data models we examine the role of health and economic factors on retirement planning using the Health and Retirement Study (HRS). We examine the rationality of plans for retirement controlling for sample selection. After controlling for sample selection, reporting biases, and unobserved heterogeneity we find that plans for retirement do follow the random walk hypothesis and pass tests of weak and strong rationality. These findings allow us to assume rationality and examine retirement plans using first differences. We then examine changes to those factors and the effects of new information on plans and find that new information contributes little to changes in plans. This leads us to conclude that on average people correctly form expectations over uncertain events when planning for retirement. These results have important implications for a wide variety of models in economics that assume rational behavior.

* The authors are grateful to the Michigan Retirement Research Consortium (MRRC) and TIAA-CREF for financial support. We also would like to acknowledge excellent research assistance from Huan Ni, Wayne-Roy Gayle, Frank Heiland, and Selcuk Eren. We also benefit from comments from participants at the Society of Labor Economists Meetings in Baltimore in May 2002. We are also grateful to John Rust, Douglas Fore, John Ameriks, and Anna Vellvé for insightful comments and discussions. All remaining errors are the authors.

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The purpose of this paper is to study the evolution of retirement plans using the Health and Retirement Study (HRS). We are interested in how these plans are influenced by individual and household factors such as wealth, pensions and Social Security, health and other taste shifters. We are also interested in how new information changes plans over time. And finally, we seek to understand how expectations are formed and how relevant information is used in that formation to test for the rationality of expectations.

Most of the retirement literature focuses on the retirement “outcome”. Dynamic retirement models use backward induction to evaluate how the decision was made with an emphasis on the role of health and economic status of agents in the household. We take a different approach and explore how people’s retirement plans evolve over time. We can examine the influence of Social Security policy and other financial incentives as well as health along the way. Understanding how factors affect expectations would give us a better understanding of the importance of these incentives.

Much of the work on expectations of retirement focuses on accuracy by testing them against outcomes (Bernheim 1988, 1989; Dwyer and Hu 1999; Dwyer 2002). Deviations are explained by unanticipated changes to relevant factors. That analysis focuses on how accurate expectations are in terms of their relationship to the outcome. It does not focus on how expectations are formed. Bernheim (1990) is one of the few papers that analyses how expectations form and evolve, which is also, in part, the purpose of our research. We want to understand which factors matter when planning for retirement, how is existing information used, and how does new information fit in. In particular, how anticipated are shocks to relevant factors and how should uncertainty be modeled**?** Panel data available through the HRS allow us to observe people’s plans as they approach retirement. We take advantage of the richness of the data, not only in evaluating factors that influence retirement plans over time, but also in analyzing how rational those plans are and how new information influence those plans. We can test theoretical models of rational behavior, allowing for uncertainty. Rational behavior is defined here as decision-making that is based on a model (possibly dynamic) with both economic and health constraints.

There is heterogeneity in how people plan for retirement. Some who have thought little of retirement reveal unconstrained preferences, while others follow the constrained model using full information. Prior work does not account for these different types of planners, except for the selection into the sample of planners. In this work we control for unobserved heterogeneity exploiting the longitudinal nature of the HRS.

We discuss the literature and our contribution in Section 1, followed by the conceptual model and econometric specifications in Section 2. Section 3 provides information about the data used in the analysis. Section 4 reports our main findings. We conclude in Section 5. The models and simulations for the dynamic programming part of the project are in the appendix.

1. **Background**

Comparing Expectations to Outcomes

Bernheim in his seminal work (1988, 1989) explores the connection between expectations and outcomes and finds that people do not use all the information available to them, but otherwise they form rational plans and stick to them. The main finding is that people report likely outcomes instead of mean dates given a probability distribution. He uses the Retirement History Survey (RHS), which represents a cohort retiring in the seventies. The data were not as rich in their ability to study retirement expectations, particularly in health status.

More recent work by Dwyer and Hu (1999) and Dwyer (2002) also examine this question in a static life cycle framework comparing baseline plans to outcomes. Dwyer and Hu (1999), using only the first two waves of the HRS, find that people who retire early as planned tend to be able to afford to do so (are more likely to have sources other than Social Security benefits to pay for additional leisure). The punchline of that preliminary work is that health was a more important predictor of retirement plans, while economic factors became more influential in determining actual retirement. Dwyer (2002) compares baseline expectations (ages 51-61) of retirement to outcomes by wave 4 (ages 57-67) when a substantial sub-sample has reached its expected retirement age. She finds that a majority of the HRS sample follows through on plans for retirement if you include partial retirement in the definition. However, health and socio-economic factors still play a role in explaining changes to plans, even after conditioning on the plans. This may have some policy implications, particularly policies involving changes to eligibility ages for retirement and other reform proposals.

That literature throws away all of the information available between the initial baseline plan and the ultimate outcome at the final stage. We care about the adjustment process in between. We also worry about heterogeneity in how much people thought about retirement. In the first round of interviews, not everyone has thought about retirement, and we only observe plans for those who have.[1] So there is a sample selection problem that is exacerbated by focusing in on only those who thought about it early on in the process**.** In this work we control for this sample selection, and we utilize full information in the five waves and examine how expectations are formed and how new information changes expectations over time.

Forni (2002) uses the first two waves of the HRS to examine how financial shocks influence deviations to plans. He uses self- reported financial shocks that are noisy and do not perform well in the models. He concludes that the data are consistent with Bernheim's finding that reported expectations measure likely retirement outcomes rather than the mean of the expected retirement age distribution.

Recent work by Coronado and Perozek (2001) examine the effect of unanticipated changes in wealth on retirement and find that households were more likely to retire early if they held more corporate equity immediately prior to the 1990s (bull market). They introduce uncertainty to financial factors and examine the retirement outcome. We examine a similar question regarding uncertain factors influencing retirement but we focus on retirement expectations over time. Lusardi (1999) focuses on the importance of information costs in the retirement decision and savings, which acknowledges uncertainty in a different way from the present project.

Expectations Formation

Not too much work has studied expectation formation. Bernheim (1990) focuses on expectations formation to test individuals' rationality. He cannot reject the hypothesis

[1] Some people report expected ages of retirement even though they admit to not having thought about it much. A majority of those who have not thought about it do not report any expected age. Many say they will likely 'never' retire if they do report something. Prior work uses any age with no adjustment for the

of strong rationality, meaning that only new information affects individual changes of expectations regarding S.S. receiving ages. We build on Bernheim's model of expectations formation. We use his tests of rationality with some modifications and updates. First, we use the full longitudinal HRS instead of the two waves of the old RHS. We measure retirement expectations differently, and with different instruments to deal with endogeneity and reporting biases problems. We also use panel data techniques and control for sample selection.

Dwyer and Mitchell (1999) study expectation formation using only wave 1 of the HRS. The contribution of that work is to incorporate health into models of labor supply. So they deal with the potential endogeneity of health. They use expectations of retirement (the same measure we use) as a proxy for retirement. The assumption is that the expectation is equal to the outcome. This work builds on that model of expectations formation, uses longitudinal data, and tests their hypothesis.

Dynamic Models

The prior research we have discussed so far, uses static life cycle models of the retirement decision and apply it to planning for retirement to test rationality. Specifically, that work examines changes to relevant factors as well as baseline expectations on realizations of retirement in a static framework, which answers a slightly different question (Dwyer, 2002, Dwyer and Hu, 1999, Bernheim, 1989). Or they examine expectation formation in the static life cycle framework (Dwyer and Mitchell, 1999). One of our objectives is to revisit some of those assumptions, but we are also interested in pursuing this question in a dynamic framework. We are interested in testing

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amount of planning that went into it. That work also uses proxies of benefit take-up for expected age if it is missing.

for rationality to understand how to appropriately incorporate uncertainty in dynamic models. The rational expectations assumption is a cornerstone of most dynamic utility maximization models under uncertainty. How realistic is this assumption when the uncertain outcome is health status? We are currently developing a model that introduces uncertainty over a variety of factors.

The recent literature on dynamic modeling has been able to solve rich dynamic life cycle models of retirement. We will apply these retirement models to study expectation formation, using the information provided in the HRS, and allowing for uncertainty over health shocks. Dynamic models to date have not focused on expectation formation with respect to the variables considered stochastic. Models to date usually assume the variables follow a certain distribution, which is then integrated out using numerical or mathematical methods. We propose to take a closer look at how expectations over uncertain outcomes are formed, and how they influence current decisions. If we are unaware of how these expectations are formed, and whether they are realized, we might be missing an important dimension of the decision making process by rational agents, potentially leading to less efficient policy recommendations. In this work, we test rationality before assuming it in the next stage of this research.

For example, Rust, Buchinsky, and Benítez-Silva (2001) model the U.S. Disability programs along with the more traditional Social Security system, to gain insight into the whole range of incentives that individuals face as they approach retirement. However, little is discussed about how agents form expectations regarding the probability of becoming disabled, or losing their current job, or how likely it is that they will have access to social insurance programs when they reach retirement. These expectations can potentially have a big impact in their current decisions regarding consumption, asset allocation, labor supply and even types of health insurance programs they want to be covered by.

We develop a model that builds on Bernheim’s (1990) model of expectation formation to derive our econometric specification as well as Benítez-Silva (2000), Rust and Phelan (1997), and Rust, Buchinsky and Benitez-Silva (2001) to derive our dynamic model. Our contributions are twofold: First, we extend Bernheim’s model to analyze retirement expectation formation. We utilize full panel data to test our model and we go further in several directions. We have 5 waves of data and can control for unobserved heterogeneity, various forms of selection bias, and also attrition bias. The results have important implications for the growing literature on dynamic modeling. Second, we are developing a dynamic model of expectation formation that assumes rational behavior. We introduce uncertainty over lifetime, interest rate, wages, and health status, and then simulate the state and control variables over time, among them the health transitions. We are working on estimating a model that focuses on uncertainty over health and wealth outcomes.

2. A Model of Expectations

Following Bernheim's model of expectation formation we define:

$$X_t^e = E\langle x \mid \Omega_t \rangle, \qquad (1)$$

where we write the expectation about the value of the variable X, call it retirement age (Social Security benefits in Bernheim 1990). The information set at time t is represented by Ω_t, and E is the expectations operator.

Variables included in the vector of regressors, Ω, come from standard life cycle models of retirement behavior (see Lumsdaine and Mitchell 1999 for a survey). It is well established that the factors that influence retirement include household health and socio-economic status. We begin our analysis by examining the role of these factors on retirement expectations. Our hypothesis is that the factors that influence retirement also influence retirement expectations in a similar way.

