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ECONOMIC INCENTIVES TO RETIRE:
A QUALITATIVE CHOICE APPROACH

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Economic Incentives to Retire: A Qualitative Choice Approach

ABSTRACT

This paper addresses two questions: (1) Are older persons' retirement ages significantly affected by the opportunities for income from earnings, private pensions, and Social Security and for leisure at alternative retirement ages?; and (2) How large are the estimated responses? Our approach to modeling the retirement problem is a forward-looking one, in which the explanatory variables include present discounted values of expected lifetime income from earnings, private pensions, and Social Security at all future retirement ages. Such data have been constructed using a unique archive on 390 workers covered by a large union pension plan. A previous paper (Fields and Mitchell, 1982) used these data to show that retirement ages are significantly associated with the present discounted value of income at age 60, and with the gain in income from deferring retirement. The current paper develops two different qualitative choice models of the retirement decision. We find: retirement ages do indeed respond significantly to future income and leisure opportunities; an ordered logit model is more suited to the data than is a multinomial logit model; and the estimated responses to changes in future income opportunities differ across model specifications, where the preferred ordered logit model exhibits larger estimated responses.

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I. A Model of Earnings, Private Pensions, Social Security, and Retirement

Building on a well-developed theoretical literature,[1] we analyze retirement in a forward-looking intertemporal framework. In essence, older people are postulated to evaluate the incomes they could receive from various sources at alternate retirement ages, and also the corresponding amounts of leisure. These income sources include some or all of the following: (a) earnings, to the extent people go on working; (b) Social Security, which covers a majority of the elderly population; (c) private pensions, for which a large and growing fraction of older workers is eligible; and (d) wealth. If the older worker defers retirement, he gives up Social Security and/or private pension benefits during that year; on the other hand by working longer, he gains another year's earnings, he lessens the early retirement reduction factor (or adds to the late retirement credit) associated with Social Security benefits, and if eligible for a pension, he typically qualifies for a larger annual benefit. In most circumstances, monetary gains will outweigh monetary losses so that each extra year of work increases lifetime income. This gain in income adds to utility but, of course, comes at a cost: he also foregoes leisure. The worker's choice of retirement age thus depends on the size of these gains and losses, as well as his valuation of them. Thus, in a sample of workers, differences in retirement ages will depend on opportunities and tastes for future income and future leisure.

Let the i'th individual's utility from retiring at age j be a positive, concave function of the present discounted value of expected lifetime consumption from year zero, the age of the retirement decision, onward ($PDVC_{ij}$)

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[1] Among the clearest theoretical developments are those by Crawford and Lilien (1981) and Burbidge and Robb (1980). These and other models are reviewed in Mitchell and Fields (1982).

and of the length of the retirment period (RET_{ij}):

$$(1) \quad U_i = U_i(PDVC_{ij}, RET_{ij}); \quad U_1, U_2 > 0 \; ; \quad U_{11}, U_{12} < 0.$$ [1]

$PDVC_{ij}$ and RET_{ij} are both functions of the retirement age R_i. R_i is chosen to maximize (1) subject to:

$$(2) \quad PDVC_{ij} = PDVY_{ij} + W_{io} - B_{io},$$

where $PDVY_{ij}$ is the present discounted value of expected lifetime income from the age of the retirement decision onward, W_{i0} is the i'th individual's wealth in year zero, and B_{i0} is his planned bequest as viewed from year zero. Taken together, (1) and (2) yield the first order condition for an interior solution:

$$(3) \quad \frac{\partial U_i}{\partial PDVY_i}\,\frac{\partial PDVY_i}{\partial R_i} + \frac{\partial U_i}{\partial RET_i}\,\frac{\partial RET_i}{\partial R_i} = 0.$$

An individual who retires later gains lifetime income ($PDVY_i$) and loses lifetime leisure (RET_i), and finds it optimal to retire when the utility values of these gains and losses offset each other.[2]

The message from the preceding paragraph is that the optimal retirement age is determined in a <u>future-oriented intertemporal context</u>.[3] In addition to leisure, the key explanatory variable is the present discounted value of expected lifetime income for all <u>future</u> retirement ages from the date of the retirement decision onward. If there are J possible retirement ages, we therefore require J PDVY's. The j'th PDVY for individual i is given by:

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[1] For ease of exposition we abstract from the possibility of part-time or post-retirement work, neither of which was pursued to any significant degree in the data sample described below. Variable hours of work are allowed for in recent models by Gustman and Steinmeier (1981) and Burtless and Moffitt (1982).

