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ABSTRACT

We model the employment and medical care decisions of older men who face health risk. The budget constraint incorporates detailed characteristics of health insurance as well as Social Security and private pensions. A man whose health insurance is tied to continued employment with his current employer faces the risk of large medical expenditures in the event of an adverse health shock if he retires before becoming eligible for Medicare at age 65. A man whose employer provides retiree health insurance or who has access to other health insurance not tied to his employment decision (e.g., from his wife) can retire before age 65 without consequences for his health insurance coverage. We use data from the Health and Retirement Survey to estimate the parameters of the model using structural methods. Simulations based on the estimates imply that changes in health insurance, including access and restrictions to retiree health insurance and Medicare have a modest impact on employment behavior among older males.

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1 Introduction

A large majority of adults in the United States who have health insurance are covered by plans provided by employers until they become eligible for Medicare at age 65. Some employers extend health insurance coverage to retirees, while others terminate coverage when an individual leaves the firm. A risk-averse individual who believes there is some chance that he will incur large medical expenses is likely to place a high value on health insurance. If such an individual faces loss of his employer-provided health insurance by retiring, then he has an incentive to remain with his employer longer than he would if health insurance was not linked to his employment status.[1]

Recent proposals for reform of the U.S. health insurance system would fully or partly break the close link between health insurance coverage and employment for older individuals. For example, the Clinton Administration proposed a reform that would allow individuals to purchase Medicare beginning at age 62. The Health Insurance Portability and Accountability Act of 1996 forbids insurance companies from denying coverage to individuals aged 55-64 who apply for health insurance after losing employer-provided coverage. If the availability of health insurance coverage influences the employment decisions of older individuals, then such reforms could encourage early exit from the labor force. Recent and proposed new Social Security reforms have been designed to encourage later retirement, but if health insurance reform has the opposite effect there could be serious consequences for the already uncertain financial prospects of both Social Security and Medicare.

The possibility that health insurance influences retirement behavior has attracted considerable attention from researchers in the last few years. Evidence from recent studies suggests that the availability of retiree health insurance has a strong impact on the employment behavior of older men. Much of the evidence is derived from reduced form models or models that represent approximations to the employment decision rules implied by economic theory. For example, in earlier work we found that the annual labor force exit rate of men aged 61 whose employer-provided health insurance includes retiree coverage is 7.5 percentage points higher than the rate for men whose

[1] Alternatively, individuals who would lose their health insurance upon retiring could purchase an individual health insurance policy. Such policies, however, are generally not a good substitute for employer-provided health insurance because they have much higher premiums for a given level of coverage than employer-provided policies and often exclude pre-existing conditions (Congressional Research Service, 1988).

employer-provided insurance does not include retiree coverage.[2] Evidence of this type is useful in establishing the existence of an effect but cannot necessarily be used to evaluate the impact of proposed policy reforms. The provisions of employer-provided health insurance, such as the premium, deductible, coinsurance rate, and so forth, vary widely across plans. The impact of retiree coverage estimated in reduced form and approximation studies is an average of the impact of plans with different provisions. In our earlier paper we show that the effect of retiree coverage is much larger if the employer pays the entire premium than if the worker and employer share the cost of the premium. The effect of a reform that mandated extension of employer-provided retiree coverage to all workers might be well-approximated by estimates from reduced form and approximation models. However, the Lucas critique applies: the effect of health insurance on employment behavior might change as the structure of health insurance changes because demand for medical care will change as financial constraints are altered. And the effect of reforms such as extending Medicare coverage to individuals aged 62-64 and requiring insurers to provide coverage to older individuals who lose employer-provided coverage could not be reliably estimated from reduced form or approximation models because Medicare and private health insurance characteristics differ significantly from the provisions of typical existing employer plans.

Structural models of labor force exit decisions that incorporate health insurance provide a basis for policy evaluation if the models incorporate health insurance in a realistic way. In order to determine whether the observed increase in retirement at age 65 can be explained by incomplete health insurance prior to age 65 (i.e., Medicare health insurance is available to all individuals 65 and older regardless of employment), Gustman and Steinmeier (1994) and Lumsdaine, Stock, and Wise (1994) evaluate the role of Medicare by adding the *average* health care expense reimbursement to the budget constraint. They find that parameter estimates and implied retirement behavior are virtually identical with or without this health insurance component. Rust and Phelan (1997) point out that health insurance is likely to be valued by risk-averse individuals for the coverage it provides against catastrophic medical bills caused by low-probability major adverse health shocks. Estimates obtained by valuing insurance at its average reimbursement do not account for the role of insurance in smoothing consumption across uncertain risky health states. The retirement model

[2]Blau and Gilleskie (2001a). See Gruber and Madrian (1995, 1996), Karoly and Rogowski (1994), and Madrian (1994) for related evidence.

of Rust and Phelan allows for risk aversion and incorporates the entire distribution of medical expenditures, conditional on health insurance, rather than the mean only. Their estimates indicate that individuals in the Retirement History Survey (RHS) sample from the late 1970s are quite risk averse and that the availability of retiree coverage has a substantial impact on the timing of labor force exit.

In this paper we specify a dynamic structural model of employment and medical care decisions and estimate its parameters using data on men aged 50-67 from the Health and Retirement Survey (HRS) spanning the 1990s. The analysis has two unique features that distinguish it from the approaches followed by previous studies. First, the model allows individuals to choose the amount of medical care to consume. Previous models have treated medical expenditure as an exogenous stochastic process. This would be a good approach if medical care is determined entirely by health status and the decisions of medical professionals. But if individuals are willing and able to substitute between medical care and other consumption in response to health shocks, then assuming that medical expenditure is exogenous could yield misleading inferences.[3]

Second, we supplement the HRS survey responses with information from employers and Social Security records that allows us to measure the budget constraints facing the individuals in our sample more accurately than in previous studies. Measuring the budget constraint accurately is crucial for producing believable estimates from a structural model, and is difficult as a result of both the complexity of the within-period constraint, and the fact that an individual's decisions in one period affect his budget set in subsequent periods. Data from Social Security earnings records along with information provided by employers on their health insurance and pension provisions allow us to model these dynamics with much greater accuracy than is possible with individual survey responses alone. Previous studies of this issue have not had access to data of this type and have been forced to rely on crude approximations to the budget set. We use our data to accurately model the impact of each employment choice on current and future health insurance coverage and Social Security and pension benefits. Furthermore, we account for the substantial variation across the sample in health insurance plan characteristics such as premium, deductible, coinsurance, and maximum coverage. This is another important motivation for modeling medical care decisions

[3]Evidence from studies of the demand for medical care shows price elasticity estimates in the range of -0.16 to -0.43 (Keeler, et al. 1988).

instead of treating medical expenditures as given or randomly drawn from a distribution. Out-of-pocket medical expenditure is the outcome of medical care consumption interacted with the parameters of health insurance coverage. Using data on the price and quantity of medical care together with health insurance plan characteristics makes it possible to determine whether health insurance plan characteristics influence medical care demand. This also allows us to evaluate the impact of alternative insurance plans with different cost-sharing characteristics.

Our modeling approach is thus a significant advance over previous studies, but it does have some limitations. First, like previous studies we treat health insurance coverage as given.[4] A model in which health insurance is a choice could not be estimated because the state space and choice set (uncertain in future periods) are too large. Thus, if an older individual can easily obtain from another source health insurance coverage comparable to coverage from his employer, our model would be misspecified. This seems unlikely because of exclusion of pre-existing conditions (pre-HIPAA) and high premiums for private plans.[5] We also do not model COBRA coverage.[6]

Second, we do not model savings behavior, again for computational reasons. An individual who expects to lose health insurance coverage upon leaving his employer could save in anticipation of this event, thus self-insuring against health risk. However, evidence on saving and health insurance shows that individuals who are uninsured have much lower wealth, other things equal, than

[4]We do, however, account for the loss of coverage as a result of leaving a job that provides health insurance without retiree coverage. What we do not account for is the possibility of gaining coverage from a new firm or by purchasing private non-group coverage, or losing coverage as a result of the firm terminating a health insurance plan.

[5]The Health Insurance Portability and Accountability Act (HIPAA) of 1996 increased health insurance accessibility to individuals changing jobs. The ability of employers to deny coverage because of pre-existing conditions has been limited but has not been eliminated. More specifically, the law states that for all plan years starting after June 30, 1997, employers and health insurers may impose a pre-existing condition exclusion only if: the exclusion relates to a condition for which the beneficiary received medical advice, diagnosis or treatment within the last six months; the exclusion lasts for no more than 12 months after the enrollment date; and the length of the exclusion is also reduced by the period of time for which the beneficiary had health insurance prior to the enrollment date. We do not model this possibility due to its dependence on information we do not observe and because our data span the years 1992 to 1998.

[6]The Consolidated Omnibus Budget Reconciliation Act of 1985 (COBRA) requires firms that provide health insurance to offer coverage to employees (and their dependents) who leave the firm for up to 18 (36) months after they leave, at a premium to the ex-employee of no more than 102 percent of the cost of the coverage. In principle, this provides a bridge to Medicare for individuals who leave employment at around age 63. However, Gruber and Madrian (1995, 1996) find that while the COBRA and earlier state continuation-of-coverage mandates seem to have induced an increase in the labor force exit rate among older men, the effect is no larger at ages 63 and 64 than at younger ages, and in one of their data sets the effects are much stronger at younger ages. Unfortunately for purposes of modeling such coverage, the HRS dataset only provides insurance information at each wave (every two years) and does not specifically identify COBRA coverage.

individuals with health insurance (Starr-McCluer, 1996). In fact, uninsured individuals have on average essentially no financial wealth. This evidence does not rule out the existence of precautionary saving behavior, but it does suggest that its impact is likely to be minimal.

Finally, we do not model the joint employment and medical care decisions of married couples. This could be important if health insurance from one spouse's employer covers both spouses and the spouse with coverage therefore faces employment incentives to maintain coverage for both spouses. In this paper, we allow for health insurance coverage from the wife, but we do not model the wife's employment or medical care decisions. Elsewhere, we analyze the joint employment behavior of married couples but treat individual medical care expenditures as exogenous (Blau and Gilleskie, 2003).

Estimates of the structural parameters of our model enable us to predict well the observed employment behavior of the sample. Our model also fits of the number of doctor visits well, but over-predicts hospital nights. Having estimated the model parameters, we are able to simulate the behavior of the sample under different policy scenarios. Of most interest in this paper is the change in employment patterns under different insurance scenarios. We simulate the impact of the availability of retiree health insurance for all individuals with employer-provided insurance and compare this to behavior when retiree insurance is available to no one. If health insurance is highly valued, then we should observe changes in employment choices when the link between health insurance and employment is altered. We find that the retention rate with the current employer is 7 percentage points higher when retiree health insurance is eliminated (among those who previously held employer-provided coverage with retiree benefits). The non-employment rate of men who previously had employer-provided health insurance with no retiree coverage rises 8.5 percentage points when retiree health benefits are added to the plans.

In the next section we specify the individual's optimization problem. Section 3 discusses the data and section 4 presents results and policy simulations. Section 5 concludes.

2 The Model

We specify a model of employment and medical care decisions of older men. We present the basic elements of the model here, omitting some details in order to clearly spell out the key ideas of our approach. The details are fairly complex as a result of both the richness and the limitations of our data, and the complexity of Social Security, pension, and health insurance benefits. Additional details are provided in the Appendix, and Section 3 below describes features of the data that influence some of the modeling decisions.

We specify a discrete-state, discrete-time model with a finite horizon, T^*, which is the maximum age to which any individual can survive. The length of a period in the model is one year. There is no capital market, so consumption equals income each period. The three decision variables each period are employment and two types of medical care consumption: doctor visits and hospital nights. The state variables that are determined by the individual's choices (and by realizations of stochastic processes) are employment status, health status, and cumulative years of job tenure and work experience. Medical care choices affect contemporaneous utility directly through the utility function and indirectly through the budget constraint. The employment decision has future consequences because earnings, pension benefits, Social Security benefits, and health insurance coverage may depend on employment status, job tenure, and experience.

