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THE ECONOMICS OF RETIREMENT BEHAVIOR

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ABSTRACT

This paper examines the role of economic factors in determining retirement behavior using a unique new data archive on more than 8,700 workers covered by ten different pension plans. We build on our earlier work by estimating several different retirement models including linear as well as discrete choice formulations. This framework provides new insights into how and why retirement ages differ across firms. We conclude that older workers' income opportunities differ depending on their pension rules, which in turn have a powerful influence on their retirement patterns. In addition the models indicate that older workers' tastes for income are not uniform, either across individuals or across firms. Finally, we show that retirement age differences are in part due to differences in worker preferences and in part due to differences in income opportunities. There appears to be some evidence of worker sorting across pension plans.

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INTRODUCTION

Why do older workers retire when they do? Although some workers withdraw from their firms when confronted with health problems[1] or mandatory retirement,[2] an economic explanation, in contrast, puts more weight on the role of income and leisure opportunities as determinants of older workers' retirement patterns.

The present paper contains several findings about the role of economic factors in retirement behavior, using a unique new data archive on more than 8,700 workers covered by ten different pension plans. It extends our earlier work based on 390 workers in a single pension plan (Mitchell and Fields, 1983; Fields and Mitchell, 1983a). The point of departure in Section I is an intertemporal model in which older individuals select a retirement age from among several possible dates by comparing the utility from each alternative. Empirical implementation of this framework requires modelling expectations about future pension and earnings streams. We do this in Section II. In Section III, various retirement models are estimated including linear as well as discrete choice formulations. We test for unobservable but systematic patterns in workers' preferences for income relative to leisure, and evaluate the sensitivity of estimated responses to changes in income parameters. We take a different tack in Section IV, by exploring how and why average retirement ages differ across firms. This last issue has received only scanty attention in existing literature, though it is critical in determining whether or not workers "sort" themselves into firms providing pension plans rewarding early or late retirement

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[1] Gordon and Blinder (1980) provide a careful analysis of the role of ill health on retirement; a recent review of how health affects older workers is contained in Bazzoli (in progress).

[2] Lazear (1979) has an interesting analysis of mandatory retirement policy.

Results and policy implications are gathered in Section V. We conclude:

1. Older workers' income opportunities differ depending on when they retire, who they are, and what their pension rules are.

2. Differences in income opportunities at older ages influence retirement patterns significantly.

3. Older workers' tastes for income and leisure are not uniform either across older workers within a firm or across firms.

4. Average retirement ages vary widely across firms; some of this variation is attributable to differences in worker preferences, and some to differences in income opportunities. In addition, we find some evidence of worker sorting.

I. MODELING CONSTRAINTS AND CHOICES

A. The Theoretical Framework

The basic model of how earnings, private pensions, and Social Security benefit streams affect workers' retirement ages is facilitated by examining Figures 1 and 2. Figure 1 depicts the intertemporal budget set for a worker contemplating retirement, taking age 60 (or some similar age) as the starting point for retirement planning and the planning horizon as T years. Each year the individual continues to work, he receives $\$E_t$ in after-tax earnings. If he retires in year R, he receives $\$\pi(R)$ in retirement income from private pension and Social Security in that year, and $\$P(R,t)$ in retirement income thereafter.[1] The upward slope of the π function reflects the widespread practice of providing higher initial benefits to a worker who defers retirement. Corresponding to each retirement date (for example, R_1 and R_2) are streams of future pension benefits, denoted by $P(R,t)$. The $P(R,t)$ functions are flat if pension streams are constant over time; they rise if post-retirement pension increases are awarded.

The monetary gain to continued work is best treated in terms of present discounted values. Let δ_t be a discount factor reflecting time preference and mortality. The present discounted value of earnings is:

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[1] This paper equates the date of retirement with pension acceptance and labor force withdrawal, which proves to be an accurate description of most older workers' behavior in later life. For a discussion of partial retirement see Gustman and Steinmeier (1981).

