A DYNAMIC STRUCTURAL MODEL OF HEALTH INSURANCE AND RETIREMENT

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Abstract

We specify a dynamic, structural model of the employment, health insurance, and medical care consumption decisions of older individuals and estimate it with data from the Health and Retirement Survey (HRS). The results are used to simulate the impact of reforms to the health insurance system on the timing of labor force entry and exit, and job switching. The analysis exploits both the detailed data available in the HRS and supplementary data provided by employers on the characteristics of health insurance and pension plans as well as administrative data on Social Security earnings histories. These additional sources of data allow us to model the budget constraint facing individuals when they make employment and health care decisions more accurately than is possible with survey data alone.

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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. The Consolidated Omnibus Budget Reconciliation Act of 1985 (COBRA) requires firms that provide health insurance to offer coverage to employees who leave the firm for up to 18 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. Alternatively, individuals who would lose their health insurance upon retiring could purchase an individual health insurance policy. Such policies, however, are 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).

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 recently 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 and Medicare 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 consider-
able 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 approxi-
mations 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
employer-provided insurance does not include retiree coverage.\(^1\) Evidence of this type is useful in
establishing the existence of an effect but cannot necessarily be used to evaluate the impact of pro-
posed 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: firms might alter the terms of coverage in response to such a
reform. 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. Gustman
and Steinmeier (1994) and Lumsdaine, Stock, and Wise (1994) specify models in which the average
cost of health insurance is included in the budget constraint. They find that parameter estimates

\(^1\)Blau and Gilleskie (2000). See Gruber and Madrian (1995, 1996), Karoly and Rogowski (1994), and
Madrian (1994) for related evidence.
and implied retirement behavior are virtually identical with or without health insurance included. Rust and Phelan (1997) note that the expected value of medical expenses is relatively low at ages 55-64, so valuing health insurance coverage at its average cost changes the budget constraint by only a small amount. But a major component of the value of health insurance to risk-averse individuals is the coverage it provides against catastrophic medical bills caused by low-probability major adverse health shocks. The estimates of these two studies cannot account for this source of demand for insurance. Rust and Phelan allow for risk aversion and model the entire distribution of medical expenditures rather than the mean only. Their estimates indicate that individuals in their Retirement History Survey (RHS) sample 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 health care decisions and estimate its parameters using data on men aged 51-63 from the Health and Retirement Survey (HRS). The analysis has three unique features that distinguish it from the approaches followed by previous studies. First, it allows individuals to choose the amount of medical care to consume. Previous models have treated medical expenditures 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 expenditures are exogenous could yield misleading inferences. We test the hypothesis that medical expenditures are exogenous.

Second, the model allows individuals to make choices about health insurance coverage. Some individuals purchase a health insurance policy in the private market, and any individual could apply for such coverage. Some men are married to a woman whose employer provides health insurance that could cover him. Some men are eligible for Medicare as a result of a disability. It is important to model both the availability of alternative sources of health insurance coverage and the choice among the available alternatives in order to avoid confounding behavior and constraints.

See Gruber and Madrian (1996, p. 119) for evidence on average medical expenditures by age. They report that the average annual medical expenditure in 1980 for individuals aged 55-64 was $2,144 (1990 dollars).

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).
Previous structural models of health insurance and retirement have treated employer-provided health insurance coverage as exogenous. In addition to allowing employment decisions to affect eligibility for employer-provided health insurance, we model the availability of alternative sources of health insurance coverage and allow individuals to choose health insurance from among the available alternatives.

Third, and most important, 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.

In the next section we describe the model. Section 3 discusses the data, section 4 will present the estimates, and section 5 will use the estimates to evaluate several proposed reforms. Section 6 will conclude.

2 The Model

We specify a model that can account for the observed sequence of employment, health insurance, and medical care decisions of a sample 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. There are three decision variables each period: employment, medical care consumption, and health insurance. The state variables that are determined by the individual’s choices (and by realizations of stochastic processes) are employment status, health insurance status, health status, and cumulative years of job tenure and work experience. Medical care choices affect the stochastic process that determines subsequent health outcomes. The employment decision has future consequences because earnings, pension benefits, Social Security benefits, and health insurance coverage may depend on job tenure or experience. The health insurance choice affects the availability to the individual of the various types of health insurance in the future.

Individuals face three sources of uncertainty about the future: health, health insurance availability, 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, health insurance, and medical care choices from the choice set available to him for the period. These choices are then fixed for the duration of the period.

### 2.1 Per-period Alternatives

The employment states are employed (\(\epsilon_t = 1\)) and not employed (\(\epsilon_t = 0\)). The employment alternatives available to an individual who was previously employed (\(\epsilon_{t-1} = 1\)) are:

\[
\begin{align*}
    j_t = 1 & : \text{ leave the labor force} \\
    j_t = 2 & : \text{ take a new job} \\
    j_t = 3 & : \text{ stay on the same job.}
\end{align*}
\]

Individuals who were previously not employed (\(\epsilon_{t-1} = 0\)) have the choices:

\[
\begin{align*}
    j_t = 1 & : \text{ remain out of the labor force} \\
    j_t = 2 & : \text{ become employed.}
\end{align*}
\]

A new job offer is received by the individual each period with no cost of search, so entering employment (if \(\epsilon_{t-1} = 0\)) and changing jobs (if \(\epsilon_{t-1} = 1\)) are always options. If a man was
employed in the previous period, layoffs are possible; remaining on the same job is not always an option.

The medical care alternatives open 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.

There are six health insurance states, denoted as follows:

$$
egin{align*}
    l_t = 0 & : \text{None} \\
    l_t = 1 & : \text{Own employer with retiree benefits} \\
    l_t = 2 & : \text{Spouse's employer} \\
    l_t = 3 & : \text{Own employer without retiree benefits} \\
    l_t = 4 & : \text{Private} \\
    l_t = 5 & : \text{Medicare}
\end{align*}
$$

Before age 65 these health insurance states are assumed to be mutually exclusive. Medicare is available before age 65 only to men who have applied for and been 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 choose to be covered by one other source as well.\footnote{We ignore Medicaid because it is uncommon in this population and is difficult to model. Any man actually observed on Medicaid is classified in category 5. 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.} We do not allow multiple sources of health insurance coverage before age 65 because doing so increases the complexity of the model substantially. We also do not model application for and enrollment in SSDI. Our approach to modeling eligibility for Medicare before age 65 is described below.

The health insurance alternatives available to a man in period $t$ ($t$) depend on the health insurance state he occupied in period $t-1$ and the realizations of random variables that determine health insurance availability. As indicated above, we assume that a man receives one job offer each period. There are three types of jobs: (1) jobs that offer employer-provided health insurance plus retiree benefits, (2) jobs that offer employer-provided health insurance but no retiree benefits, and (3) jobs that do not offer employer-provided health insurance. With probability $\lambda_t$ the job offer
received at the beginning of period $t$ is of type $r$, where $\sum_{r=1}^{3} \lambda_r = 1$. So, depending upon the realization of the random variable “type of new job offer,” a man who did not have a job with employer-provided health insurance in period $t-1$ may have the option of becoming employed at a firm that offers such insurance in period $t$. Furthermore, a firm’s insurance type can change. An employer may drop health insurance as a benefit, or may drop retiree insurance, or may add health insurance and/or retiree insurance. With probability $y_{rr'}$, a job of type $r$ held at period $t-1$ becomes a job of type $r'$ at the beginning of period $t$, where $\sum_{r'=1}^{3} y_{rr'} = 1, r = 1, 2, 3$.\(^5\)

Our approach to modeling health insurance from the wife’s employer is to treat it in a manner similar to the specification of insurance from the man’s own employer, with the exception that we avoid treating the wife’s employment status as a state variable. We leave for future research a model in which husbands and wives jointly choose employment and health insurance. Here we focus only on the decisions of men. Accordingly, define $z_{12}$ as the probability that a wife who has health insurance from a current or former employer that can cover the husband at period $t-1$ does not have such insurance in period $t$, and $1 - z_{12}$ is the probability that the wife retains such insurance. Let $z_{21}$ be the probability that a wife who does not have such insurance in period $t-1$ does have it in period $t$, and $1 - z_{21}$ is the probability that she does not gain insurance that can cover the husband. In our model, a wife whose employer’s health insurance is not available to the husband is equivalent to a wife whose job does not offer insurance or a wife who is not employed: in each case health insurance coverage from his wife’s employer is not part of his choice set.