Using the law of iterated expectations and equation (1) we get:

$$E\left\langle X_{t+1}^{e} \middle| \Omega_t \right\rangle = E[E\left\langle X \middle| \Omega_t, \omega_{t+1} \right\rangle | \Omega_t] = E\left\langle X \middle| \Omega_t \right\rangle = X_t^{e}, \qquad (2)$$

where ω_{t+1} represents information that comes available between periods t and t+1. This expression presents the evolution of expectation through time and implies that

$$X_{t+1}^{e} = X_t^{e} + \eta_{t+1}, \quad (3)$$

where $E(\eta_{t+1}|\Omega_t)=0$. In fact η_{t+1} should be a function of new information received since period t, ω_{t+1}. Bernheim tests the framework with the following regression:

$$X_{t+1i}^{e} = \alpha + \beta X_{t,i}^{e} + \gamma \Omega_{t,i} + \varepsilon_{t,i} \qquad (4)$$

where the theory implies that $\alpha=\gamma=0$ and $\beta=1$.[2] A weak test of rationality assumes that $\gamma=0$ and tests for $\alpha=0$ and $\beta=1$ - in other words tests to see if expectations follow a random walk. A strong test of rationality is less restrictive and also tests for $\gamma=0$. Bernheim (1990) cannot reject these hypotheses once he controls for measurement error

[2] Bernheim (1989), Dwyer and Hu (1999) and Dwyer (2002) use a similar model and test using outcomes against expectations.

in the self-reports using instrumental variables.[3] We will retest them using the full longitudinal HRS and we also control for measurement error and sample selection.[4]

As in Bernheim, we are interested in rationality, as well as the role of new information in expectation formation. How do shocks affect expectations? Are shocks to some degree anticipated? Re-arranging equation (3) and allowing for errors we get:

$$X^{e}_{t+1i} = \mu + X^{e}_{t,i} + \gamma\eta_{t+1,i} + \varepsilon_{t,i} \text{ or}$$

$$X^{e}_{t+1i} - X^{e}_{t,i} = \mu + \gamma\eta_{t+1,i} + \varepsilon_{t,i} \quad (5)$$

This assumes β=1. We can examine the role of changes to specific factors (in Ω) on changes to expectations. We test whether γ=0. In other words, does new information affect retirement expectations or was that new information anticipated, on average, and included in last period's expectations?

Econometric Concerns

First, we need to appropriately control for observed heterogeneity, which is not trivial when we consider omitted variable as well as potential reporting biases. How to incorporate relevant factors that are imperfectly observed has it's own set of issues. In addition, respondents make decisions on many factors that may not be observable to the analyst. Given these measurement error and omitted variable bias issues, unobserved heterogeneity becomes a concern. We want to take into account the unobserved heterogeneity potentially present in our characterization of the econometric model. If we

[3] He instruments with other expectations that may be equally plagued with measurement error. He does not test the instruments as we do. We will discuss our instruments in the results section.

do not control for the unobserved components we will be confounding partial and total effects of our variables of interest. Panel data sets allow us to model explicitly how those unobserved components enter the econometric specification, and we can choose to include them as a fixed effect or as a random variable, and test the different specifications.[5]

Related to this is sample selection. Not only do people differ in their far-sightedness, but in their ability to process information. For this reason we need to control for sample selection as well. It is not very difficult to control for sample selection in cross-sections, but it becomes a more complex problem in panel data models with attrition, and the unbalanced nature of the panels becoming an issue. This presents interesting methodological challenges.

Sample selection can be depicted in the following schematic model of retirement expectations that controls for clustering (see Deaton, 1997):

$$X_{ti}^{e} = \alpha_1 + \gamma\Omega_{t,1i} + \varepsilon_{t,1i} \quad (6)$$

and

$$Y_i = \alpha_2 + \gamma_2\Omega_{2i} + \varepsilon_{2i} \quad (7)$$

where the set of individual characteristics, Ω_{1i} consists of various socio-economic and demographic variables, and other variables we will describe below, and X_{ti}^{e} represents the expected retirement age at time t. Y_i is an indicator of whether or not any thought has been given to the retirement plans and determines whether or not we observe X_{ti}^{e}, and ε_{1i}

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[4] Rosen (1990) in his commentary on Bernheim's work acknowledges the potential for selection bias in responses to survey questions about expectations.

[5] For an interesting discussion of these econometric concerns see Wooldridge (2002), Hsiao (1986), Nijman and Verbeek (1992), Verbeek and Nijman (1992), Vella and Verbeek (1999), Kyriazidou (1997) and Kyriazidou (1999).

and ε_{2i} are not independent. This means that the selection rule is potentially not independent of the behavioral function being estimated. It is fairly straightforward to estimate the full model by Maximum Likelihood or by standard two-step procedures.

The HRS provides us with repeated observations of the same individuals. This allows us to control for potential unobserved components that could enter our econometric model. Our main equation of interest can now be written as:

$$X_{ti} = \alpha\Omega_{ti} + c_i + u_{ti} \quad (8)$$

where c_i represents the unobserved heterogeneity component, and u_{ti} are the idiosyncratic disturbances. We can estimate this model assuming either no correlation between observed explanatory variables and the unobserved effect (random effects), or allowing for arbitrary correlation between the unobserved effect and the observed explanatory variables (fixed effects). We can then test whether the random effects specification or the fixed effect specification is more appropriate, and whether the former is more appropriate than the pooled OLS regression.

The more complex issues arise when we have to take into account selection and attrition bias in this panel model as well. We combine the above models to include the unobserved component as well as the sample selection correction.

Pooled OLS, Fixed Effects and Random Effects Models with Sample Selection

The three models we test make different assumptions about how unobserved heterogeneity enters the model. OLS models assume c_i=0, fixed effects assume no distribution on c_i and that it is fixed and non-random across individuals, and the random effects models assume random assignment of c_i based on some distribution.

Identification of these models becomes trickier when we incorporate sample selection, another form of unobserved heterogeneity into the picture.

3. Data

We follow respondents through all five waves of the HRS. The HRS is a nationally representative longitudinal survey of 7,700 households headed by an individual aged 51 to 61 as of the first round of interviews in 1992-93. The primary purpose of the HRS is to study the labor force transitions between work and retirement with particular emphasis on sources of retirement income and health care needs. It is a survey conducted by the Survey Research Center (SRC) at the University of Michigan and funded by the National Institute on Aging. The data for the respondents are merged from wave 5 backwards to waves 4,3,2, and 1, and we construct a set of consistent variables on different sources of income, financial and non-financial wealth, health, and socio-economic characteristics that will be assigned to each decision maker appropriately.

We include any observation for respondents that are working, full time or part time, in any wave. We exclude respondents who do not report retirement plans for more than two consecutive years and for whom we observe relevant information, which results in 4,980 respondents in the sample and 12, 854 observations in the analysis of pooled data.

We construct relevant dependent and independent variables for each wave. We also construct a transitions dataset that consists of changes to these variables across waves, since for part of the analysis we are interested in changes of variables over time.

In each wave working respondents are asked when they plan to fully or partially depart from the labor force.[6] They were also asked if they thought about retirement much. These questions are not mutually exclusive, but most of the people who have not thought about retirement do not report an expected age.[7] Many people report they will never retire. These same people often change their minds at some point and report an age. The analysis is sensitive to how we treat "never retire" since we need to put in some older age that we select arbitrarily. We report results for two alternatives. First, we assign an age of 85 for those who never retire. We call this the full model. Next, we omit them from the analysis, but correct for the selection into this group.[8] The way we measure expected retirement age deviations is by taking the difference between the current wave and the prior one in the reported expected age of retirement.[9]

As indicators of economic status, we constructed variables of net worth and household wealth. We also control for income for the respondent and the spouse. We are working on retirement income variables and better controls for health insurance for the household. At this time we control for whether or not respondents have private health insurance.

We use health limitations, self-ratings, as well as a number of disease indicators and activities of daily living to control for health status. We also control for the self-reported probability of living to age 85 as a measure of the individual's time horizon. This

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[6] In wave 1 they only were asked about a full departure.

[7] Many of them report that they will never retire. If they have not given it any thought, and they say they will never retire, we consider them as missing information. If they give a retirement age we treat them as non-missing.

[8] Using age 85 creates a large variance in the mean of this estimate, which affects the constant in the regressions.

[9] We do not need to worry about censoring in this way because we just examine changes to plans over time. If there are missing values for one wave we use the prior wave of information but we are only willing to go

variable may be correlated with health and own discount rates. Hurd and McGarry (1995) find this variable to be highly correlated with own health status and parent mortality.

Table 1 reports descriptive statistics on the pooled sample. It is broken up into four tables. The first two tables report levels and transition by sample type (full versus restricted). The next two tables report levels and transitions by selection criteria. For the transition data each observation represents transitions between two of the five waves so that each individual has up to four observations. 73% of our sample has information for all four transition periods and 84% have it for three.

Beginning with Table 1a, we see that removing those who report that they will never retire reduces the average expected retirement age from 64.3 to 61.5. This is to be expected since those who were removed receive are assigned a value of 85. Other than this definitional difference, there are no statistically significant differences between the two samples. Earnings of those who plan to work forever are only slightly higher but this is not statistically significant. With the exception of stroke and high blood pressure, the group that plans to never retire is slightly healthier and expects to live longer. Looking at the transitions of this data in Table 1b, we see that there are much bigger transitions in expected retirement ages if we include the people who report they will never retire. The frequency of change is only slightly higher for the full sample, but the magnitude of the change is much larger. This is because of the arbitrarily high age that we needed to use for the "nevers". These plans do change 58.3% of the time so there is a sufficient amount of variation to study. On average people are postponing retirement since the average

back one wave. In other words, if the expected retirement age is missing for two consecutive waves then we treat the observation as missing.

deviation in expected retirement age is positive. There are bigger changes in earnings and private health insurance status among those who never plan to retire.

There is nothing surprising in the factors that influence retirement. Roughly 24% of the sample report work limitations. Most of them report themselves in good to fair health. The most common physical condition reported is arthritis.

Tables 1c and 1d compare by the selection criteria; whether or not you thought about retirement. Roughly 42% of the sample gave retirement some thought. Those who have not thought about retirement are less likely to be employed during the panel, and are significantly worse off financially. They report more health limitations and worse overall general health. They visit the doctor more but have fewer heart problems, lower blood pressure, and less arthritis and diabetes than those who have thought about retirement. Those who have not thought about retirement are slightly older and more likely to be female. They are also less educated and more likely to have higher earner spouses.

4. Results from Econometric Models

Analysis of Expectations Formation

The first part of the analysis examines factors that influence how people form retirement expectations. As previously mentioned, this is the first paper to study this question using panel data and focusing on the expectation formation with controls for unobserved heterogeneity and sample selection. Table 2a,i reports pooled OLS, and fixed and random effects results with no sample selection controls for the full sample. Using the Hausman specification test we can reject the fixed effects model over the random effects (we can reject the hypothesis that the coefficients are the same). Using a

Lagrange Multiplier (Breusch-Pagan) test we find that the random effects model specification is preferred to the pooled OLS. We find that people with higher net worth plan to retire earlier probably because they can afford to. People who can afford private health insurance are also more likely to plan an earlier retirement. Higher earners are postponing retirement.