[2] If the left hand side of (3) can in fact be equated to zero, and if the second order condition is satisfied, the solution is an interior one. But if, as is possible, the left hand side of (3) is negative for all conceivable retirement ages, it is optimal to retire immediately.

[3] Past decisions and events are reflected in current wealth, wages, and other variables.

$$(4)\quad PDVY_{ij} = \int_{o}^{R_i} E_{it}\delta_t dt + \int_{R_i}^{T} [PP_{it} + SS_{it}]\delta_t \, dt,$$

where: E_{it} is earnings in the t'th year of work; PP_{it} and SS_{it} are respectively the private pension benefits and Social Security benefits in year t, both of which depend on the choice of retirement age R_i; and δ_t is a discount factor reflecting time preference and mortality.

In the balance of this paper, we develop an empirical model using this intertemporal framework to explain workers' choices among nine possible retirement ages, 60-68.

II. Empirical Specification

To estimate empirically the determinants of retirement based on the model of Section I, the most immediate problem is that utility functions are unobservable. To make headway, we write the i'th individual's utility from retiring in year j as

$$(5) \quad U_{ij} = [\alpha \log PDVY_{ij} + \beta \log RET_{ij}] + \varepsilon_{ij}$$

Here α and β are parameters to be estimated by maximum likelihood across the individuals in our sample. The term in brackets, $[\alpha \log PDVY_{ij} + \beta \log RET_{ij}]$, is termed the average individual's "strict utility" associated with particular values $PDVY_{ij}$ and RET_{ij}. However, the i'th individual's utility function differs from the average for a host of unobserved reasons. These unobserved components may be summarized by a disturbance term ε_{ij} in (5), about which additional distributional assumptions must be made.

At this juncture, two classes of models might be considered by the econometrician: probit and logit. The probit framework maintains that the ε_{ij} are distributed multivariate normally for each individual, but independently across individuals. While a probit model merits serious consideration when the number of choices is no greater than five, we have nine retirement ages and probit becomes computationally infeasible for a nine-way choice set.[1] Hence, probit must be rejected for use in the present context.

A popular alternative is the logit class of models. In these models, $(\varepsilon_{i1}, \ldots, \varepsilon_{ij})$ are distributed according to the multivariate extreme value distribution for each individual i. As McFadden (1978) shows, the function:

$$(6) \quad F(\varepsilon_1, \ldots, \varepsilon_j) = \exp\{-G(e^{-\varepsilon_1}, \ldots, e^{-\varepsilon_j})\}$$

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[1] Hausman and Wise (1978) discuss size limitations in multi-outcome probit models.

is a multivariate extreme value distribution. G ( ) is a general function; below, we present the forms of G ( ) corresponding to specific logit formulations. Equation (6) gives rise to a probabilistic choice model

$$(7) \quad P_j = e^{V_j} G_j(e^{V_1}, \ldots, e^{V_j})/G(e^{V_1}, \ldots, e^{V_J}),$$

where P_j is the probability that retirement age j is chosen and V_j is the strict utility associated with alternative j, i.e., the bracketed term in (5). The general class of logits given by (7) is known as the Generalized Extreme Value (GEV) framework.

A simple representative of the GEV class, and the one used most extensively in the economics literature, is the multinomial logit (MNL) model:

$$(8) \quad P_j = \frac{e^{V_j}}{\sum_{j=1}^{J} e^{V_j}} .$$

This corresponds to

$$(9) \quad G(y_1, \ldots, y_J) = \sum_{j=1}^{J} y_j,$$

where y_j, a function of attributes of choice j for individual i, is equal to e^{V_j}.

