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MARKET WAGES, RESERVATION WAGES, AND RETIREMENT

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ABSTRACT

The paper is an empirical cross-section of the retirement decisions of American white men between the ages of 58 and 67, predicated on the theoretical notion that an individual retires when his reservation wage exceeds his market wage. Reservation wages are derived from an explicit utility function in which the most critical taste parameter is assumed to vary both systematically and randomly across individuals. Market wages are derived from a standard wage equation adjusted to the special circumstances of older workers.

The two equations are estimated jointly by maximum likelihood, which takes into account the potential selectivity bias inherent in the model (low-wage individuals tend to retire and cease reporting their market wage). The model is reasonably successful in predicting retirement decisions and casts serious doubt on previous claims that the social security system induces many workers to retire earlier than they otherwise would. The normal effects of aging (on both market and reservation wages) and the incentives set up by private pension plans are estimated to be major causes of retirement.

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1. Introduction and Preview

Why do people retire? This question is now attracting increasing attention because of recent and proposed changes in the minimum age of mandatory retirement and because of the likelihood that the social security system will be in need of major structural overhaul in the coming years. It is clear that labor force participation rates among older men are declining quite rapidly. The reasons behind this trend are less clear.

We can enumerate five basic classes of reasons why older people retire from the labor force. First, failing health in old age may make work much more difficult, or less remunerative if wages decline as a result of ill health. Second, advancing age may pull wages downward even when health is not an issue.[1] Third, it has been suggested that the social security system sets up powerful incentives that induce people to retire earlier than they otherwise would.[2] Fourth, private pension arrangements may offer similar financial incentives for retirement. Fifth, as people age their preferences may shift in favor of leisure and against work. Our purpose in this paper is to estimate the relative importance of each of these competing hypotheses--health, wages, social security, private pensions, and tastes--in explaining retirement decisions, and to see which (if any)

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[1] That is, even for individuals whose health is average for their age.

[2] See, for example, Boskin (1977), Boskin and Hurd (1978), Burkhauser (1977), Burkhauser and Turner (1978). This list could easily be extended.

can explain the trend toward earlier retirement.

Health: It is by now well documented that, when retirees are asked to explain their actions, ill health is the most common explanation of retirement.[3] Our estimates find a substantial, though not overwhelming, effect of ill health. However, effects of health on retirement age will not explain the trend in retirement age since health improvements over time would imply an increase, not a decrease, in retirement ages.

Wages. When or if an individual chooses to retire depends critically on the life-cycle pattern of wages.[4] There is some controversy in the human capital literature over whether age *per se* has a depressing effect on wages. By using an econometric correction for selectivity bias, we uncover evidence here that it does. But a concave age-wage profile can explain an *increasing* propensity to retire only if it shifts in a manner that is unfavorable to older workers. We find tentative evidence that this has happened, too.

Social Security. The *net* wage late in life can decline either because the *gross* wage falls (as just suggested) or because the tax-and-transfer wedge between gross and net wages increases. Many people have thought that the social security system--and particularly the earnings test--causes such an effect by placing a heavy tax on work effort late in life. We doubt that this explanation of retirement makes sense, and have designed our research program accordingly. The reasons for our skepticism

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[3]For a summary, see Campbell and Campbell (1976).

merit some explanation.[5]

Many observers have pointed out that the social security law creates a complex multi-armed budget constraint for eligible individuals.[6] Though labor supply decisions are distorted by social security, perhaps substantially, it is most unlikely that social security sets up strong incentives to retire--that is, to reduce hours of work to zero--because:

1. a small amount of earnings (currently $3,000 per year) is allowed before the earnings test is applied. Hence, in the neighborhood of zero hours of work, the marginal tax rate implicit in the social security system is zero.

2. current earnings have a potentially important effect on future social security benefits. We have shown elsewhere that under plausible circumstances this effect can amount to approximately a 50% wage subsidy and might well discourage people from retiring. (Blinder, Gordon, and Wise (1980a))

3. individuals who opt not to begin collecting social security benefits at age 62 earn an upward adjustment in their potential benefits at age 65 that often provides more than actuarially fair compensation. (Blinder, Gordon, and Wise (1980a).)

Consequently, we decided to concentrate our initial efforts on retirement decisions, not labor supply decisions in general, leaving the more difficult, but worthwhile, extension to hours of work to future research.[7] Our basic model of retirement

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[5]For a much fuller treatment of this issue, see Blinder, Gordon, and Wise (1980a).

[6]Boskin and Hurd (1978), Hanoch and Honig (1978), and others.

[7]For a preliminary attempt, see Blinder, Gordon, and Wise (1978), Chapter VI. We are far from satisfied with the results.

assumes that social security is irrelevant to retirement decisions. As a check on this, however, we append a few variables designed to "pick up" any social security effects that may have been overlooked. In general, these variables achieve statistical significance, but are of little empirical importance.

It hardly needs pointing out that if social security has little effect on retirement decisions, the *growth* of the social security system cannot explain the *trend* toward retirement--frequent claims to the contrary notwithstanding.

Private Pensions. The story is rather different, however, when we consider private pensions.[8] First of all, many private pension plans include a provision for mandatory retirement at a prescribed age [Skolnik (1976)]. In such cases, the incentive to retire is fairly obvious: a compulsory change in jobs may occasion a loss of wages so severe that the worker prefers to retire rather than take a job at a much reduced wage. One goal of our model is to estimate this wage loss, and we find it to be very substantial.

The effect of private pensions in the absence of mandatory retirement is more subtle, but may be quite powerful nonetheless. Once the age of eligibility for the pension arrives, a worker who continues to work reduces the discounted present value of his pension benefits if he remains on the job because his future

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[8] For more details on these matters, see Blinder, Gordon, and Wise (1978), especially Chapters I and II.

annual rate of benefits is rarely adjusted upward. Thus if w is his annual wage and b is his annual pension benefit, the marginal return to a year of work drops from w to $w-b$ at the age of eligibility for the pension. Furthermore, many private pension plans create a bonus for early retirement by failing to adjust the annual pension benefit downward by the full actuarial amount if the worker elects to retire early.[9] Our estimates suggest a very strong effect of a private pension on the retirement decision. Since private pension plans have grown so explosively during the postwar period, this factor can help account for the growing prevalence of retirees.[10]

The plan of the paper is as follows. The next section discusses our theoretical model of retirement decisions, and the following section briefly describes the data source and estimation technique. Sections 4 and 5, the heart of the paper, flesh out the details of our precise econometric specifications of a market wage equation and a reservation wage equation respectively, and also present and interpret the estimated coefficients. The model, however, is sufficiently nonlinear and complicated that the coefficient estimates do not "speak for themselves." Thus Section 6 is devoted to analyzing the implications of our estimates for retirement decisions. Section 7 concludes the

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[9]See Skolnik (1976), especially pp. 8-9.

[10]In a broad sense, these effects of private pensions can perhaps be considered indirect effects of social security since it is probably the social security system that singled out age 65 as the standard age for pension eligibility and/or mandatory retirement.

paper with some brief remarks on why people retire.

2. A Model of the Retirement Decision

If we are to model retirement decisions, we must first settle on a definition of retirement--a concept that is not nearly so unambiguous as it may sound. In this paper, we define retirement in the most straightforward possible way: as zero hours of work for money. We note, however, that some other authors have preferred alternative definitions.[11]

Our model of retirement is simple. Indifference curves between leisure and income shift naturally over time due to the aging process, and also due to changes in health. Similarly, the market wage changes over time because of age, experience, and other reasons. At some point <u>for some people</u> there comes an age (the age of retirement) at which the highest indifference curve is reached at a corner solution with zero hours of work, as depicted in Figure 1. Notice in Figure 1 that the shape of the budget line far away from zero hours of work probably has no bearing on the retirement decision,[12] though it may have a crucial bearing on the choice of optimal hours for those who are not retired.

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[11]See, for example, Boskin (1977) or Reimers (1977).

[12]There is one important exception to this. If the budget set is extremely convex--for example because current earnings have a large positive effect on future social security benefits--the shape of the budget line at high hours of work could influence the retirement decisions of some people. This effect would induce these people to stay in the labor force, not to retire. For more on this, see Blinder, Gordon, and Wise (1980a).