People who report themselves in poor health plan to retire later. People who plan to live longer also plan to work longer. The other health factors are not significant and robust. Heart problems are significant but once we control for unobserved heterogeneity that effect goes away. Married people plan to retire earlier.

Controlling for sample selection changes the results considerably and the selection bias is significant. This is not surprising given the differences in all factors by whether or not people have given thought to retirement. We see in table 2a.ii., that after controlling for sample selection the magnitude of the effect of earnings is slightly larger and the opposite sign. So people who earn more are more likely to plan to work longer (higher opportunity cost, substitution effect). A report of work limitations significantly reduces the expected retire date by a year. The effect of overall poor health goes away. This was positive when we did not account for how much thought went into the plan. After controlling for sample selection, the subjective mortality probability remains significant but a little smaller in magnitude. People with heart problems plan later retirements, maybe because they have learned to adjust to their condition with respect to when it was diagnosed. Or perhaps harder workers are more likely to have heart problems. The effect of marriage remains the same. People with a higher propensity to have thought about retirement, retire later.

Tables 2b reports the same models for the restricted sample. Removing those who never thought about retirement reduces some of the estimated magnitudes (health limitations in particular). The notable differences are in general health, heart problems and martial status. People in average to below average general health are planning to retire later. People with heart problems report plans that are 2 years earlier on average than those without heart problems. For the full sample this was smaller in magnitude (1.2) and positive. People who plan to never retire are more likely to have heart problems. So they were assigned an age of 85 which was driving that positive sign in the full model. Married people still plan to retire earlier, but the magnitude of the effect is smaller by a year.

The punchline from this part of the analysis is that health, time horizon, and socio-economic factors play a role in plans for retirement, even after controlling for unobserved differences and sample selection. Sample selection is significant. We also learn that the respondents who report they will never retire are significantly different and this needs to be controlled for.

Tests of Rationality

Table 3a reports the weak and strong tests of rationality for the full sample and Table 3b reports the same for the restricted sample. In the full sample the data support the weak and strong rationality hypotheses only in a model that corrects for sample selection and measurement error in the report of expected retirement age.[10] We get coefficients for beta of 0.94 and 0.80 for the weak and strong tests respectively. For the restricted sample we cannot reject the hypothesis of rationality when we control for

[10] We perform an F-test based on the null hypothesis that $\beta=1$ to test for rationality.

measurement error. The sample selection correction results in a rejection of the random walk hypothesis but not the strong rationality assumption in that restricted sample.

The strong test includes information available at time t that should not be significant after controlling for time t expectations. Significance would imply that this factor was not incorporated in the previous periods expectations and implies underutilized information. After controlling for sample selection and measurement error we find that most of these factors are no longer significant. So once we get closer to a model of rationality, this information becomes redundant. This is less true for the full model than for the restricted. So in the full model people with cancer are significantly more likely to plan to retire earlier. Cancer may be a disease that is less predictable than others. Also for the full model, poor general health makes a difference. This could be correlated with other disease related shocks.[11] Similarly, people with unanticipated health shocks are less likely to report that they will never retire, and then are out of the restricted sample. So these effects go away when we remove those individuals from the sample.

The objective behind instrumental variables estimation here is to correct for potential measurement error in the reported expected age of retirement at time t. Since people are reporting expectations over uncertain events, we expect some degree of reporting error that may be correlated with unobserved factors thus the error term. In fact, Bernheim (1988) finds that expectations are reported noisily. Like Bernheim (1990), we correct for this problem using instrumental variables analysis. The instruments must be correlated with the expected retirement age but not with the error term or any new information relevant to the t+1 expectation. We use time t subjective survival to age 85 probabilities and an indicator of smoking behavior as instruments for expected retirement age. The strongest specification remains the corrected IV on the full sample. The instruments pass the test of overidentifying restrictions.

The punchline from this part of the analysis is that people, on average, seem to plan rationally for retirement. However, we may want to pay some attention to health shocks that may not be anticipated in formation of expectations.

The Role of New Information

In this analysis we are interested in the role of new information, or shocks since the prior period, on expected retirement age. We examine the effects of changes to all of the relevant factors on plan deviations. We hypothesize that there will be no effects if on average people are able to anticipate shocks. Table 4a reports results with and without sample selection corrections for the full model. Analogous results are reported for the restricted sample in Table 4b.

The findings are very interesting. The only factors that consistently significantly alter retirement plans are changes to reports of subjective survival probabilities (to age 85) and new cancer diagnoses. These results are robust across all specifications, with the exception of the fixed effects model with no sample selection where cancer is not statistically significant. People who have a new cancer since the last wave (last two years) and survive, are delaying their plans to retire by about 2 years. People who increase their likelihood of a longer time horizon also postpone retirement by 1.6 years.

[11] Dwyer and Mitchell (1999) find that this rating is a good indicator of underlying diseases rather than a measure of functional status and ability to perform work. So an unexpected diagnosis of disease is more

Changes to economic status have no effect, nor do any of the other health and demographic indicators. We may conclude that cancer is a disease that is not often predicted and anticipated. The probability of living to age 85 will be adjusted based on own health and family health. So researchers need to pay careful attention to incorporating the uncertainty of health shocks in dynamic models.

These same variables, cancer and the time horizon indicator, are never significant in the model that excludes people who report they will never retire. But health continues to be the only significant shock affecting retirement plans. Results are fairly robust across specifications. It is not functional status changes that alter plans, but new diseases and illnesses. Variables like diabetes transitions, stroke, and having high blood pressure are significant. The self-rating is significant in all but the uncorrected fixed effects model. This variable represents an index of disease and illness (Dwyer and Mitchell, 1999).

The punchline of this analysis is that on average, people incorporate uncertainty over economic factors and ability to perform work in their retirement expectations. But on average they do not do as well with uncertainty over disease, illness, and longevity.

5. Conclusions and Future Research

There are three main areas that this research makes its contributions. First, we examine factors that influence expectation formation using panel econometric techniques to control for potential sample selection bias and unobserved heterogeneity. We learn that unobserved heterogeneity significantly explains some of the variation in expectation

likely to be unanticipated and this is not too surprising.

formation and that people who have thought about retirement are selectively different in factors that influence retirement. The findings are consistent with prior work on retirement behavior as well as cross sectional work on expectation formation. Health and socio-economic factors are all factors that influence the formation of expectations, with health explaining more of the variation.

Second, we test for rationality in the formation of expectations. Rational behavior is defined as following a model of retirement that uses information about household health and socio-economic status in formation of expectations. We perform weak and strong tests of rationality and cannot reject it after controlling for reporting error and sample selection. The tests are based on the hypothesis that average expected retirement ages are not changing over time, or on average people are forming expectations accurately. This has important implications for dynamic work that is often identified under the assumption of rational expectations.

Finally we examine the role of new information, or shocks, to changes in retirement plans. We further test the rational expectations hypothesis, this time focusing on how well people anticipate shocks over factors relevant to the retirement decision. If we can incorporate uncertainty in a way that shocks can be modeled as following a distribution that is known, or in other words, if on average shocks are anticipated, the dynamic model is more clearly identified. So now we test the use of new information in the formation of expectations. We find that components of health that are associated with disease and longevity are not predicted well and warrant extra attention in the dynamic framework if we seek to better fit the data.

The results in this analysis are preliminary. Future work will incorporate health insurance in a way that is exogenous to the model as well as better information about retirement income. Prior work finds that health insurance availability is one of the most important predictors of retirement and expected retirement. We will also investigate potential attrition bias.

The econometric work motivates a more structural approach to examining transitions to health and their effects on plans. We have a preliminary dynamic model (see appendix) and we include some simulations that are very preliminary as well. We plan to estimate the model incorporating our health transitions model as well as introducing uncertainty to other factors. This is all part of a broader research agenda where we plan to simulate Social Security reform proposals (in the form of changes to benefits) as well as examine the implications for savings behavior with new information over time. Future work will also examine joint expectation formation, and joint retirement decisions.[12]

[12] We have done most of the analysis in this paper on married couples, assuming that the spouse's information is exogenous to the individual utility maximization problem. We do find that spouse's information is significant, in a model of expectations formation, and therefore we need to expand the model to allow for joint expectation formation. However, changes to spouse’s variables seem to be well anticipated.

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Table 1a. Summary Statistics for full and restricted sample

Variables	Full Sample N=14606	Restricted Sample, N= 13863
Retirement Plans and Outcomes		
Expected Retirement Age	64.332 (8.537)	61.478 (3.976)
Employee	0.607 (0.489)	0.604 (0.489)
Self employed	0.111 (0.314)	0.102 (0.303)
Economic Factors		
Net Worth	2.619 (5.325)	2.604 (5.260)
Housing wealth	0.802 (1.316)	0.802 (1.327)
Respondent Earnings	26.017 (61.271)	25.714 (61.446)
Health Insurance		
Tied to work	0.794 (0.404)	0.795 (0.404)
Retiree	0.912 (0.283)	0.914 (0.281)
Government	0.119 (0.324)	0.121 (0.326)
Private	0.143 (0.350)	0.142 (0.349)
Health Factors		
Health Limitations	0.241 (0.428)	0.245 (0.430)
Self-Rating	2.403 (1.068)	2.410 (1.068)
Doctor visit times	5.098 (7.596)	5.136 (7.617)
Probability of living to age 85	0.448 (0.305)	0.445 (0.303)
Diabetes	0.046 (0.209)	0.046 (0.208)
Arthritis	0.191 (0.393)	0.191 (0.393)
Difficulty walking one mile	0.104 (0.305)	0.105 (0.307)
Difficulty climbing stairs	0.062 (0.241)	0.063 (0.243)
Stroke	0.004 (0.059)	0.003 (0.057)
Heart Problems	0.036 (0.187)	0.036 (0.186)
Cancer	0.020 (0.141)	0.020 (0.140)
High blood pressure	0.171 (0.377)	0.170 (0.376)
Demographic		
Age	56.352 (5.485)	56.333 (5.473)
Male	0.453 (0.498)	0.449 (0.497)
Married	0.819 (0.385)	0.820 (0.384)
Bachelor’s Degree	0.244 (0.430)	0.243 (0.429)
Professional Degree	0.089 (0.285)	0.089 (0.285)
Spouse Health (where relevant)	0.270 (0.444)	0.270 (0.444)
Spouse income	20.776 (55.274)	20.772 (55.479)

Table 1b. Summary Statistics for full and restricted sample (changes).