The main attraction of the MNL model is its computational simplicity. However, MNL possesses a property known as Independence from Irrelevant Alternatives (IIA), which states that the relative odds for any two alternatives are independent either of the attributes or of the availability of any other alternative. IIA denies the possibility that some individuals are "workaholics" and others are "leisure-lovers." We have strong reason to believe that the error term ε_{im} is correlated with the error term ε_{in} for two retirement ages m and n near one another, but this correlation is not allowed in the MNL model.

Rather than imposing IIA, we prefer to work with models that allow error terms to correlated for a given individual and to test for IIA formally.

Ordered logit models enable us to do this, since they recognize that in many qualitative choice contexts, alternatives can be ordered along a natural dimension. The pathbreaking work on ordered logit was done by Small (1981, 1982), who considered the decision of how late or early to arrive at work. In the retirement context, the retirement age may also be ordered from early to late. It is useful to model this ordering explicitly.

A Simple Ordered Logit model (SOL) maintains that the attractiveness of any given alternative depends upon the attributes of immediately adjacent alternatives as well as of the specific alternative in question. For example, a workaholic has a higher probability under SOL than under MNL of choosing the next closest late retirement age, and likewise a leisure-lover is given a higher probability of choosing the next closest early retirement age. Intuitively, the SOL model tilts the structure of probabilities in one direction or the other as compared with the MNL model. This is achieved by developing a G function of the form:

$$(10)\quad G(y_1, \ldots, y_J) = \sum_{j=1}^{J+1} \left(\tfrac{1}{2} y_j^{1/\rho} + \tfrac{1}{2} y_{j-1}^{1/\rho}\right)^{\rho},$$

where ρ is an index of independence of adjacent alternatives. When $\rho=1$, IIA holds; $\rho=0$ corresponds to identical alternatives.

From (7) and (10), the choice probabilities for the SOL model can be written as

$$(11)\quad P_j = \frac{e^{V_j/\rho}\left[\left(e^{V_{j-1}/\rho} + e^{V_j/\rho}\right)^{\rho-1} + \left(e^{V_j/\rho} + e^{V_{j+1}/\rho}\right)^{\rho-1}\right]}{\sum_{j=1}^{J+1}\left(e^{V_j/\rho} + e^{V_{j-1}/\rho}\right)^{\rho}}.$$

(Note: For $j = 0$ and $j = J+1$, take $e^{V_j/\rho} = 0$.)

Expression (11) involves non-linear estimation. Small suggests approximating (11) by

$$(12)\quad P_j \cong \frac{e^{V_j + \sigma N_j}}{\sum_{j=1}^{J} e^{V_j + \sigma N_j}},$$

in which N_j is defined as:

$$(13)\quad N_j = -\tfrac{1}{2}[\log(\tfrac{1}{2}) + \log\,(1 + P^o_{j-1}/P^o_j) + \log(1 + P^o_{j+1}/P^o_j)] \text{ and}$$

P^o_k is the probability of choosing alternative k under the IIA assumption. The variable N_j may be thought of as a proxy for alternative-specific unobserved taste variation, otherwise omitted in the absence of N_j.

Having constructed a model that permits but does not require IIA, IIA can be tested using either of two approaches:

(i) Hausman and McFadden propose a test using the statistic:

$$(14)\quad T = (\theta_R - \theta_U)'[\mathrm{cov}(\theta_R) - \mathrm{cov}(\theta_U)]^t(\theta_R - \theta_U)$$

where θ_U(=(α,β) from (5)) is the coefficient vector estimated for the full model; θ_R is the coefficient vector estimated among individuals who selected a subset of the total choice set; cov(θ) refers to the relevant parameter covariance matrix; and t denotes a generalized inverse. The test statistic is shown to be distributed Chi-square with two degrees of freedom[1] and is interpreted such that a value of T larger than the critical value rejects the independence of irrelevant alternatives assumption for the specific formulation of the model at hand.[2]

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[1]The relevant degrees of freedom are given by

$$df = \mathrm{tr}[\mathrm{cov}(\theta_R) - \mathrm{cov}(\theta_U)]^t[\mathrm{cov}(\theta_R) - \mathrm{cov}(\theta_U)].$$

[2]Hausman and McFadden (1981) make the point that alternative specifications of explanatory variables might satisfy the IIA assumption, as might alternative functional relationships.