We assume that a man can costlessly apply for private health insurance coverage, so all men who do not have private health insurance in period $t-1$ apply for such coverage in period $t$. Let $q_1$ denote the probability that the application is accepted. If the application is accepted then private health insurance is part of a man’s choice set for that period. A man who was covered by private health insurance in period $t-1$ faces a probability $q_2$ of having his coverage terminated in period $t$.

A man under the age of 65 is eligible for Medicare if he is enrolled in Social Security Disability (SSDI). We ignore the fact that there is a two year waiting period for Medicare eligibility after

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\(^5\)As noted in the introduction, individuals who leave a firm that provides health insurance are entitled by the COBRA mandate to continued coverage for up to 18 months after leaving the firm. It is straightforward to incorporate this entitlement in the model, but the data unfortunately do not provide a reliable measure of whether individuals who are not employed are in fact receiving insurance coverage under the COBRA mandate. Thus we do not incorporate the COBRA entitlement in the model.
acceptance into SSDI and assume that application is costless. Let \( q_3 \) be the probability that a man under the age of 65 who was not covered by Medicare in period \( t - 1 \) is accepted by SSDI and becomes eligible for Medicare in period \( t \); and let \( q_4 \) be the probability that a man under the age of 65 who was enrolled in Medicare in period \( t - 1 \) as a result of SSDI enrollment loses his Medicare eligibility in period \( t \) as a result of loss of SSDI coverage.

Let \( d_{ijvkt} \) indicate the employment, medical treatment, and health insurance decisions of an individual in period \( t \). \( d_{ijvkt} = 1 \) if employment alternative \( j \), \( v \) doctor visits, \( k \) hospital nights, and insurance alternative \( \ell \) are chosen during period \( t \) and \( d_{ijvkt} = 0 \) otherwise (and if a particular employment or health insurance alternative is not available).

### 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:

- **the employment state at end of \( t - 1 \)**: \( e_{t-1} = \begin{cases} 1 & \text{if } j_{t-1} = 2 \text{ or } 3 \text{ or not laid off} \\ 0 & \text{otherwise} \end{cases} \)

- **the health insurance state in \( t - 1 \)**: \( l_{t-1} = \ell_{t-1} \text{ if } d_{ijvkt} = 1 \)

- **tenure in the current job**: \( x_{1t} = \begin{cases} x_{1t-1} + 1 & \text{if } d_{3ijvkt} = 1 \\ 0 & \text{otherwise} \end{cases} \)

- **total work experience**: \( x_{2t} = \begin{cases} x_{2t-1} & \text{if } d_{ijvkt} = 1 \\ x_{2t-1} + 1 & \text{otherwise} \end{cases} \)

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 medical care decisions in \( t \) 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

\[
\pi_{t+1}^{ia}(v_i,k_i,Z_t,\mu) = \text{pr}(h_{t+1} = a \mid h_t = i, v_t, k_t, Z_t, \mu) \\
= \frac{\exp \left( \gamma_{0ia} + \gamma_{1ia} v_t + \gamma_{2ia} k_t + \gamma_{3ia} Z_t + \rho_{1ia} \mu \right)}{\sum_{b=0}^{2} \exp \left( \gamma_{0ib} + \gamma_{1ib} v_t + \gamma_{2ib} k_t + \gamma_{3ib} Z_t + \rho_{1ib} \mu \right)} \quad (1)
\]
where $\pi_i^0 + \pi_i^1 + \pi_i^{i2} = 1 \forall i, \forall t$, $Z$ is a vector of observed fixed or deterministic exogenous variables, $\mu$ is an unobserved (to the researcher) component of health, and the $\gamma$'s and $\rho_i$'s are parameters. Thus,

$$h_{t+1} = \begin{cases} 0 \text{ with prob } \pi_i^h0 \\ 1 \text{ with prob } \pi_i^h1 \\ 2 \text{ with prob } 1 - (\pi_i^h0 + \pi_i^h1) \end{cases}$$

The vector of state variables at the beginning of period $t$ is $s_t = (c_{t-1}, l_{t-1}, h_t, x_{1t}, x_{2t}, Z_t)$.

### 2.3 Utility Function and Budget Constraint

The utility of consumption and medical visits during period $t$, conditional on being alive during the period, depends upon health, health insurance, and employment status and is given by

$$U^i(C_t, d_t, Z_t, \mu, \epsilon_t) = \begin{cases} \alpha \epsilon_t + \frac{1}{\alpha_{1t} \epsilon_t} C_t^\alpha + \alpha_{2t} \epsilon_t v_t + \alpha_{3t} \epsilon_t (v_t)^2 + \alpha_{4t} \epsilon_t k_t + \alpha_{5t} \epsilon_t (k_t)^2 \\ + \alpha_{6t} \epsilon_t (v_t)^3 + \alpha_{7t} \epsilon_t (k_t)^3 + \alpha_{8t} \epsilon_t Z_t + \alpha_{9t} \epsilon_t \mu + \epsilon_t \\ \alpha_{10t} \epsilon_t + \epsilon_t \\ \alpha_{11t} \epsilon_t + \epsilon_t \end{cases}$$

$$= U_{jk \ell}^i(C_t) + \epsilon_t$$

where $C_t$ is consumption of a composite commodity, $\epsilon_t = (\epsilon_{ij}^v, \forall i, j, v, k, \ell)$ is a vector of period $t$ choice-specific utility shocks, $\alpha$ and $\rho$ are vectors of parameters that vary by health and employment state, and $U_{jk \ell}^i(C_t)$ is the deterministic part of the utility of choosing alternatives $j, v, k,$ and $\ell$ in health state $i$ during period $t$. The utility of a deceased individual is assumed to be zero. Preferences are allowed to depend on health and employment status as indicated by the $i$ and $e$ subscripts on $\alpha$ and $\rho$. The marginal utility of consumption is decreasing and approaches $\infty$ as $C \to 0$. The marginal utility of medical visits is decreasing if $\alpha_{1i} > 0$, $\alpha_{2i} > 0$, $\alpha_{3i} > 0$, and $\alpha_{4i} < 0$. The quadratic specification is a simple way of ensuring a determinate solution for medical visits, 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

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3Three other 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 reenters employment following a nonemployment spell after age 61. The role of these variables is discussed in the Appendix.
case. Medical visits can provide utility in both the good health and bad health states, with the marginal utility of a visit allowed to depend on health and employment status. The utility function specification also allows for the possibility that health insurance affects utility directly, with effects that are allowed to differ by health and employment status. There is no obvious economic rationale for this, but we incorporate it as a test of the hypothesis that health insurance affects choices only via the budget constraint. Under this hypothesis, \( \alpha_{(g+\ell)ij} = 0 \). If the hypothesis is rejected then this is evidence that the economic part of our model does not fit the data well. Finally, changing jobs is allowed to directly affect utility.

The utility shocks \((\epsilon_t)\) 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. It would be desirable to allow for correlation of the shocks across states within a given period. However, this is not computationally feasible given the large number of states. A relatively flexible specification of the coefficients \((\rho)\) on \(\mu\) allows for correlation across the permanent components of unobserved preferences for each combination of discrete choices and health outcomes. \(\mu\) is treated as a random effect with a distribution to be estimated, as discussed below.