To express these simple intuitive notions in a way that lends itself to econometric work, let the market wage available to individual i at date t be described by a "wage equation" of the form:

$$\log w_{it} = f(X_{it},\beta) + \epsilon_{it} , \qquad (1)$$

where w is the wage, X is a vector of characteristics relevant to wages, β is a vector of coefficients in the wage equation, and ϵ is a normally distributed error term.[13]

To derive the reservation wage, consider the following utility maximization model of labor-leisure choice. Each individual lives for three periods: the "past," the "present," and the "future." These will be denoted periods 0, 1, and 2 respectively, and assumed to have lengths (measured in years) T_0, 1, and T_2. Letting C_i denote consumption in the three periods (bequests are ignored, but can easily be allowed for) and L_i denote the fraction of each period spent at leisure, the utility function to be maximized is assumed to be:

$$J = T_0\{U(C_0) + V(L_0)\} + \frac{U(C_1) + V(L_1)}{1+\rho_1} + T_2 \frac{U(C_2) + V(L_2)}{(1+\rho_1)(1+\rho_2)} ,$$

where ρ_1 and ρ_2 are subjective discount factors. Ignoring human capital formation and assuming perfect capital markets, the only relevant constraint is the lifetime budget constraint:

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[13]Our precise specification of the function $f(\cdot)$ will be explained in Section 4.

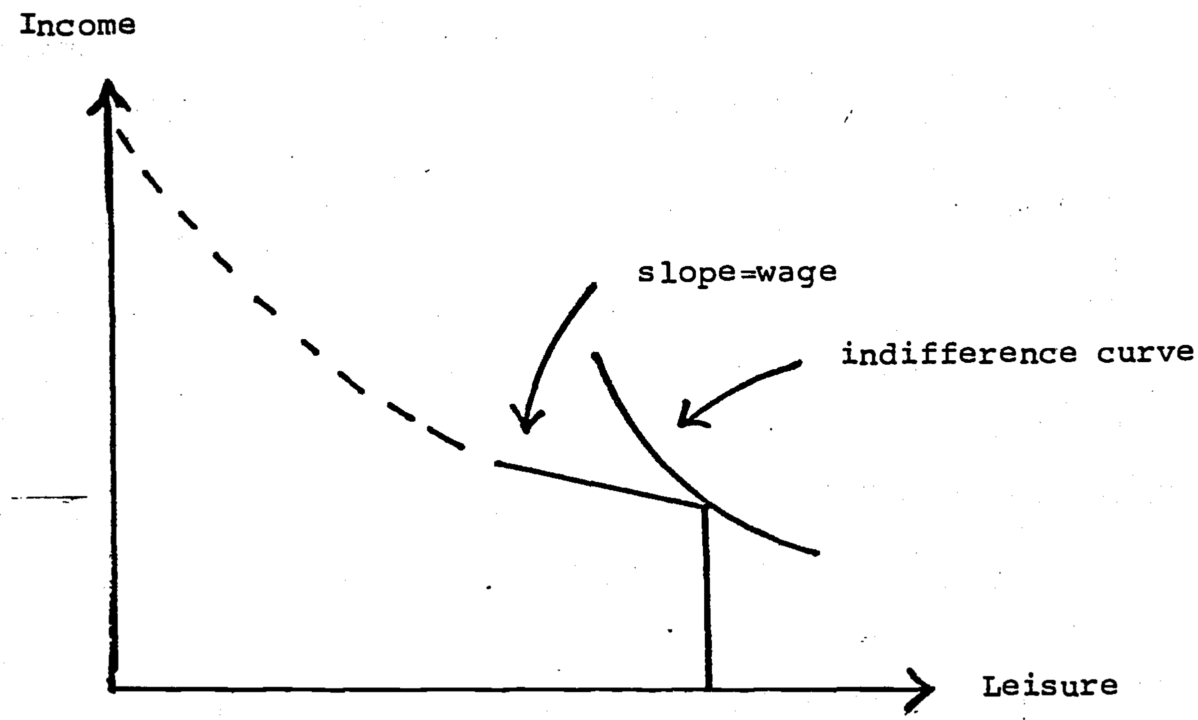

Figure 1

$$T_0C_0 + \frac{C_1(T_1)}{1+r_1} + \frac{T_2C_2}{(1+r_1)(1+r_2)} = A_0 + w_0T_0(1-L_0)$$

$$+ \frac{w_1(1-L_1)}{1+r_1} + \frac{w_2T_2(1-L_2)}{(1+r_1)(1+r_2)} \quad , \tag{2}$$

where A_0 is initial wealth, r_1 and r_2 are the relevant interest factors, and leisure time is measured as a fraction of the period.

Under the following simplifying notation:

$$d_0 \equiv 1, \quad d_1 \equiv \frac{1}{1+r_1}, \quad d_2 \equiv \frac{1}{(1+r_1)(1+r_2)}$$

$$\theta_0 \equiv 1, \quad \theta_1 \equiv \frac{1+\rho_1}{1+r_1}, \quad \theta_2 \equiv \frac{(1+\rho_1)(1+\rho_2)}{(1+r_1)(1+r_2)}$$

$$F \equiv A_0 + \sum_{i=1}^{3} w_iT_id_i = \text{"full income,"}$$

the first-order conditions for a maximum can be written:

$$\sum_{i=1}^{3} d_iT_i(C_i + w_iL_i) = F \qquad \text{(the budget constraint)} \tag{3}$$

$$U'(C_i) = \lambda\theta_i \qquad \text{(optimal consumption choices)} \tag{4}$$

$$\left.\begin{array}{ll} V'(L_i) = \lambda w_i\theta_i & \text{if } 0 < L_i \leq 1 \quad (5a) \\ V'(1) > \lambda w_i\theta_i & \text{if } L_i = 1 \quad (5b) \\ V'(0) < \lambda w_i\theta_i & \text{if } L_i = 0 \,. \quad (5c) \end{array}\right\} \text{(optimal leisure choices)}$$

We assume here that consumption is always at an interior solution, but must consider corner solutions for leisure more carefully.

To make headway toward an econometric specification, we adopt the following particular utility functions:[14]

$$U(C_i) = \frac{C_i^{1-\delta}}{1-\delta} \tag{6}$$

$$V(L_i) = \xi_i \frac{L_i^{1-\delta}}{1-\delta} \quad , \tag{7}$$

where the age-specific taste parameters ξ_i are our way of incorporating systematic changes in preferences toward leisure as an individual ages. Since prime-age men have been observed to supply labor very inelastically, we further assume that ξ_0 is approximately zero, so that labor supply in period 0 is inelastic at T_0 (i.e., $L_0 = 0$ in accord with (5c)).

We are interested in the L_1 decision and, in particular, whether or not L_1 will be less than unity. Since the result differs somewhat depending on whether or not the individual assumes he will be retired in period 2, we present here the reservation wage for period 1 under the assumption that the individual will be retired in period 2.[15] Assuming $L_2 = 1$

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[14] Pollak (1971) proves that a minor generalization of this is the most general class of additively separable utility functions leading to demand functions that are linear in income. This form is widely used in both theoretical and empirical work on a variety of subjects.

[15] The next two footnotes deal with the case in which the individual will not be retired in period 2.

and using (4)-(7) and the budget constraint (3), we can solve for consumption and leisure in all three periods. The resulting demand for leisure in period 1 is:

$$L_1 = \frac{(F-w_2d_2T_2)\mu_1(\frac{w_1}{\xi_1})^{-\frac{1}{\delta}}}{Q + w_1d_1\mu_1(\frac{w_1}{\xi_1})^{-\frac{1}{\delta}}} \qquad (9)$$

where

$$Q \equiv T_0 + d_1\mu_1 + d_2T_2\mu_2 \quad \text{and} \quad \mu_i \equiv (\theta_i)^{-\frac{1}{\delta}} .$$

The reservation wage, denoted w_1^R is defined as the value of w_1 that makes L_1 just equal to unity. A little algebraic manipulation shows this to be given by:

$$\log w_1^R = -\delta \log Q + \log \xi_1 + \delta \log\mu_1 + \delta\log(A_0+w_0T_0). \qquad (9)$$

Each of the terms in (9) merits consideration. The first term is basically a constant.[16] The second term is a taste variable which will be modelled more explicitly below. The third term captures the typical intertemporal tradeoff found

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[16] Specifically, in an n-period lifetime, with constant interest rate r and constant time discount rate ρ, Q would be:

$$\sum_{i=0}^{n-1} [(\frac{1+\rho}{1+r})^t]^{-\frac{1}{\delta}} .$$

If the individual will not be retired in period 2, the following term must be added to Q:

$$w_2T_2d_2\mu_2(\frac{w_2}{\xi_2})^{-\frac{1}{\delta}} .$$

For plausible parameter values, and our estimated value of δ, this term is less than 0.01, so ignoring it is inconsequential.