Variables	Full Sample N= 7664	Restricted Sample, N= 6777
Retirement Plans and Outcomes		
Changes in Expected Retirement Age	0.653 (0.476)	0.368 (0.869)
Frequency of change	0.583 (8.466)	0.528 (0.499)
Economic Factors		
Changes in Net Worth	0.165 (4.500)	0.172 (4.314)
Changes in Respondent Earnings	2.900 (69.409)	2.648 (71.794)
Health Insurance		
Changes in Private Health Insurance	-0.017 (0.424)	-0.014 (0.423)
Health Factors		
Health limitation transitions[13]	0.017 (0.410)	0.021 (0.409)
Self Rating G, F, P transitions[14]	0.111 (0.879)	0.115 (0.880)
Stroke transitions[15]	0.000 (0.076)	0.000 (0.073)
Heart Problems transitions[3]	-0.031 (0.223)	-0.030 (0.219)
Cancer transitions[3]	-0.010 (0.186)	-0.009 (0.186)
Diabetes transitions	-0.032 (0.287)	-0.032 (0.288)
High blood pressure transitions[3]	-0.172 (0.562)	-0.174 (0.564)
Arthritis transitions	-0.137 (0.592)	-0.137 (0.592)
Smoking transitions	-0.022 (0.234)	-0.024 (0.232)
Probability of living to age 85	-0.013 (0.250)	-0.012 (0.297)
Doctor's visits	1.716 (7.372)	1.732 (7.412)
Climbing stairs	0.013 (0.250)	0.013 (0.253)
Walking a mile	0.019 (0.293)	0.021 (0.292)
Demographic		
Marriage Transitions[16]	0.010 (0.098)	0.009 (0.094)

[13] =1 if new limitation, 0 if no change, and -1 if you got better
[14] positive means health worsened (=1 if excellent, =5 if poor)
[15] positive means condition (Stroke, cancer, hbp) worsened (0 no change, -1 if better)
[16] =1 means new marriage, = 0 no change, =-1 dissolved marriage (widow, divorce…)

Table 1c. Summary Statistics by Sample Selection (Using Full Sample)

Variables	Thought About N= 6124	Not Thought, N= 8482
Retirement Plans and Outcomes		
Expected Retirement Age	64.332 (8.537)	-
Employee	0.811 (0.391)	0.459 (0.498)
Self employed	0.125 (0.331)	0.101 (0.301)
Economic Factors		
Net Worth	2.703 (5.663)	2.558 (5.067)
Housing wealth	0.830 (1.468)	0.783 (1.194)
Respondent Earnings	36.730 (82.731)	18.282 (37.161)
Health Insurance		
Tied to work	0.899 (0.301)	0.718 (0.450)
Retiree	0.887 (0.316)	0.930 (0.254)
Government	0.072 (0.258)	0.154 (0.361)
Private	0.127 (0.333)	0.155 (0.362)
Health Factors		
Health Limitations	0.178 (0.383)	0.287 (0.452)
Self-Rating	2.255 (0.986)	2.509 (1.111)
Doctor visit times	4.420 (6.613)	5.587 (8.120)
Probability of living to age 85	0.452 (0.304)	0.446 (0.304)
Diabetes	0.050 (0.218)	0.043 (0.202)
Arthritis	0.211 (0.408)	0.177 (0.382)
Difficulty walking one mile	0.650 (0.247)	0.131 (0.338)
Difficulty climbing stairs	0.039 (0.194)	0.079 (0.269)
Stroke	0.003 (0.051)	0.004 (0.064)
Heart Problems	0.039 (0.194)	0.034 (0.182)
Cancer	0.021 (0.142)	0.020 (0.140)
High blood pressure	0.203 (0.402)	0.148 (0.355)
Demographic		
Age	55.935 (4.875)	56.653 (5.868)
Male	0.526 (0.499)	0.401 (0.490)
Married	0.826 (0.379)	0.813 (0.390)
Bachelor’s Degree	0.295 (0.456)	0.207 (0.405)
Professional Degree	0.120 (0.325)	0.067 (0.250)
Spouse Health (where relevant)	0.244 (0.430)	0.289 (0.453)
Spouse income	20.403 (42.039)	21.041 (63.003)

Table 1d. Summary Statistics by Sample Selection (Using Full Sample changes)

Variables	Thought About N= 5008	Not Thought, N= 2656
Retirement Plans and Outcomes		
Changes in Expected Retirement Age	0.583 (8.466)	-
Frequency of change	0.561 (0.496)	-
Economic Factors		
Changes in Net Worth	0.294 (4.537)	-0.077 (4.420)
Changes in Respondent Earnings	3.939 (83.85)	0.943 (25.287)
Health Insurance		
Changes in Private Health Insurance	-0.035 (0.433)	0.017 (0.406)
Health Factors		
Health limitation transitions[17]	0.016 (0.410)	0.020 (0.409)
Self Rating G, F, P transitions[18]	0.120 (0.867)	0.096 (0.900)
Stroke transitions[19]	-0.001 (0.075)	0.002 (0.078)
Heart Problems transitions[3]	-0.038 (0.241)	-0.018 (0.182)
Cancer transitions[3]	-0.012 (0.197)	-0.008 (0.163)
Diabetes transitions	-0.040 (0.292)	-0.016 (0.275)
High blood pressure transitions[3]	-0.212 (0.561)	-0.098 (0.559)
Arthritis transitions	-0.179 (0.594)	-0.056 (0.581)
Smoking transitions	-0.020 (0.234)	-0.029 (0.233)
Probability of living to age 85	-0.014 (0.294)	-0.011 (0.306)
Doctor's visits	1.903 (7.273)	1.364 (7.545)
Climbing stairs	0.012 (0.240)	0.016 (0.269)
Walking a mile	0.015 (0.287)	0.027 (0.303)
Demographic		
Marriage Transitions[20]	0.011 (0.103)	0.008 (0.089)

[17] =1 if new limitation, 0 if no change, and -1 if you got better
[18] positive means health worsened (=1 if excellent, =5 if poor)
[19] positive means condition (Stroke, cancer, hbp) worsened (0 no change, -1 if better)
[20] =1 means new marriage, = 0 no change, =-1 dissolved marriage (widow, divorce…)

Table 2a . Factors Influencing How People Form Expectations - Levels Analysis
Full Sample,
i. No Selection Correction
coefficient (standard error)

Variables	Pooled OLS	Fixed Effects	Random Effects
Economic Factors			
Net Worth	0.020 (0.023)	0.077 (0.037)**	0.033 (0.019)*
Respondent Earnings	-0.003 (0.001)**	-0.0004 (0.002)	-0.002 (0.001)*
Private Health Insurance	1.008 (0.297)**	0.015 (0.409)	0.729 (0.264)**
Health Factors			
Health limitation	-0.393 (0.290)	0.093 (0.460)	-0.281 (0.283)
Self Rating G, F, P	0.263 (0.129)**	0.287 (0.222)	0.286 (0.120)**
Doctor visit times	-0.029 (0.027)	0.018 (0.027)	-0.016 (0.015)
Probability of living to age 85	2.392 (0.384)**	1.433 (0.654)**	2.260 (0.351)**
High blood pressure	-0.128 (0.257)	0.123 (0.344)	-0.152 (0.236)
Diabetes	0.679 (0.470)	0.196 (0.669)	0.533 (0.428)
Cancer	0.706 (0.727)	1.417 (0.984)	0.942 (0.665)
Stroke	-1.682 (3.210)	-1.682 (3.210)	2.372 (1.181)
Heart Problems	1.208 (0.560)**	0.016 (0.788)	0.794 (0.508)
Arthritis problem	-0.128 (0.242)	-0.284 (0.324)	-0.255 (0.227)
Difficulty walking	0.437 (0.468)	-0.080 (0.713)	0.273 (0.439)
Difficulty climbing stairs	0.819 (0.613)	0.759 (0.837)	0.785 (0.528)
Demographic			
Age			
Age Sq.			
Male			
Bachelor's Degree			
Professional Degree			
Married	-1.557 (0.307)**	-1.604 (0.985)	-1.624 (0.296)**
Adj. R-Square	0.016	0.008	0.016
Fraction of variance due to unobserved component		0.66	0.53
Corr(c_i, ε_I)		-0.019	0 (assumed)

Test Results:
Breusch and Pagan Lagrangian Multiplier (OLS vs. RE): chi2(1)=349.4, p>chi2 = 0
Hausman Test Statistic (RE vs. FE): chi2(16) = 223.3, p>ch2=0.11

Table 2a . Factors Influencing How People Form Expectations - Levels Analysis
Full Sample,
ii. Selection Correction
coefficient (standard error)

Variables	Pooled OLS	Random Effects
Economic Factors		
Net Worth	0.005 (0.019)	0.010 (0.019)
Respondent Earnings	0.003 (0.002)**	0.003 (0.001)**
Private Health Insurance	0.838 (0.272)**	0.628 (0.264)**
Health Factors		
Health limitation	-0.904 (0.305)**	-1.011 (0.294)**
Self Rating G, F, P	-0.009 (0.125)	0.002 (0.113)
Doctor visit times		-0.045 (0.016)**
Probability of living to age 85	1.916 (0.362)	1.945 (0.352)**
High blood pressure	-0.284 (0.265)	0.089 (0.236)
Diabetes	0.534 (0.465)	0.528 (0.426)
Cancer	0.164 (0.725)	0.903 (0.662)
Stroke	1.744 (1.921)	1.455 (1.804)
Heart Problems	1.802 (0.562)	1.167 (0.506)**
Arthritis problem	-0.422 (0.259)	-0.054 (0.227)
Difficulty walking	-0.584 (0.478)	-0.390 (0.444)
Difficulty climbing stairs	0.211 (0.575)	0.196 (0.530)
Demographic		
Age		
Age Sq.		
Male		
Bachelor's Degree		
Professional Degree		
Married	-1.405 (0.277)**	-1.581 (0.296)**
Lambda	5.173 (0.475)**	4.712 (0.494)**
Adj. R-Square		0.0268
Fraction due to unobserved		0.53

Table 2b. Factors Influencing How People Form Expectations - Levels Analysis
Restricted Sample - Excludes Nevers for people who have not thought about it
i. NO selection correction

Variables	Pooled OLS	Fixed Effects	Random Effects
Economic Factors			
Net Worth	-0.022 (0.009)**	0.009 (0.018)	-0.009 (0.010)
Respondent Earnings	0.001 (0.0003)**	0.0003 (0.0008)	0.001 (0.001)
Private Health Insurance	0.260 (0.153)*	-0.095 (0.181)	0.151 (0.126)
Health Factors			
Health limitation	-0.204 (0.153)	-0.091 (0.204)	-0.155 (0.134)
Self Rating G, F, P	0.174 (0.064)**	0.365 (0.097)**	0.222 (0.057)**
Doctor visit times	-0.005 (0.010)	0.008 (0.012)	0.001 (0.007)
Probability of living to age 85	0.414 (0.201)**	0.552 (0.290)*	0.470 (0.170)**
High blood pressure	0.109 (0.130)	-0.024 (0.149)	0.015 (0.109)
Diabetes	0.438 (0.222)**	0.427 (0.289)	0.392 (0.201)*
Cancer	0.335 (0.326)	0.170 (0.424)	0.233 (0.311)
Stroke	-1.460 (1.014)	-1.649 (1.360)	-1.597 (0.930)*
Heart Problems	0.228 (0.234)	-0.543 (0.350)	-0.087 (0.242)
Arthritis problem	-0.072 (0.124)	0.095 (0.141)	-0.045 (0.105)
Difficulty walking	0.383 (0.224)*	0.045 (0.320)	0.196 (0.211)
Difficulty climbing stairs	-0.176 (0.277)	0.083 (0.384)	-0.078 (0.257)
Demographic			
Age			
Age Sq.			
Male			
Bachelor's Degree			
Professional Degree			
Married	-0.636 (0.114)**	-1.233 (0.449)**	-0.692 (0.150)**
Adj. R-Square	0.010	0.006	0.010
Fraction of variance due to unobserved component		0.73	0.65
Corr(c_i, ε_i)		-0.08	0 (assumed)