The budget constraint is given by

\[
C_t = w_t (1 - d_t^{vkk\ell}) + b_t - m_t \quad \forall t, j, v, k, \ell
\]

where \(w_t\) is earnings if employed in period \(t\), \(b_t\) is nonwage income (benefits) in period \(t\), and \(m_t\) represents the individual’s out-of-pocket medical expenditures at time \(t\). Earnings may depend on tenure, experience, age \((A_t)\), and fixed exogenous characteristics, but are not stochastic: \(w_t = w(x_{1t}, x_{2t}, A_t, Z_t)\). 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. Nonwage income is defined by \(b_t = b(\epsilon_t, x_{1t}, x_{2t}, A_t)\). 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 decision at that age; and the pension benefit to which he is entitled as a function of his age, tenure, and employment decision. The computation
of Social Security benefits follows the formulas used by the Social Security Administration closely, though not exactly in every instance. Pension benefits are determined by formulas derived from the plan descriptions provided by employers. Nonwage income also includes earnings of the spouse and income from assets. Details on each source of income are provided in the next section.

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 chosen at the beginning of period $t$: $m_t = m(v_t, k_t, p_v, p_k, F_\ell)$, where the $p$'s are per-visit or per-night prices and $F_\ell$ is a vector of insurance characteristics associated with insurance choice $\ell$. These characteristics include the premium, deductible, coinsurance rate, maximum out-of-pocket expenditure, and maximum insurance liability. Insurance characteristics depend on the insurance choice because employer plan characteristics differ across jobs, private plan characteristics differ from employer plan characteristics, Medicare characteristics differ from both, and the characteristics of the “no-insurance” option differ from all three. Plan availability may depend on an individual’s previous employment choice (via the exogenous probabilities defined above), but, conditional on the health insurance choice, insurance characteristics do not depend on current employment. The next section provides details of the insurance specification.

2.4 Value Function

An individual’s employment and health insurance choices in period $t - 1$ and the exogenous probabilities associated with job offer types, changes in health insurance offerings by a firm, etc., determine the set of health insurance options available in period $t$. Let $N_i^t$ denote the $\ell$th health insurance choice set that could be available to the man at the beginning of period $t$. For example, $N_i^t = (0, 1, 2)$ indicates that insurance options 0, 1, and 2 are part of the choice set for period $t$. The expected present discounted value (EPDV) of lifetime utility from choosing employment state $j$, medical visits $v$ and $k$, and health insurance of type $\ell$ in period $t < T$, given health status $i < 2$ and the insurance choice set $N_i^t$, is
\[ V_{ij}^i(s_t, e_t^i | \mu, N_t^i) = \mathcal{U}_{ij}^i(C_t) + \epsilon_{ij}^{voh} \]
\[ + \beta \left[ (1 - \phi) \left[ \pi_{t+1}^{0}\ V^0(s_{t+1} | \mu) + \pi_{t+1}^{1}\ V^1(s_{t+1} | \mu) + (1 - (\pi_{t+1}^{0} + \pi_{t+1}^{1}))\ V^2(s_{t+1}) \right] \right. \]
\[ + \phi \left[ \pi_{t+1}^{0}\ V^0(s_{t+1} | \mu) + \pi_{t+1}^{1}\ V^1(s_{t+1} | \mu) + (1 - (\pi_{t+1}^{0} + \pi_{t+1}^{1}))\ V^2(s_{t+1}) \right] \right] \quad i = 0, 1 \quad (5) \]

where \( C_t = w(x_{1t}, x_{2t}, A_t, Z_t)(1 - d_{t}^{voh}) + b(e_t, x_{1t}, x_{2t}, A_t) - m(v_t, k_t, p, p_t, F_{\ell}) \) and \( \beta \) is the discount factor. The probability of being laid off at the end of period \( t \), if employed during period \( t \), is denoted \( \phi \). In the event of death at period \( t \), the value function (which involves no choices and does not vary with observed or unobserved heterogeneity) is \( V^2(s_t) = 0 \). Maximal expected utility of being in health state \( i \) in period \( t + 1 \) (unconditional on choices at \( t + 1 \), but conditional on the available health insurance alternatives) is

\[ V^i(s_{t+1} | \mu, N_{t+1}^i) = E_t\left[ \max V_{ij}^i(s_{t+1}, e_{t+1}^i | \mu, N_{t+1}^i), \ \forall j, v, k, \ell \right]. \quad (6) \]

Unconditional on the set of health insurance options, the EPDV of lifetime utility in each health state (expressions in the square brackets of Equation 5) is

\[ V^i(s_{t+1} | \mu) = \sum_{c=1}^{C} \eta_{c} V^i(s_{t+1} | \mu, N_{t+1}^i) \quad (7) \]

where \( \eta_{c} \) is the probability that the \( c \)th health insurance choice set is available in period \( t \). The \( \eta \)'s are functions of the \( y \)'s, \( z \)'s, \( q \)'s, \( \lambda \)'s, and health status (allowing for the possibility that the acceptance rates into private and Medicare coverage are a function of health). Expressions for the \( \eta \)'s are given in the Appendix.

### 2.5 Solution

Although \( T^* \) represents the end of life and, theoretically, the end of decisionmaking, we model individual decisions to period \( T < T^* \) for computational tractability. In the empirical analysis we set \( T = 70 \). Instead of modelling employment, medical care, and health insurance decisions for \( t > T \), we follow Mroz and Weir (1993) and specify a nonparametric 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 \( V(s_T | \mu) = f(s_T | \mu) \), where \( f(\cdot) \) is a nonparametric 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 \( T \). The only variables that are unobserved by the econometrician at \( t \) (conditional on \( \mu \)) are the \( \epsilon_t \)'s. The assumption that the \( \epsilon_t \)'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 \( t + 1 \) (see Equation 6). Thus,

\[
V^i(s_{t+1}, \mu, N^e_{t+1}) = E_t \left[ \max_j V^j_{jvkt} (s_{t+1}, \epsilon_{t+1} | \mu, N^e_{t+1}), \forall j, v, k, \ell \right] = \rho \left( \gamma + \ln \left( \sum_{j=1}^{J(s_{t+1})} \exp \left( \sum_{v=0}^{K} \sum_{k=0}^{K} \sum_{\ell=0}^{L(s_{t+1})} \exp \left( \frac{\nabla^i_{jvkt} (s_{t+1} | \mu, N^e_{t+1})}{\rho} \right) \right) \right) \right)
\]

where \( \gamma \) denotes Euler’s constant, \( \rho \) is a parameter of the Extreme Value distribution, \( J(s_t) \) and \( L(s_t) \) indicate the number of employment and health insurance alternatives (and are functions of the employment and health insurance state), and \( \nabla^i_{jvkt} (s_t, \mu, N^e_t) = V^i_{jvkt} (s_t, \epsilon_t | \mu, N^e_t) - \epsilon^j_v k^k t \). The need for multi-dimensional integration over the distribution of \( \epsilon_t \) is avoided. It also follows from the assumptions about the \( \epsilon_t \)'s that the choice probabilities, (conditional on \( \mu \)), have the multinomial logit form

\[
p(d^j_{jvkt} = 1 | s_t, \mu, N^e_t) = \frac{\exp \left( \nabla^i_{jvkt} (s_t | \mu, N^e_t) \right)}{\sum_{j'=1}^{J(s_t)} \sum_{v'=0}^{K} \sum_{k'=0}^{K} \sum_{\ell'=0}^{L(s_t)} \exp \left( \frac{\nabla^i_{j'vkt} (s_t | \mu, N^e_t)}{\rho} \right)}
\]

Solving backwards yields probabilities like those defined in Equation 9 for each element of the state space in each period \( t \). The additional probabilities used to form the likelihood of individual behavior observed in the data include the health transition probabilities (\( \pi_{t+1} \)), the job-type offer probabilities (\( \lambda \)), the health insurance transition probabilities (\( y_z q \)), and the probabilities associated with the mass points of the distribution of \( \mu \) (\( \theta_m \)).