Individuals face three sources of uncertainty about the future: health, layoffs, and preferences. Realizations of the stochastic processes that determine the period-t values of these variables occur at the beginning of the period. These realizations, together with the choices made by the individual in the past, determine his choice set for the current period. He makes his employment and medical care choices from the available choice set each period, and these decisions are then fixed for the duration of the period.

2.1 Per-period Alternatives

The employment states in period t are employed ($e_t = 1$) and not employed ($e_t = 0$). Individuals who were previously employed ($e_{t-1} = 1$) may be laid off ($f_t = 1$) at the beginning of the current period with probability ϕ. The employment alternatives available to an individual who was previously employed ($e_{t-1} = 1$) and not laid off ($f_t = 0$) are:

$j_t = 1$: leave the labor force

$j_t = 2$: take a new job

$j_t = 3$: stay on the same job.

Individuals who were previously not employed ($e_{t-1} = 0$) or who were employed and laid off ($e_{t-1} = 1$ and $f_t = 1$) have the alternatives:

$j_t = 1$: remain out of the labor force

$j_t = 2$: become employed.

One new job offer is received by the individual at the beginning of each period with no cost of search, so entering employment or changing jobs are always options.

The medical care alternatives available to an individual include any combination of physician visits and hospital nights up to a maximum of K each per period. The alternatives are denoted by v_t for the number of physician visits and k_t for the number of hospital nights. Purchase of medication and other medical expenses are not modeled. Let d_t^{jvk} indicate the employment and medical treatment decisions of an individual in period t. $d_t^{jvk} = 1$ if employment alternative j, v doctor visits, and k hospital nights are chosen during period t, and $d_t^{jvk} = 0$ otherwise.

The health insurance coverage of individuals under age 65 is classified into one of the following seven categories:

$\ell_t = 0$: no insurance

$\ell_t = 1$: own-employer health insurance with retiree benefits

$\ell_t = 2$: spouse's employer health insurance

$\ell_t = 3$: own-employer health insurance without retiree benefits

$\ell_t = 4$: private insurance

$\ell_t = 5$: Medicaid

$\ell_t = 6$: Medicare.

Although Medicaid provides free medical care to financially-eligible individuals regardless of age, we do not account for the income and asset limits in our model. Medicare is available before age 65 only to men who have applied for and are enrolled in the Social Security Disability (SSDI) program. Upon becoming eligible for Medicare at age 65 a man is assumed to be covered by Medicare and may be covered by one other source.[7] We do not allow multiple sources of health insurance coverage before age 65 because doing so increases the complexity of the model substantially.

As noted above, computational feasibility requires that we treat health insurance coverage as given. Thus, we assign a man his observed health insurance coverage and characteristics in the periods for which we have data. We assume that he expects his health insurance coverage to remain unchanged following the last period for which we have data. If an individual with own-employer insurance changes jobs, he is assumed to have health insurance on the new job, with characteristics (premium, deductible, etc.) assumed to be those of a "generic" plan described in the Appendix, instead of the characteristics of the plan the individual had in the first observed job. Also, if an individual is covered by his employer's health insurance plan without retiree coverage, he becomes uninsured if he chooses non-employment. He remains uninsured until he is observed to become employed again (with health insurance) or he reaches age 65 and receives Medicare coverage. Men with Medicare coverage before age 65 are assumed to lose such coverage if they chose to become employed. Health insurance coverage of a man covered by his employer's plan with retiree insurance, by a spouse's employer's plan, or by a private plan is unaffected by his own employment decisions.

2.2 State Variables and Laws of Motion

The state variables characterize the information available to an individual at the beginning of a period and determine his choice set for the period. The main state variables that determine the alternatives available and/or the utility derived from each alternative in period t and their laws of motion are:

$$\text{employment state at end of } t-1: \qquad e_{t-1} = \begin{cases} 1 & \text{if } j_{t-1} = 2 \text{ or } 3 \\ 0 & \text{otherwise} \end{cases}$$

$$\text{laid off at beginning of } t: \qquad f_t = \begin{cases} 1 & \text{if } e_{t-1} = 1 \text{ \& laid off entering of } t \\ 0 & \text{otherwise} \end{cases}$$

[7]Men who report being covered by insurance from the Veteran's Administration or the Civilian Health and Medical Program of the Uniformed Services (CHAMPUS) are classified as having employer-provided insurance with retiree benefits. Men who are observed to be on Medicare before age 65 are included in the analysis, but we do not model the decision to apply for SSDI.

total work experience: $$x_t = \begin{cases} x_{t-1} & \text{if } d_{t-1}^{1vk} = 1 \\ x_{t-1}+1 & \text{otherwise} \end{cases}$$

The health states are good ($h_t = 0$), bad ($h_t = 1$), and deceased ($h_t = 2$). The health state in period $t+1$ is determined by health in t, age at t, and by a shock. The probability of making a transition from health state i in period t to health state a in period $t+1$ is given by

$$\pi_{t+1}^{ia}(\mathbf{Z}_t) = \text{pr}(h_{t+1=}\ a \mid h_{t=}\ i, \mathbf{Z}_t) = \frac{\exp\left(\gamma_{0ia}+\gamma_{1ia}'\mathbf{Z}_t\right)}{\sum_{b=0}^{2}\exp\left(\gamma_{0ib}+\gamma_{1ib}'\mathbf{Z}_t\right)} \tag{1}$$

where $\pi_t^{i0} + \pi_t^{i1} + \pi_t^{i2} = 1\ \forall i, \forall t$ and $\mathbf{Z}$ is a vector of observed fixed or deterministic exogenous variables. The vector of state variables[8] at the beginning of period t is $\mathbf{s}_t = (e_{t-1}, f_t, h_t, x_t, \mathbf{Z}_t)$.

2.3 Utility Function and Budget Constraint

Per-period utility, conditional on being alive during the period, is defined for each employment (j) and utilization (v doctor visits and k hospital nights) alternative during period t. That is,

$$U^i(C_t, \mathbf{d}_t, \mathbf{Z}_t, \epsilon_t^i) = \begin{cases} \alpha_{0,ie} + \frac{1}{\alpha_{1,ie}} C_t^{\alpha_{1,ie}} & \\ \quad + e_{t-1}(\alpha_{2,i0} + \alpha_{3,i0} f_t + \alpha_{4,i1} d_t^{2vk} + \alpha_{5,i1} d_t^{3vk}) & \\ \quad + (1-e_{t-1})(\alpha_{6,i1} d_t^{2vk} A_t) & \\ \quad + \alpha_{7,ie} v_t + \alpha_{8,ie} v_t^2 + \alpha_{9,ie} v_t A_t & \\ \quad + \alpha_{10,ie} k_t + \alpha_{11,ie} k_t^2 + \alpha_{12,ie} k_t A_t & \\ \quad + \alpha_{13,ie} \mathbf{A}_t + +\alpha_{14,ie} \mathbf{A}_t^2 + \epsilon_t^{ijvk} & \text{if } C_t > 0 \\ & \\ \alpha_{15,ie} & \text{if } C_t \le 0 \end{cases} \tag{2}$$

$$= \overline{U}_{jvk}^i(C_t) + \epsilon_t^{ijvk}$$

where C_t is consumption of a composite commodity and $\epsilon_t = (\epsilon_t^{ijvk}, \forall i, j, v, k)$ is a vector of period t choice- and health-specific utility shocks. Preferences are allowed to depend on the current realized health state and the current employment choice as indicated by the i and e subscripts on α. Utility is increasing and concave in consumption if $\alpha_{1,ie} < 1$, allowing for risk aversion. Also, the marginal utility of consumption is decreasing and approaches ∞ as $C \to 0$. For men who were previously

[8] Three additional state variables are required in order to model the details of Social Security and pensions. These are the age at which an individual leaves the job held at the initial survey date, the age at which he begins his first nonemployment spell after age 61, and a binary indicator of whether he ever re-enters employment following a nonemployment spell after age 61. The role of these variables is discussed in Appendices A2 and A3.

employed, the utility of each employment choice differs (α_2 through α_5). Those who were previously non-employed face utility costs that vary by age when re-entering the workforce (α_6). Medical care can provide utility in both the good health and bad health states, with the marginal utility of a visit or night allowed to depend on health (i), employment status (e), and age (A_t). For a given age, the marginal utility of medical care is decreasing if $\alpha_{7,ie} > 0$, $\alpha_{8,ie} < 0$, $\alpha_{10,ie} > 0$, and $\alpha_{11,ie} < 0$. The quadratic specification is a simple way of ensuring a determinate solution for medical care choices, and the constant relative risk aversion specification for consumption allows for the possibility that health insurance will be valuable to the individual, with risk-neutrality as a special case. If consumption falls below zero (i.e., if out-of-pocket medical expenses exceed after-tax income) in a given year, then individuals receive utility of $\alpha_{14,ie}$, a parameter to be estimated. This approach to modeling the consequences of negative income in the face of no wealth or savings decisions follows that of Rust and Phelan (1997). As mentioned above, we do not allow for savings for reasons of computational feasibility.

The expression $\overline{U}^i_{jvk}(C_t)$ is the deterministic part of the utility of choosing alternatives j, v, and k in health state i during period t. The utility shocks (ϵ_t) are assumed to be independently and identically distributed over time and across states and to follow the Extreme Value distribution. These assumptions are made for computational tractability. The model does not allow for time-invariant unobserved heterogeneity.

The budget constraint is given by

$$C_t = w_t(1 - d_t^{1vk}) + b_t - m_t - \Gamma(w_t, b_t, m_t), \qquad \forall t, j, v, k \tag{3}$$

where w_t is earnings if employed in period t, b_t is non-wage income (benefits) in period t, m_t represents out-of-pocket medical expenditures at time t, and $\Gamma()$ is an income tax function that accounts for the medical expense deduction. Earnings may depend on experience, age, and fixed exogenous characteristics, but are not stochastic: $w_t = w(x_t, A_t, \mathbf{Z}_t)$. We do not allow individuals to choose hours of work in response to a given hourly wage; rather, we assume that individuals are confronted with a take-it-or-leave-it salary offer. Rust (1990) shows that most of the variation in annual hours worked among older men is due to variation in employment status; variation in hours worked among the employed is quite small. Non-wage income is given by $b_t = b(e_t, x_t, A_t)$. This is shorthand for a complex algorithm that determines the Social Security benefit to which an individual is entitled at a given age as a function of his work experience and employment status at that age; and the pension benefit to which he is entitled as a function of his age, experience, and employment status. The computation of Social Security benefits follows the formulas used by the Social Security Administration closely, although not exactly in every instance. Pension benefits are determined by formulas derived from the plan descriptions provided by employers.[9] Non-wage income also includes earnings of the spouse,[10] income from assets, and unemployment insurance. Details on each source of income are provided in the next section.[11]

Out-of-pocket medical expenses, m_t, depend on the number of physician visits and hospital nights chosen by the individual, the price per visit or per night, and the characteristics of health insurance coverage at the beginning of period t: $m_t = m(v_t, k_t, p_v, p_k, P)$, where the p's are per-visit or per-night prices and P is a vector of insurance plan characteristics. These characteristics include the premium, deductible, coinsurance rate, maximum out-of-pocket expenditure, and maximum insurance liability.

The expected present discounted value (EPDV) of lifetime utility from choosing employment state j and medical visits v and k in period $t < T^*$ given health status $i < 2$ is

$$\begin{aligned} V^i_{jvk}(\mathbf{s}_t, \epsilon^i_t) &= \overline{U}^i_{jvk}(C_t) + \epsilon^{ijvk}_t \\ &\quad + \beta\Big[(1-\phi)\left[\pi^{i0}_{t+1}\, V^0(f_{t+1}{=}\,0, \mathbf{s}_{t+1}) + \pi^{i1}_{t+1}\, V^1(f_{t+1}{=}\,0, \mathbf{s}_{t+1})\right] \\ &\qquad + \phi\left[\pi^{i0}_{t+1}\, V^0(f_{t+1}{=}\,1, \mathbf{s}_{t+1}) + \pi^{i1}_{t+1}\, V^1(f_{t+1}{=}\,1, \mathbf{s}_{t+1})\right]\Big] \quad i = 0,1 \end{aligned} \tag{4}$$

where C_t is defined in Equation 3, β is the discount factor, and ϕ is the probability of being laid off at the beginning of period $t+1$, if employed during period t. In the event of death at period t, the value function (which involves no choices and does not vary with observed or unobserved

[9] The pension benefit formula depends on the age of exit from the period $t = 1$ job which is also a state variable.