in all life-cycle models. Written out explicitly, it is:

$$\delta \log \mu_1 = \delta[-\frac{1}{\delta} \log \theta_1] = \log(1+r_1) - \log(1+\rho_1) .$$

The interpretation is clearest if the annual interest and time discount rates are approximately constant and equal to r and ρ respectively, for then this term is $(r-\rho)A$, where A is age. If ρ is low (high) relative to r, the individual prefers to postpone leisure (work), i.e., the reservation wage rises (falls) with age. The final term in (9) is "full income" in past years.[17]

Statistically identical individuals, however, make different labor-leisure choices (or, in this context, have different reservation wages), presumably because they have different tastes. So it seems important, in the stochastic specification of the model, to allow for individual differences in tastes. Though the utility function we have used has five taste parameters, it is clear that where retirement decisions are concerned the parameter of greatest economic significance is ξ_1 , the weight on current-period leisure in equation (7). So, for empirical purposes, this is the one we allow to vary across individual, viz.:

$$\log \xi_i = \log \bar{\xi}_i + \eta_i ,$$

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[17] If the individual will work in period 2, then $w_2 d_2 T_2$ must be included in the "full income" concept.

where η_i is a normally distributed random variable. In the empirical work, $\log\bar{\xi}_i$ is taken to be a linear function of a number of observable variables (age, health, etc.) so we can write (9) as:

$$\log w_i^R = Z_i\gamma + \eta_i \, , \tag{10}$$

where Z_i is a vector including age, full income, and all the determinants of $\log\bar{\xi}_i$. A full account of Z will be given in Section 5.

Given equation (1) for the market wage and equation (10) for the reservation wage, the model of retirement described in words and depicted in Figure 1 can be stated algebraically as follows:

Individual i will be retired or working according as:

$$\log w_i^R \gtrless \log w_i$$

$$\text{or} \tag{11}$$

$$Z_i\gamma + \eta_i \mathrel{\substack{\geq \\ = \\ <}} f(X_i,\beta) + \epsilon_i \, .$$

It will be noted that our approach to deriving condition (11) as a model of retirement is strikingly similar to the method introduced by Heckman (1974) for dealing with selectivity bias in another context. The application of Heckman's analysis to our problem is quite clear. Individuals who happen to draw low values of ϵ_i will decide to retire, and hence we will not observe their wages. This suggests, for example, that the effects of age on wages as estimated from the working population will be biased upward by sample selection because it will be mostly those with favorable drawings of ϵ_i that actually get into the sample. Thus, in addition to providing an empirical model of the retirement decision, the model we estimate here offers the side benefit of providing estimates of a standard wage equation like (1) that are not afflicted by selectivity bias. Selectivity bias corrections turn out to be sizeable in some cases.

3. Data and Method of Estimation

The data used to estimate the model were drawn from the first three waves (1969, 1971, and 1973) of the Longitudinal Retirement History Survey (LRHS). This survey conducted extraordinarily detailed interviews of 11,153 individuals aged 58-63 in 1969, and repeated the interviews at two-year intervals for those individuals who survived and could be located. In each survey year, individuals were asked a variety of questions (wage rate, typical hours, eligibility for pension, etc.) about their current job, if they had one. In addition, the 1969 interview included questions about their previous job--which would have been their last job if they were already retired, and about a number of socioeconomic variables that would not change through time (e.g., family background, education).

From these data we extracted a sample of white males who were not self employed and who worked for pay at least some time in their lives as our basic sampling frame. Certain other exclusions were forced upon us by the data. For example, since a principal focus of the wage equation was to estimate separately the returns to prior experience and tenure on the current job, a respondent who did not report his job tenure, and for whom this information could not be deduced,[18] was dropped from the sample. Secondly, respondents were free to report wages for any time period they chose (e.g., hourly, weekly, monthly). We converted each response into an hourly wage and expressed each in 1969 dollars. However, whenever the reported information was inadequate to construct the hourly wage rate, or was clearly erroneous,[19] the observation was dropped from the sample. With a few minor exceptions,[20] we imputed all other missing data as best we could rather than censor the sample. On balance, of

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[18] For example, if job tenure was unknown in 1969, but reported as 25 years in 1971, we assumed it was 23 years in 1969.

[19] Reported wage rates above $50 per hour (or $100 per hour in the case of managers and professional workers) or below one third of the average wage rate in manufacturing (which was $1.06 in 1969) were considered erroneous.

[20] There were a few cases in which there was not adequate information on the lifetime pattern of job holdings to construct the measure of "full income" needed for equation (9). In a few other cases, the reported data implied what to us was an implausibly long hiatus between the end of schooling (or, more accurately, years of education plus 6) and the start of the first full time job. When this gap was greater than 15 years, we dropped the observation from the sample.

our original potential sample of 7,420 white males in 1969, we lost 258 individuals in all three years because of an inability to construct permanent income; dropped 143 retirees because they did not report their job tenure on their last job; and dropped 1,789 observations in 1969, 1,308 observations in 1971, and 1,625 observations in 1973 because of missing data on wage rate or job tenure. In addition, there was some sample attrition due to death or inability to locate the individual for re-interview. After all these deletions, however, we were still left with a sample 1f 15,981 observations, of which 9,879 were workers and 6,102 were retirees.

Estimation was by maximum likelihood. $\text{Log}(w_i)$ is stochastic due to ϵ_i and retirement status is stochastic due to the joint influence of ϵ_i and η_i. We assumed that ϵ_i and η_i were related by:

$$\eta_i = \rho\epsilon_i + v_i \quad , \tag{12}$$

where ϵ_i and v_i are independent normal variables. Given any set of estimates of all the parameters, the model implies both a density for the market wage and a probability that the individual will be retired (conditional on his wage, if it is observed). The data tell us which people are retired, and the actual wages for those who are working. The parameters were chosen to maximize the likelihood of obtaining the sample.[21]

[21]Details on the precise likelihood function are provided in the appendix.

4. The Market Wage Equation

Our market wage equation:

$$\log w_i = f(X_i,\beta) + \epsilon_i \qquad (1)$$

is rather complicated, and can best be understood if its objectives are made clear at the outset. They were:

(1) To examine in some detail the effects of aging on wages, seeking to untangle the interrelated effects of age, vintage, and experience, since each of these might be relevant to retirement decisions.

(2) To investigate the effects of pensions and pension-related job provisions (such as mandatory retirement) on wages. As mentioned in the introduction, job transitions late in life induced either by mandatory retirement or by pensions may imply a substantial loss of earning power if job tenure (henceforth, j) is more valuable than previous experience on other jobs (henceforth, x). A sharp drop in wages, in turn, might induce retirement.

(3) To measure the loss in market wages from job transitions late in life that stem from reasons other than pensions (e.g., from a desire to reduce hours of work). This requires us not only to separate out the effects of job tenure from those of previous experience, but also to disaggregate by occupation group since there is every reason to believe that the cost of a job transition varies by occupation.

Previous Experience and Job Tenure

The nonlinear part of (1) deals with the effects of experience on wages, which the work of Mincer (1974) and others has taught us is nonlinear. The need to (a) separate the effects of j from those of x and (b) disaggregate by occupation led us to adopt a rather parsimonious functional form that nonetheless allowed for diminishing returns to experience. We selected as our basic specification:

$$\log w = \beta_{0k} + \alpha_k \log(j+b_k x) \ ,$$

where the subscript k indicates that these coefficients vary by occupation. If $b_k = 1$, then only the sum $j+x$ matters--as in the conventional specification of wage equations. To the extent, however, that previous experience is less valuable than experience on the current job, b_k will be less than unity. (In our estimates, all of the b's turned out to be substantially less than unity.) Supposing that all the α's and b's turn out to be positive (as they do), the specification implies positive but diminishing returns to both j and x, and a negative interaction term, i.e., as job tenure increases, the value of previous experience decreases. These properties seem reasonable on a priori grounds to us--more reasonable, e.g., than assuming no interaction between j and x.

This basic specification was extended in three ways in order to implement the objectives listed above. First, we allowed both the basic wage-experience profile and the relative returns of j versus x to differ between jobs with or without pensions. Second, we allowed a change in occupation to "devalue" one's previous experience. Third, we recognized that in jobs with pensions some part of hourly compensation is deferred, and that workers might not value pension contributions equally with straight wages. These led to the following amendments to our basic specification:

$$\log(w+\lambda p) = \beta_{0k} + \beta_4 DP + \alpha_k \log[(1+\beta_1 DP)j + (\beta_{2k}+\beta_3 DO)x] \quad (13)$$

where p is (our estimate of) the hourly pension contribution made by the employer,[22] DP is a dummy equal to one for workers with pensions, and DO is a dummy equal to one for workers who are currently in an occupation different from that of their longest job. The parameter λ indicates the weight given to pension contributions relative to straight wages. We expect $0 < \lambda < 1$, $\beta_3 \leq 0$, but have no particular supposition about β_1.