(ii) In the SOL model, N provides an indication of the presence or absence of IIA. If IIA holds in the data, the inclusion of N will not alter results, and the predictions from the SOL model (12) will be identical to the predictions from the MNL model (8). But if IIA does not hold, SOL predictions will differ from MNL predictions. A suitable test statistic is:

$$(15) \quad V = \sum_{j=1}^{J} \left[\frac{(\hat{P}_j^{SOL} - \hat{P}_j^{MNL})^2}{\hat{P}_j^{MNL}} \right],$$

where $\hat{P}_j^{SOL}$ and $\hat{P}_j^{MNL}$ are the predicted frequencies for choice j in the SOL and MNL models respectively. V is distributed chi-square with J-1 degrees of freedom.

Estimates of both retirement models and tests of IIA follow.

III. Data and Results

A. Data[1]

To estimate the intertemporal retirement model income available at all future retirement ages must be recorded for each sample individual.[2] Most previous researchers have not had access to such complete information, and are able to examine only partial income measures at the time of the survey or, at best, two alternative years.[3] The data set we analyze is unique in that it contains sufficient information for us to be able to construct the earnings, private pension, and Social Security benefits available to each worker in the sample for all retirement ages from 60 through 68.

Our sample consists of 390 male employees of a manufacturing firm, for which the private pension formulas were known. In this firm, pension formulas are based solely on seniority and age; earnings levels do not affect benefits at all. These workers retired between the ages of 60 and 68, the latter age being the mandatory retirement age at the firm. We focus on a specific cohort of individuals born in 1909 and 1910, for two reasons: all cohort members had reached the age of mandatory retirement (age 68) as of the survey date (1978), thereby averting truncation bias due to uncompleted work spells; and also because these workers were as young as possible while still having passed the mandatory retirement age, mortality bias is minimized.

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[1] A more detailed description of the pension rules and other aspects of the data source is available in Fields and Mitchell (1982). The larger data set of which this is a subsample is known as the Benefits Amounts Study, under development at PWBP/LMSA, U.S. Department of Labor. For an overview of the variability in existing pension structures, see Lazear (1982).

[2] For the empirical work in this paper, we define retirement as the age of leaving the main employer and accepting a pension.

[3] Given the present state of data availability, researchers must choose between comprehensive budget set information and representativeness. In this paper, we choose the former course, as did Burkhauser (1979) and Burtless and Hausman (1981).

Construction of the PDVYs for alternate retirement ages involved several steps. Past earnings from 1951 on were available from Social Security earnings histories. We imputed values for earnings beyond the Social Security taxable maximum and predicted earnings for each worker up to age 68. These were adjusted for income taxes and Social Security taxes. From the earnings histories, and from knowledge of the Social Security formulas in effect when these individuals were age 60 and before, we calculated the streams of Social Security benefits that these people could have expected to receive for alternate retirement ages. Then, because we knew the pension rules in the firm in question, we were also able to construct private pension benefits for alternate retirement ages.

To illustrate these various components, take as an example a worker with the mean level of seniority (27 years) who retired at the mean age in this firm (63 years). This worker would earn \$20,600 (in present value terms) between ages 60 and 63, would receive an expected present value of Social Security benefits from age 63 onward of \$31,900 (after adjusting for time preference at a nominal rate of 5% and for mortality probabilities), and would receive an expected present value of private pension benefits from age 63 onward of \$26,300. The sum of these three components is the present discounted value of income (PDVY) as viewed from age 60 if retirement were to occur at age 63. For the mean individual in our sample, this sum is \$78,900.