FIGURE 1

Annual Earnings and Pension Benefit Amounts Available at Alternative Retirement Ages

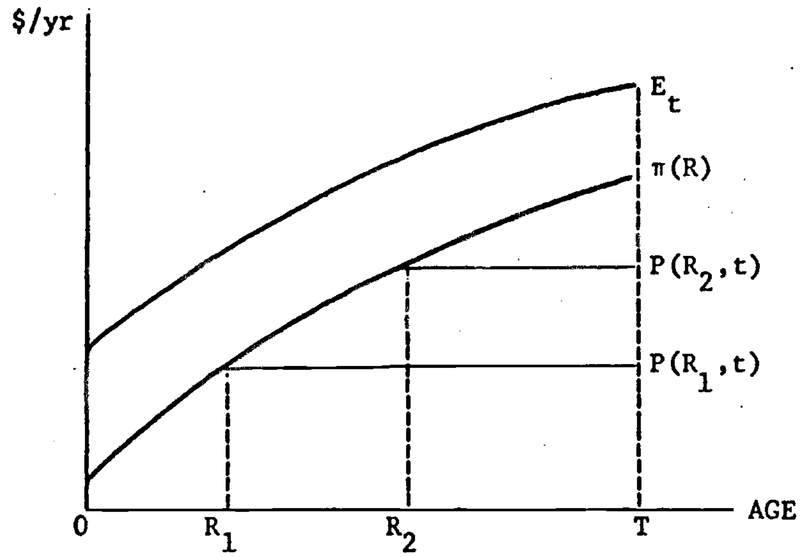
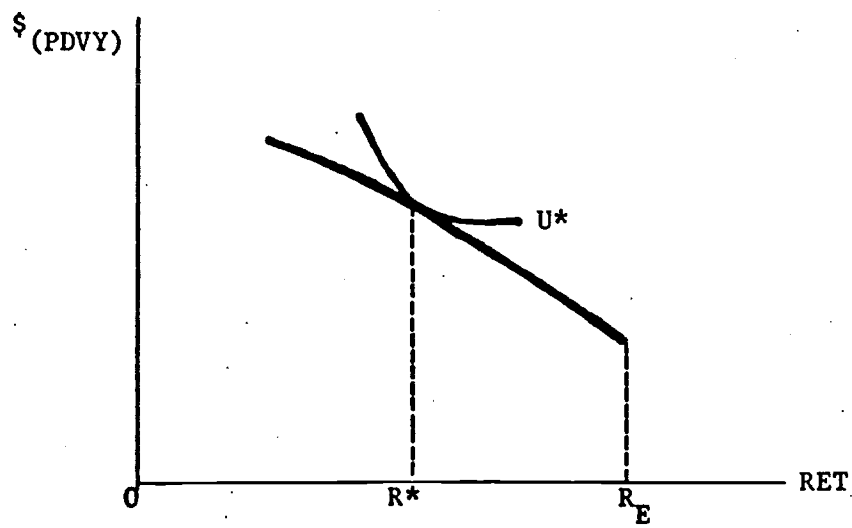


FIGURE 2

Present Value of Total Income at Alternative Retirement Ages



$$PDVE = \int_0^R E_t \delta_t \, dt, \quad (1)$$

This increases with length of worklife R so long as $E_t > 0$. The pension structure rewards or discourages continued work in accordance with

$$PDVP = \int_R^T (PP_t + SS_t)\delta_t dt. \quad (2)$$

When retirement is postponed, pension benefits typically are higher per year, but they are received for fewer years. If PDVP(R) is constant regardless of the date of retirement, the pension structure is said to be actuarially neutral. Generally, however, neither private pensions nor Social Security are neutral in this sense. The total payoff from working until a particular age and then retiring is the sum of PDVE and PDVP:

$$PDVY = \int_0^R E_t \delta_t dt + \int_R^T (PP_t + SS_t)\delta_t \, dt. \quad (3)$$

The earnings and pension streams depicted in Figure 1 produce a PDVY locus which increases monotonically in R.

The choice of retirement age is determined by combining this intertemporal budget set with an intertemporal utility function, here postulated to have as its arguments present discounted value of expected lifetime income (PDVY, as given by (3)) and number of leisure years (RET = T-R). The control variable R is selected to maximize

$$U = U(PDVY, RET) \text{ where } U_1, U_2 > 0, U_{11}, U_{22} < 0 \quad (4)$$

subject to (3). As shown in Figure 2, the goal is to achieve the highest possible utility level U* consistent with the intertemporal budget set. The optimal retirement date R* equates the marginal utility of income from an additional year of work with the marginal utility of one more year of leisure.

B. Econometric Formulations

Two different econometric models are used in the present paper to determine empirically how responsive retirement ages are to changes in the budget constraint.