The choice of occupational groupings was meant to balance our desire to obtain disaggregated information against our fear of letting an already awesome computational problem become entirely unmanageable. Since each occupational group leads to three new parameters, as can be seen in (13), we decided to limit ourselves to the following four occupational groupings:

<u>Occupation Group 1</u>: Professionals and technical workers; Managers, officials, and proprietors.

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[22]The construction of p was quite complicated, owing to certain shortcomings in the data. Details are available on request.

<u>Occupation Group 2</u>: Salesmen; Clerical workers.

<u>Occupation Group 3</u>: Craftsmen, Operatives, Private household workers, Service workers.

<u>Occupation Group 4</u>: Nonfarm laborers, Farm managers, Farm laborers, Occupation unknown.

The occupation groups were chosen for their inherent similarity and can be loosely thought of as "high class" white collar, "low class" white collar, skilled blue collar, and unskilled blue collar.

Estimates of the parameters just discussed appear in the top portion of Table 1, which reports estimates of all the parameters of the likelihood function that pertain to the market wage. The reader is reminded, however, that the market and reservation wage equations were estimated jointly. This was necessary because the estimated market wage equation would otherwise be afflicted by selectivity bias.

The estimates contain a number of interesting results. First, returns to experience (the α_k in equation (13)) turned out to differ surprisingly little across occupations. The estimates imply that the marginal returns to an additional year of job tenure (j) are quite low for older workers. If $j = 20$ and $x = 25$, which are typical figures in our sample, the marginal returns to an additional year of tenure on the job range between 0.66% and 0.83%, depending on occupation. Even in an extreme case like $j = 5$, $x = 40$, the range is only from 1.11% to 2.17% per year. As we expect, professionals and managers reap the greatest returns from job tenure and laborers the least.

There is more variation across occupations in the returns to previous experience. But, more importantly, we see very low returns to previous experience in all occupations. The weight attached to x in the weighted sum $j + bx$ ranges from .07 to .28 if there has not been a change in occupation, and from .03 to .24 if there has been. Marginal returns to an additional year of previous experience apparently are trivial for older workers.

The tremendous effect that having a pension has on the job tenure profile is of particular interest because of its importance for retirement decisions. As can be seen in (16), we allowed the existence of a pension to affect both the intercept and the slope of the wage-tenure profile. Specifically, for jobs without pensions equation (13) becomes:

$$\log w = \beta_{0k} + \alpha_k \log[j + \beta_{2k}x], \tag{13a}$$

while for jobs with pensions it becomes:

$$\log w = \beta_{0k} + \beta_4 + \alpha_k \log(1+\beta_1) + \alpha_k \log[j + \frac{\beta_{2k}}{1+\beta_1} x] . \tag{13b}$$

Given our parameter estimates, wages are systematically higher on jobs with pensions, though the amount by which they are higher varies both by occupation and according to the mix of job tenure and prior experience. The wage differential between jobs with and without pensions is greatest when j is small relative to x, and diminishes as j rises relative to x.[23] It seems clear that the pension dummy is "picking up" some unmeasured attribute that pays off in the form of higher wages; among the possibilities are ability, reliability, some unmeasured aspect of human capital, or even the returns to union membership.[24]

An important question to ask, given our interest in retirement decisions, is: what does it cost an older worker to change jobs late in his career (perhaps because he wants to step down to a job with shorter hours)? To answer this, we assume first that he has no pension on either job, so the issue is merely one of swapping j for x. Table 2 displays the effect on wages of giving up a job on which the worker has either 45, 20, or 10 years of experience in order to take a new job (with $j = 0$, $x = 45$). The losses are typically quite substantial.[25]

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[23]For example, the differential is 82% when $j=0$ and $x=45$, falls to between 35% and 54% (depending on occupation) when $j=15$ and $x=45$, and to 20% - 33% when $j=30$ and $x=15$.

[24]Our data did not tell us which individuals were union members, and it is well known that pensions are more common in the unionized sector.

[25]The calculation is based on comparing the value of $\exp[\alpha_k \log(j+\beta_{2k}x)]$ when j and x are as indicated in the table with $\exp[\alpha_k \log(45\beta_{2k})]$.

TABLE 1

Parameters of the Market Wage Equation

Variable	Coefficient	(Standard Error)	OLS Estimate[a]	(Standard Error)
weight on pensions (λ)	.519	(.110)		
Overall constant	.235	(.056)	-.106	(.252)
Constant for				
OCC 1	.210	(.033)	1.346	(.439)
OCC 2	.018	(.052)	.103	(.420)
OCC 4	-.086	(.076)	-.539	(.576)
Log of total experience (α_k) in				
OCC 1	.165	(.014)	-.008	(.099)
OCC 2	.196	(.021)	.228	(.096)
OCC 3	.172	(.016)	.420	(.140)
OCC 4	.179	(.021)	.267	(.067)
Weight on x (β_{2k}) in				
OCC 1	.066	(.016)	-34.9	b
OCC 2	.147	(.034)	.320	b
OCC 3	.106	(.022)	.699	b
OCC 4	.281	(.055)	.575	b
Change in occupation slope	-.040	(.009)	-.591	b
Pension Variables				
Pension slope (β_1)	-.947	(.014)	-.205	b
Pension intercept (β_4)	.601	(.021)	.269	(.017)
Government pension dummy (GP)	-.116	(.020)	-.097	(.017)
Private Pension dummy (PP)	-.053	(.016)	-.014	(.013)
Age Variables				
AGE - 61	-.026	(.005)	.005	(.005)
AGE times blue collar dummy	-.017	(.004)	-.010	(.004)

TABLE 1 (continued)

Variable	Coefficient	(Standard Error)	OLS Estimate[a]	(Standard Error)
10 minus years to mandatory retirement (YEARSMR)	+.0033	(.0015)	.0047	(.0017)
Health Variables				
Short-term health problem	-.094	(.010)	-.028	(.014)
Long term health problem	-.101	(.011)	-.037	(.013)
Left last job for health reasons	-.880	(.037)	-.126	(.076)
VINTAGE	.0010	(.0038)	-.0092	(.004)
Father nonfarm (DNF)	-.001	(.008)	.080	(.010)
Education				
Slope 1-8 years	.029	(.003)	.021	(.004)
Slope 9-12 years	.032	(.005)	.033	(.006)
Jump for high school diploma	.015	(.018)	-.019	(.021)
Slope beyond 12 years	.045	(.006)	.037	(.007)
Jump for college diploma	.077	(.026)	.120	(.035)
Standard error (σ_ϵ)	.468	(.004)	.424	
Number of observations	15,981		9,879	
reporting wages	9,879		9,879	
not reporting wages	6,102		-0-	
log likelihood[c]	-11,756.6		R^2 = .34	

[a] In the OLS regression, the nonlinear terms had to be approximated linearly. See, for example, footnote 29.

[b] Since the reported coefficients here are ratios of estimated coefficients, we do not report a standard error.

[c] For the full equation, including retirees.

workers with even moderate amounts of job tenure (10 years) lose a lot by changing jobs--except for workers in occupation group 4 (unskilled laborers).

Next we consider the wage loss from leaving a job with a pension. If the new job has no pension, then the wage loss is tremendous, as Table 3 indicates.[26] Such a job transition entails both a loss of the benefits from being on a pensioned job and substantial devaluation of one's previous experience. By contrast, however, there is no wage loss (in fact, a slight gain) if the new job has a pension.

On balance, the typical wage loss from a job transition late in life appears to be quite severe. It is doubtful, therefore, that many older workers will want to make such transitions voluntarily. Loss of a job through unemployment, mandatory retirement, or a temporary bout of ill health, may well induce a worker to retire rather than change jobs late in life.

Value of Pension Contributions

As already noted, an estimate of the hourly pension contribution was included in the lefthand side of (13), multiplied by a weight λ.[27]

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[26]Of course, to the extent that our pension dummy is picking up unmeasured individual traits that are portable (e.g., ability) workers will not actually experience such a large wage loss.