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 richer set of employment choices. Gustman and Steinmeier (1994) do not allow any sources of risk, and do not model health,

\[\footnote{We follow Mroz (1999) and Heckman and Singer (1984) in approximating the distribution of \( \mu \) by a step function. The points of support of the distribution and the probabilities associated with each point of support (\( \theta'_m \)) are estimated jointly with the other parameters.} \]
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 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, part-time employment (but not job switching), and do not model changes in health insurance. They treat medical expenditure as the realization of an exogenous stochastic process.

3 Data

We use data from the first two waves of the Health and Retirement Survey (HRS), fielded in 1992 and 1994. The 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. Three 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 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

---

8A preliminary release of data from the third wave, fielded in 1996, is available, but a number of variables we need were not included in this release.
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.

Table 1: Sample Derivation

<table>
<thead>
<tr>
<th>Row</th>
<th>Description</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Men in the HRS</td>
<td>5,867</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Age-eligible men</td>
<td>4,552</td>
<td>77.6% of row 1</td>
</tr>
<tr>
<td>3.</td>
<td>With complete data on key HRS variables</td>
<td>3,869</td>
<td>85.0% of row 2</td>
</tr>
<tr>
<td>4.</td>
<td>With a Social Security record</td>
<td>3,668</td>
<td>94.8% of row 3</td>
</tr>
<tr>
<td>5.</td>
<td>With employer-provided health insurance at wave 1</td>
<td>2,829</td>
<td>73.1% of row 3</td>
</tr>
<tr>
<td>6.</td>
<td>With a HIPPS health insurance record</td>
<td>1,932</td>
<td>68.3% of row 5</td>
</tr>
<tr>
<td>7.</td>
<td>With complete HIPPS health insurance data</td>
<td>686</td>
<td>35.5% of row 6</td>
</tr>
<tr>
<td>8.</td>
<td>Covered by a pension at wave 1</td>
<td>2,655</td>
<td>68.6% of row 3</td>
</tr>
<tr>
<td>9.</td>
<td>With a pension provider record</td>
<td>1,655</td>
<td>62.3% of row 8</td>
</tr>
<tr>
<td>10.</td>
<td>With complete data from pension provider or</td>
<td>1,655</td>
<td>100.0% of row 9</td>
</tr>
<tr>
<td></td>
<td>missing information filled in from the HRS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Estimation sample</td>
<td>1,179</td>
<td>30.5% of row 3</td>
</tr>
</tbody>
</table>

Notes: 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.

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. We were also able to fill in missing information on pensions from current employers in some cases.

The sample we use consists of 1,179 men who either do not have a pension or health insurance coverage or provide complete information. This is not a representative subsample from the HRS. As Table 2 indicates, men without pensions and 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. We plan to test this assumption in an extension of the analysis by specifying an auxiliary equation explaining which HRS sample members are included in our estimation sample, incorporating the unobserved heterogeneity ($\mu$), and estimating it jointly with the parameters of the structural model.

Table 2: Sample Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Full Sample</th>
<th>Estimation Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at wave 1 survey</td>
<td>55.8</td>
<td>55.8</td>
</tr>
<tr>
<td>Education</td>
<td>12.3</td>
<td>11.8</td>
</tr>
<tr>
<td>Black</td>
<td>0.15</td>
<td>0.17</td>
</tr>
<tr>
<td>Hispanic</td>
<td>0.08</td>
<td>0.09</td>
</tr>
<tr>
<td>Married at wave 1</td>
<td>0.81</td>
<td>0.75</td>
</tr>
<tr>
<td>Employer health insurance</td>
<td>0.73</td>
<td>0.44</td>
</tr>
<tr>
<td>With retiree coverage</td>
<td>0.79</td>
<td>0.73</td>
</tr>
<tr>
<td>Pension</td>
<td>0.69</td>
<td>0.56</td>
</tr>
<tr>
<td>Good health at wave 1</td>
<td>0.79</td>
<td>0.74</td>
</tr>
<tr>
<td>Attrited by wave 2</td>
<td>0.09</td>
<td>0.07</td>
</tr>
<tr>
<td>Number</td>
<td>3,869</td>
<td>1,179</td>
</tr>
</tbody>
</table>

Note: Full sample refers to the age-eligible men with no missing data on key variables in the wave 1 and, if a non-attriter, wave 2 HRS surveys. Data from the wave 1 survey 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 wave 2 survey (conducted approximately two years after the wave 1 survey) gives us a measure of employment status at wave 2, and a monthly record of employment between the interviews provides the information needed to measure employment status at a date one year after the wave 1 interview. Employment status could be measured at finer intervals than one year, but we miss very few transitions by using one-year intervals (See Blau and Gilleskie, 2000). Table 3 displays the employment distributions at these four dates for the estimation sample, and for the full sample. The employment rate in the estimation sample falls by 3.7 percentage points during this three year interval. About 44 percent of the estimation sample is not employed at at least one of the four dates observed, 8.7 percent ever change from one job to another, 10.9 percent ever enter employment from nonemployment, and 43 percent are employed at the same firm at all four dates. The corresponding figures for the full sample show more job stability and less nonemployment.

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 wave 1 and wave 2 interviews. The sample distributions of hospital nights and what we refer to as doctor visits are shown in Figure 1 for the estimation sample. 85.9 percent of the sample had no hospital nights during the 12 months prior to the wave 1 survey, and 79.5 percent had none during the interval between the wave 1 and wave 2 interviews. About 56-58 percent of the cases with at least one hospital stay were in the hospital for 1-7 nights per year in both waves. The median number of hospital nights among cases with at least one stay is 6 in both waves. The distribution
Table 3: Employment Status Distributions

<table>
<thead>
<tr>
<th>Description</th>
<th>Estimation Sample</th>
<th>Full Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>t=1</strong> (one year before the wave 1 interview date)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employed</td>
<td>69.0</td>
<td>78.3</td>
</tr>
<tr>
<td>Employed at the same job as one year ago</td>
<td>62.4</td>
<td>71.2</td>
</tr>
<tr>
<td>Employed at a new job</td>
<td>5.5</td>
<td>7.0</td>
</tr>
<tr>
<td>Not employed</td>
<td>32.1</td>
<td>21.7</td>
</tr>
<tr>
<td><strong>t=2</strong> (wave 1 interview date)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employed</td>
<td>67.9</td>
<td>78.0</td>
</tr>
<tr>
<td>Employed at the same job as one year ago</td>
<td>62.5</td>
<td>72.2</td>
</tr>
<tr>
<td>Employed at a new job</td>
<td>5.5</td>
<td>5.8</td>
</tr>
<tr>
<td>Not employed</td>
<td>32.1</td>
<td>22.0</td>
</tr>
<tr>
<td><strong>t=3</strong> (one year after the wave 1 interview date)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employed</td>
<td>69.0</td>
<td>76.1</td>
</tr>
<tr>
<td>Employed at the same job as one year ago</td>
<td>59.8</td>
<td>68.9</td>
</tr>
<tr>
<td>Employed at a new job</td>
<td>9.3</td>
<td>7.3</td>
</tr>
<tr>
<td>Not employed</td>
<td>31.0</td>
<td>28.1</td>
</tr>
<tr>
<td><strong>t=4</strong> (wave 2 interview date)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employed</td>
<td>65.3</td>
<td>71.9</td>
</tr>
<tr>
<td>Employed at the same job as one year ago</td>
<td>59.8</td>
<td>66.0</td>
</tr>
<tr>
<td>Employed at a new job</td>
<td>9.3</td>
<td>5.9</td>
</tr>
<tr>
<td>Not employed</td>
<td>31.0</td>
<td>28.1</td>
</tr>
</tbody>
</table>

**Summary:**

- Ever not employed | 44.7 | 35.3 |
- Ever change jobs | 8.7 | 7.9 |
- Ever enter employment | 10.9 | 8.8 |
- same job throughout | 42.9 | 48.7 |
of doctor visits is much less skewed, with 18-27 percent having zero visits. The median number of visits is two in wave 1 and three in wave 2.\(^9\)

### 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.\(^{10}\) We create a dichotomous measure of health at waves 1 \((t = 2)\) and 2 \((t = 4)\) 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 wave 2 survey asks individuals to compare their current health to their health two years ago and therefore cannot be used to construct a health status measure at \(t = 3\).) The scheme for classifying health at \(t = 1\) is shown below. Some arbitrariness is unavoidable since a direct question on health status one year ago was not asked.