Test Results:
Breusch and Pagan Lagrangian Multiplier (OLS vs. RE): chi2(1)=601.9, p>chi2 = 0
Hausman Test Statistic (RE vs. FE): chi2(16) = 17.1, p>ch2=0.38

Table 2b. Factors Influencing How People Form Expectations - Levels Analysis
Restricted Sample - Excludes Nevers for people who have not thought about it
ii. Selection correction

Variables	Pooled OLS	Random Effects
Economic Factors		
Net Worth	-0.033 (0.010)**	-0.018 (0.010)*
Respondent Earnings	0.005 (0.001)**	0.003 (0.001)**
Private Health Insurance	0.135 (0.137)	0.104 (0.125)
Health Factors		
Health limitation	-0.458 (0.155)**	-0.388 (0.138)**
Self Rating G, F, P	0.015 (0.064)	0.116 (0.059)**
Doctor visit times		-0.007 (0.007)
Probability of living to age 85	-0.090 (0.190)	0.263 (0.173)
High blood pressure	0.040 (0.136)	0.124 (0.110)
Diabetes	0.326 (0.240)	0.386 (0.200)*
Cancer	0.056 (0.375)	0.201 (0.310)
Stroke	-2.300 (1.078)**	-1.916 (0.923)**
Heart Problems	0.517 (0.293)*	-0.028 (0.241)
Arthritis problem	-0.259 (0.133)*	0.054 (0.105)
Difficulty walking	-0.236 (0.246)	-0.018 (0.212)
Difficulty climbing stairs	-0.563 (0.301)*	-0.310 (0.258)
Demographic		
Age		
Age Sq.		
Male		
Bachelor's Degree		
Professional Degree		
Married	-0.419 (0.146)**	-0.619 (0.151)**
Lambda	3.349 (0.243)**	1.735 (0.230)**
Adj. R-Square		0.017
Fraction due to unobserved		0.66

Table 3a. The Strong Test of Rationality - Expected Retirement Age Conditional on last period's - Full Sample

Variables	Pooled OLS	IV	Corrected IV
Weak Test (H_0: exp t =1):	**Reject**	**Reject**	**Cannot Reject**
Constant	35.5 (1.14)**	21.7 (11.2)**	4.4 (4.9)
Expected Retirement Age time t	0.46 (0.02)**	0.67 (0.18)**	0.94 (0.08)**
Test of Overid Restrictions		Cannot Reject Null	Reject Null
Strong Test (H_0: exp t =1):	**Reject**	**Reject**	**Cannot Reject**
Constant	59.887 (11.876)**	51.663 (19.510)**	25.133 (17.673)
Expected Retirement Age time t	0.371 (0.023)**	0.495 (0.194)**	0.799 (0.163)**
Economic Factors time t			
Net Worth	0.034 (0.022)	0.033 (0.022)	0.031 (0.023)
Respondent Earnings	-0.001 (0.002)	-0.0003 (0.0016)	0.0003 (0.0018)
Private Health Insurance	0.344 (0.328)	0.289 (0.341)	0.127 (0.365)
Health Factors time t			
Health limitation	0.137 (0.338)	0.168 (0.340)	0.194 (0.370)
Self Rating G, F, P	-0.238 (0.133)*	-0.232 (0.140)*	-0.251 (0.152)*
Doctor visit times	0.009 (0.017)	0.023 (0.021)	0.035 (0.022)
High blood pressure	-0.138 (0.291)	-0.059 (0.302)	0.001 (0.328)
Diabetes problems	-0.729 (0.478)	-0.689 (0.552)	-0.705 (0.602)
Cancer	-1.826 (0.786)**	-2.053 (0.862)**	-2.186 (0.938)**
Stroke	-1.660 (0.642)**	-1.144 (2.870)	0.505 (3.083)
Heart Problems	-0.153 (0.682)	-0.274 (0.644)	-0.495 (0.695)
Arthritis problems	0.474 (0.292)	0.467 (0.291)	0.424 (0.317)
Difficulty walking	0.158 (0.536)	-0.028 (0.561)	-0.194 (0.370)
Difficulty climbing stairs	0.861 (0.685)	0.678 (0.695)	0.729 (0.757)
Demographic time t			
Age	-1.066 (0.419)**	-1.003 (0.436)**	-0.599 (0.440)
Age squared	0.013 (0.004)**	0.012 (0.005)**	0.007 (0.004)
Male	0.947 (0.244)**	0.970 (0.277)**	0.824 (0.295)**
Ba	0.059 (0.318)	0.172 (0.328)	0.309 (0.353)
Profd	-0.930 (0.398)**	-0.904 (0.429)**	-0.863 (0.467)*
Married	-0.593 (0.307)*	-0.417 (0.453)	0.085 (0.441)
Education			
Adjusted R_squared	0.240	0.224	0.078
Lambda			
Test of OverId Restrictions		Reject Null	Reject Null

Table 3b. The Strong Test of Rationality - Expected Retirement Age Conditional on last period's - Restricted Sample

Variables	Pooled OLS	IV	Corrected IV
Weak Test (H_0: exp t =1):	**Reject**	**Cannot Reject**	**Reject**
Constant	19.6 (1.72)**	-22.8 (31.7)	-36.5 (12.6)**
Expected Retirement Age time t	0.69 (0.03)**	1.38 (0.51)**	1.60 (0.20)**
Test of Overid. Restrictions		Cannot Reject Null	Cannot Reject
Strong Test (H_0: exp t =1):	**Reject**	**Cannot Reject**	**Cannot Reject**
Constant	28.575 (8.697)**	41.976 (32.452)	-19.143 (37.389)
Expected Retirement Age time t	0.488 (0.034)**	0.339 (0.693)	1.572 (0.838)*
Economic Factors time t			
Net Worth	-0.009 (0.015)	-0.016 (0.039)	0.042 (0.042)
Respondent Earnings	0.0005 (0.0006)	0.0005 (0.0014)	-0.0008 (0.0015)
Private Health Insurance	-0.003 (0.140)	-	-
Health Factors time t			
Health limitation	0.190 (0.125)	0.079 (0.133)	0.386 (0.272)
Self Rating G, F, P	-0.106 (0.061)*	-0.055 (0.052)	-0.197 (0.120)
Doctor visit times	0.008 (0.009)	0.002 (0.009)	0.015 (0.014)
High blood pressure	-0.086 (0.106)	0.033 (0.114)	-0.180 (0.212)
Diabetes problems	-0.451 (0.183)**	-0.240 (0.206)	-0.719 (0.421)
Cancer	-0.707 (0.272)**	-0.527 (0.292)*	-0.649 (0.566)
Stroke	0.083 (0.547)	-0.231 (0.263)	1.567 (2.029)
Heart Problems	-0.031 (0.184)	0.232 (0.263)	0.062 (0.437)
Arthritis problems	-0.099 (0.105)	-0.114 (0.186)	0.152 (0.275)
Difficulty walking	0.057 (0.282)	-0.071 (0.203)	-0.240 (0.440)
Difficulty climbing stairs	0.687 (0.219)	-0.082 (0.291)	0.740 (0.704)
Demographic time t			
Age	-0.172 (0.303)	-0.419 (0.143)**	-0.362 (0.291)
Age squared	0.004 (0.003)	0.007 (0.003)**	0.001 (0.003)
Male	0.134 (0.098)	0.233 (0.263)	-0.079 (0.242)
Ba	-0.008 (0.125)	0.061 (0.126)	-0.271 (0.291)
Profd	-0.246 (0.156)	-0.205 (0.153)	-0.357 (0.354)
Married	-0.005 (0.118)	-0.072 (0.267)	0.357 (0.354)
Education			
Adjusted R_squared	0.527	0.487	
Lambda			
Test of Overid. Restrictions		Cannot Reject	Reject Null

Table 4a . The affect of new information on changes to plans for retirement
Full Sample,

i. No Selection Correction
coefficient (standard error)

Variables	Pooled OLS	Fixed Effects
Economic Factors		
Changes in Net Worth	0.034 (0.049)	0.044 (0.187)
Changes in Respondent Earnings	0.00004 (0.00085)	0.0005 (0.0047)
Changes in Private Health Insurance	-0.178 (0.434)	1.330 (1.484)
Health Factors		
Health limitation transitions[21]	-0.171 (0.487)	-0.273 (1.968)
Self Rating G, F, P transitions[22]	0.068 (0.239)	0.718 (1.119)
Stroke transitions[23]	-4.238 (2.956)	-
Heart Problems transitions[3]	0.645 (0.863)	5.699 (6.105)
Cancer transitions[3]	2.195 (1.045)**	0.054 (4.302)
Diabetes transitions	0.672 (0.591)	-0.853 (3.690)
High blood pressure transitions[3]	0.407 (0.355)	-0.013 (1.393)
Arthritis transitions	-0.331 (0.342)	-1.743 (1.401)
Smoking transitions	0.963 (1.187)	-0.070 (3.951)
Probability of living to age 85	1.557 (0.695)**	5.457 (2.632)**
Doctor's visits	-0.030 (0.026)	0.191 (0.177)
Climbing stairs	-0.402 (0.947)	-5.179 (3.966)
Walking a mile	0.358 (0.816)	5.712 (3.680)
Demographic		
Marriage Transitions[24]	-1.118 (2.338)	-6.658 (7.021)
Adj. R-Square	0.010	0.002
Fraction of variance due to unobserved component		0.39
Corr(c_i, ε_i)		-0.35

[21] =1 if new limitation, 0 if no change, and -1 if you got better
[22] positive means health worsened (=1 if excellent, =5 if poor)
[23] positive means condition (Stroke, cancer, hbp) worsened (0 no change, -1 if better)
[24] =1 means new marriage, = 0 no change, =-1 dissolved marriage (widow, divorce…)

Table 4a . The affect of new information on changes to plans for retirement
Full Sample,

ii. Selection Correction
coefficient (standard error)