[27]Unfortunately, in about half of the observations with pensions the information needed to construct p was missing. Our approach to this problem led to the inclusion of two dummy variables:

GP = dummy equal to 1 for a government job with a pension whose benefits are unknown

(continued)

TABLE 2

Percentage Loss of Wages from Job Transition
when Neither Job Has a Pension

	Initial j and x		
Occupation Group	j=45, x=0	j=20, x=25	j=10, x=35
1	36.3	28.1	21.0
2	31.3	22.1	15.0
3	32.0	23.5	16.6
4	20.4	12.8	7.8

TABLE 3

Percentage Loss of Wages from Job Transition from Old Job with a Pension to New Job without a Pension

	Initial j and x		
Occupation Group	j=45, x=0	j=20, x=25	j=10, x=35
1	43.1	44.3	44.7
2	32.9	41.4	43.5
3	38.2	42.7	44.0
4	25.9	40.6	43.2

The point estimate of λ suggests that $1 contributed to a pension fund is worth about 52¢ in direct compensation. This is rather lower than might be expected, but it must be remembered that some of these pensions were not vested and others were not funded very soundly. In addition, our rough approximation to the variable p (the average pension contribution per hour over the life of the job) may be a poor approximation to the marginal contribution rate--suggesting downward bias from measurement error. This bias may be aggravated further by potential endogeneity of p (i.e., a positive correlation of p with ϵ).

Age Variables

As noted earlier, the pure effect of aging on wage rates is of some importance for explaining why people retire. Furthermore, there is some controversy in the human capital literature over

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(footnote 27 continued)

PP = dummy equal to 1 for a private job with a pension whose benefits are unknown.

The rationale is as follows. Consider the lefthand side of (13) as a function of λ. Expanding it to find the Taylor series approximation around $\lambda = 0$ gives:

$$\log(w+\lambda p) \approx \log w + \frac{p}{w}\lambda .$$

For people with unknown p, we set p=0 on the lefthand side of (13) and entered instead a dummy variable on the righthand side whose coefficient is to be interpreted (with sign reversed) as an estimate of the ratio of $\lambda p/w$ in these jobs. Since we know that this ratio is typically much greater in government jobs than in private-sector jobs, we entered the two dummy variables defined above.

whether there is such an effect, once schooling and experience are controlled for. If there is a direct effect of age on wages, it seems most likely to show up among older workers. We tested for it by including the following two variables:

AGE - 61 = age minus 61 if positive
0 otherwise

AGEBC = age minus 58 for blue collar workers (groups 3 and 4 above)
0 for white collar workers

The parameter estimates in Table 1 do indeed suggest an effect of age _per se_ on wages. Specifically, we estimate a typical decline in _real_ wages of about 2.6 percent per year starting at age 61 for white collar workers, and a decline of about 1.7 percent per year between ages 58 and 61 rising to about 4.3 percent per year after age 61 for blue collar workers. Since these numbers are much larger than the estimated returns to job tenure at these ages, real wages typically will be falling after age 61, and this will provide some inducement to retire.

One further aging variable was included to try to gain some understanding of the mandatory retirement phenomenon. It seemed to us that the existence of mandatory retirement must imply that--for some reason--wages diverge from marginal productivity late in life, and that firms have a need to terminate this implicit subsidy after some point.[28] Viewing the rest of the

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[28]See Lazear (1980) for some rationalizations for this phenomenon.

equation as measuring marginal productivity, we included the following variable to measure the gap between marginal products and wages:

YEARSMR = 10 minus the number of years until mandatory retirement *if* this number is positive and *if* the job has mandatory retirement

= 0 otherwise

For workers on jobs with mandatory retirement, this variable begins at 1 nine years before retirement and grows linearly to 10 just before retirement. A positive coefficient would therefore indicate that such workers are increasingly "overpaid" relative to their marginal products, and hence would provide a rationale for mandatory retirement.

Though the estimated coefficient is positive, and its "t ratio" is moderately respectable, we cannot consider this variable to be successful in explaining mandatory retirement because of its small size--about one-third of a percent per year. A substantial gap between wages and (our proxy for) marginal products late in life for jobs with mandatory retirement does not appear in these data.

Health Variables

Three dummy variables for poor health were included:

HS = a dummy equal to 1 if there is a short-term health problem that limits ability to work

HL = a dummy equal to 1 if there is a long-term health problem that limits ability to work

HJ = a dummy equal to 1 if the worker left his last job for health reasons

The estimated coefficients of these variables merit some comments. A health limitation on the ability to work seems to account for about a 10 percent drop in wages whether it was acquired recently or long ago. However, the estimated coefficient of "left last job for health reasons" is huge--too huge, in fact, to be believed. The data show vividly that almost all individuals who reported leaving their last job for health reasons are now retired. Very few, therefore, report a wage rate that can be used to infer the negative effect of this variable on market wages. The role of the coefficient of HJ in the equation is to ensure that persons with HJ = 1 have an expected wage so low that they are virtually certain to be retired. Frankly, we wonder if some people who wanted to retire for other reasons simply found "left last job for health reasons" to be a socially acceptable rationale for retirement.

Vintage (Birth Cohort)

As noted in the introduction, one possible explanation for the trend in retirement is that older workers did not share equally in the overall productivity growth of the economy. We were able to test this hypothesis for the 1969-1973 period since our longitudinal sample made it possible to separate the effects of age and experience from those of vintage, which we defined as:

VINTAGE = age in 1969, minus 57.

This variable ran from 1 for the youngest cohort (those born in 1911) to 6 for the oldest (born in 1906).

The coefficient of the vintage variable turned out to be almost zero--far short of the economy-wide average rate of increase of real wages between 1969 and 1973, which was 1.6% per annum. Thus it seems that productivity growth during this short time span was <u>not</u> neutral across vintages, and in fact shifted the age-wage profile in a way that was unfavorable to older workers.

The last two columns in Table 1 are included for econometricians interested in the value of our correction for selectivity bias. They show the point estimates (and standard errors) from a linear ordinary least squares version of our wage equation, run on a data set consisting only of the 9,879 workers. (Some of the parameters are not directly comparable because the nonlinear aspects of our wage equation were approximated linearly.[29]) The main coefficients of interest are those pertaining to aging, since this is a principal determinant of labor force participation. It can be seen that the age coefficients in ordinary least squares suggested no direct effect of aging on wages for white collar workers, and a very small negative effect for blue collar workers. By contrast, our corrected estimates show wages falling significantly with age. Another interesting comparison is of the two vintage effects: roughly 1 percent per year in the OLS regression, but zero in the corrected regression. The coefficient of short term (but not long term)

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[29]For example, the basic specification $\log(w+\lambda p) = \alpha\log(j+bx)$ was approximated by setting λ to its estimated value and expanding the righthand side in a Taylor series around b=1 to get:

$$\alpha\log(j+x) + \alpha(b-1)\frac{x}{j+x}.$$

health problems also appears to have been plagued by serious selectivity bias in OLS.

5. The Reservation Wage Equation

As noted in Section 2, the reservation wage equation takes the form:

$$\log w_i^R = Z_i\gamma + \eta_i \ , \tag{10}$$

where Z_i includes age, variables relevant to labor-leisure tastes, and the log of lifetime discounted potential earnings.[30] Estimation results for the reservation wage function are shown in Table 4.[31]

Full Income

When (10) is estimated, the coefficient of $\log Y$ is our estimate of δ, the elasticity parameter in the utility function (see equation (9). It can be seen that full income does indeed get the expected positive coefficient. However, the coefficient of .10 is surprisingly low. Since the variable is $\log Y$,

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[30]To avoid an obvious simultaneity problem, in constructing Y we used a least squares estimate of each individual's lifetime earnings, rather than his actual earnings. This estimate was based on a linear wage equation similar to that in Table 1, which was used to forecast and backcast wages. (For more details on the procedure, see Blinder, Gordon, and Wise (1980b).)

According to the theoretical derivation in Section 2, Y ought to include only potential earnings in past years if the individual will be retired in "the future," but should include future potential earnings as well if he will not be retired. As an empirical compromise between these two notions, we assumed full-time work (2,000 hours per year) until age 67, and complete retirement thereafter.

[31]The reader is again reminded that these estimates come from the same maximum likelihood estimation problem as those in Table 1.

TABLE 4

Parameters of the Reservation Wage Equation

Variable	Coefficient	Standard Error
Constant	-.759	.218
full income (logY)	.097	.017
Age effects		
slope, ages 58-61	.042	.007
slope, ages 62-64	.036	.007
finite jump at 65	.059	.026
slope, ages 65-67	.059	.014
SSW/Y		
Under age 62	.049	.125
Age 62 and older	.310	.105
Blue collar effects		
BC	-.108	.023
AGEBC	-.019	.005
Health compared to others	.072	.011
Years of education	.030	.002
Vintage	-.014	.004
Family Status		
Married	-.071	.011
No. of children supported	+.010	.004
No. of children ever had	-.006	.002
Pension effects		
DP	.246	.015
DP65	.209	.025
GP+PP	-.024	.017
Changed occupation	-.163	.011
ρ	.578	.025
σ_0^2	.026	.003
s	.022	.003

a rise of 1.0 represents a huge increase in lifetime income, and yet increases w^R by only about 10 percent.