Average PDVY's for alternate retirement ages are summarized in Table 1. PDVY is an increasing function of the retirement age: it rises monotonically from \$57,500 for retirement at age 60 to \$101,000 for retirement at age 68. This happens because earnings always exceed the sum of private pension and Social Security benefits. However, the PDVY function is decidedly non-linear. The marginal payoff to an additional year of work declines from \$7,500

TABLE 1.

THE INTERTEMPORAL BUDGET SET FOR THE MEAN WORKER IN COMPANY X

Retirement Age	Present Discounted Value of Income (PDVY) from Age 60 on for Alternate Retirement Ages	$PDVY_t - PDVY_{t-1}$
60	$57,500	----
61	65,000	$7,500
62	72,400	7,400
63	78,800	6,400
64	84,900	6,100
65	90,600	5,700
66	94,600	4,000
67	98,000	3,400
68	101,000	3,000

between ages 60 and 61 down to $3,000 between ages 67 and 68. These budget set nonlinearities are handled quite readily in the discrete choice models described above.

B. Results

Table 2 presents two sets of coefficient estimates for the retirement equation. Column 1 contains MNL results and column 2 SOL results. In both models, income and leisure have positive and statistically significant effects, confirming that older workers value more of both when deciding when to retire.

Despite the fact that the two sets of coefficient estimates appear similar, it is useful to test formally the assumption of IIA as discussed above. We do so first with the Hausman-McFadden test, based on MNL coefficients from column 1. These were compared with coefficient estimates obtained by re-estimating the model on two different subsets: (a) those choosing retirement at ages 60 to 65, and (b) those choosing retirement at ages 60 to 62. The resultant values of the T statistic given by equation (14) are:

Comparison	Computed Value of T
60-68 versus 60-65	17.2
60-68 versus 60-62	65.8

The critical value of chi-square with 2 degrees of freedom (.005 significance level) is 10.6. Hence, IIA is rejected using this test.

The second test for IIA compares coefficients from both MNL and SOL. For our data, the statistic given by equation (15) takes the value V = 69.7, compared to the critical chi-square value with 8 degrees of freedom (.005 significance level) of 22.0 Hence, IIA is rejected by this second test as well.

Rejection of IIA by both criteria confirms that the ordered logit model fits the data better than does a conventional logit setup. This agrees

TABLE 2.

COEFFICIENT ESTIMATES FOR THE AGE OF RETIREMENT

EQUATION USING MULTINOMIAL LOGIT (MNL) AND SIMPLE ORDERED LOGIT (SOL)
(standard errors in parentheses)

Variable:	(1) MNL	(2) SOL
PDVY (Income)	14.152 (1.297)	14.284 (1.445)
RET (Retirement Years)	13.705 (1.191)	13.850 (1.385)
N (Pseudo-variable used to test IIA)		-.149 (.717)
Log L	-730.35	-730.33

with our theoretical preference for a model that allows covariance among proximate retirement age alternatives, which SOL does. Hence, the estimated SOL coefficients from column 2 of Table 2 receive primary emphasis in what follows though further MNL results are also presented for purposes of comparison.

Because estimated utility function coefficients are not directly interpretable, and because the budget set is quite nonlinear, it is useful to determine how responsive retirement ages are to particular changes in income parameters. We estimate in turn the effects of six such changes; holding all other budget set parameters constant:

Change A: Each worker's earnings stream is increased by 10% of his base (age 60) earnings amount.

Change B: Each worker's earnings stream is tilted such that earnings at every age are increased by 10%.

Change C: The pension benefit at each age is increased by 10% of the age 60 pension amount.

Change D: The slope of the pension function is raised by 10%.

Change E: The Social Security benefit stream is raised by 10% of the initial amount.

Change F: The slope of the Social Security function is increased by adding 10% to every year's benefits.

Estimated coefficients from Table 2 are used to determine how each individual would be likely to alter his retirement age if confronted with these new budget sets. By summing these probabilities across people and comparing them with initial probabilities, we can evaluate anticipated retirement age responses to these particular policy changes.