Variables	Pooled OLS	Random Effects
Economic Factors		
Changes in Net Worth	0.032 (0.045)	0.033 (0.045)
Changes in Respondent Earnings	-0.0003 (0.0020)	-0.0001 (0.0019)
Changes in Private Health Insurance	-0.181 (0.435)	-0.183 (0.437)
Health Factors		
Health limitation transitions[25]	-0.166 (0.472)	-0.193 (0.475)
Self Rating G, F, P transitions[26]	0.052 (0.230)	0.056 (0.230)
Stroke transitions[27]	-4.220 (3.024)	-4.204 (3.037)
Heart Problems transitions[3]	0.854 (0.816)	0.712 (0.792)
Cancer transitions[3]	2.350 (1.012)**	2.212 (1.002)**
Diabetes transitions	0.839 (0.697)	0.735 (0.681)
High blood pressure transitions[3]	0.622 (0.417)	0.446 (0.351)
Arthritis transitions	-0.125 (0.394)	-0.291 (0.329)
Smoking transitions	0.909 (0.948)	0.943 (0.950)
Probability of living to age 85	1.629 (0.671)**	1.569 (0.669)**
Doctor's visits	-0.033 (0.029)	-0.030 (0.029)
Climbing stairs	-0.399 (0.860)	-0.397 (0.864)
Walking a mile	0.456 (0.746)	0.377 (0.742)
Demographic		
Marriage Transitions[28]	-1.214 (1.909)	-1.149 (1.914)
Adj. R-Square		
Inverse Mill's Ratio	-0.693 (0.752)	-0.626 (0.841)

[25] =1 if new limitation, 0 if no change, and -1 if you got better
[26] positive means health worsened (=1 if excellent, =5 if poor)
[27] positive means condition (Stroke, cancer, hbp) worsened (0 no change, -1 if better)
[28] =1 means new marriage, = 0 no change, =-1 dissolved marriage (widow, divorce…)

Table 4b . The affect of new information on changes to plans for retirement
Restricted Sample,

i. No Selection Correction

coefficient (standard error)

Variables	Pooled OLS	Fixed Effects
Economic Factors		
Changes in Net Worth	0.002 (0.027)	0.074 (0.053)
Changes in Respondent Earnings	-0.0001 (0.0006)	-0.001 (0.001)
Changes in Private Health Insurance	-0.422 (0.187)**	-0.547 (0.487)
Health Factors		
Health limitation transitions[29]	-0.069 (0.197)	-0.503 (0.656)
Self Rating G, F, P transitions[30]	0.188 (0.082)**	0.037 (0.350)
Stroke transitions[31]	-1.442 (0.555)**	-
Heart Problems transitions[3]	-0.235 (0.245)	-0.367 (1.979)
Cancer transitions[3]	0.161 (0.315)	-0.229 (1.191)
Diabetes transitions	0.376 (0.202)*	0.372 (1.139)
High blood pressure transitions[3]	0.007 (0.118)	0.161 (0.474)
Arthritis transitions	0.049 (0.115)	-0.547 (0.487)
Smoking transitions	-0.228 (0.371)	0.782 (1.238)
Probability of living to age 85	0.208 (0.249)	-0.393 (0.933)
Doctor's visits	-0.013 (0.016)	0.075 (0.057)
Climbing stairs	-0.332 (0.298)	-2.962 (1.167)**
Walking a mile	0.076 (0.263)	1.889 (1.278)
Demographic		
Marriage Transitions[32]	-0.755 (0.514)	-2.010 (2.205)
Adj. R-Square	0.013	0.001
Fraction of variance due to unobserved component		0.51
Corr(c_i, ε_i)		-0.33

[29] =1 if new limitation, 0 if no change, and -1 if you got better
[30] positive means health worsened (=1 if excellent, =5 if poor)
[31] positive means condition (Stroke, cancer, hbp) worsened (0 no change, -1 if better)
[32] =1 means new marriage, = 0 no change, =-1 dissolved marriage (widow, divorce…)

Table 4b . The affect of new information on changes to plans for retirement
Restricted Sample,
iii. Selection Correction
coefficient (standard error)

Variables	Pooled OLS	Random Effects
Economic Factors		
Changes in Net Worth	0.005 (0.018)	0.004 (0.018)
Changes in Respondent Earnings	0.0004 (0.0007)	0.0001 (0.0007)
Changes in Private Health Insurance	-0.411 (0.162)**	-0.407 (0.163)**
Health Factors		
Health limitation transitions[33]	-0.074 (0.180)	-0.013 (0.179)
Self Rating G, F, P transitions[34]	0.222 (0.087)**	0.208 (0.086)**
Stroke transitions[35]	-1.433 (1.119)	-1.447 (1.185)
Heart Problems transitions[3]	-0.504 (0.313)	-0.357 (0.301)
Cancer transitions[3]	-0.019 (0.377)	0.174 (0.367)
Diabetes transitions	0.134 (0.260)	0.278 (0.248)
High blood pressure transitions[3]	-0.323 (0.163)**	-0.060 (0.131)
Arthritis transitions	-0.259 (0.153)*	-0.025 (0.123)
Smoking transitions	-0.121 (0.368)	-0.164 (0.364)
Probability of living to age 85	0.098 (0.253)	0.188 (0.249)
Doctor's visits	-0.008 (0.011)	-0.013 (0.011)
Climbing stairs	-0.374 (0.328)	-0.364 (0.326)
Walking a mile	-0.049 (0.283)	0.082 (0.278)
Demographic		
Marriage Transitions[36]	-0.726 (0.756)	-0.790 (0.748)
Adj. R-Square		0.020
Inverse Mill's Ratio	1.054 (0.311)**	0.964 (0.278)**

[33] =1 if new limitation, 0 if no change, and -1 if you got better
[34] positive means health worsened (=1 if excellent, =5 if poor)
[35] positive means condition (Stroke, cancer, hbp) worsened (0 no change, -1 if better)
[36] =1 means new marriage, = 0 no change, =-1 dissolved marriage (widow, divorce…)

Appendix Table 1. Selection Equation Results - Probability of Thinking
i.. Levels

Variables	Probit	Random Effects Probit
Economic Factors		
Net wealth	-0.007 (0.002)**	-0.014 (0.002)**
Income	0.005 (0.0002)**	0.007 (0.0003)**
Financially knowledgeable	0.037 (0.020)*	0.043 (0.026)*
Health Factors		
Limitations	-0.188 (0.025)**	-0.273 (0.027)**
Self-ratings	-0.021 (0.010)**	-0.050 (0.012)**
Doctor's visits	-0.012 (0.001)**	-0.007 (0.001)**
Probability of living to 85	-0.041 (0.029)	-0.021 (0.033)
Walking one mile	-0.188 (0.035)**	-0.156 (0.038)**
Climbing stairs	-0.023 (0.042)	-0.050 (0.045)
High blood pressure	-0.056 (0.021)**	0.056 (0.023)**
Diabetes	-0.019 (0.036)	-0.008 (0.040)
Cancer	0.042 (0.056)	0.019 (0.061)
Stroke	-0.238 (0.127)*	-0.263 (0.129)**
Heart problems	0.187 (0.046)**	0.092 (0.050)*
Arthritis	0.560 (0.020)**	0.087 (0.022)**
Smoker	-0.084 (0.021)**	-0.063 (0.027)**
Psych problems	-0.161 (0.036)**	-0.076 (0.038)**
Back problems	0.235 (0.021)**	0.108 (0.024)**
Demographic		
Age	0.280 (0.019)**	0.340 (0.023)**
Age squared	-0.003 (0.0002)**	-0.003 (0.0002)**
Male	0.300 (0.020)**	0.331 (0.026)**
BA	0.055 (0.025)**	0.120 (0.032)**
Professional degree	0.095 (0.036)**	0.142 (0.048)**
Married	-0.024 (0.024)	-0.020 (0.031)

Appendix Table 1. Selection Equation Results - Probability of Thinking
ii.. Deviations

Variables	Probit	Random Effects Probit
Economic Factors		
Net wealth	0.0004 (0.0014)	-0.0008 (0.0018)
Income	0.001 (0.0003)**	0.0009 (0.0004)**
Financially knowledgeable	0.060 (0.035)*	0.109 (0.046)**
Health Factors		
Limitations	-0.054 (0.041)	0.023 (0.037)
Self-ratings	0.034 (0.019)*	0.041 (0.017)**
Doctor's visits	0.009 (0.002)**	0.004 (0.002)**
Probability of living to 85	-0.105 (0.055)*	0.008 (0.050)
Walking one mile	-0.176 (0.056)**	-0.027 (0.049)
Climbing stairs	0.006 (0.065)	-0.019 (0.057)
High blood pressure	-0.440 (0.032)**	-0.136 (0.029)**
Diabetes	-0.324 (0.062)**	-0.170 (0.055)**
Cancer	-0.400 (0.098)**	-0.170 (0.086)**
Stroke	-0.191 (0.219)	-0.240 (0.185)
Heart problems	-0.376 (0.077)**	-0.121 (0.074)
Arthritis	-0.442 (0.031)**	-0.167 (0.028)**
Smoker	0.061 (0.073)	0.011 (0.064)
Psych problems	-0.118 (0.061)*	-0.023 (0.057)
Back problems	0.129 (0.035)**	0.090 (0.032)**
Demographic		
Age	0.435 (0.044)**	0.527 (0.046)**
Age squared	-0.004 (0.0004)**	-0.005 (0.0004)**
Male	0.485 (0.035)**	0.681 (0.047)**
BA	0.170 (0.044)**	0.259 (0.061)**
Professional degree	0.231 (0.064)**	0.333 (0.096)**
Married	-0.005 (0.171)	-0.160 (0.189)

Appendix: The Dynamic Model

Here we provide a brief description of the dynamic model we analyze, and we also provide some simulations of a preliminary version of the model that reflect the ability that this type of framework has to capture the types of features that we believe are desirable in a model of retirement behavior. Our objective is to extend the traditional life cycle model to adequately account for Social Security, private pensions, and various sources of uncertainty. In order to successfully introduce these changes we build upon the work of Heckman (1974), who endogenizes the labor supply decision in the traditional life cycle model. He shows that by extending the traditional life cycle model in this realistic fashion it is possible to reconcile the empirical evidence on the patterns of consumption and income with the theory. He finds that it is not necessary to resort to borrowing constraints, or income uncertainty (as Thurow 1969, and Nagatani 1972 have argued) in order to explain why consumption tracks income over the life cycle, once labor supply is endogenous. However, his model does not allow for non-participation or uncertainty. Recent work by Low (1998, and 1999), French (2000), Benítez-Silva (2000), and Rust, Buchinsky, and Benítez-Silva (2001), have contributed to this literature showing that the more complete models are solvable, and excellent tools for policy analysis.