This low coefficient has two principle implications. First, since the estimated income effects on labor supply are so weak, it seems unlikely that rising average income levels have been a major cause of the trend toward earlier retirement. Second, since the estimated indifference curves between labor and leisure are so flat, the implied labor supply function should be highly elastic to wage rates. This implication is not as unrealistic as it may seem. It implies, in essence, that the typical worker will work full time inelastically until he nears retirement, then a brief period of extreme sensitivity will ensue, followed by complete withdrawal from the work force. In fact, this is what the data seem to show. In 1973, when our sample ranged in age from 62 to 67, 60% worked zero hours while 34% worked 35 hours per week or more.

Note finally that, in conjunction with our earlier finding of substantial wage loss from job transitions late in life, these flat indifference curves suggest that few workers will make such transitions. They will opt for retirement instead.

Age Effects

We entered age in a piecewise linear form with changes in slope at ages 62 and 65 and a finite jump at age 65, an age chosen to reflect eligibility for full social security benefits.[32]

[32] The effect of age on $\log w^R$ includes both the effect of age on the taste for leisure (ξ_i) and the difference between the rates of interest and time discount.

For reasons explained in Section 1, we did not expect any particular effect of social security on retirement. Despite this, a finding that there is either a jump in the reservation wage at age 65 or a sharp increase in slope at age 62 might be grounds to suspect that social security really matters after all--perhaps only because of a demonstration effect.

The estimated age effects on $\log w^R$ proved to be substantial, and in the anticipated direction: the reservation wage rises with age. More specifically, the reservation wage grows at roughly 4 percent per year from age 58 to 65, makes a finite jump of about 6 percent at age 65, and then grows at about 6 percent per year after age 65. There are several interesting observations to be made about this set of coefficients.

First, while we allowed for it, there is no apparent break in the reservation wage trend at age 62, the age of eligibility for partial social security benefits. This is as we expected. Second, there is however a noticeable (though small) jump at age 65, the age of full eligibility. This provides some weak evidence (the standard error is almost half as large as the coefficient) that social security may be having some effects.

Third, the rate of increase of the reservation wage with age (4-6 percent per year) is moderately higher than the rate of decrease of the market wage (about 2.6 percent after age 61)--indicating that increasing tastes for leisure are somewhat more important than falling wages in explaining retirement behavior.

<u>More on Social Security</u>

To test further for possible effects of social security on retirement decisions, we added to our equation the ratio of potential social security wealth (i.e., the discounted present value of potential social security benefits) to full income called SSW/Y.

The rationale for a variable like this one is as follows. It could be that many older workers want to retire, but are deterred because a substantial fraction of their wealth is tied up in a highly illiquid form--social security wealth. When they reach age 62, it becomes possible for them to draw on this wealth, and they consequently retire.[33] If this scenario is empirically important, the ratio of SSW/Y should enter the reservation wage equation strongly and positively after age 62, but should get a negative sign before age 62. Consequently, we interacted SSW/Y with a dummy variable for those 62 and older, and entered the two variables indicated in Table 4.

To construct SSW/Y, it was necessary to supplement our data source with information from each individual's social security file--information that was available from the 1975 wave of the LRHS. However, because of potential endogeneity problems, we did not use the actual SSW of each person, but rather an

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[33]This hypothesis was suggested to us by several readers of the earlier draft of this paper.

instrument constructed by assuming a fixed age-hours profile.[34] This made each individual's SSW/Y ratio independent of his particular labor-leisure choices.

Qualitatively, the results gave little indication that the illiquidity of social security wealth influences retirement decisions very much. Prior to age 62, social security wealth is totally insignificant (and incorrectly signed). After age 62, its coefficient is significantly positive, but economically unimportant. A typical value for SSW/Y is about .07, with most people clustered in a range from .05 to .12. An increase of .01 in this variable thus represents a substantial boost in social security benefits. Yet it adds only 0.3% to the reservation wage according to the estimate.

Blue Collar Work

Since blue collar work has an element of physical arduousness that is mostly absent from white collar work, it seemed a plausible conjecture that reservation wages rise more steeply for blue collar workers than for white collar workers. To test

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[34] In particular, we normally took the age profile of the fitted wage rates used in constructing Y (full income), multiplied by 2000 hours per year, assumed retirement at age 65, and calculated the implied actuarial present value of social security benefits in 1969 using the 1969 law and information about the ages of the spouse and children (if any). However, if the individual had insufficient quarters of coverage to receive benefits according to his social security record, we set SSW=0. In addition, if the reported earnings on the social security record in any year the individual worked were below 40% of our forecasted earnings, we assumed that the individual's main job in that year was not covered by social security, and set that year's earnings to zero when calculating SSW.

for this, both the intercept and slope of the reservation wage-age profile were allowed to differ between blue and white collar employment by entering the following two variables:

DBC = a dummy equal to 1 for blue collar workers (occupation groups 3 and 4)

AGEBC = the same age/blue collar interaction used in the market wage equation.

The estimates contradicted our expectations. Apparently, blue-collar workers have lower, and more slowly growing, reservation wages than white-collar workers. Indeed, for blue-collar workers, reservation wages seem to rise at about 2-4% per year (versus 4-6% for white-collar workers).

Health

From among the several possible health variables, we selected only:

HCO = health is worse than others of same age.

According to the estimates, having bad health compared to others adds about 7% to the reservation wage.[35]

Education

It has been suggested, e.g., by Mincer (1974), that people who acquire more schooling remain in the labor force longer in order to recoup the costs of their human investments. Our

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[35] The dummy variable HJ (left last job for health reasons) is conspicuous by its absence. The paltry number of wage observation for which this dummy was "on" made it fruitless to try to include it in both the market wage equation (the vector X) and the reservation wage equation (the vector Z). Our decision to include it only in X was an arbitrary one.

estimate of the effect of education on the reservation wage, which is highly significant, has the opposite sign from that suggested by Mincer. Other things (especially their market wages) held equal, more educated people are <u>more</u> prone to retire, not less.

<u>Vintage</u>

Another plausible taste variable is vintage, the supposition being that older cohorts have a stronger work ethic and hence a lower reservation wage. We thus expect a negative coefficient for the variable VINTAGE defined earlier, which is precisely what the estimate shows. However, it should be noted that VINTAGE will also pick up any systematic (linear) effects of calendar time, so the interpretation of the coefficient is not entirely clear.

<u>Pensions</u>

While the variables mentioned to this point can legitimately be considered as potential <u>determinants</u> of tastes, a further set of variables pertaining to pensions was included for rather different reasons. The estimation technique that we used requires that any taste differences that are impounded in the error term v_i (i.e., not controlled for by inclusion in Z_i) must be orthogonal to the variables included in X_i . Now, since there are many jobs with and without pension plans, it seems likely that workers with an unobservable "taste for retirement" around 65 will <u>sort themselves</u> into jobs with pensions. Thus the following two variables could be highly correlated with whatever omitted taste variables lead to a high reservation wage:

DP = dummy equal to 1 if the job has a pension

DP65 = dummy equal to 1 if the job has a pension <u>and</u> the worker is 65 or older.

(The latter variable allows the effect of pensions on the reservation wage to jump at age 65--the age typically prescribed for retirement.) Consequently, for purely econometric reasons, we decided to include both of these variables in Z .

Only about half of all workers with pensions know what those pensions are worth in future benefits. It is possible that not knowing the value of one's pension (late in life) is an indication that one does not plan to make use of it, i.e., an indication of a low reservation wage. So we entered a variable defined as:

GP + PP = a dummy equal to 1 if the worker has a pension, but does not know its amount.

In the same spirit, a change from one's longest occupation might conceivably be a signal of a desire to remain in the labor force rather than retire. So we included the variable:

DO = a dummy equal to 1 if the current occupation differs from the occupation of longest job.