[10] We assume in solution of the model that marital status is deterministic and known with perfect foresight for those periods it is observed. Additionally, we assume that once a man's marriage ends for whatever reason, he remains unmarried thereafter. (The marriage continuation rate from wave 1 to wave 2 was 0.959, with no obvious trend by age, implying a one-year continuation rate of 0.979.) Also, once a marriage dissolves, earnings from the spouse and health insurance from the spouse's employer are no longer available. In solution beyond those periods observed in the data, we assume marital status does not change from the status last observed.

[11] Allowing earnings and benefits to be uncertain would require additional state variables, such as the Average Indexed Monthly Earnings (AIME) in the determination of Social Security benefits, and result in additional computer-intensive computation, such as integration over the distribution of future earnings, which increases solution and estimation time considerably. The probability of being laid off, an important component of income uncertainty, is modeled.

heterogeneity) is $V^2(\mathbf{s}_t) \equiv 0$. Maximal expected utility of being in health state i in period $t+1$ (unconditional on choices at $t+1$) is $V^i(\mathbf{s}_{t+1}) = \mathrm{E}_t\Big[\max V^i_{jvk}(\mathbf{s}_{t+1}, \epsilon^i_{t+1}), \quad \forall j, v, k\Big]$.

2.4 Solution

Although T^* represents the end of life, we model individual decisions only to period $T < T^*$ for computational tractability. In the empirical analysis we set $T = 70$. Instead of modelling employment and medical care decisions for $t > T$, we follow Mroz and Weir (1993) and specify an approximation to the value function at T. In addition to computational considerations, our sample does not include individuals aged over T, so we would have little empirical basis for modelling the behavior of such individuals in any case. Thus, we specify $V(\mathbf{s}_T) = g(\mathbf{s}_T)$, where $g(\cdot)$ is a function of the state space at T, with parameters that are estimated jointly with the other parameters of the model.

The model is solved by backwards recursion beginning at the terminal period T for a random subset of the state space. Following Keane and Wolpin (1994), a flexible regression function fitting the value function to the period t state variables is estimated. The estimated regression function is used to approximate the value function for points in the state space for which the value function was not computed. The only variables that are unobserved by the econometrician at t are the ϵ_t's. The assumption that the ϵ_t's are additively separable and independent and identically Extreme Value distributed yields a closed form solution of the expected maximum over all possible alternatives in period $t+1$. Thus,

$$\begin{aligned} V^i(\mathbf{s}_{t+1}) &= \mathrm{E}_t \Big[\max V^i_{jvk}(\mathbf{s}_{t+1}, \epsilon^i_{t+1}), \quad \forall j, v, k \Big] \\ &= \gamma + \ln(\sum_{j=1}^{J(\mathbf{s}_{t+1})} \sum_{v=0}^{K} \sum_{k=0}^{K} \exp \overline{V}^i_{jvk}(\mathbf{s}_{t+1})) \end{aligned} \tag{5}$$

where γ denotes Euler's constant, $J(\mathbf{s}_t)$ indicates the number of employment alternatives (which is a function of the employment state entering the period), and $\overline{V}^i_{jvk}(\mathbf{s}_t) = V^i_{jvk}(\mathbf{s}_t, \epsilon_t) - \epsilon^{ijvk}_t$. Multi-dimensional integration over the distribution of ϵ_t is avoided. It also follows from the assumptions about the ϵ's that the choice probabilities have the multinomial logit form

$$\mathrm{p}\ (d^{jvk}_t = 1 \mid \mathbf{s}_t) = \frac{\exp(\overline{V}^i_{jvk}(\mathbf{s}_t))}{\sum_{j'=1}^{J(\mathbf{s}_t)} \sum_{v'=0}^{K} \sum_{k'=0}^{K} \exp(\overline{V}^i_{j',v',k'}(\mathbf{s}_t))} \ \forall t\ . \tag{6}$$

Solving backwards yields the choice probabilities for each point in the state space in each period t. The additional probabilities used to form the likelihood function include the health transition probabilities (π_{t+1}) and the layoff probability (ϕ).

Other recent structural models of retirement do not have as detailed a specification of health insurance and medical expenditure as ours, but in some cases allow for a different set of employment choices. Gustman and Steinmeier (1994) do not allow any sources of risk, and do not model health, medical expenditures, or health insurance choice. They include part-time employment in the choice set but do not model job switching. Berkovec and Stern (1991) do not incorporate Social Security, pensions, or health insurance, but allow a richer employment choice set. Lumsdaine, Stock, and Wise (1994) value health insurance at average cost and do not model medical expenditures, health, or health insurance choice or availability. (They use data from a single firm.) Rust and Phelan (1997) allow for shocks to income, model part-time employment (but not job switching), and treat medical expenditure as the realization of an exogenous stochastic process. They exclude individuals with pensions and disability insurance. Thus, we view the contribution of our work to be that of precisely modeling the actual budget constraint that individuals face with respect to health insurance and medical care consumption.[12]

3 Data

We use data from the first four waves of the Health and Retirement Survey (HRS), fielded at two-year intervals beginning in 1992. The original HRS sample contains individuals aged 51-61 in 1992, and their spouses even if the spouses are outside the specified age range. We use the subsample of age-eligible men. The survey includes an employment history, and extensive sections on pensions, health insurance, Social Security, earnings, assets, nonwage income, and health. Two additional sources of information have been matched to the survey responses. The Social Security earnings records of individuals who agreed to sign release forms were made available by the Social Security Administration. Individuals who reported being covered by a pension or by employer-provided health insurance were asked to provide the names and addresses of the firms that provide

[12]For this reason, we solve the model for every individual in the data set, using the observed values of individual characteristics in each time period.

the coverage. These firms were surveyed by telephone and asked to provide details of health insurance plans over the telephone and to provide written descriptions of their pension plans. These supplementary sources of data provide crucial pieces of information that allow us to construct an accurate approximation to the budget constraint. However, they also limit the sample that we can use because there are many cases in which the supplementary information is unavailable.

Table 1 describes how we obtain the sample we use. Of the 5,867 men surveyed in 1992, 4,552 are age-eligible (51-61 in 1992). We lose about 15 percent of these men as a result of missing information on employment, demographic variables, and health, leaving 3,869 cases. Social Security records are available for 94.8 percent of these 3,869 men. Most of the cases without Social Security records are the result of the absence of a signed release, but some cases may be due to the fact that a man was never employed in a job covered by Social Security. This is difficult to determine so we drop all men without a Social Security record.

Of the men who reported being covered by an employer-provided health insurance plan from a current or former employer of their own or their wife, 68.3 percent have a record on the Health Insurance and Pension Provider Survey (HIPPS). Records are missing if the man did not provide a name and address for the relevant employer or if the employer did not respond to the request for an interview. There is also a substantial amount of missing health insurance information in the HIPPS records: over half are missing at least one piece of information that we need. The HRS interview asked respondents to provide some information about their health insurance, but did not include questions on the key variables we need, so we are forced to drop all cases with missing health insurance data in our effort to account for the financial effects of insurance coverage characteristics.

Of the men who report being covered by a pension from a current or former employer, 62.3 percent can be matched to a written plan description provided by the employer. Over half of these descriptions are missing information that we need. However, the HRS asked respondents to provide a large amount of information about their pensions, and this allowed us to fill in missing data on pensions from former employers and, in some cases, current employers.

The sample we use in estimation consists of 1,167 men who either provide complete information on pension or health insurance coverage or do not have a pension or health insurance. This is not a representative subsample from the HRS. As Table 2 indicates, men without pensions

Table 1: Sample Derivation

Row	Description	Number	Percent
1	Men in the HRS	5867	
2	Age-eligible men	4552	77.6% of row 1
3	With complete data on key HRS variables (referred to as Full Sample)	3869	85.0% of row 2
4	With a Social Security record	3667	94.8% of row 3
5	With employer-provided health insurance at wave 1	2829	73.1% of row 3
6	With a HIPPS health insurance record	1932	68.3% of row 5
7	With complete HIPPS health insurance data	686	35.5% of row 6
8	Covered by a pension at wave 1	2655	68.6% of row 3
9	With a pension provider record	1655	62.3% of row 8
10	With complete data from pension provider or missing information filled in from the HRS	1655	100.0% of row 9
11	Estimation sample	1167	30.1% of row 3

Note: The estimation sample consists of age-eligible men with complete data on key HRS variables, a Social Security record, no employer health insurance or employer health insurance with a complete HIPPS record, no pension coverage or a pension and either complete data from the pension provider or missing information filled in from the HRS.

and without health insurance are over represented. This sample can be used to obtain consistent estimates of the parameters, despite its nonrepresentative nature, if the structural parameters are invariant across observations.

Table 2: Sample Characteristics

Characteristic*	Full Sample	Estimation Sample
Age	55.8	54.8
Education	12.3	11.9
Black	0.15	0.17
Hispanic	0.08	0.09
Married	0.81	0.75
Employer health insurance	0.73	0.44
With retiree coverage	0.79	0.84
Pension	0.69	0.56
Good health	0.79	0.74
Attrited by wave 2	0.09	0.07
Attrited by wave 3	0.24	0.22
Attrited by wave 4	0.29	0.28
Number	3869	1167

* at wave 1 survey unless otherwise noted.

Note: The full sample refers to the age-eligible men with no missing data on key variables in wave 1 and, if a non-attriter, in all subsequent waves of the HRS surveys. Data from all relevant waves are included in the analysis for attriters.

The following subsections describe the key variables.

3.1 Employment Status

We measure employment status at one year intervals. The wave 1 survey provides information on employment status at wave 1, and the job history collected at wave 1 allows us to determine employment status one year prior to the date of the wave 1 interview. The surveys of subsequent waves give us a measure of employment status at that wave, and a monthly record of employment between the interviews provides the information needed to measure employment status at a date one year after the interview of the previous wave. Employment status could be measured at finer intervals than one year, but we miss very few transitions by using one-year intervals (Blau and Gilleskie, 2001a). Table 3 displays the employment distributions in these eight years (1991-1998) for the estimation sample and for the full sample. The employment rate in the estimation sample falls by 14.4 percentage points during this eight year interval as the sample ages from 50-60 years old (in 1991) to 57-67 years old (in 1998). About 58.5 percent of the estimation sample is not employed in at least one of the eight dates observed, 30.6 percent ever change from one job to another, 23.0 percent ever enter employment from nonemployment, and 24.6 percent is employed at the same firm in all eight years. The corresponding figures for the full sample show a little more job stability and less nonemployment.[13]

3.2 Medical Care

The HRS asks respondents to report the number of nights spent in the hospital and the number of times they have seen or talked to a medical doctor about their health, including emergency room or clinic visits, during the 12 months preceding the wave 1 interview and during the interval between the subsequent interviews. Table 4 describes hospital nights and doctor visits of the estimation sample classified into four or five discrete categories. Note that the wave 2, 3, and 4 figures represent utilization over a two year period while the wave 1 numbers reflect one year utilization rates.[14] Over three-fourths of men had at least one doctor visit per year, but about 80% had no hospital nights. The median number of doctor visits among those with any visits increases from 3 to 6 over the four waves and for hospital nights, among cases with at least one stay, the median falls from 6 to 5 among those who do not attrit or die.

[13]The higher new job rates in periods 5 and 7 suggest a seam problem (Rust, 1990).

[14]In solution of the model, we assign half of the observed two-year medical care behavior to each of the corresponding two one-year choice periods (e.g., $t = 2$ and 3 for wave 2 data), and randomly assign the remainder when there is an odd number of visits or nights over the two-year period.