<table>
<thead>
<tr>
<th>Current Health</th>
<th>Current health compared to one year ago</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. excellent</td>
<td>good</td>
</tr>
<tr>
<td>2. very good</td>
<td>bad</td>
</tr>
<tr>
<td>3. good</td>
<td>bad</td>
</tr>
<tr>
<td>4. fair</td>
<td>bad</td>
</tr>
<tr>
<td>5. poor</td>
<td>bad</td>
</tr>
</tbody>
</table>

The distribution of health and health changes is shown in Table 4. The cross-sectional distributions are quite stable, but there is a substantial amount of movement between states.

---

\(^9\)The wave 2 survey asked respondents to report their medical expenses for the interval between the surveys. A regression of medical expenses on a quartic in hospital nights and doctor visits yields an \(R^2 = 0.65\).

\(^{10}\)See Blau, Gilleskie, and Slusher (1999) and Bound et al. (1999) for detailed analysis of the effect of health on employment in the HRS.
Figure 1: Distribution of Medical Care Consumption
Note: 27.1% had 0 doctor visits at Wave 1 (t=1); 18.2% had 0 doctor visits at Wave 2 (t=3); 85.9% had 0 hospital nights at Wave 1 (t=1); 79.5% had 0 hospital nights at Wave 2 (t=3).
About nine percent of men in good health fall into bad health by the next year, and 25 percent of men in bad health “recover” by the next year.

<table>
<thead>
<tr>
<th>Period</th>
<th>t=1</th>
<th>t=2</th>
<th>t=4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Good</td>
<td>Bad</td>
<td>Good</td>
</tr>
<tr>
<td>t+1</td>
<td>73.8</td>
<td>26.2</td>
<td>72.9</td>
</tr>
<tr>
<td>Good</td>
<td>89.9</td>
<td>24.9</td>
<td></td>
</tr>
<tr>
<td>Bad</td>
<td>10.1</td>
<td>75.1</td>
<td></td>
</tr>
</tbody>
</table>

### 3.4 Health Insurance

The HRS provides data on the source of the respondent’s health insurance, but it does not provide information on the amount of the premium or features such as the deductible, coinsurance rate, etc. We use the HRS data to classify individuals into one of the six mutually exclusive and exhaustive health insurance categories shown in Table 5. 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
As shown in Table 5, the distribution of health insurance coverage 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 at wave 2 is derived from the wave 2 HRS survey in an identical manner. Wave 1 insurance status is assigned to period 1 and wave 2 insurance status is assigned to period 3. We do not observe health insurance status in periods 2 and 4, but we are able to form the likelihood function to account for this missing information by integrating over the distribution of possible health insurance choices at these dates, using the health insurance offer probabilities defined in the previous section $(y_{1r'}, z_{12}, z_{21}, q_r, \lambda_r$, and several others defined in the Appendix).

Table 5: Health Insurance Distribution at Wave 1

<table>
<thead>
<tr>
<th>Description</th>
<th>Estimation Sample</th>
<th>Full Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>0. No health insurance</td>
<td>24.9</td>
<td>12.5</td>
</tr>
<tr>
<td>1. Own employer with retiree coverage</td>
<td>32.1</td>
<td>48.7</td>
</tr>
<tr>
<td>2. Spouse’s employer</td>
<td>7.5</td>
<td>11.4</td>
</tr>
<tr>
<td>3. Own employer without retiree coverage</td>
<td>9.7</td>
<td>15.8</td>
</tr>
<tr>
<td>4. Privately purchased coverage</td>
<td>14.9</td>
<td>6.8</td>
</tr>
<tr>
<td>5. Federal coverage</td>
<td>10.9</td>
<td>4.8</td>
</tr>
</tbody>
</table>

Notes: Federal = Medicare or Medicaid; VA/CHAMPUS cases have been classified as having own-employer coverage with retiree benefits.

Table 6 displays the distribution of health insurance status at wave 2 by health insurance status at wave 1. Men with retiree coverage from their own employer have the most stable health insurance status, followed by men with insurance from the spouse’s employer, men with Federal health insurance, and men with own-employer insurance without retiree benefits. Only about half

11 About eight percent of men assigned to category 1 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 to category 3 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 to category 2 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 category 4 also have coverage from Medicare or Medicaid.
the men with private insurance at wave 1 still had private insurance at wave 2. Forty percent of men with no health insurance at wave 1 had gained insurance by wave 2, with the majority obtaining either federal or private insurance. Not shown in the table is the fact that 8 percent of men who had insurance at wave 1 had no insurance at wave 2, with the great majority having had private or federal insurance at wave 1.

Table 6: Cross-tabulation of Health Insurance Status at Waves 1 and 2

<table>
<thead>
<tr>
<th>Health Insurance Status at Wave 2</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>at Wave 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>59.7</td>
<td>8.0</td>
<td>5.3</td>
<td>6.1</td>
<td>7.2</td>
<td>13.7</td>
<td>100</td>
</tr>
<tr>
<td>1</td>
<td>3.4</td>
<td>91.5</td>
<td>0.6</td>
<td>1.4</td>
<td>1.1</td>
<td>2.0</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>4.6</td>
<td>3.4</td>
<td>88.5</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
<td>100</td>
</tr>
<tr>
<td>3</td>
<td>9.3</td>
<td>4.7</td>
<td>2.8</td>
<td>80.4</td>
<td>2.8</td>
<td>0.0</td>
<td>100</td>
</tr>
<tr>
<td>4</td>
<td>17.7</td>
<td>20.1</td>
<td>4.7</td>
<td>5.9</td>
<td>47.9</td>
<td>3.5</td>
<td>100</td>
</tr>
<tr>
<td>5</td>
<td>7.1</td>
<td>5.3</td>
<td>1.8</td>
<td>0.0</td>
<td>3.5</td>
<td>82.3</td>
<td>100</td>
</tr>
</tbody>
</table>

An important drawback of the HRS health insurance data is that respondents who reported not being covered by employer health insurance were not asked whether their employer provides such coverage. Some men may choose to forego coverage by their employer if, for example, coverage from their spouse’s employer is available with better terms. Our structural model allows individuals to choose the source of health insurance coverage from among the alternatives available to them, so it is important to have information about the insurance choice set. The data do not allow us to determine whether men who are not covered by employer health insurance work for a firm that does not provide health insurance or chose to opt out of the firm’s health insurance plan. Similarly, we do not know whether a wife who is not covered by health insurance from her employer works for a firm that does not offer insurance or opted out of her firm’s insurance plan. Therefore, we use other sources of data to compute probabilities that various alternatives are part of a man’s choice set in
cases in which we do not observe the man choosing a particular alternative. The measurement of these probabilities is described in the appendix.

The characteristics of health insurance plans that we use in constructing the budget constraint are described in Table 7. They include the premium, deductible, coinsurance rate, maximum out-of-pocket costs, and maximum coverage. There is substantial variation across plans both in whether a given feature is present and the magnitude.