The pension variables seem quite successful at "picking up" a propensity to retire. According to the estimates, individuals with pensions have a log reservation wage some .25 above that for individuals without pensions up to age 65, and a log reservation wage about .46 higher after 65. The dummy for not knowing the amount of pension benefits has the expected sign, but a very small magnitude. The dummy variable for a change in occupation has the anticipated effect on w^R; and it is substantial--roughly a 15 percent reduction in the reservation wage.[36]

Stochastic Specification

It will be recalled that the error term in (10) was assumed to follow:

$$\eta_i = \rho\epsilon_i + v_i \quad .$$

In addition, the variance of v was allowed to vary with age, viz.:

$$\sigma_v^2 = \sigma_0^2 + s(\text{AGE}-61) \ .$$

The stochastic specification produced some striking results. First, $\rho = .58$ indicates a substantial correlation between the error terms in the market wage and reservation wage equations: people with surprisingly high market wages also have surprisingly high reservation wages. One possible explanation for this positive correlation is that omitted variables ("ability") affect both the market wage and lifetime income in the same direction. Second, the variance of v is very small prior to age 62. (For comparison, the variance of ϵ is more than 8 times as high.) This means that, except for differences embodied in the

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[36]Several family status variables were also included in the equation, but are not discussed. See Table 4.

vector Z, tastes for leisure are rather uniform. However, third, this variance grows quickly with age since the parameter s in equation (14) is almost as large as σ_0^2.

6. Analysis of the Retirement Decision

As should be clear from the last two sections, a number of variables (such as age) affect both market wages and reservation wages. If we are to analyze the retirement decision, both effects must be considered simultaneously. For each individual, our estimates of the vectors γ and β, along with data on X_i and Z_i and estimates of the variances of ϵ and v, enable us to generate an estimated probability of retirement by integrating under the relevant normal density functions. In fact, there are two different ways to generate this estimated probability, called $\hat{P}$.

First, we can assume ignorance of the available wage rate w_i, and forecast the probability that an individual will be retired based just on information in X and Z.[37] The distributions of the forecasted probabilities, reported separately for those who were actually retired and for those who were actually working, are reported in Table 5. We find that the

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[37]Using formula (A.2) in the appendix.

"goodness of fit" of the model varies substantially across age groups.

Discrimination is really quite good for 58-61 year olds. The vast majority is still working, and our model forecasts their behavior extraordinarily well. For the minority of 58-61 year olds who are retired, the model correctly retires about 60% and incorrectly labels about 37% as still working.[38] Results are almost as good among 62-64 year olds, a group that is much more evenly divided between retirement and work. Of those actually retired, the model correctly classifies about 49% and incorrectly classifies about 33%. Of those actually still working, the model correctly classifies about 88% and misclassifies almost no one.

The model has less success, however, in capturing the retirement decisions of those aged 65-67. While very few retirees are incorrectly classified as working, many workers are incorrectly classified as retired. We do not know how to explain this. It is worth stressing, however, that if our model erred by underestimating the incentives to retire provided by the social security system, we would expect it to "retire" too few workers over 65. In fact, it retires too many.

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[38] In this sentence, and in what follows, the model is considered to classify a person as retired if it gives him a $\hat{P}$ above .6, and to classify him as working if it gives him a $\hat{P}$ below .4. Persons assigned $\hat{P}$ values between .4 and .6 are considered to be "not classified."

TABLE 5

Distribution of Estimated Probabilities of Being Retired ($\hat{P}$), Assuming Unknown Wage (in percent)

	People Actually Retired			People Actually Working		
Range for $\hat{P}$	Ages 58-61	Ages 62-64	Ages 65-67	Ages 58-61	Ages 62-64	Ages 65-67
Under .01	0.5	0.0	0.0	3.6	0.0	0.0
.01-.20	23.5	11.2	0.0	85.7	46.9	1.0
.20-.40	13.1	22.3	3.6	9.5	41.4	14.8
.40-.60	3.2	17.7	18.5	1.0	10.3	43.1
.60-.80	0.5	4.5	41.5	0.1	1.1	37.6
.80 .99	22.2	25.7	15.8	0.0	0.1	2.2
Over .99	37.0	18.7	20.6	0.1	0.2	1.3
Percent Correctly Classified[a]	59.7	48.9	77.9	98.8	88.3	15.8
Percent Not Classified[b]	3.2	17.7	18.5	1.0	10.3	43.1
Percent Incorrectly Classified[c]	37.1	33.5	3.6	0.2	1.4	41.1
Sample Size	1,094	2,782	2,226	4,576	4,335	968

[a] $\hat{P} > .6$ for retirees or $\hat{P} < .4$ for workers.

[b] $.4 \leq \hat{P} \leq .6$.

[c] $\hat{P} < .4$ for retirees or $\hat{P} > .6$ for workers.

Thus whatever weaknesses remain in the model, its treatment of social security does not seem to be one of them.

A second forecasting method is available for those who actually chose to work. Since we know the wage (and hence the value of ϵ_i) for these men, we can forecast the probability that these individuals would indeed choose to work, conditional on this value of ϵ_i.[39] The resulting probabilities are reported in Table 6.

Comparing these results to the righthand panel of Table 5, we see that knowledge of the wage leads to minor improvements in our (already very good) ability to predict the behavior of those between the ages of 58 and 64. Misclassifications are almost entirely eliminated. Forecasting improvements are much greater for those aged 65-67, but we still do not do very well.

How sensitive is the probability of retirement to changes in any of the determinants of market wages or reservation wages (the elements of X and Z)? To answer this, we first computed the retirement probability (assuming ignorance of the true market wage) of a "typical" member of our sample, whom we call the "base case."[40] For such a typical individual, the estimated

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[39] Using the first term in equation (A.4) in the appendix.

[40] He is 62 years old, married, has 12 years of education, is in the youngest vintage (born in 1911), is in good health, has no pension, has 24 years on his present job and 20 years of previous experience (j=24, x=20), is currently a salesman or a clerical worker and has not changed occupation, had a non-farm father, had lifetime full income in 1969 dollars of $373,250, the average in the sample for that occupation, and had an SSW/Y ratio of .0726, the overall average in the sample.

TABLE 6

Distribution of Estimated Probabilities of Being Retired ($\hat{P}$), Assuming Known Wage (in percent)

	People Actually Working		
Range for $\hat{p}$	Ages 58-61	Ages 62-64	Ages 65-67
Under .01	56.5	10.0	0.6
.01-.20	34.9	56.3	13.7
.20-.40	5.2	20.1	20.0
.40-.60	2.2	9.3	30.7
.60-.80	1.0	3.5	26.0
.80-.99	0.3	0.9	8.7
Over .99	0.0	0.0	0.2
Percent correctly classified[a]	96.6	86.4	34.3
Percent not classified[b]	2.2	9.3	30.7
Percent incorrectly classified[c]	1.3	4.4	34.9
Sample Size	4,576	4,335	968

[a] $\hat{P} < .4$

[b] $.4 \leq \hat{P} \leq .6$

[c] $\hat{P} > .6$

probability of being retired is only .187. Table 7 shows how this estimated probability varies as a number of these characteristics change. Reading across any line shows the pattern of retirement probabilities by age, and comparing any of lines 2 through 11 with line 1 shows the effect of various deviations from the base case.

Given our estimated effects of aging on market and reservation wages, the age pattern of retirement probabilities[41] begins very low at age 58 in the base case (about 4 percent), rises slowly until age 61, and then rises more quickly thereafter. It makes a substantial jump (from .34 to .48) at age 65, and reaches .62 by age 67. This general age profile is pretty typical of all the cases considered in Table 7, though they differ in details.

Poor health (line 2) noticeably increases the probability of being retired--by an amount ranging between 10 and 18 percent, depending on age.[42]

In line 3, we increment the ratio SSW/Y by .01. As noted earlier, this is a substantial change that has little effect on

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[41] In this experiment, j varies with age and x is held constant.

[42] In line 2, the individual is assumed to have a short-term (not a long-term) health problem and to be in poor health compared to others of the same age. Those who report that they "left last job for health reasons" are assigned retirement probabilities of .99 or more at any age by the model.