Table 3: Employment Status Distributions

Description	Full Sample: Employed, same job	Full Sample: Employed, new job	Full Sample: Not employed	Estimation Sample: Employed, same job	Estimation Sample: Employed, new job	Estimation Sample: Not employed
t=1 (1 year before wave 1 interview)	71.2	7.0	21.8	62.4	8.0	29.6
t=2 (wave 1 interview date)	72.2	5.8	22.0	64.2	5.3	30.5
t=3 (1 year after wave 1 interview)	68.8	7.3	23.9	62.0	8.7	29.3
t=4 (wave 2 interview date)	66.0	5.9	28.1	60.1	6.8	33.1
t=5 (1 year after wave 2 interview)	55.2	13.6	31.2	49.4	17.4	33.2
t=6 (wave 3 interview date)	57.2	6.2	36.6	56.7	6.3	37.0
t=7 (1 year after wave 3 interview)	49.0	13.1	37.9	44.4	15.6	40.0
t=8 (wave 4 interview date)	51.1	5.7	43.2	49.5	6.5	44.0
Summary:						
Ever not employed	56.2			58.5		
Ever change jobs	26.9			30.6		
Ever enter employment	21.3			23.0		
Same job throughout	27.8			24.7		

Table 4: Medical Care Distributions

Category		Wave 1	Wave 2	Wave 3	Wave 4
Doctor Visits					
0	[0]	27.34	18.06	13.02	13.19
1-2	[2]	33.08	28.06	24.46	19.32
3-5	[4]	19.54	21.11	21.29	22.85
6-12	[8]	13.71	21.39	26.27	29.50
13+	[20]	6.34	11.39	14.95	15.14
Mean		4.38	6.63	7.27	8.78
(sd)		(9.51)	(12.79)	(9.36)	(19.82)
Mean>0		6.04	8.09	8.35	10.11
(sd)		(10.71)	(13.71)	(9.57)	(20.95)
Median>0		3	4	5	6
Hospital Nights					
0	[0]	86.38	79.54	78.82	75.46
1-3	[2]	4.88	6.57	7.59	9.53
4-10	[6]	4.63	7.50	10.19	9.01
11+	[18]	4.11	6.39	3.40	6.01
Mean		1.70	2.71	1.76	2.53
(sd)		(8.63)	(10.58)	(8.78)	(11.12)
Mean>0		12.49	13.22	8.30	10.30
(sd)		(20.33)	(20.22)	(17.64)	(20.62)
Median>0		6	6	5	5
Sample size		1167	1080	883	766

Note: Wave 1 data refer to the 12 months prior to the survey date. Waves 2, 3, and 4 data refer to the period between waves, which is 24 months on average. The numbers in brackets are the values assigned to the indicated categories in solution of the model.

3.3 Health

The HRS has a rich set of health measures, including self-assessed general health and disability, functional limitations, chronic diseases, and many others. Despite this abundance of measures, we take a very simple approach to measuring health in order to focus on the economic aspects of the analysis and to avoid the proliferation of parameters and expansion of the state space that would result from exploiting the richness of the health data.[15] We create a dichotomous measure of health at each wave (t=2, 4, 6, and 8) from responses to the question "Would you say your health is excellent, very good, good, fair, or poor?" by combining excellent, very good, and good (good), and poor and fair (bad). We use responses to the question "Compared with one year ago, would you say that your health is much better now, somewhat better now, about the same, somewhat worse, or much worse than it was then?" to measure health one year before wave 1 ($t = 1$). The analogous question in the survey at subsequent waves asks individuals to compare their current health to their health *two* years ago and therefore cannot be used to construct a health status measure in odd years beyond t=1.[16] The scheme for classifying health at $t = 1$ is shown below. Some arbitrariness is unavoidable since a question on health status one year ago was not asked.

		Current health compared to one year ago			
Current Health	1. Much better	2. Somewhat better	3. Same	4. Somewhat worse	5. Much worse
1. excellent	good	good	good	good	good
2. very good	bad	good	good	good	good
3. good	bad	bad	good	good	good
4. fair	bad	bad	bad	good	good
5. poor	bad	bad	bad	bad	good

The distribution of health and health changes is shown in Table 5. The cross-sectional distributions are quite stable, but there is a substantial amount of movement between states. About 10-15 percent of men in good health fall into bad health by the next year, and 20-25 percent of men in bad health "recover" by the next year. Death rates increase across waves as the sample ages.

[15] See Blau and Gilleskie (2001b) and Bound et al. (1999) for detailed analysis of the effect of health on employment in the HRS.

[16] In estimation of the model, we integrate over all possible health outcomes for years in which health is not observed.

Table 5: Health Distributions and Transitions

Period	Row %	Health Status		
		Good	Bad	Dead
t = 1			t = 2	
Good	73.8	90.1	9.9	0.0
Bad	26.2	25.2	74.8	0.0
t = 2			t = 4	
Good	73.3	90.2	9.5	0.3
Bad	26.7	21.7	76.9	1.4
t = 4			t = 6	
Good	71.7	89.4	9.4	1.2
Bad	28.3	24.9	64.6	10.5
t = 6			t = 8	
Good	74.8	83.2	15.1	1.7
Bad	25.2	19.1	73.2	7.7

Original health variables

Health	Wave 1	Wave 2	Wave 3	Wave 4
excellent	21.5	19.0	16.0	10.3
very good	24.9	24.9	29.4	25.6
good	26.5	28.2	29.6	33.7
fair	14.1	15.9	16.1	19.7
poor	13.1	12.0	9.0	10.7

3.4 Health Insurance

We use the HRS data to classify individuals into one of the seven mutually exclusive and exhaustive health insurance categories shown in Table 6. Cases with multiple sources of insurance are assigned to categories in the order shown in the table. For example, a man with both employer-provided coverage and privately purchased coverage is assigned to employer coverage. Multiple sources of health insurance are not uncommon, but allowing multiple sources of insurance complicates our model considerably.[17] As shown in Table 6, the distribution of health insurance coverage (at wave 1) is skewed away from employer coverage in the estimation sample compared to the full sample. This results from the large number of nonresponses and missing items from HIPPS. Health insurance status in subsequent waves is derived from the survey in an identical manner. Wave 1 insurance status is assigned to period 1, wave 2 insurance status is assigned to period 3, wave 3 to period 5, and wave 4 to period 7. We do not observe health insurance status in periods 2, 4, 6, and 8. As noted above, we assume health insurance in these periods (as well as that in periods beyond the sampling time frame) is the same as the last observed period unless an individual with own-employer coverage but no retiree health benefits chooses to leave employment or an individual under age 65 with Medicare chooses to take a job.

Table 7 displays health insurance transition rates from time $t, t = 1, 3, 5$ to time $t + 2$. Aside from the special cases of Medicare coverage prior to age 65 and Medicaid, men with retiree coverage from their own employer or with coverage from their spouse's employer have the most stable health insurance status, followed by men with own-employer insurance without retiree benefits and private coverage. Over 60 percent of men with no health insurance in one wave gain insurance by the subsequent wave, with the majority obtaining health insurance through an employer.

The HIPPS supplement from employers provides cost-sharing characteristics of health insurance plans such as the premium, deductible, coinsurance rate, maximum out-of-pocket costs, and maximum coverage. We use these characteristics, described in Table 8, in constructing the budget

[17] About eight percent of men assigned EPRHI coverage also have coverage from the spouse's employer; 4.7 percent have Medicare coverage in addition to own-employer coverage; and nine percent have private coverage in addition to own-employer coverage. About four percent of men assigned EPHI also have coverage from the spouse's employer; and 12 percent have private coverage in addition to own-employer coverage. About seven percent of men assigned coverage from a spouse's employer also have coverage from their own employer, 12 percent have Medicare or Medicaid; and 13 percent have private coverage in addition to spouse-employer coverage. Five percent of men assigned to private coverage also have coverage from Medicare or Medicaid.

Table 6: Health Insurance Distribution

	At wave 1		At all waves	
	Full	Estimation	Estimation Sample	
Description	Sample	Sample	age < 65	age ≥ 65
EPRHI	48.7	31.9	33.4	3.4
EPHI	15.8	9.9	12.7	13.5
Spouse	11.4	7.6	8.0	8.4
Private	6.8	14.9	12.0	16.0
None	12.5	24.7	20.9	47.9
Medicaid	2.6	5.6	6.9	10.9
Medicare	2.3	5.4	6.0	-

Note: EPRHI = employer-provided retiree health insurance;
EPHI = employer-provided health insurance.
VA/CHAMPUS cases are classified as having EPRHI.
All males are less than age 65 in Wave 1.

Table 7: Health Insurance Transitions (men less than age 65)

	Health Insurance Status at $t+2$						
	EPRHI	EPHI	Spouse	Private	None	Medicaid	Medicare
at $t = 1, 3, 5$							
EPRHI	74.3	12.0	2.0	3.0	6.5	0.7	1.5
EPHI	24.5	59.3	4.4	3.1	7.8	0.6	0.3
Spouse	6.4	6.4	70.0	5.4	10.3	0.5	1.0
Private	14.8	5.6	4.0	53.5	16.3	1.9	3.7
None	24.6	8.4	6.4	13.3	36.3	6.1	5.0
Medicaid	2.5	0.0	0.0	3.1	7.6	73.0	13.8
Medicare	4.1	0.0	1.3	4.8	4.1	24.7	61.0

constraint. There is substantial variation across plans both in whether a given feature is present and the magnitude.

We observe the characteristics of employer insurance (own and spouse) only for the insurance policy held by the man at the time of the wave 1 HRS interview in 1992. If a man subsequently changes employers or drops coverage from his own employer and picks up coverage from his wife's firm, we do not know the characteristics of the new health insurance plan. Therefore we specify "generic" employer health insurance plans (of each type EPRHI, EPHI, and spouse) with cost-sharing characteristics given by the median characteristics of the observed plans of that type.

Private insurance plans were not included in the HIPPS survey and the characteristics of such plans (except for the premium) were not recorded in the HRS, so we use another data source to construct a set of characteristics of a "generic" private plan, and assign these to all private plans. Medicare characteristics and rules governing the interaction between Medicare and other insurance beginning at age 65 are used. Medicaid coverage requires no cost-sharing by the recipient. The HRS lacks information on the price per doctor visit and hospital night, so we derive these measures from another data source. Additional details on medical care prices and the cost-sharing characteristics of all health insurance plans are provided in Appendix A1.

3.5 Pensions

The HRS collects detailed data on pensions for all jobs that provide pension coverage. This includes information on the type of plan (defined benefit or defined contribution), years included in the plan, the respondent's current contribution rate, the age at which the respondent expects to receive benefits, the expected benefit amount, and various other features. These data provide a rich source of descriptive information, but do not include the actual formula used to determine the benefit as a function of age of exit from the firm, tenure, earnings, and so forth. The formula is needed in order to compute the benefit to which the respondent would be entitled at different ages of exit from the firm. In many cases the written plan descriptions sent to the HRS in response to the request made during the HIPPS telephone interview provide the information needed to construct the formula. Programmers at the Institute for Social Research at the University of Michigan coded the data from the plan descriptions into a computer program that computes the benefit to which

Table 8: Health Insurance Characteristics

Description	% of plans with char non-missing	% of plans char > 0	Conditional on char > 0 Mean	Std Dev	Median
Premium					
Annual employee	0.98	0.48	522	720	335
Annual family	0.94	0.65	1,508	1,500	1,172
Average for employer-provided insurance*	1.00	0.53	868	1,066	480
Average for retiree insurance (EPRHI)*	0.84	0.58	1,094	1,294	552
Deductible					
Annual for all services*	1.00	0.62	291	822	200
Annual for office visits only	1.00	0.04	127	93	100
Copayment					
Flat amount per office visit	1.00	0.36	10	4	10
Percentage per office visit*	1.00	0.32	18	7	20
Flat amount per hospital stay	0.74	0.16	173	191	100
Percentage per hospital stay*	0.25	1.00	19	9	20
Annual amount for hospital stays	0.74	0.05	683	795	400
Maximum Deductible Amount					
Annual out-of-pocket max for office visits*	1.00	0.34	1,572	1,461	1,000
Annual out-of-pocket max for hospital stays*	0.99	0.34	1,652	1,389	1,200
Out-of-pocket max per hospital stay	1.00	0.02	666	586	413
Maximum Coverage Amount					
Annual maximum coverage limit*	0.65	0.99	67,450	129,920	50,000
Lifetime maximum coverage limit	0.64	0.95	1,011,603	507,093	1,000,000

Note: The sample consists of all cases with own or spouse employer health insurance, except where noted otherwise. Cases with VA/CHAMPUS coverage are not included in the descriptive statistics, but these cases are included in the analysis and are assigned the characteristics of VA/CHAMPUS coverage. ∗ indicates the characteristics used in generic plans when specific characteristics are not available (with the level set to the median).

the individual is entitled for specified quit dates from the firm providing the pension. We used this program together with the HRS survey responses to compute the benefit from the pension on the job held at period $t = 1$ (if any) for each possible quit date from 1991 until the respondent reaches age 70, treating job tenure at $t = 1$ as given.[18] For pensions provided by previous employers we used the program to compute the benefit to which the individual would be entitled at the earliest age at which he is eligible for a benefit under the plan. We have information on up to three pension plans from the period 1 job and three pensions from previous employers.