The first approach takes the age of retirement as the dependent variable, and estimates its sensitivity to a parameterization of the intertemporal budget set. In particular, we postulate that the PDVY function in Figure 2 may be summarized by two variables: (1) Base wealth (YBASE), or the present value of income available at the earliest possible retirement age; and (2) The gain in the present value of income that would be obtained by working longer and postponing retirement (YSLOPE). In earlier work (Fields and Mitchell, 1983a), we showed theoretically that the age of retirement should be negatively related to YBASE, ceteris paribus, because of the ordinary negative income effect. YSLOPE on the other hand has a theoretically ambiguous effect on the age of retirement; a higher income gain from postponing retirement makes the worker's leisure time more costly (inducing more work), but also provides higher income each year he does work (inducing earlier retirement). If the substitution effect dominates, the partial effect of YSLOPE on the age of retirement should be positive. These hypotheses are tested in Section III.

While the OLS model is invaluable as a first-round approach to the age of retirement problem, it is also useful to determine what further insights are obtained from a more structured econometric procedure. An approach that proved fruitful in our earlier study of workers in a single firm (Mitchell and Fields, 1983) is to model retirement in a discrete choice framework. Drawing on the pathbreaking work of McFadden (1974), we postulate that the i'th worker would receive utility U_{ij} if he retired at age j, where utility is comprised of a "strict utility" component for the average person as well as a disturbance term which varies across people:

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

Here α and β are average taste parameters to be estimated across a sample of individuals.

To close the model, we must add a distributional assumption about the ε_{ij}. A common tactic in qualitative choice analysis is to assume that ε_{ij}'s are distributed independently of one another and that each ε_{ij} has the Weibull distribution. This produces a multinomial logit estimating model (MNL):

$$P_{ij} = \frac{e^{U_{ij}}}{\sum_j e^{U_{ij}}}. \tag{6}$$

As is well known, however, this distributional assumption requires Independence from Irrelevant Alternatives (IIA), i.e., the relative probabilities of any two choices are unaffected by the attributes or availability of other choice options. In particular, IIA means that there is no correlation between ε_{ik} and ε_{ij} $(k \neq j)$. However, in the retirement context there is strong reason to believe that such correlation may be important--particularly if individuals are likely to be "workaholics" or "leisure lovers."

In order to allow for this kind of correlation, we propose an ordered logit (OL) setup, in which the probability of choosing a given retirement age is allowed to depend on the attractiveness of the next closest retirement ages.[1] The probability of selecting from among several ordered choices may be approximated as:

$$P_j = \frac{e^{V_j + \sigma N_j}}{\sum_{k=1}^{K} (e^{V_k + \sigma N_k})} \tag{7}$$

where $N_j = \frac{-1}{2} (\log (\frac{1}{2}) + \log(1 + P^o_{j-1}/P^o_j) + \log(1 + P^o_{j+1}/P^o_j))$ and P^o_k is the probability of selecting retirement age k under the IIA assumption. N_j plays the role of a proxy for alternative-specific variation in tastes, which otherwise would be omitted from the Logit model; its coefficient (σ) indicates the importance of such variation. Iterated maximum likelihood estimation produces estimates of the coefficients of interest, reported in Section III.

C. <u>Data</u>

As is evident from the previous discussion, estimating retirement models requires that the analyst have complete information for each sample individual about: (1) the actual retirement age he selected, and (2) the intertemporal budget set he faced.

Concerning the actual retirement age, many data sets deal with individuals who have not yet retired. Our data set, a subsample of the Benefits Amounts Survey developed by the US Department of Labor, avoids this difficulty since we include only those individuals who reached the age of mandatory retirement by the time of the survey in 1978.[1] As a result these data are free from "censored spells" problems which plague other labor force modelers. At the same time, we wish to avoid mortality bias, and thus select the youngest possible group of workers in the sample--those born in 1909 and 1910. The data set then consists of 8733 males in ten firms who retired between the ages of 60 and 68. This is a much larger group of workers than used in other studies of retirement patterns, and in addition extends the 390-retiree sample used in our own previous empirical studies.

The Benefit Amounts Survey is also exceptionally useful for building the components of each worker's intertemporal budget set. This is because the data were collected on each worker's years of service, birth year, and retirement year, and then the individual files matched with Social Security administrative records and firms' pension rules. The Social Security records provided a detailed earnings history for each worker from 1951 on,[2] which was used to im-

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[1]Mandatory retirement ages varied across firms in the 1970's; six firms in our sample used age 65, one used age 66, and the rest were later or had no compulsory withdrawal age.