Table 7: Health Insurance Characteristics

<table>
<thead>
<tr>
<th>Description</th>
<th>Mean</th>
<th>Std Dev</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any employee premium</td>
<td>0.47</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual employee Premium (if any)</td>
<td>523</td>
<td>719</td>
<td>336.0</td>
</tr>
<tr>
<td>Any family premium</td>
<td>0.61</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual Family premium (if any)</td>
<td>1,504</td>
<td>1,500</td>
<td>1,168.2</td>
</tr>
<tr>
<td>Any deductible for office visits only</td>
<td>0.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual deductible for office visits only (if any)</td>
<td>127</td>
<td>93</td>
<td>100.0</td>
</tr>
<tr>
<td>Any deductible for all services</td>
<td>0.62</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual deductible for all services (if any)</td>
<td>290</td>
<td>822</td>
<td>200.0</td>
</tr>
<tr>
<td>Any maximum annual coverage</td>
<td>0.64</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum annual coverage (if any)</td>
<td>67,412</td>
<td>129,930</td>
<td>50,000</td>
</tr>
<tr>
<td>Any maximum lifetime coverage</td>
<td>0.60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum lifetime coverage (if any)</td>
<td>1,010,802</td>
<td>507,704</td>
<td>1,000,000</td>
</tr>
<tr>
<td>Any flat copayment per office visit</td>
<td>0.36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copayment amount per office visit (if any)</td>
<td>9.8</td>
<td>4.0</td>
<td>10.0</td>
</tr>
<tr>
<td>Any percentage copayment per office visit</td>
<td>0.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage copayment per office visit (if any)</td>
<td>18.4</td>
<td>7.0</td>
<td>20.0</td>
</tr>
<tr>
<td>Any maximum out-of-pocket cost for office visits</td>
<td>0.34</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual maximum out-of-pocket cost for office visits (if any)</td>
<td>1,553</td>
<td>1,461</td>
<td>1,000</td>
</tr>
<tr>
<td>Any copayment for hospital stays</td>
<td>0.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copayment amount per hospital stay (if any)</td>
<td>173</td>
<td>191</td>
<td>100.0</td>
</tr>
<tr>
<td>Any percentage copayment for hospital stays</td>
<td>0.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage copayment per hospital stay (if any)</td>
<td>18.9</td>
<td>9.4</td>
<td>20.0</td>
</tr>
<tr>
<td>Any annual copayment for hospital stays</td>
<td>0.04</td>
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<td></td>
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<tr>
<td>Annual copayment amount for hospital stays (if any)</td>
<td>654</td>
<td>785</td>
<td>300.0</td>
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<tr>
<td>Any maximum out-of-pocket cost per hospital stay</td>
<td>0.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum out-of-pocket cost per hospital stay (if any)</td>
<td>666</td>
<td>586</td>
<td>412.5</td>
</tr>
<tr>
<td>Any maximum annual out-of-pocket cost for hospital stays</td>
<td>0.34</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum annual out-of-pocket cost for hospital stays (if any)</td>
<td>1,612</td>
<td>1,366</td>
<td>1,000</td>
</tr>
</tbody>
</table>

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.
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" insurance plans of types 1-3 with characteristics given by the median characteristics of the observed plans of that type. If the choice set in period $t$ includes insurance of type $\ell$ ($\ell = 1,2,3$) from a source other than his or his spouse's wave 1 insurance plan, then the characteristics of that plan are assumed to be those of the generic plan of that type. See the Appendix for details.

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 other data to construct a set of characteristics of a "generic" private plan, and assign these to all private plans. Finally, Medicare characteristics and rules governing the interaction between Medicare and other insurance beginning at age 65 are used. See the Appendix for details. The HRS also lacks information on the price per doctor visit and hospital night, so we derive these measures from another data source, as described in the Appendix.

3.5 Pensions

The HRS collects detailed data on pensions for all current and former jobs held by the respondent which provide him with 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 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.\textsuperscript{12} 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. As indicated above, many firms did not provide plan descriptions and others provided descriptions that did not contain all of the ingredients of the benefit formula. 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. We use 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 survey about characteristics of the pension but no information on the benefit formula, since the new employer was not included in the HIPPS survey. For now, we ignore pensions on jobs that begin after period $t = 1$. Thus health insurance is treated as a characteristic that a new job offer may or may not have, but pension coverage is not. We plan to modify the model so as to make pension coverage a job characteristic, using average pension formula characteristics to construct a “generic” benefit formula to assign to new jobs in the same way that we construct a generic health insurance plan for new jobs.

Table 8 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 55-57 on average, and the average return to postponing exit from the firm by one year is about three percent in the first five years.

\textsuperscript{12}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 8: Pension Characteristics

<table>
<thead>
<tr>
<th>Description</th>
<th>Mean</th>
<th>Std Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wave 1-1 Job</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Youngest age at which benefits could be collected:</td>
<td>57.0</td>
<td>3.8</td>
</tr>
<tr>
<td>Annual Benefit (if benefit &gt; 0 and age &lt; 71)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>if exit job in 1991</td>
<td>11,880</td>
<td>12,382</td>
</tr>
<tr>
<td>if exit job in 1996</td>
<td>13,517</td>
<td>14,722</td>
</tr>
<tr>
<td>if exit job in 2001</td>
<td>16,567</td>
<td>17,233</td>
</tr>
<tr>
<td>if exit job in 2006</td>
<td>20,556</td>
<td>20,755</td>
</tr>
<tr>
<td>if exit job in 2011</td>
<td>21,711</td>
<td>19,056</td>
</tr>
<tr>
<td>Previous Jobs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Youngest age at which benefits could be collected:</td>
<td>56.3</td>
<td>8.4</td>
</tr>
<tr>
<td>Annual Benefit (if &gt; 0)</td>
<td>11,761</td>
<td>13,200</td>
</tr>
</tbody>
</table>

### 3.6 Earnings

As noted above, we treat earnings as deterministic because of the added computational complexity of modeling earnings uncertainty and the drastic increase in the size of the state space that would be caused by allowing the distribution of earnings to depend on earnings in the previous period (whether a discrete or continuous earnings distribution was assumed). Aside from the risk of layoff, 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 the wave 1 job and up to two previous jobs, while the SSER file contains annual earnings for every year in which an individual was employed on a covered job from 1951 through 1991. The earnings 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 we use the most recent measure of earnings from the SSER file
as an estimate of an individual’s earnings in any period in which he chooses to be employed. The mean is $21,609 and the standard deviation is $17,764.\textsuperscript{13}

We also used the SSER file to compute a measure of each man’s total years of work experience through 1991. We use this file instead of the HRS survey responses to construct the experience measure because the HRS does not contain a complete work history from which total experience can be reconstructed, and the experience variable is used in the model only for constructing Social Security benefits. Mean experience through 1990 is 31.1 years with a standard deviation of 8.6.

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 an individual who leaves the labor force after age 61 receives Social Security benefits (unlike Rust and Phelan (1997), who model the entitlement decision of individuals eligible for Social Security).

If a man exits the labor force, begins receiving a SSB, and then reenters employment, his SSB when he exits employment the second time will be different from his first benefit because\textsuperscript{13} The earnings records in the SSER file are truncated at the maximum taxable annual earnings.
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 take a different approach. We used the exact formula to compute the PIA for employment histories that involve reentry to the labor force following an initial exit from age 62 on, computed the SSB to which the man would be entitled upon exiting the labor force following reentry, and ran age-specific regressions of the benefit on the PIA. These regressions gave very good fits, and we use them in the solution to the dynamic programming (DP) problem to assign benefits to employment sequences involving such behavior.

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 9 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.

3.8 Other Nonwage Income

Other sources of nonwage income include the earnings of the wife, asset income, and income from annuities. We treat these sources of income as exogenous and certain (income from earnings-tested or means-tested government programs such as SSDI or Supplemental Security Income (SSI) are excluded). We summed all of these sources to create a single measure of other nonwage income for the 12 months prior to wave 1 and the 12 months prior to wave 2. We regressed the log of other nonwage income on polynomials in age and education for single men, and age and education of the
Table 9: Social Security Primary Insurance Amount for Alternative Amounts of Cumulative Experience Since 1990

<table>
<thead>
<tr>
<th>Description</th>
<th>Mean</th>
<th>Std Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIA as of 1990</td>
<td>705</td>
<td>284</td>
</tr>
<tr>
<td>PIA after 5 additional years of work</td>
<td>742</td>
<td>292</td>
</tr>
<tr>
<td>PIA after 10 additional years of work</td>
<td>773</td>
<td>298</td>
</tr>
<tr>
<td>PIA after 15 additional years of work</td>
<td>809</td>
<td>308</td>
</tr>
<tr>
<td>PIA after 20 additional years of work</td>
<td>826</td>
<td>338</td>
</tr>
</tbody>
</table>

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

wife for married men and used fitted values from these regressions as measures of other nonwage income for periods in which the data are not available. Some men had no nonwage income and were excluded from the regressions. These men were assigned zero nonwage income for all periods. Mean observed other nonwage income at wave 1 was $16,117 with a standard deviation of $24,694. The regression results are in the Appendix.