In this extended model utility is a function of consumption (c) and leisure (l), and agents optimally choose both (and indirectly also savings since they are defined as wealth minus consumption in a given period) in every period of their finite lives (agents live up to T periods). They effectively solve:

$$\max_{c_s, l_s, c_T, l_T} E_t \left[\sum_{s=t}^{T-1} (\tau_s \, \beta^{s-t} \, u(c_s, l_s, h_s) + (1-\tau_s) \, K \, \beta^{s-t} u(w_s - c_s)) + \beta^T \, u(c_T, l_T, h_T) + K \, \beta^T u(w_T - c_T) \right] , \quad (1)$$

where $K \in (0,1)$ is a bequest factor.[1] β is a classic discount factor, and τ_t represents age-specific survival probabilities, which in the empirical model can be, for older individuals, estimated using for example the HRS and AHEAD data, or directly taken from the U.S. Life Tables. Savings, w_t, accumulate at an uncertain rate of return $\tilde{r}$, which for the moment we characterize as $i.i.d.$ draws from a log-normal distribution, such that

$$w_{t+1} = \tilde{r}(w_t + \omega \, (1-l) - c_t) \; , \quad (2)$$

where ω represents wages. The within period utility function is assumed to be Isoelastic and Cobb-Douglas

[1] Agents in this model care only about the absolute size of their bequests, which is why it has been called the "egoistic" model of bequests. A bequest factor of one would correspond to valuing bequest in the utility function as much as current consumption. The importance of bequest motives is still an open issue in the literature. Here we take the position of acknowledging that bequests do exist, and we can explore the implications of changing the importance of the bequest motive in the utility function. Hurd (1987, 1989), Bernheim (1991), Modigliani (1988), Wilhem (1996) and Laitner and Juster (1996) are some of the main references on the debate over the significance of bequests and altruism in the life cycle model.

between consumption and leisure in time t:

$$u(c_t, l_t, h_t) = \frac{(c_t^{\eta} l_t^{1-\eta})^{1-\gamma}}{1-\gamma} - 2h\,, \tag{3}$$

where γ is the coefficient of *relative risk aversion* and η is the valuation of consumption versus leisure.[2] Consumption and leisure are substitutes or complements depending on the value of γ as discussed in Heckman (1974) and Low (1998). Below we will assume they are substitutes. For the moment we assume that labor is discrete, agents can choose to work full-time, part-time, or not at all. h is health and takes the value 0 (good health), 1 (poor health), and 2 (disabled). We then add wage uncertainty to this model. We introduce serially correlated wages, such that

$$ln\, \omega_t \;=\; (1-\rho)\, \alpha_t + \rho\, ln\, \omega_{t-1} \;+\; \varepsilon_t\,, \tag{4}$$

where α_t is a quadratic trend that follows a wage profile that mimics the average of the U.S. population. The ε_t are $i.i.d.$ draws from a normal distribution with mean 0 and variance σ_t^2. If ρ is 0, this reduces to a case of $i.i.d.$ wages.

We use dynamic programming to characterize this problem, and solve it by backward induction. The individual in the last period of life solves

$$V_T(w, \omega, h) = \max_{(0 \le c \le w + \omega\,(1-l), l)} U(c, l, h) + K\, U(w + \omega\,(1-l) - c)]\,, \tag{5}$$

where labor is again chosen among the three possible states. Once we obtain the decision rules numerically we can write the value function in the next to last period:

$$V_{T-1}(w, \omega, h) = \max_{(0 \le c \le w + \omega(1-l), l)} U(c, l, h) + (1 - \tau_{T-1}) K\, U(w + \omega(1-l) - c) + \tau_{T-1}\, \beta\, E\, V_T(w + \omega\,(1-l) - c, \omega, h)\,. \tag{6}$$

The functions for the earlier periods are again obtained recursively. The expectation $E\, V_t(\omega\,(1-l) + w - c, \omega)$ appearing in the value functions for the different periods can be written as follows:

$$\int_0^{\overline{r}} \int_0^{\overline{\omega}} V(\tilde{r}(w + \tilde{\omega}\,(1-l) - c), \tilde{\omega})\; f(\tilde{\omega}) d\tilde{\omega}\, f(\tilde{r}) d\tilde{r}\,. \tag{7}$$

The interpolation of the values of the next period value function has to be carried out in two dimensions, a slightly cumbersome and slow procedure. The double integrals are solved by Gauss-Legendre quadrature, and we use iterated integration since we are assuming independence of wages and interest rates.[3]

[2] See Browning and Meghir (1991) for evidence on non-separability of consumption and leisure within periods.

[3] Given that the value function depends on wealth and wages, we needed to discretize both variables in order to approximate the integrals, using 50 points for wealth and 50 points for wages. We found that using fewer points significantly affected the accuracy of the calculations, leading to possible erroneous conclusions. See Rust (1996) and Judd (1998) for a discussion of the numerical techniques used to solve this type of model.

In Figures 1 to 3 we provide simulation results for an eighty period model. This is only a preliminary set up of the model, and these simulations do not pretend to be realistic but illustrative of the capacity of this model to replicate the qualitative patterns in the data. Figure 1 shows the average consumption path, and also plots the average wages that full-time workers had access to. We can observe that this extended model is able to capture the empirical regularity of consumption profiles tracking income, confirming the results of Heckman (1974) once non-participation and various sources of uncertainty are permitted. On average, individuals work full-time most of their lives, something not very surprising given that we are not modeling Social Security, pensions, or health uncertainties, in this preliminary model. Once we take those into account we are likely to be able to replicate the labor supply patterns in the population. Finally, Figure 3 and 4, show the simulated and actual patterns of wealth accumulation over the life cycle, respectively. The latter comes from Poterba (1998), who uses data from repeated cross-sections of the Survey of Consumer Finances. Qualitatively, these patterns are strikingly similar, with most of the accumulation happening later in life. This pattern has been very difficult to replicate with any other type of life cycle model (See Hubbard et al. 1994, and 1995). Once we are able to replicate actual patterns, we can simulate policy changes.

Health status has been shown to be one of the most important determinants not only of retirement outcomes, but also of likely discrepancies between expectations and outcomes among the elderly, and we have seen that in our results as well. Therefore, the incorporation of health in our model is one of our main tasks to complete if this project is funded. There are many ways to incorporate health and we plan to experiment with all of them. In the simplest specification health can be proxied as an aging effect that changes the valuation of consumption and leisure as work becomes more difficult as the person ages. We can also model it as a direct taste shifter. This effectively means to introduce it as a discrete stochastic variable over which individuals form expectations of been either healthy or unhealthy. This is how we chose to introduce it in the model above and in the simulations, shown in Figures 5 to 8. There we introduce in the dynamic model the probability of moving from one state of health to another (good health, bad health, disabled), and then compare the path of health states that the dynamic model predicts with the path we find in the HRS. As we can see the model replicates very well the empirical regularities. Notice, however, that is important to take into account how survival probabilities affect the results. These results suggest our strategy to incorporate health is quite successful and that the model predicts that individuals take into account the uncertainty over their health states in order to update their decisions over the life cycle.

The most challenging project, however, is to introduce it as a continuous stochastic variable that ranges from completely healthy to disabled. This can be computationally more demanding and we are still exploring the feasibility of this extension.

We consider these preliminary results of the model as very promising. This is the benchmark model on top of which we plan to adequately characterize the Social Security and private pensions incentives, and where health uncertainty can be added. From analyzing the extended model we will be able to characterize a set of testable behavioral implications, which we are analyzing using the rich data provided in the HRS. And more importantly, we are beginning to better understand the role of uncertainty and expectations in a more realistic model of retirement decisions.