The HIPPS survey covers wave 1 employers and previous employers but does not include any new employers after wave 1. If a man took a job that provides pension coverage after wave 1 we have information from the wave 2, 3, and 4 survey about characteristics of the pension but no information on the benefit formula, since the new employer was not included in the HIPPS survey. Thus, we ignore pensions on jobs that begin after period $t = 1$. Additional information is provided in Appendix A2.

Table 9 summarizes two key characteristics of pensions: the earliest age at which benefits can be collected and the benefit amount for alternative quit dates. The youngest age at which benefits can be collected is 57 on average, and the average return to postponing exit from the firm by one year is 2.6 percent in the first five years.

3.6 Earnings

As noted above, we treat earnings as deterministic because of the added computational complexity of modeling earnings uncertainty. Aside from the risk of layoff, which we do model, we view earnings fluctuations as a relatively minor source of risk at older ages, compared to health risk. Consequently, the main issue for modeling earnings is how to obtain good forecasts to include in the model as a measure of individuals' expectations about their future earnings. We compared forecasts from earnings data derived from the HRS survey to forecasts derived from the Social Security Earnings Records (SSER). The HRS records annual earnings from jobs held each wave and up to two previous jobs, while the SSER file contains (truncated) annual earnings for every year in which an individual was employed on a covered job from 1951 through 1991. The earnings

[18]We are grateful to Dan Hill and Jody Lamkin at ISR for their help with the program, and to Charlie Brown for advice on how to use it.

Table 9: Pension Characteristics

Description	Mean	Std Dev
<u>$t = 1$ Job</u>		
Youngest age at which benefits could be collected	57.0	3.8
Annual Benefit (if benefit>0 and age<71)		
if exit job in 1991	11,880	12,382
if exit job in 1996	13,517	14,722
if exit job in 2001	16,567	17,233
if exit job in 2006	20,556	20,755
if exit job in 2011	21,711	19,056
<u>Previous Jobs</u>		
Youngest age at which benefits could be collected	56.3	8.4
Annual Benefit (if benefit > 0)	11,761	13,200

regressions based on the SSER data have a much better fit. We set aside the last four years of data from the SSER, ran log earnings regressions using the earlier years, and used the regressions to forecast earnings for the last four years. We tried many different specifications and found that a first-order autoregression provided decent forecasts and additional lags of earnings reduced the median absolute forecast error by only a small amount. Therefore, for individuals who remain on their t=1 job, we use earnings in 1991 from the SSER file as our wage forecast for subsequent years. (Note: all dollar values in the model are expressed in 1992 dollars.) For individuals who become employed anytime after leaving their t=1 jobs, or who were not employed at t=1, we predict wages using a regression function fit to the most recent SSER earnings, an indicator for a current period job change, and current period health.

We also used the SSER file to compute a measure of each man's total years of work experience through 1991.[19] We use this file instead of the HRS survey responses to construct the experience measure because the HRS does not contain a compete work history from which total experience

[19]Work experience up to period $t = 1$ is treated as an initial condition in the model.

can be reconstructed, and the experience variable is used in the model only for constructing Social Security benefits. Mean experience through 1990 is 31.0 years with a standard deviation of 8.7.

3.7 Social Security Benefits

We use the SSER earnings history from 1951 through 1990 to construct each individual's Average Indexed Monthly Earnings (AIME) and Primary Insurance Amount (PIA) as of 1990, using the formula in effect for 1990. The PIA is the basis for computing the Social Security Benefit (SSB), and is a nonlinear, highly progressive function of the AIME, which is a deflated average of earnings from age 21 to the current age, minus the lowest five years of earnings. We then use the earnings measure described above to compute the AIME and PIA for each of the possible total number of years of experience the individual could accumulate from 1991 through age 70. A man who is aged 50 in 1991 could accumulate up to 21 additional years of experience if he worked every year from 1991 until the age of 70, so we compute 21 PIAs for such a man. We use these to compute the SSB for which a man would be eligible upon exiting the labor force for each possible number of years of experience from his age in 1991 through age 70. These benefit measures are based on the exact formulas used by the Social Security Administration (which differ by cohort as the 1983 Social Security reforms are phased in), accounting for reduced benefits for early retirement and increased benefits for delayed retirement. We do not model the decision to apply for Social Security benefits. Instead, we assume that every individual who leaves the labor force after age 61 receives Social Security benefits. Rust and Phelan (1997) model the entitlement decision of individuals eligible for Social Security. Because our focus is on health insurance, we do not complicate the model further by modeling this decision.

If a man exits the labor force, begins receiving a SSB, and then re-enters employment, his SSB when he exits employment the second time will be different from his first benefit because his PIA will be recomputed to give him credit for additional earnings, and any early retirement penalty he may have suffered will be modified. In order to use the exact formulas governing these recomputations it would be necessary to keep track of the actual sequence of employment choices from ages 62 through 70 rather than simply the cumulative number of periods of employment. This would increase the size of the state space substantially, so we use an approximation described in Appendix A3.

Finally, we compute benefits conditional on employment as well as nonemployment, applying the Social Security earnings test to determine the benefit entitlement conditional on being employed. This test, which is also cohort-specific, results in zero benefits for most men, but some low-earnings men have a positive benefit while employed.

Table 10 shows the average PIA as of 1990, as well as for various additional accumulated years of experience. To provide some sense of what these figures mean in terms of benefits, note that for the older cohorts in the sample a man who first begins collecting benefits at age 65 is entitled to a monthly benefit equal to the PIA; a man who begins collecting benefits at the earliest possible age (62) is entitled to a benefit equal to 80 percent of the PIA; and a man who postpones collecting benefits until age 70 is entitled to a benefit equal to 125 percent of the PIA.

Table 10: Social Security Monthly Primary Insurance Amount
for Alternative Years of Work Experience Since 1990

Description	Mean	Std Dev
PIA as of 1990	705	284
PIA after 5 additional years of work	742	292
PIA after 10 additional years of work	773	298
PIA after 15 additional years of work	809	308
PIA after 20 additional years of work	826	338

Note: The sample in each row includes only those men who are age 70 or younger after the indicated number of additional years of experience.

3.8 Other Nonwage Income

Other sources of nonwage income include the earnings of the wife, asset income, and income from earnings-tested or means-tested government programs such as SSDI, Supplemental Security Income (SSI), or unemployment insurance. We summed all of these sources to create a single measure of other nonwage income, which we regressed on polynomials in age and education. We used fitted values from these regressions as measures of other nonwage income for periods in which the data are not available. The regression results are in Appendix A3.

3.9 Taxes

We use the 1992 Federal income tax and payroll tax schedules to compute measures of after-tax income. The computations account for taxation of Social Security benefits, the medical expense deduction, and marriage.

3.10 Likelihood Function

The probability that an individual chooses alternative j, v, and k conditional on the state vector is p ($d_t^{jvk} = 1 \mid \mathbf{s}_t$). As defined in section 2.4, ϕ is the probability of being laid off and f_t indicates whether or not an individual is observed to be laid off at the beginning of period t. Let $\Phi_t = (1-\phi)^{1-f_t}\phi^{f_t}$. The probability of a health transition from health state i in period t to health state a in period $t+1$ is denoted π_t^{ia}.

We observe the employment decisions and layoff indicators of individuals in every period. We observe annual medical care consumption (number of doctor visits and hospital nights) of individuals in period 1, but only observe the two-year sum of these choices in subsequent waves of the data. Because we randomly distribute the reported two-year sum of each type of care over the relevant one-year periods, medical care utilization is observed in every period except the last year individuals are in the sample. The health state of individuals is known for periods 1, 2, 4, 6, and 8. We integrate over all possible health states if alive in odd numbered periods after period 1 (see line 3 of Equation 7 below). If an individual dies, the period of death is observed. These death dates help to identify the health transition probabilities. Health insurance is observed in odd periods only. It is assumed that health insurance does not change in periods in which it is unobserved except in particular cases when employment or marital status changes (i.e., individuals cannot keep employer-provided insurance that does not provide retiree benefits if they leave their job, nor can they retain a spouse's employer-provided insurance if they are no longer married). Finally, the likelihood contribution of those who attrit (for reasons other than death) is truncated at their last observed period, T_n. The likelihood function contribution for individual n is

$$
\begin{aligned}
\mathcal{L}_n(\mathbf{\Theta}) \quad = \\
& \left[\prod_{j=1}^{J(s_1)}\prod_{v=0}^{K}\prod_{k=0}^{K}\left[\mathrm{p}(d_1^{jvk}=1\,|s_1)\pi_1^{ia}\right]^{d_1^{jvk}}\right]^{1(h_1=i,h_2=a)} \\
& \cdot \prod_{t=2}^{T_n-2}\left\{\prod_{j=1}^{J(s_t)}\prod_{v=0}^{K}\prod_{k=0}^{K}\left[\Phi_t\mathrm{p}(d_t^{jvk}=1\,|s_t)\right.\right. \\
& \cdot \left[\sum_{a'=0}^{1}\left(\pi_t^{aa'}\left[\prod_{j'=1}^{J(s_{t+1})}\prod_{v'=0}^{K}\prod_{k'=0}^{K}\left[\Phi_{t+1}\mathrm{p}(d_{t+1}^{j'v'k'}=1\,|s_{t+1})\pi_{t+1}^{a'a''}\right]^{d_3^{j'v'k'}}\right]^{1(h_{t+2}=a'')}\right)\right]^{1(h_{t+1}\neq 2)} \\
& \cdot \left.\left.\left[\pi_t^{a2}\right]^{1(h_{t+1}=2)}\right]^{d_t^{jvk}}\right\} \\
& \cdot \left[\prod_{j=1}^{J(s_{T_n})}\sum_{v=0}^{K}\sum_{k=0}^{K}\left[\Phi_{T_n}\mathrm{p}(d_{T_n}^{jvk}=1\,|s_{T_n})\right]^{d_{T_n}^{jvk}}\right]^{1(h_{T_n}=i)} \qquad (7)
\end{aligned}
$$

where line 1 of Equation 7 is the likelihood of the first period employment and medical care decisions and the subsequent observed health transition. Lines 2, 3, and 4 summarize behavior prior to 1997 in two year intervals. Here, health is observed in the latter year, but is not observed (unless the individual dies), and is therefore integrated out, in the first of these two years. The last line of the likelihood function includes the probability of the last observed employment choice and integrates over the distribution of medical care choices since they are not observed. Health transitions from the last observed period are not observed and not modeled. The likelihood for the entire sample is

$$
\mathcal{L}(\mathbf{\Theta}) = \prod_{n=1}^{N}\mathcal{L}_n(\mathbf{\Theta})\,.
$$

4 Estimation Results

4.1 Parameter Estimates

Table 11 displays the parameter estimates and standard errors. Full interpretation of the structural parameters requires solution of the model, but some discussion of these parameters does provide a better understanding of the model's features. The coefficient of relative risk aversion $(1-\alpha_{1,ie})$ is allowed to differ by health and employment status. The estimated values are between 0.928 and 0.976, indicating that individuals are averse to risk. These values are similar to Rust and Phelan's (1997) estimate of 1.072 and Hurd's (1989) estimates of 0.73 and 1.12. The estimates indicate that the marginal utility of an additional unit of consumption is higher when not working than when working (unconditional on health). These coefficients also suggest that the marginal utility of consumption is higher in good health (as opposed to bad health) when working, but higher for those in bad health (vs. good health) when not working. Gilleskie (1998) also found the marginal utility of consumption to be smaller during episodes of acute illness than in periods of wellness among working men. Rust and Phelan (1997), on the other hand, found the marginal utility of consumption to be greater in poorer health (unconditional on employment status) in their model of retirement behavior.