TABLE 7

Estimated Retirement Probabilities

	Age									
	58	59	60	61	62	63	64	65	66	67
1. Base case	.042	.056	.073	.094	.187	.254	.336	.483	.558	.623
2. Health problem	.141	.173	.210	.251	.370	.443	.512	.647	.705	.753
3. Higher SSW	.043	.056	.073	.094	.189	.257	.339	.486	.561	.626
4. Oldest vintage	.022	.030	.040	.054	.127	.196	.265	.408	.488	.559
5. Occupation group 1	.022	.030	.041	.054	.131	.202	.271	.416	.496	.567
6. Occupation group 3	.034	.044	.058	.074	.160	.233	.303	.447	.523	.590
7. Occupation group 4	.045	.059	.076	.096	.192	.269	.339	.485	.559	.623
8. Pension w/o Mandatory Retirement	.038	.052	.071	.095	.195	.279	.355	.707	.760	.802
9. Pension with Mandatory Retirement	.034	.046	.061	.081	.172	.250	.322	.735	.768	.800
10. Log wage 50% higher	.001	.001	.001	.002	.012	.032	.062	.142	.207	.277
11. Log wage 50% lower	.837	.867	.894	.917	.927	.928	.931	.957	.963	.969

	Years of Education								
	2	4	6	8	10	12	14	16	18
12. Age=62	.170	.178	.186	.195	.197	.137	.167	.097	.085

	Types of Experience				
	j=4, x=40	j=14, x=30	j=24, x=20	j=34, x=10	j=44, x=0
13. Age=62	.410	.262	.187	.142	.112

the reservation wage. Not surprisingly, retirement probabilities increase by miniscule amounts.

The vintage effect on retirement is moderate (see row 4). As compared with men born in 1911 (the base case), men born in 1906 are 2-8 percent less likely to be retired, depending on age.

Differences among occupation groups are also very small. In fact, retirement probabilities among farmers and unskilled blue-collar workers (group 4) are virtually identical to those of sales and clerical workers (group 2). Professional workers and managers have the lowest retirement probabilities, and skilled blue-collar workers have the next lowest.

As can be seen in row 8, workers with pensions are no more likely to retire than workers without pensions up to age 64. However, at age 65, when the retirement probability for workers without pensions jumps by .15, that for workers with pensions jumps by .35. The retirement pattern for workers with pension plans <u>and</u> mandatory retirement (at age 65) is qualitatively similar to this, but quantitatively different. The jump in the retirement probability at age 65 is .41.

Finally, lines 10 and 11 show the extreme sensitivity of retirement decisions to wage rates. In line 10, the log wage is increased by 50 percent (which adds 40.5% to the market wage). This makes retirement extremely unlikely up to age 63 or 64, and leaves the probability as low as .28 even at age 67. In line 11, the log wage is reduced by 50 percent (this lowers the market wage by 69%), which raises retirement probabilities very dramatically, especially at younger ages.

Lines 12 and 13 show two rather different types of retirement profiles. Holding age constant at 62, line 12 indicates how the probability of being retired varies with years of education.[43] It can be seen that the probability rises slowly up to 10 years of schooling, and then falls. College graduates are only half as likely to be retired at age 62 as are high school graduates. In line 13 we see the effect that exchanging previous experience for job tenure has on the market wage: as j rises and x falls, the probability of retirement drops. Workers with long job tenure are therefore much less likely to retire than those with short job tenure.

7. Conclusion

This has been a long paper, and many interesting results have been pointed out along the way. Rather than try to catalog these, let us close by addressing the questions posed at the outset of the paper:

First, why do people retire?

1) It is clear that age has a dramatic effect, both because age affects wages and because age affects labor-leisure tastes (reservation wages). In our base case, the probability of retirement increases from below 10 percent at age 61 to above

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[43] In this experiment x and j both adjust to the change in years of education, with the difference $j-x$ held constant.

60 percent by age 67.

2) If we put aside people who say they left their last job for health reasons (who may be using this to rationalize a decision made on other grounds), poor health seems to be a moderately important cause of retirement.

3) Pension plans--with or without associated mandatory retirement provisions--provide powerful incentives to retire at the age of eligibility for the pension (normally 65). Social security, however, has a much weaker effect (if any) on retirement decisions.

4) Retirement decisions are highly sensitive to market wages. For this reason, few people will voluntarily change jobs late in life if that job transition implies a substantial reduction in wages (as it normally does). Similarly, individuals forced to leave their main jobs because of mandatory retirement normally will retire rather than take a new job at a lower wage.

While one must exercise extreme caution in drawing time series inferences from cross-sectional data, the following tentative explanation for the trend toward retirement is suggested.

1. Wages late in life may have declined relative to wages earlier in life, thus inducing more men to retire.

2. Private pensions have expanded rapidly. These plans typically provide strong incentives to leave the job, often even mandating it. The resulting drop in market wages normally is severe enough to induce complete withdrawal from the labor force.

3. Younger cohorts seem to have a stronger taste for leisure, perhaps due to growth in the economy, causing them to retire earlier.

4. It seems unlikely that the growth of the social security system, as impressive as it has been, has contributed much to the trend toward retirement.

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APPENDIX

Since the market wage and reservation wage equations are respectively:

$$\log w_i = f(X_i, \beta) + \epsilon_i \tag{1}$$

$$\log w_i^R = Z_i\gamma + \eta_i \ , \tag{10}$$

and since the two errors are related by:

$$\eta_i = \rho\epsilon_i + v_i \ , \tag{12}$$

the condition for being retired can be written:

$$(1-\rho)\epsilon_i - v_i < Z_i\ \gamma - f(X_i, \beta) \rightarrow \text{retired.}$$

Letting σ_ϵ^2 and σ_v^2 denote the variances of ϵ and v respectively, this can be rewritten:

$$\frac{(1-\rho)\epsilon_i - v_i}{[(1-\rho)^2\sigma_\epsilon^2 + \sigma_v^2]^{\frac{1}{2}}} \leq \frac{Z_i\gamma - f(X_i;\beta)}{[(1-\rho)^2\sigma_\epsilon^2 + \sigma_v^2]^{\frac{1}{2}}} \ . \tag{A.1}$$

The left hand side of (A.1) is a unit normal deviate, so the probability of an individual being retired, conditional on Z_i and X_i is:

$$\Phi\left[\frac{Z_i\gamma - f(X_i;\beta)}{((1-\rho)^2\sigma_\epsilon^2+\sigma_v^2)^{\frac{1}{2}}}\right] \tag{A.2}$$

where $\Phi(\cdot)$ is the cumulative unit normal. The portion of the log likelihood function contributed by the retired people is thus:

$$\sum_{i\in R} \log \Phi\left[\frac{Z_i\gamma-f(X_i;\beta)}{((1-\rho)^2\sigma_\epsilon^2+\sigma_v^2)^{\frac{1}{2}}}\right], \tag{A.3}$$

where the sum runs over the observations for retirees.

The contribution to the likelihood from each working person is more complex since it is the joint probability of (a) being at work and (b) having a wage w_i, and these are not independent events.

Specifically,

Prob(wage$=w_i$ and working) =[1]

$$= \text{Prob}(\text{working}\,|\,\text{wage}=w_i) \times \text{Prob}(\text{wage}=w_i)$$

$$= \text{Prob}(\log w_i > Z_i\gamma + \rho\epsilon_i + v_i\,|\,\text{wage}=w_i) \times \text{Prob}(\epsilon_i=\log w_i-f(X_i;\beta))$$

by (1), (12) and (A.1);

$$= \text{Prob}[(1-\rho)\log w_i + \rho f(X_i;\beta) - Z_i\gamma > v_i] \times \text{Prob}(\epsilon_i=\log w_i-f(X_i,\beta))$$

by (1) since v is independent of $\log w_i$;

$$= \text{Prob}\left[\frac{(1-\rho)\log w_i+\rho f(X_i;\beta) - Z_i\gamma}{\sigma_v} > \frac{v_i}{\sigma_v}\right] \times \text{Prob}(\epsilon_i=\log w_i-f(X_i,\beta))$$

$$= \Phi\left[\frac{(1-\rho)\log w_i+\rho f(X_i,\beta)-Z_i\gamma}{\sigma_v}\right] \phi\left[\frac{\log w_i-f(X_i;\beta)}{\sigma_\epsilon}\right] \tag{A.4}$$

[1] Here "Prob(wage$=w_i$)" is heuristic notation for the height of the density function at $\epsilon_i = \log w_i-f(X_i,\beta)$.

where ϕ is a standard normal density function.

The contribution to the log likelihood function of all working people is thus:

$$\sum_{i \epsilon W} \left\{ \log \phi\left[\frac{\log w_i - f(X_i;\beta}{\sigma_\epsilon}\right] + \log \Phi\left[\frac{(1-\rho)\log w_i + \rho f(X_i,\beta) - Z_i\gamma}{\sigma_v}\right]\right\}. \quad (A.5)$$

The overall log likelihood function is the sum of (A.3) and (A.5), and it is maximized with respect to β, γ, ρ, σ_ϵ and σ_v.

In addition, σ_v^2 was assumed to be given by:

$$\sigma_v^2 = \sigma_0^2 + s(AGE-61)\,, \quad (A.6)$$

so σ_v actually contains two parameters. Given 31 components of β and 20 components of γ, there are 55 parameters in all.