Figure 1: Simulated Consumption. Serially Correlated Wages

Figure 2: Simulated Labor Supply. Serially Correlated Wages

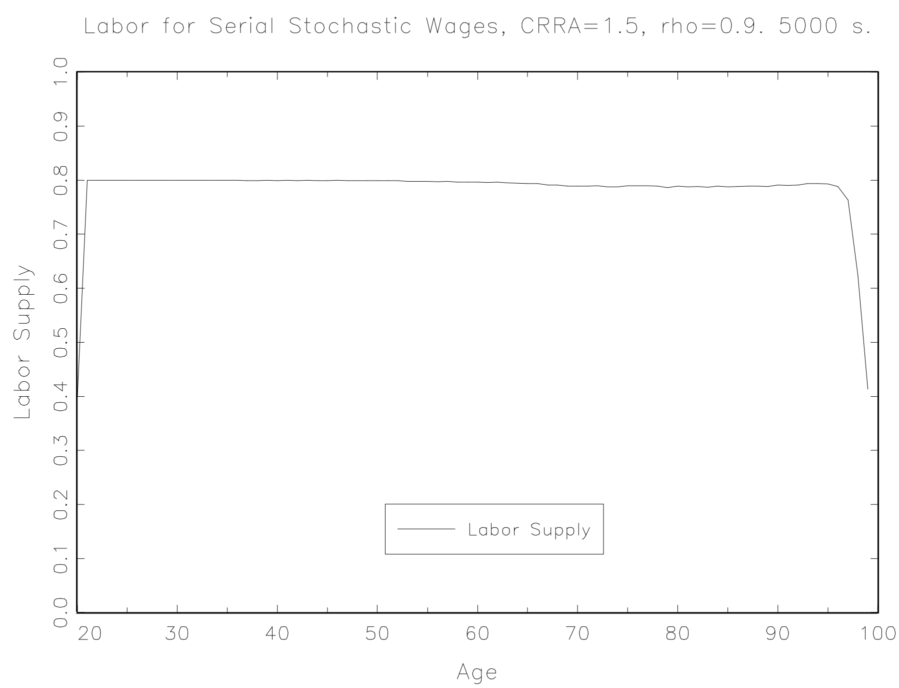


Figure 3: Simulated Wealth. Serially Correlated Wages

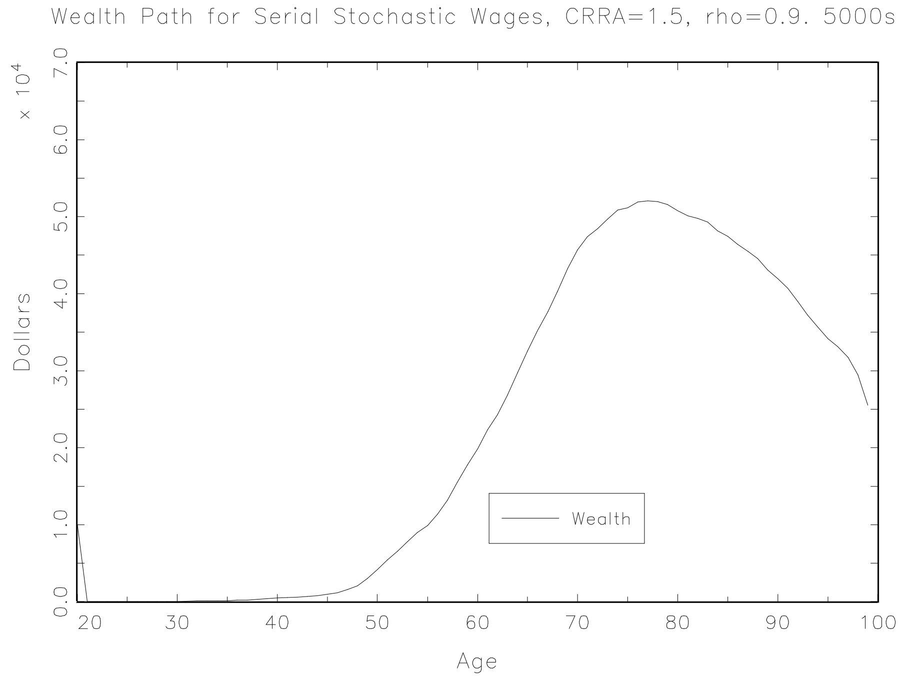


Figure 4: Wealth Accumulation from the SCF

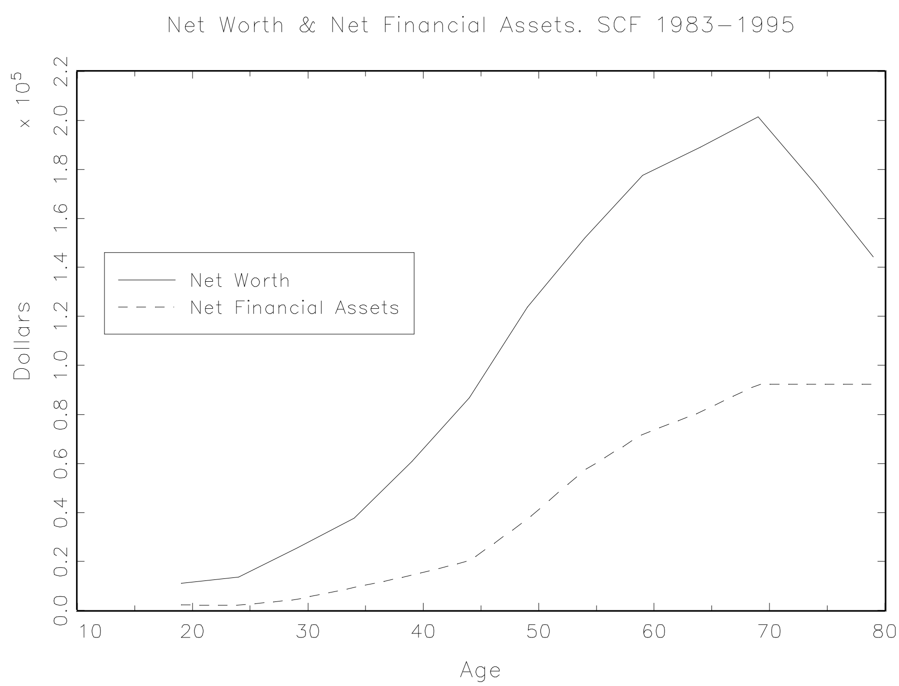


Figure 5: Survival probabilities. Life Tables and Simulations.

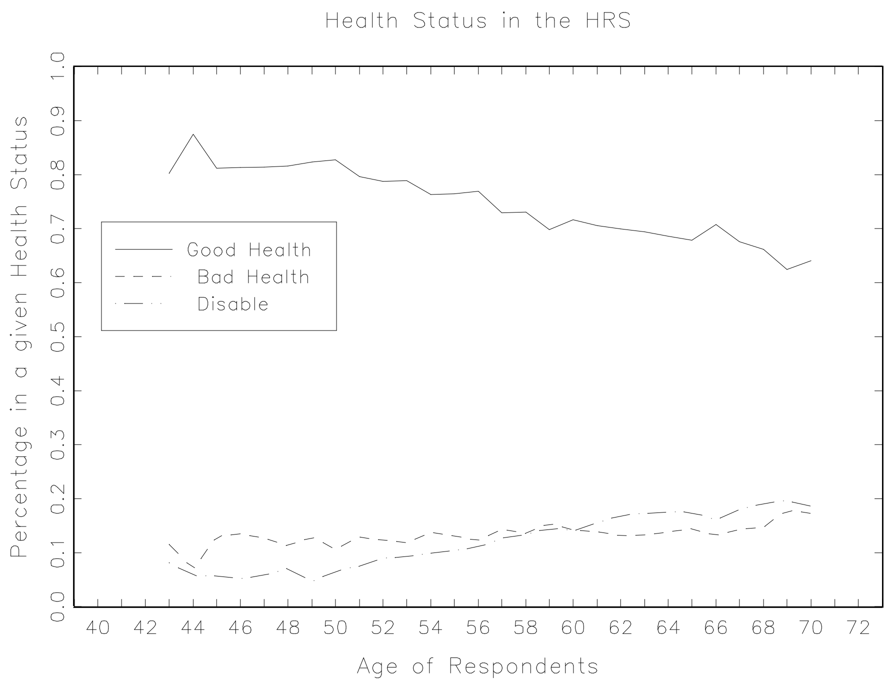


Figure 6: Health States. HRS. All waves.

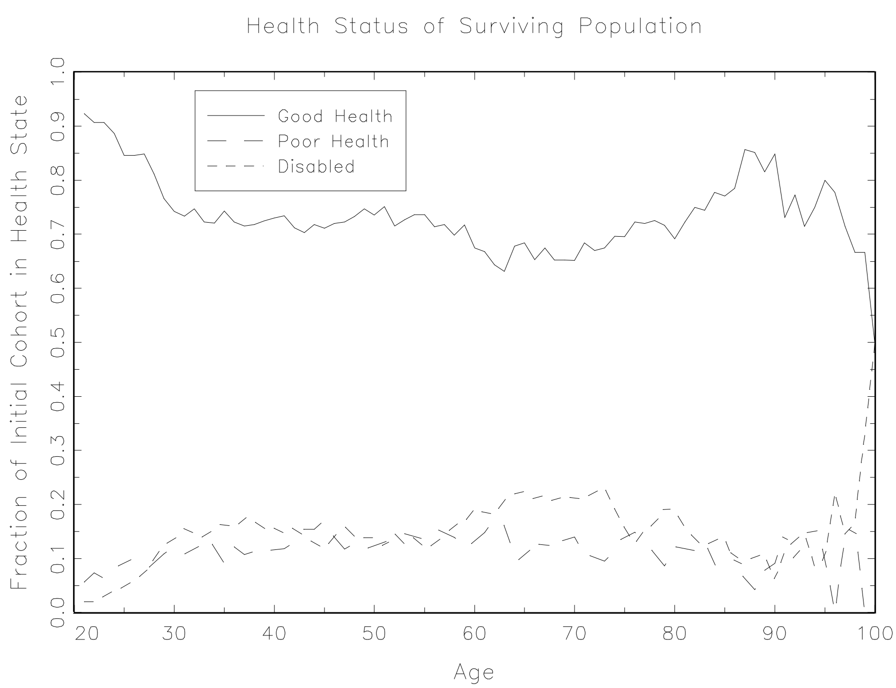


Figure 7: Health States. Simulations.

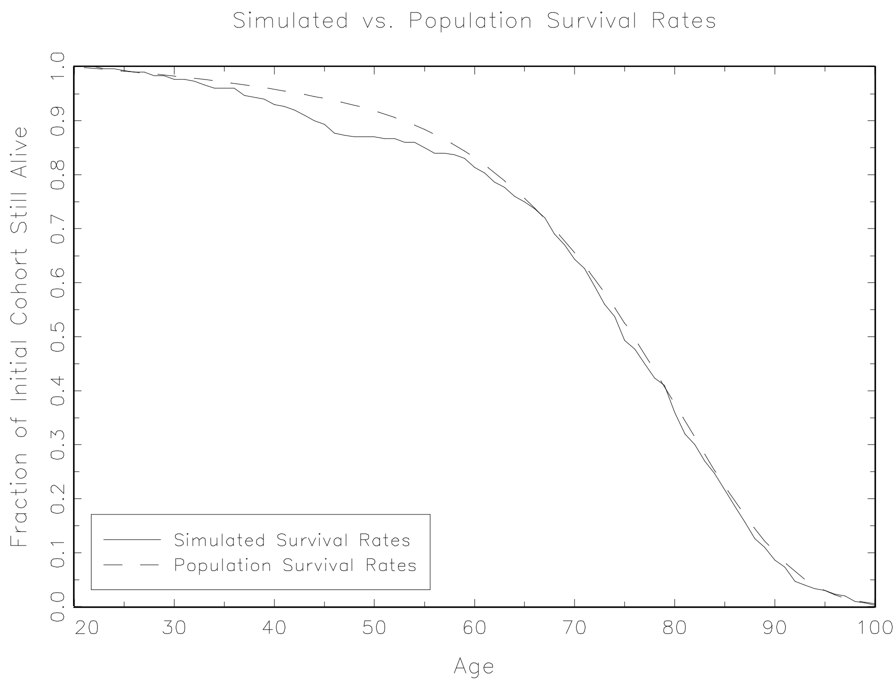
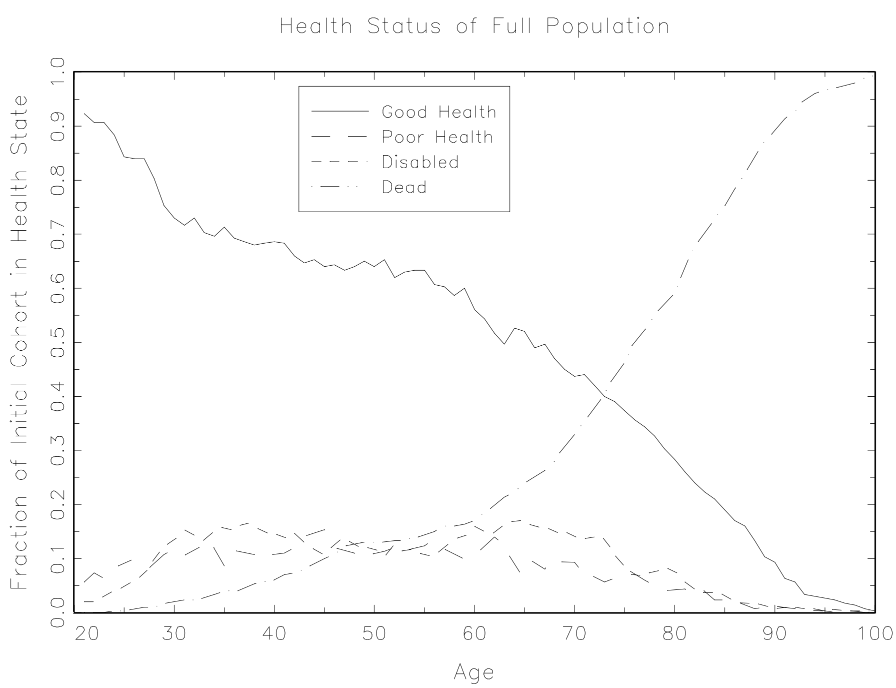


Figure 8: Health States. Simulations.



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