### 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 and the medical expense deduction.

### 3.10 Likelihood Function

An important consideration in obtaining consistent estimates of the parameters of this model is the fact that the initial conditions of the process generating the data are not observed. The data needed in order to estimate the model on the entire employment, medical care, and health insurance history are unobserved. Instead, we model behavior beginning one year prior to the initial survey and follow individuals from that age forward. Initial conditions such as tenure, earnings, the PIA,
health insurance coverage, and pension coverage as of the first period in which we observe them are likely to be correlated with the permanent error component, $\mu$, if previous employment decisions were determined by the same model as the employment decisions beginning at the initial survey. Failure to account for these initial conditions would lead to inconsistent parameter estimates. We deal with this by specifying models for the initial conditions, allowing them to be functions of $\mu$, and we estimate the parameters of the initial conditions models jointly with the other parameters. This approach was followed by Blau (1994) and is consistent with the approaches suggested by Heckman (1981).

The probability an individual chooses alternative $j, v, k, \ell$, unconditional on the available choice set and conditional on the state vector and unobserved heterogeneity is

$$p(d_{jvkl} = 1 \mid s_t, \mu) = \sum_{c=1}^{C} \eta_c p(d_{jvkl} = 1 \mid s_t, \mu, N_i) .$$

The conditional choice probability is integrated over the distribution of the unobserved health insurance choice set. As defined in section 2.4, $\phi$ is the probability of being laid off. Let $f_t$ indicate whether an individual is observed to be laid off at the end of period $t$ or not. Define $\Phi_t = (1 - \phi)^{t-1} \phi f_t$. The observed choices in period 1 depend on the individual’s state entering the period, as well as potentially endogenous initial conditions. Although the health state is observed in period 1, it’s probability cannot be modeled as a transition from the health state in period 0 because health and medical care consumption in period 0 are not observed. Let $I_b(B, \delta_b, \rho_{b\delta})$ represent the probability of observing a given value of the $b$'th endogenous initial condition (e.g., pia, earnings, health), where $B$ is a vector of non-time-varying explanatory variables, $\delta_b$ is a parameter vector, and $\rho_{b\delta}$ is a factor loading.

We observe the employment decisions and layoff indicators of individuals in every period. Medical care consumption is reported as a sum over two years. We randomly assign visits and hospital stays in each of the two years, and thus observe medical care consumption for each year. Health insurance choices are observed in periods 1 and 3 only. We integrate over all possible choices of health insurance in periods 2 and 4 (see line 2 of the likelihood function in Equation 10). The health state of individuals is known for periods 1, 2, and 4. We integrate over all possible health states if alive in period 3 (see line 3 of Equation 10). If an individual dies, the period of death is observed. These death dates help to identify the health transition probabilities. Conditional on $\mu$,
the likelihood function contribution for individual \( n \) is

\[
\mathcal{L}_n(\Theta | \mu) = \prod_{i} I_i(\mathbf{B}, \delta_i, \rho, \mu) \left[ \prod_{j=1}^{J_i} \prod_{v=0}^{K} \prod_{k=0}^{L_i} \prod_{\ell=0}^{d_{ijvk\ell}} \left[ p(d_{ijvk\ell}^1 = 1 | \eta, \mu) \Phi_i \pi_i^1 \right] \right]^{1(h_i = i, h_2 = n)}
\]

\[
= \prod_{t=2}^{4(\mu^2 + 2)} \left\{ \prod_{j=1}^{J_{s(t)}} \prod_{v=0}^{K} \prod_{k=0}^{L_{s(t)}} \left[ \sum_{\ell=0}^{d_{ijvk\ell}} p(d_{ijvk\ell}^1 = 1 | \eta, \mu) \Phi_i \pi_i^1 \right] \right\} \left[ \prod_{s(t+1)} \prod_{j' = 1}^{J_{s(t+1)}} \prod_{v' = 0}^{K} \prod_{k' = 0}^{L_{s(t+1)}} \prod_{\ell' = 0}^{d_{ijvk'\ell'}} \left[ p(d_{ijvk'\ell'}^1 = 1 | \eta, \mu) \Phi_{i+1} \pi_{i+1}^1 \right] \right]^{1(h_{t+2} = n)} \left[ (h_{t+1} \neq 2) \right] \left[ \pi_i^{0.2} \right]^{1(h_{t+1} = 2)}
\]

The unconditional likelihood contribution of individual \( n \) is

\[
\mathcal{L}_n(\Theta, \delta, \theta) = \sum_{m=1}^{M} \theta_m \mathcal{L}_n(\Theta | \mu_m) .
\]

The likelihood for the entire sample is

\[
\mathcal{L}(\Theta, \delta, \theta) = \prod_{n=1}^{N} \mathcal{L}_n(\Theta, \delta, \theta) .
\]

4 Estimation Results

5 Policy Experiments

6 Conclusion
Appendix

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 yet been coded.

If a man ever chooses 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. The generic employer plan characteristics were chosen as follows. Because most individuals in our sample who have a complete HIPPS record have a deductible that applies to all services, 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 premium for plans without retiree health insurance is $482.80 and for plans with retiree coverage is $672.74.

Data from Pension Providers

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 the wave 1 survey (which we refer to as w1-1), we used the program to compute the benefit to which a man would be entitled for every possible year in which he could quit the firm, from w1-1 until he reaches age 70. The program takes as input the man’s age and tenure with the firm as of w1-1, and his annual earnings for 1991 as reported by him in the wave 1 survey. For jobs held prior to w1-1, 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 a w1-1 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. 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 w1-1, since the respondent’s employment decisions from w1-1 on do not affect the benefit amount from jobs held prior to w1-1. These data are not sufficient to fill in missing information for pensions on jobs held at w1-1, 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 w1-1 in the solution to the DP problem. This is therefore a state variable for men who are covered by a pension at the w1-1 job.

*Medicare Characteristics*

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 percent. Part B coverage is optional but we assume that all men take it up.
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 copayment of 25 percent for outpatient care,
and a copayment of min($360/day, 25 percent) 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.

**Marital Status**

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 $x = 0.979$. We use this as a measure of the
exogenous probability that a marriage remains intact. Once a marriage dissolves, health insurance
from the spouse’s employer is no longer part of his choice set.

**Availability of Medicare prior to age 65**

We assume that Medicare is the relevant public insurance program, and use the acceptance
rate into SSDI as an indicator of public insurance availability, ignoring the fact that there is
actually a two-year wait after enrollment in SSDI before eligibility for Medicare. The wave 1
survey asks people who report ever having been disabled whether they had ever applied to SSDI
and if so whether they had ever been accepted. We assume that people who report never having
been disabled have a zero probability of being accepted to SSDI if they apply. We also assume
that people who report having been disabled but who never applied to SSDI would have a zero
acceptance rate if they applied and if they report being in good, very good, or excellent health,
and would have the same acceptance rate as the people who did apply if they report being in fair or poor health. The acceptance rate into SSDI using these assumptions was 0.070 for men in good, very good or excellent health, and 0.325 for men in fair or poor health. These are not truly annual rates, but we treat them as such, and set \( q_3 = 0.070 \) or 0.325 as a function of health. These did not vary significantly with age. We have no information with which to compute a measure of the probability of losing SSDI once enrolled, so we assume \( q_4 = 0 \).