In order to identify preferences, we normalized the utility intercept associated with good health and not working ($\alpha_{0,ie}$).[20] Working while well, unconditional on the employment transition, provides lower utility. In general, poor health reduces utility regardless of employment status. However, working provides higher utility than not working when in poor health. The utility of working declines with age at an increasing rate ($\alpha_{13,ie}$ and $\alpha_{14,ie}$). The rate of decline is slower for those in bad health relative to those in good health. Non-employment at younger ages (early 50s) creates disutility regardless of health, but working becomes relatively less attractive as one ages (and at a much faster rate if in good health).

Utility also depends on the employment transition, and therefore is not completely captured by these intercepts and age effects. Leaving employment for non-employment reduces utility ($\alpha_{2,ie}$), but the disutility of this choice is smaller if laid off from the previous job ($\alpha_{3,ie}$). Non-employment after being laid off, however, is relatively more attractive when in good health than when in bad health. Conditional on being employed previously, changing jobs reduces utility and the reduction is larger for those in good health compared to those in bad health ($\alpha_{4,ie}$), while staying with the same job provides additional utility ($\alpha_{5,ie}$). Entering employment from non-employment also involves costs ($\alpha_{6,ie}$), which are higher in bad health.

[20] We chose a positive number for normalization simply because bad health and working should theoretically reduce utility, and a positive normalization could potentially keep per-period utility positive. This is, of course, not necessary, but seemed to simplify interpretation when estimation initially began.

Table 11: Estimation Results

Description			Parameter	Estimate	Std. Error
Utility Function Parameters					
Utility Constants					
good health	not working[a]		$\alpha_{0,00}$	25.000	-
bad health	not working		$\alpha_{0,10}$	18.320	0.1623
good health	working		$\alpha_{0,01}$	22.178	0.1777
bad health	working		$\alpha_{0,11}$	24.143	0.1420
Consumption					
good health	not working		$\alpha_{1,00}$	0.028	0.0001
bad health	not working		$\alpha_{1,10}$	0.023	0.0001
good health	working		$\alpha_{1,01}$	0.070	0.0004
bad health	working		$\alpha_{1,11}$	0.070	0.0005
Employment Transitions					
good health	employed	to non-employed	$\alpha_{2,00}$	-0.510	0.0030
good health	employed & laidoff	to non-employed	$\alpha_{3,00}$	0.651	0.0042
good health	employed	to new job	$\alpha_{4,01}$	-0.762	0.0055
good health	employed	to same job	$\alpha_{5,01}$	1.592	0.0114
good health	non-employed	to new job	$\alpha_{6,01}$	-0.056	0.0004
bad health	employed	to non-employed	$\alpha_{2,10}$	-1.524	0.0140
bad health	employed & laidoff	to non-employed	$\alpha_{3,10}$	1.378	0.0098
bad health	employed	to new job	$\alpha_{4,11}$	-1.614	0.0123
bad health	employed	to same job	$\alpha_{5,11}$	0.863	0.0073
bad health	non-employed	to new job	$\alpha_{6,11}$	-0.133	0.0007
Medical Care Use					
good health	visits		$\alpha_{7,0e}$	0.072	0.0005
good health	visits^2		$\alpha_{8,0e}$	-0.019	0.0001
good health	visits*age		$\alpha_{9,0e}$	0.0008	0.0001
bad health	visits		$\alpha_{7,1e}$	0.136	0.0009
bad health	visits^2		$\alpha_{8,1e}$	-0.007	0.0001
bad health	visits*age		$\alpha_{9,1e}$	0.0025	0.0002
good health	nights		$\alpha_{10,0e}$	0.011	0.0001
good health	nights^2		$\alpha_{11,0e}$	-0.220	0.0005
good health	nights*age		$\alpha_{12,0e}$	0.0007	0.0001
bad health	nights		$\alpha_{10,1e}$	0.024	0.0002
bad health	nights^2		$\alpha_{11,1e}$	-0.012	0.0001
bad health	nights*age		$\alpha_{12,1e}$	0.0001	0.0001

a: Parameter $\alpha_{0,00}$ fixed.

Table 11: Estimation Results — continued

Description			Parameter	Estimate	Std. Error
Utility Function Parameters - continued					
Demographic Preference Shifters					
Age	good health	not working	$\alpha_{13,00}$	-2.648	0.0007
Age^2/100	good health	not working	$\alpha_{14,00}$	0.727	0.0031
Age	good health	working	$\alpha_{13,01}$	-1.812	0.0013
Age^2/100	good health	working	$\alpha_{14,01}$	-0.122	0.0008
Age	bad health	not working	$\alpha_{13,10}$	-2.231	0.0014
Age^2/100	bad health	not working	$\alpha_{14,10}$	0.004	0.0001
Age	bad health	working	$\alpha_{13,11}$	-1.902	0.0022
Age^2/100	bad health	working	$\alpha_{14,11}$	-0.048	0.0004
Utility of negative consumption			$\alpha_{15,ie}$	-70.930	0.1777
Final Period Value Function Parameters					
Exponential constant		good health	ν_{0e}	10.801	0.0723
Exponential constant		bad health	ν_{1e}	5.470	0.0452
Health Transition Parameters					
Transitions from good to good health					
Constant			$\gamma_{0,00}$	9.318	0.0475
Coeff on age			$\gamma_{1,00}$	-0.093	0.0007
Transitions from good to bad health					
Constant			$\gamma_{0,01}$	7.534	0.0516
Coeff on age			$\gamma_{1,01}$	-0.101	0.0007
Transitions from bad to good health					
Constant			$\gamma_{0,10}$	19.506	0.0760
Coeff on age			$\gamma_{1,10}$	-0.334	0.0014
Transitions from bad to bad health					
Constant			$\gamma_{0,11}$	7.959	0.0452
Coeff on age			$\gamma_{1,11}$	-0.097	0.0005
Other Probability Parameters[b]					
Layoff constant			ϕ	-3.476	-
$\ln\mathcal{L}(\mathbf{\Theta})$ = -22331.134					

b: Parameters fixed.

Conditional on age, the utility of doctor visits is positive but decreases with each additional visit. Visits are more utility enhancing (or less utility decreasing) for individuals in bad health versus those in good health ($\alpha_{7,ie}$ and $\alpha_{8,ie}$). Hospital stays reduce utility for individuals in good health, and increase utility at low levels of utilization for those in bad health ($\alpha_{10,ie}$ and $\alpha_{11,ie}$). As individuals age, the utility of medical care consumption increases.[21]

The utility of non-positive consumption is negative and large ($\alpha_{15,ie}$) and always less than the utility of positive consumption regardless of employment or medical care choices. The estimates of the final period value function are also displayed in Table 11. The value of future utility is higher if the individual reaches age 70 in good health rather than bad health.

The estimated health transitions reflect very accurately the health transitions observed in the data (not shown). Individuals in good health can expect to stay in good health with only a slight increase in the probability of death between ages 50 and 69. However, the probability of one's health improving once in bad health falls dramatically as one ages, with the probability of death increasing by 15 percentage points between ages 50 and 69. The age-69, one-year transition rates from good health and bad health to death, respectively, are 3% and 17%.

4.2 Model Fit

Simulated choice probabilities derived from solution of the model are compared to the data in Tables 12-14. The model provides a good fit to the employment distribution in general (Table 12). Conditional on previous employment status, the model accurately predicts most transitions, but tends to under-predict transitions to non-employment from employment (i.e., retiring). The estimated model captures the main features of the distribution of office visits, with some tendency to over-predict the two highest categories (Table 13). The probability of any hospital nights during the year is over-predicted. These patterns also appear when the predictions are disaggregated by health status. We allow health insurance to affect employment decisions via the budget constraint only where out-of-pocket medical expenses are determined endogenously by medical care utilization

[21]Note that the benefits and costs of medical care consumption operate through contemporaneous utility and the budget constraint only. The model does not allow for dynamic effects of medical care, such as a reduction in the probability of a negative health outcome. The productive role of medical care is difficult to ascertain at this level of aggregation in both the measurement and timing of health and medical care utilization (Gilleskie and Harrison, 1998).

decisions. Over-predicting hospital nights, which are more costly than doctor visits, exaggerates medical expenses and hence suggests that our estimates of the effect of health insurance are biased upward.

Table 12: Observed and Predicted Employment Behavior

Behavior	Observed	Predicted
Unconditional on Previous Employment		
Not employed	33.80	26.12
Employed in new job	8.97	10.90
Employed in same job	57.23	62.96
Conditional on Being Employed		
Not employed	8.45	5.65
Employed in new job	8.26	10.65
Employed in same job	83.28	83.69
Conditional on Being Non-Employed		
Not employed	89.48	88.34
Employed in new job	10.52	11.66
Ever non-employed	58.54	46.64
Ever changed jobs	30.62	44.84
Ever enter employment	23.04	21.75
Always on same job	24.66	18.95

Table 14 demonstrates that the model captures employment behavior by health insurance status quite well in general. The predicted employment choices reflect the fact that there is greater attachment to a job if the individual holds EPHI only rather than also having access to retiree health insurance (EPRHI). Similarly, a man is more likely to leave an employer if he is covered by his spouse's employer or private health insurance than if he has EPHI. Despite the fact that *availability* of public health insurance prior to age 65 is not modeled, the model does a good job of capturing the non-employment choices of individuals with public health insurance. We impose the

Table 13: Observed and Predicted Medical Care Utilization

Visits	Observed	Predicted	Nights	Observed	Predicted
Unconditional on Health Status					
0	22.20	23.33	0	81.35	63.46
1-2	36.78	24.99	1-3	10.72	29.27
3-5	22.68	26.28	4-10	5.27	6.62
6-12	13.44	19.52	11+	2.66	0.65
13+	4.90	5.88			
Conditional on Good Health					
0	25.82	27.32	0	87.09	72.42
1-2	40.68	28.81	1-3	8.44	27.34
3-5	20.73	28.75	4-10	2.97	0.06
6-12	9.80	14.99	11+	1.50	0.19
13+	2.97	0.13			
Conditional on Bad Health					
0	16.17	14.13	0	67.96	42.85
1-2	22.55	16.19	1-3	13.37	33.73
3-5	25.75	20.58	4-10	12.08	21.72
6-12	24.25	29.97	11+	6.59	1.70
13+	11.28	19.12			

constraint that individuals cannot be employed and covered by Medicare while under age 65. We do not model, however, the income and asset restrictions for eligibility for Medicaid and hence, over-predict employment while covered by Medicaid. The model's ability to capture the employment patterns by health insurance suggests that the influence of health insurance through other avenues such as preferences or health transitions is minimal.[22]

Table 14: Employment Choices by Health Insurance Status, Age < 65

Health Insurance	Observed Employment Choice			Predicted Employment Choice		
	Non empl	New job	Same job	Non empl	New job	Same job
EPRHI	21.43	5.80	72.76	17.21	8.22	72.54
EPHI	8.35	10.44	83.30	3.23	8.21	86.78
Spouse	32.66	10.44	56.90	29.59	8.42	61.31
Private	24.61	22.82	52.57	20.22	9.37	67.59
None	27.71	23.21	49.09	22.79	10.53	62.31
Medicaid	89.45	3.12	7.42	59.94	8.74	30.98
Medicare	91.80	4.51	3.69	87.36	7.96	6.19

Note: EPRHI = employer-provided retiree health insurance;
EPHI = employer-provided health insurance.

Further evidence of the model's fit is provided graphically in Figure 1 which displays the predicted and actual employment choices of individuals at the observed ages in the sample (ages 50-67). Prior to age 62, employment is over-predicted slightly. However, the model captures the large increase in the non-employment rate at age 62 (an observed 7.3 percentage point increase vs. a predicted 10.5 percentage point increase). Similarly, a second large exodus from employment occurs at age 65 (an observed 7.6 percentage point increase) and this is captured by the model (10.8

[22]In our work that models the joint retirement behavior of couples, we are similarly able to explain the differences in employment patterns of men with and without RHI by aversion to medical expenditure risk. However, this explanation accounts for only one-third of these differences among women (Blau and Gilleskie, 2003).

percentage points). This behavior is consistent with eligibility for Social Security early retirement benefits at age 62 and normal retirement benefits at age 65. (Note that the sample size after age 65 is quite small.)