Table 3 reports the findings for these six budget changes. Consider first the preferred SOL specification in column 1. A 10% increase in earned income would increase the average retirement age by about 0.2 years, ceteris paribus. Earnings have both income and substitution effects on the demand for retirement, and in this formulation, the substitution effect appears to dominate. On the other hand, changing the private pension and Social Security benefit structure would reduce retirement ages. For instance, raising private pension and Social Security benefits by a given amount at each age (Changes C and E) produces only income effects, which encourages earlier retirement. An increase of 10% in the age-60 amount is estimated to reduce the average retirement age by about 0.2 years. The two changes that raise private pension and Social Security benefits by 10% in every year (Changes D and F) entail both income and substitution effects, rendering the predicted effects ambiguous. Empirically, we find that both these changes are estimated to have negative effects: -.15 years for the private pension case and -.07 years in the case of Social Security. The changes in D and F are less negative than the changes in C and E, because income effects only are present in C and E whereas these are partially offset in D and F by substitution effects in the opposite direction.

To see what difference the econometric specification makes, compare the MNL results in column 2 of Table 3 with the SOL results (column 1). The estimated responses from the MNL model are much smaller than those based on the SOL model. This occurs because the SOL model allows nearby alternatives to be "closer" to the chosen alternative than does the MNL model. Consequently, when the budget constraint is changed, there is more predicted movement between retirement ages using the SOL model, as compared to the MNL model, which assumes IIA.

TABLE 3.

EFFECT OF BUDGET SET CHANGES ON MEAN AGE OF RETIREMENT, IN YEARS, FOR SOL AND MNL MODELS

	Budget Set Change	Change in Mean Retirement Age	
		Preferred Specification (SOL)	Alternative Specification (MNL)
Change A:	Raise earnings stream by 10% of age 60 amount	+.19	+.04
Change B:	Raise earnings stream by 10% at each age	+.22	+.05
Change C:	Raise private pension stream by 10% of age 60 amount	-.22	-.05
Change D:	Raise private pension stream by 10% at each age	-.15	-.03
Change E:	Raise Social Security stream by 10% of age 60 amount	-.19	-.04
Change F:	Raise Social Security stream by 10% at each age	-.07	-.02

IV. Conclusions

In this paper we have developed a qualitative choice model of the economic incentives to retire and estimated it with a sample of 390 male workers in one large manufacturing firm. Theory suggests that lifetime leisure and streams of earnings, private pension benefits, and Social Security benefits enter into the choice of retirement age. We summarize these streams with two variables which we observe empirically in our data set: PDVY, the present discounted value of expected lifetime income from earnings, pensions, and Social Security associated with each alternative retirement age; and RET, the expected number of retirement years associated with each retirement age. Theory also suggests that in addition to PDVY and RET, retirement ages are affected as well by individuals' preferences for income and leisure. Though these utility function components are unobservable, they presumably reflect persistent individual-specific differences in tastes. "Workaholism" and "leisure-loving" should be accommodated empirically.

To take account of these determinants, and to allow for the non-linearity of the lifetime budget set, we formulated a qualitative choice model with retirement age as the dependent variable. We did not, however, wish to maintain the multinomial logit model (MNL) with its attendant assumption of independence from irrelevant alternatives (IIA) in the retirement context. Instead, we estimated a simple ordered logit model (SOL), which allows for nearby alternatives to be correlated with the alternative chosen.

We performed two tests of IIA and rejected IIA by both of them. On this basis, the SOL model is judged to be the preferred specification on empirical as well as theoretical grounds. SOL coefficient estimates were then used to evaluate the effects on retirement ages of various changes in the components of lifetime income. We found that, on average, raising earnings induces longer worklives, but increases in private pensions and Social Security benefits induce earlier retirement. Changes of 10% in the streams of earnings, pensions, or Social Security produce changes in average retirement ages of about 0.2 years in our sample according to the SOL estimates. For comparison, we also presented MNL estimates, which are less warranted for theoretical and empirical reasons, and found much smaller estimated effects. In future work, we intend to evaluate other data sets to determine the robustness of these findings.

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