**Private Health Insurance**

The HRS asks everyone in wave 1 (but not in wave 2) “have you ever been turned down when you applied for health insurance?” but they don’t ask whether you ever applied. If we assume that anyone who ever applied and was not denied is covered by private health insurance at the wave 1 survey date, then we can infer the proportion of men who ever applied as the proportion who report having been denied plus the proportion covered now and not denied = 0.054 + 0.144 = 0.198. This gives an acceptance rate of 0.144/0.198 = 0.727, which we use as the value of \( q_1 \). There is no way to identify the probability of losing private health insurance coverage (\( q_2 \)) from the HRS or any other data of which we are aware, so we set \( q_2 = 0 \). The characteristics of the private health insurance plan (except for the premium) are obtained from private plans held by individuals in the 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 $2221.88, the average premium reported.

**Probabilities of Gaining or Losing Employer Health Insurance**

As described in the text, we do not have information on the health insurance offered by firms unless the man or his wife is covered by the firm’s insurance. Therefore, we require measures of the probability that a man’s employer offers Health Insurance (HI) with Employer-Provided Retiree Health Insurance (EPRHI), \( Y_1 \), HI without EPRHI, \( Y_2 \), or neither, \( Y_3 = Y_1 - Y_2 \). We also need measures of the probability that a wife’s current or former employer offers HI that could cover the husband, \( Z_1 \). And we require measures of the probability that a job of type \( r \) in period \( t \) becomes a job of type \( r’ \) in period \( t+1 \), \( y_{t+1} \), \( r, r’ = 1, 2, 3 \) for husbands, and \( z_{12} \) and \( z_{21} \) for wives.

We use data from the April 1993 Supplement to the Current Population Survey to construct measures of \( Y_1 \) and \( Z_1 \).
offered by the individual's employer, whether the spouse could be covered, and whether retiree health insurance was available. We used the sample of men from the CPS who were in the same age range as our HRS sample to compute $Y_r$ as the fraction of men not covered by own-employer health insurance who report that the employer offers insurance of type $r$. This yielded $Y_1=0.038$, $Y_1=0.128$, and $Y_1=0.834$. We used the sample of married women from the CPS who were in the same age range as our HRS sample of wives to compute $Z_{1s}$ as $A/(A + B)$, where $A$ is the number of women not covered by insurance from their own employer and whose employer offered insurance that would cover the spouse; and $B$ is the number of women whose employer offered no insurance or insurance that would not cover the spouse.

Unfortunately, there are no data sources that allow us to measure the probability that employers change their health insurance offers, so we arbitrarily set $y_{rr} = 1$ and $y_{rr'} = 0$, $r' \neq r$, and similarly for the $z_{ss'}$'s. Conditional on identifying the $y_{rr'}$'s and $z_{ss'}$'s, the $\lambda$'s (job offer probabilities) are exactly identified functions of the $y_{rr'}$'s.

**Health Insurance Availability Probabilities**

The probability that a given health insurance option ($\ell$) will be part of a man’s choice set in period $t + 1$, given his health insurance choice in period $t$ ($l_t$), is denoted $\gamma_{l\ell}$ and is specified below for individuals under age 65. Note that the health insurance choice in period 0 is not observed (and therefore $l_1$ is not observed) and that the probabilities account for this fact. Men age 65 and older are assumed to be covered by Medicare, and may choose to supplement this insurance.

$$
\begin{align*}
\gamma_0 &= 1 \\
\gamma_1 &= 
\begin{cases} 
\frac{y_{11}}{} + (1 - y_{11})\lambda_1 & \text{if } l_t = 1 \text{ and } t > 1 \\
\frac{y_{31}}{} + (1 - y_{31})\lambda_1 & \text{if } l_t = 3 \text{ and } t > 1 \\
\left(Y_1(y_{11} + (1 - y_{11})\lambda_1) + Y_2(y_{21} + (1 - y_{21})\lambda_1) + Y_3(y_{31} + (1 - y_{31})\lambda_1)\right) & \text{otherwise}
\end{cases} \\
\gamma_2 &= 
\begin{cases} 
x(1 - z_{12}) & \text{if } l_t = 2 \text{ and } t > 1 \text{ and married at } t + 1 \\
x(Z_1(1 - z_{12}) + (1 - Z_1)z_{21}) & \text{if } l_t \neq 2 \text{ and married at } t + 1 \\
0 & \text{if not married at } t + 1
\end{cases} \\
\gamma_3 &= 
\begin{cases} 
\frac{y_{12}}{} + (1 - y_{12})\lambda_2 & \text{if } l_t = 1 \text{ and } t > 1 \\
\frac{y_{22}}{} + (1 - y_{22})\lambda_2 & \text{if } l_t = 3 \text{ and } t > 1 \\
\left(Y_1(y_{12} + (1 - y_{12})\lambda_2) + Y_2(y_{22} + (1 - y_{22})\lambda_2) + Y_3(y_{32} + (1 - y_{32})\lambda_2)\right) & \text{otherwise}
\end{cases}
\end{align*}
$$
\[
\gamma_4 = \begin{cases} 
1 - q_2 & \text{if } l_t = 4 \text{ and } t > 1 \\
q_1 & \text{otherwise}
\end{cases}
\]
\[
\gamma_5 = \begin{cases} 
1 - q_4 & \text{if } l_t = 5 \text{ and } t > 1 \\
q_5(i) & \text{if } l_t \neq 5 \text{ and } h_{t+1} = i
\end{cases}
\]

The expression for the probability that the choice set in period \( t \) includes each combination \( c, c = 1, \ldots, C \), of health insurance options \( (\eta_c) \) is the product of the \( \gamma \)'s over all available health insurance plans. Availability is determined by the insurance plan held in the previous period, age, and marital status, and the available insurance alternatives are denoted by the set \( N_c \). Thus,

\[
\eta_c = \prod_{t=0}^{5} \gamma_t^{1(\ell \in N_c)} (1 - \gamma_t)^{1(i \notin N_c)}
\]

For example, if \( N_c = (0, 1, 2) \), then \( \eta_1 = \gamma_0 \gamma_1 \gamma_2 (1 - \gamma_3)(1 - \gamma_4)(1 - \gamma_5) \). There are 32 different combinations of health insurance alternatives available given by the \( 2^5 \) different combinations of the five health insurance types. Option 0 (no insurance) is always available. A given firm offers only one of the three employer health insurance options but a man always has the option of taking a new job and the new job may offer a different option than his current job (if any).

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 $65.00 reflects the 1987 average price for a physician office visit among males 50 years old and older. The price per hospital night, $1210.00, is obtained similarly. The corresponding prices in 1992 dollars are $80.25 and $1493.83. Attempts were made to explain medical care prices as a function of health status and age, but coefficients were often insignificant or counterintuitive. Unexpected signs might have resulted from construction of the per night hospital cost. The per night figure is the total cost of the hospital stay divided by the length of the hospital stay. Individuals of different ages or health statuses differ in their lengths of stay and consequently, a per night price disaggregated by health status, for example, might not reflect the true distribution of prices.

Other Nonwage Income

Nonwage income (NWI) 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, and annuities. Standard
errors are in parentheses.

Single men: \( \log\left( \frac{NWI}{10000} \right) = -1.921 + 0.124*\text{educ} - 0.014*\text{age} \)

\[ R^2 = 0.07 \]

Married men: \( \log\left( \frac{NWI}{10000} \right) = -3.103 + 0.059*\text{seduc} + 0.00567*\text{seduc2} \)

\[ R^2 = 0.11 \]

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 above reenters 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 \( \text{SSB} = a + b*\text{PIA} \), the results are listed below.
| Age | a     | b     | \( R^2 \) | \(|\text{res}|\) |
|-----|-------|-------|----------|--------|
| 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    |

\(|\text{res}| = \text{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 reentering employment following a nonemployment 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 reenters employment following a nonemployment spell after age 61.
References


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