Figure 2 presents predicted non-employment rates disaggregated by age and health insurance.[23] Among those men receiving health insurance from their employers, those without retiree health insurance (EPHI) have a greater attachment to employment than those with this benefit (EPRHI). Notice the larger increase in non-employment between ages 61 and 62 among those with retiree health insurance (a 7.3 percentage point increase) vs. those without it (a 1.5 percentage point increase). In fact, the trend toward increasing non-employment probabilities begins as early as age 56 for those covered by retiree health insurance. Although not displayed in the figure, the non-employment probabilities of those with EPRHI is similar to that of males with private health insurance coverage. In the next section, we determine how much of this observed difference is explained by health insurance status.

4.3 Alternative Policy Scenarios

Having estimated the structural parameters of our model we are able to simulate behavioral responses to changes in policy variables of interest. Choice probabilities computed from solution to the model determine the random assignment of period 1 employment and medical care use, conditional on an individual's initial observed state. The health transition and layoff probabilities define his random health and employment state entering the subsequent period. The state space is updated to reflect the simulated choice, health, and layoff status. We simulate behavior for each individual from his period $t = 1$ age (ranging from 50-60 in the sample) to age 70 under different policy scenarios. The alternative scenarios we consider include adding retiree health insurance to all employer plans, eliminating retiree health insurance from employer plans, providing universal health insurance that is not tied to employment, and changing the age of Social Security and Medicare eligibility.

[23]Although the observed choice probabilities are subject to small sample variation when behavior is disaggregated by age and health insurance (and hence not displayed), the model's predicted behavior exhibits the features generally observed in the data.

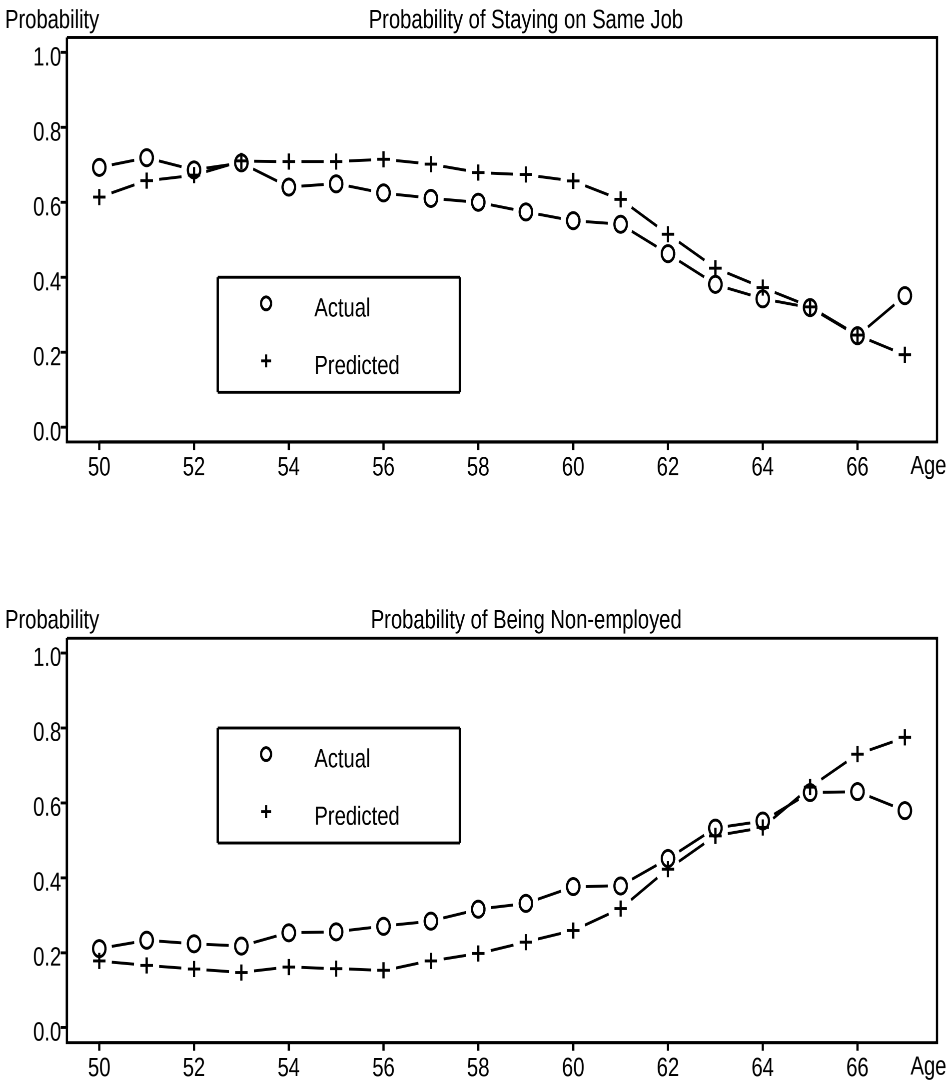

Figure 1: Employment Choice Probabilities by Age

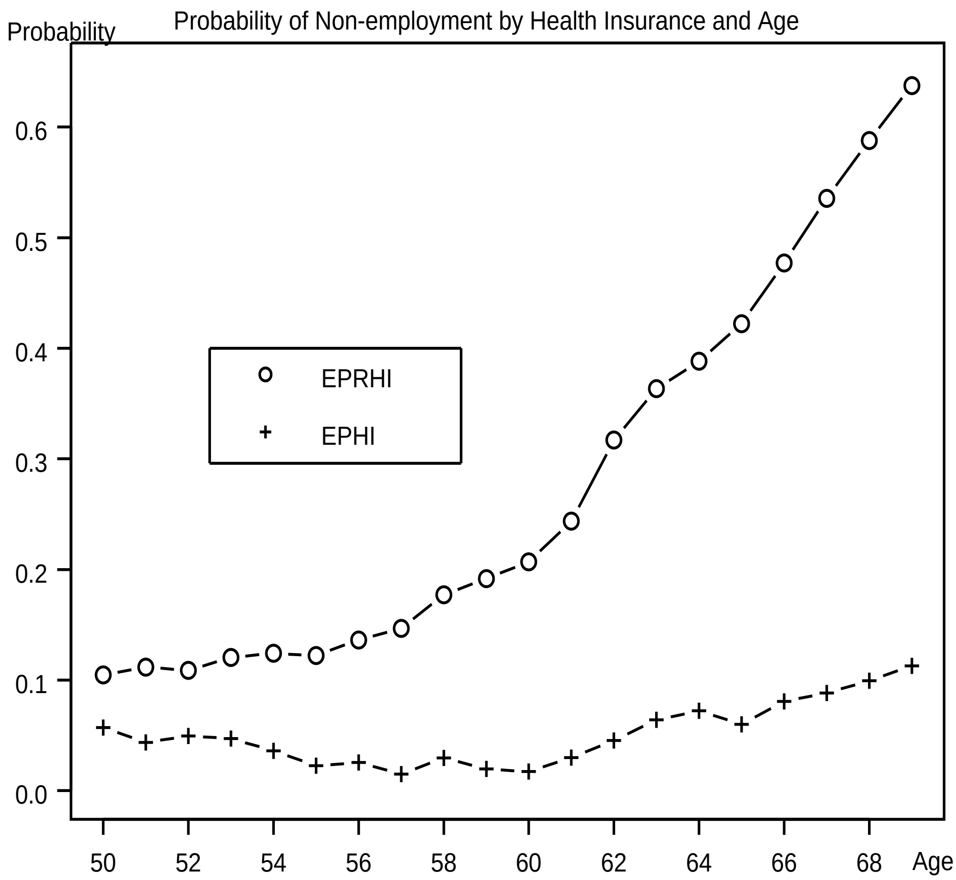

Figure 2: Employment Choice Probabilities by Age and Health Insurance

Table 15: Simulated Employment Choice Probabilities

Group	Baseline		Sim 1: Add RHI to employer plans		Sim 2: Eliminate RHI from employer plans		Sim 3: No health insurance before age 65		Sim 4: Universal insurance before age 65	
	Non empl	Same job	Non empl	Same job	Non empl	Same job	Non empl	Same job	Non empl	Same job
All	0.375	0.539	0.378	0.536	0.363	0.550	0.346	0.560	0.385	0.534
Employed at $t-1$	0.068	0.830	0.070	0.829	0.067	0.830	0.069	0.827	0.067	0.832
EPRHI	0.311	0.608	0.304	0.614	0.233	0.677	0.292	0.621	0.303	0.615
EPHI	0.049	0.856	0.134	0.778	0.053	0.852	0.131	0.779	0.119	0.791
EPRHI, employed at $t-1$	0.062	0.842	0.061	0.842	0.052	0.849	0.063	0.840	0.060	0.843
EPHI, employed at $t-1$	0.042	0.864	0.054	0.855	0.042	0.865	0.054	0.853	0.052	0.856

Table 15 displays the baseline probabilities of being non-employed and of staying on the same job for all males as well as by health insurance status and previous employment. The non-employment rate averages 0.375 among men aged 50 to 70. Conditional on being employed in the previous period, this rate falls to 0.068. Unconditional on previous employment, men with EPRHI are six times more likely to be non-employed than men with EPHI only. Conditional on being employed in the previous period, men with EPRHI are 50% more likely to be non-employed (0.062 vs. 0.042) on average.

In order to determine how much of the difference in observed behavior is explained by retiree health insurance, we simulate behavior when RHI is added to all employer health insurance plans (sim 1) and when RHI is eliminated from all employer plans (sim 2). Overall we see a very slight increase in non-employment rates when all employer health insurance plans offer retiree health insurance, and a similar decrease when it is eliminated. However, when compared to their baseline health insurance status, men who gain RHI almost triple their non-employment rate (0.049 to 0.134) and men who lose RHI reduce their rate by almost a quarter (0.304 to 0.233).[24] These employment effects appear large, but are driven by the effect of previous non-employment on current non-employment rates. That is, once an individual stops working, he is likely to remain in that state. Among those who were employed in the previous period, the annual exit rate from employment increases by about one percentage point for men who gain EPRHI, and the exit rate declines by one percentage point for men who lose EPRHI. Hence, the employment effects of retiree health insurance appear to be small.

In order to further understand how aversion to medical care expenditure risk explains employment decisions, we consider a scenario where no one has health insurance prior to age 65 (sim 3) and one where universal health insurance is provided (sim 4). The universal plan has generous cost-sharing characteristics (i.e., a $100 deductible, a 20% coinsurance rate, a $1000 maximum deductible amount, and a $200 premium). Overall there is a four percentage point difference in the non-employment rates with no health insurance and universal health insurance (0.346 vs. 0.385).

[24]Note that in simulation of the model beyond ages observed in the data, health insurance is assumed to be whatever was last observed in the data, and is consistent with the current employment choice. That is, if an individual was last observed to have EPHI, then he is assumed to take a job with EPHI if he ever re-enters employment beyond ages observed in the sample. An individual who is observed to have EPHI at some point in the data and who subsequently is observed to leave his employer and lose his health insurance (i.e., become uninsured) would be uninsured if he re-enters employment beyond the observed ages.

However, conditional on baseline health insurance status, the simulated behavior reveals very little change under these two scenarios. This simulation suggests that health insurance does affect employment decisions of older men, but the modest impact of these drastic simulated changes indicates that the effect is small.

Other policy scenarios that we simulated (but do not include in the table) included raising the age of Medicare and Social Security eligibility to 67, both separately and together. Increasing the age of SS eligibility led to significant reductions in the non-employment rate. However, raising the age of Medicare eligibility only, which should shed more light on the importance of health insurance in explaining the employment patterns of the elderly, produced little change in employment behavior.

The estimated effects of EPRHI that we find here are smaller than the effects reported in our earlier paper (Blau and Gilleskie, 2001a). That paper estimated an approximation to the structural model that did not allow us to identify the source of the EPRHI effect. Here, we restrict EPRHI to affect behavior only through aversion to medical expenditure risk. The smaller effects that we find here suggest that EPRHI may affect behavior through other mechanisms not included in our structural model. For example, health insurance could affect health through its impact on medical care consumption. This is an important issue to pursue in future work.

5 Conclusion

Simulations from our estimated model imply that changes in health insurance, including access and restrictions to retiree health insurance, have only a modest impact on the employment behavior of older males. The effects we find are small, and are smaller than those found by Rust and Phelan (1997). Several factors may account for this difference: we have more recent data, we have information on pensions which allow for a more representative sample, and we model medical expenditure choices.

Our model confirms a role for health insurance, but restricts the avenue through which health insurance affects behavior to the budget constraint and aversion to risk. Although we have not explored whether health insurance operates through any other mechanism, we are able to explain differences in employment behavior by health insurance through aversion to health risk and medical expenditure.

Our results are based on the assumption that health insurance coverage is exogenous except when one's employment decision results in loss of insurance. We suspect that relaxation of this assumption is likely to reduce the impact of health insurance on employment decisions. A richer model that accounts for health insurance availability and choice is an important avenue for future research.

Appendix A1: Health Insurance

Data from Health Insurance Providers

Names and addresses of 4,487 establishments with health insurance plans covering an HRS respondent were obtained from the respondents in the wave 1 survey. Of these, 3,350 responded to the HIPPS telephone survey, yielding a file with observations on 6,505 plans (spouses covered by the same plan each have their own record with identical data). Some 430 individuals are covered by more than one plan from a given employer. However, the survey does not provide any information on interactions between the plans. We decided to ignore multiple plans and use the "best" plan available for a given individual, where best is defined by the most generous coverage. If an employer had multiple health insurance plans and the HRS respondent did not provide enough information to identify which of the plans covered him, interviewers requested information on the plan used by most employees at the firm. The HIPPS file includes data only on those plans that appear to match a plan reported by an HRS respondent. Information about "cafeteria" plans was not elicited. Information was collected on age and tenure requirements that an employee must satisfy in order to be eligible for retiree coverage, but these data have not been coded.

Generic Health Insurance Plan Characteristics

If a man is ever observed to have a health insurance plan from an employer other than the HIPPS job or a type of health insurance different from the HIPPS job, then we assign him the characteristics of a generic plan of the type chosen. Because most individuals in our sample who have a complete HIPPS record have a deductible that applies to all services (see Table 8), we specify a deductible of this type for the generic plan and set it equal to the median deductible observed in the HIPPS data ($200). Similarly, the generic coinsurance rate is set to 20%, the maximum deductible amount for office visits is $1000, the maximum deductible amount (per year) for hospital stays is $1200, and the maximum annual coverage is $50,000. The average annual premium for plans without retiree health insurance is $480 and for plans with retiree coverage is $552.

Private Health Insurance Characteristics

The characteristics of the private health insurance plan (except for the premium) are obtained from private plans held by individuals in the 1987 National Medical Expenditure Survey (NMES) data. The deductible is \$100, the coinsurance rate is 20%, the maximum deductible amount is \$1000, and the maximum amount covered is \$100,000. The premium is obtained from the responses to the wave 1 HRS survey from those respondents who had private coverage, and is set to \$1870, the average premium reported.

Medicare Characteristics

We take Medicare enrollment prior to age 65 as given. We assume that a man who is observed to be covered by Medicare prior to age 65 will keep such coverage unless he chooses to enter employment, and that men who are not observed to be covered by Medicare prior to age 65 will never receive such coverage (until age 65). We use characteristics of Medicare that were in place as of 1994. There is no premium for Part A, which provides coverage for hospitalization. Coverage is provided for up to 90 days of inpatient care during each benefit period, where a benefit period begins on entry to a hospital and ends 60 days after the individual was last in a hospital or skilled nursing facility. The deductible for inpatient hospital care is \$696. Days 1-60 in a hospital are fully covered once the deductible is met. Days 61-90 require a copayment of \$174 per day. There is a lifetime reserve of 60 days of inpatient coverage that can be applied to hospital stays that exceed 90 days during a benefit period. For simplicity, we assume that the lifetime reserve is available every year. Part B provides supplementary insurance for physician care, and has a monthly premium of \$41.10, an annual deductible of \$100, and a coinsurance rate of 20 %. Part B coverage is optional but we assume that all men take it up. (In 1992, 96% of all eligible individuals enrolled in part B of Medicare.) Medicare is the primary payer for retirees, and is the secondary payer for workers and their spouses aged 65 and over who elect to be covered by employer-provided health insurance by a firm with at least 20 employees. Employer-provided retiree coverage converts to "Medigap" coverage at age 65 and becomes the secondary payer, while employer-provided coverage for active employees remains the primary payer as long as the worker remains employed by the firm providing the coverage.

VA/CHAMPUS Characteristics

This program helps veterans pay for civilian medical care when military care is not available. There is no premium, an annual deductible of \$150, a coinsurance rate of 25 % for outpatient care, and a copayment of min(\$360/day, 25 %) for inpatient care. Coverage is available regardless of employment status, and the coverage integrates with Medicare at age 65 in the same way as any other health insurance plan.

Medicaid Characteristics

Publicly-funded health care is available to all individuals who qualify for Medicaid. The means-tested program has income and asset limits that differ in each U.S. state. We do not model qualification for Medicaid and simply assume it is held when observed in the data. There is no cost-sharing required by a covered individual; that is, no deductible, 0% coinsurance, no maximum deductible amount, no maximum amount covered, and no premium.

Medical Care Prices

Prices for medical care services are calculated from charges for every medical care service received by NMES respondents in 1987. The per visit price of \$65 reflects the 1987 average price for a physician office visit among males 50 years old and older. The price per hospital night, \$1210, is obtained similarly. The corresponding prices in 1992 dollars are \$96 and \$1765, using the medical care price index as the price adjuster.

Appendix A2: Pensions

The Pension Provider Survey (PPS) obtained written plan descriptions for 6,381 pension plans. The plan characteristics were coded by the Institute for Social Research (ISR) at the University of Michigan into a computer program that calculates benefits under alternative scenarios. For jobs held at a date one year before the wave 1 survey ($t = 1$), we used the program to compute the benefit to which a man would be entitled for every possible year in which he could leave the firm, from $t = 1$ until he reaches age 70. The program takes as input the man's age and tenure with the firm as of $t = 1$, and his annual earnings for 1991 as reported by him in the wave 1 survey. For jobs held prior to $t = 1$, we used the program to compute the benefit available at the earliest age of benefit availability, taking as input his tenure and annual earnings at the time he left the firm. We have not seen the source code but have been assured by ISR that the program accounts for all provisions of plans reported in the written descriptions. Benefits are computed for both defined benefit and defined contribution plans, with benefits for the latter expressed in the form of an annuity. Benefits are computed for as many as three different plans from the $t = 1$ job and three different plans from previous jobs.

As noted in the text, there was a substantial amount of missing data on pension benefits due to absence of written descriptions, and written descriptions that lacked some of the information needed to compute benefits. If the information needed to construct the benefit formula for a pension on a job held at period 1 is missing we are forced to discard the observation because the HRS does not have the information needed to compute benefits at every possible quit date. But when information was missing on pensions from jobs that ended before period 1 we were often able to use the HRS survey responses to fill in the age at which the respondent becomes eligible for benefits and the benefit amount. This allowed us to avoid discarding a large number of cases. The HRS asked respondents to report the age at which they expect to start receiving benefits and the benefit amount for every pension plan for which they are or will be eligible for a benefit. We used these data to fill in missing values for pension benefits and age of eligibility for jobs held prior to $t = 1$, since the respondent's employment decisions from then on do not affect the benefit amount from jobs held prior to period 1. These data are not sufficient to fill in missing information for pensions on jobs held at $t = 1$, since benefits from such jobs depend on the man's employment decisions via the benefit formula, which we do not have in such cases.

In order to use the PPS data we have to keep track of the age at which an individual leaves the job held at $t = 1$ in the solution to the DP problem. This is therefore a state variable for men who are covered by a pension at the $t = 1$ job.

Appendix A3: Earnings and Benefits

Wage Earnings

Earnings (w_t) of employed males who change jobs or who were not employed at $t = 1$ and take a new job are estimated outside the model and are a function of the most recent measure of earnings from the individuals SSER file (w_0). We also include an indicator for a new job and for a good health status. The fitted values from this regression are used in solution to the model.

$$\hat{w}_t = 6061 + 411 * \frac{w_0}{1000} + 14 * d_t^{2vk} + 6106 * \mathbf{1}(h_t = 0)$$

Mean positive earnings are $26,000 and the standard deviation is $15,695.[25]

Other Nonwage Income

Nonwage income (b_t) other than Social Security and pension benefits is assigned from the fitted values of the following regressions, which were estimated on the samples with positive values of nonwage income, defined as the sum of spouse's income, asset income, means-tested income, and annuities. Standard errors are in parentheses, and (s)age and (s)educ are the age and education of the man (his spouse).

$$\text{Not married, not employed:} \quad \frac{\hat{b}_t}{10000} = 2.7076 - 0.0196 * \text{age} - 0.2686 * \text{educ} + 0.0174 * \text{educ}^2$$

$$\text{Not married, employed:} \quad \frac{\hat{b}_t}{10000} = 0.7990 - 0.0188 * \text{age} - 0.3933 * \text{educ} + 0.0279 * \text{educ}^2$$

$$\text{Married, not employed:} \quad \frac{\hat{b}_t}{10000} = 2.2774 - 0.0069 * \text{sage} - 0.2993 * \text{seduc} + 0.0246 * \text{seduc}^2$$

$$\text{Married, employed:} \quad \frac{\hat{b}_t}{10000} = -1.9730 + 0.0736 * \text{sage} + 0.1159 * \text{seduc} + 0.0261 * \text{seduc}^2 - 0.0079 * \text{sage} * \text{seduc}$$

Some men had no nonwage income and were excluded from the regressions. These men were assigned zero nonwage income in the periods in which zero was observed only. Mean observed

[25] The earnings records in the SSER file are truncated at the maximum taxable annual earnings.

other nonwage income (over all ages) was $9,479 (with a standard deviation of $19,265) for non-employed, unmarried men and $15,883 ($55,104) for employed, unmarried men. For married males, these figures were $20,026 ($24,068) and $24,473 ($27,352).

Social Security Benefits

As described in the text, the first time a man is not employed and at least 62 years old his Social Security Benefit (SSB) is computed using the exact formula for men of his cohort. The formula is cohort-specific as a result of the 1983 reforms that gradually increase the normal age of retirement to 67 and phase in other changes as well. We use the 1992 formula for each cohort.

If a man who experiences a non-employment spell at age 62 or older re-enters the labor force, the SSB for which he is eligible when he exits employment again can be computed using the exact formula only by making the complete sequence of employment choices from age 62 on a state variable. This makes the state space too large for solution of the DP problem. Instead we proceed as follows. First we use the exact formula to calculate the benefit for which a man would be eligible for every possible employment sequence involving reentry after age 62. We then regressed the benefit on the PIA corresponding to the cumulative years of experience associated with the sequence at the time of reexit, with separate regressions for each age of reexit. Recall that cumulative experience is a state variable, and the PIA associated with each possible level of cumulative experience is part of the data set. We use the fitted values from these regressions to assign the SSB for non-employment spells that follow a spell of employment which itself followed a spell of nonemployment from age 62 on (i.e., individuals in their second nonemployment spell after age 61). Letting the form of the regression be SSB = a + b*PIA, the results are listed below.

Age	a	b	R^2	|res|
63	12.481	0.779	0.996	1.0
64	13.171	0.811	0.979	4.0
65	12.876	0.844	0.955	7.1
66	14.465	0.884	0.935	6.0
67	14.909	0.915	0.917	7.0
68	15.528	0.944	0.897	7.3
69	14.805	0.974	0.874	7.6
70	13.294	1.005	0.850	9.1

|res| = Mean absolute value of the residual
as a percent of the dependent variable.

In order to follow this approach we have to keep track of whether a given sequence of states involves a man re-entering employment following a non-employment spell after age 61. This increases the size of the state space but not by as much as keeping track of the exact employment sequence. Therefore the state vector includes a binary indicator of whether a man ever re-enters employment following a non-employment spell after age 61.

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