[2]For years in which earnings exceeded the payroll tax ceiling, we imputed earnings using a variant of the Fox method (1976).

pute what each individual would have made (after taxes) had he continued to work between the ages 60 and 68.[1] In addition, published Social Security regulations were used to compute each worker's benefit streams for all possible retirement ages. For private pensions, descriptions of benefits rules were taken from union contracts and/or summary plan descriptions on file with the Labor Department, rendered computer useable by constructing complex benefit algorithms for each of the ten plans used in the analysis.[2,3]

II. EARNINGS, PRIVATE PENSIONS, AND SOCIAL SECURITY BENEFIT STREAMS

The income opportunities available to each worker at all feasible retirement are presented in Table 1. The perspective taken is a forward-looking one: we ask, from the viewpoint of age 60, what is the discounted present value of pension benefits, Social Security income, and earnings available to the worker if he were to retire at age 60, or age 61, or later?[4] We follow standard practice by discounting each year's benefits by the probability of mortality at each age, based on survival rate information for the cohort. In addition future benefits are deflated by inflation and a real discount rate, assumed to be 2%.

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[1] More information about the construction of the intertemporal budget set is available from the authors upon request.

[2] Pension descriptions in effect during the 1970's when sample members were retiring were complemented with earlier descriptions, used to determine how benefits had changed during the previous decade. The empirical analysis below builds in pre-retirement pension increases consistent with what each plan did during this period; since most plans did not grant post-retirement increases, nominal benefits upon retirement are taken to be constant.

[3] The ten plans in our sample cannot be identified individually for confidentiality reasons; however the sample includes four blue collar plans negotiated by the United Auto Workers, and several non-union manufacturing and service sector plans.

[4] The computations assume that an individual files for Social Security when he retires or at age 62, whichever is later.

TABLE 1.

PRESENT VALUE OF TOTAL INCOME (PDVY) AND ITS COMPONENTS FOR ALTERNATIVE RETIREMENT AGES IN TEN PLANS

	Retirement Age:					
	60	61	62	63	64	65
Ten Plan Mean[1]						
PDVE	0	7,472	14,825	22,007	28,981	35,581
PDVSS[2]	28,363	29,339	30,256	31,798	33,196	34,265
PDVPP	22,892	22,759	23,200	22,457	21,717	21,354
PDVY	51,255	59,570	68,281	76,262	83,894	91,200

Notes:

[1] Benefits are computed only until age 65, because some of the sample plans had mandatory retirement at that age.

[2] Social Security benefits are computed assuming the individual retires in the year in question and files for benefits when first eligible.

Several regularities stand out in these data. First, discounted lifetime income always increases as retirement is deferred. This is a result of higher cumulative earnings which outweigh any actuarial penalty imposed by private pension plans, and the Social Security penalty when retirement is deferred past age 65.[1] Second, the intertemporal budget set is highly nonlinear. On average, a worker postponing retirement from age 61 to 62 would gain about $8700, but for delaying retirement between ages 64 and 65 receives a marginal gain 16% smaller. This arises because of the underlying nonlinearities in the pension and Social Security systems and the interactions between them. Some of our sample plans integrate benefits with Social Security payments, paying "early retirement supplemental income" until the retiree is eligible for Social Security. The payoff to deferring retirement is greater for some ages than for others in all sample plans.

Another important feature of the data is that the intertemporal budget sets vary substantially across workers. The major source of this variability is clear from Table 2, which reports means and standard deviation of private pension income streams in each of the ten plans.[2] Differences in years of service account for much of the variation in expected benefits across workers in the pattern plans, where benefits are determined primarily as a function of tenure at the firm. The conventional plans exhibit somewhat more cross-worker variation since they include both service and salary history in computing benefits. The fact that there are differences across workers' intertemporal budget sets is critical in estimating retirement responses, just as it is necessary to have wage differences in order to trace out labor supply patterns in the cross sectional context.[3]

[1] Social Security rules in effect in the 1980's are somewhat different; see Fields and Mitchell (1983b).

[2] Plan 1 was the subject of analysis in our previous empirical work.

[3] Additional differences in workers' intertemporal budget sets arise from earnings and Social Security benefit amounts.

TABLE 2.

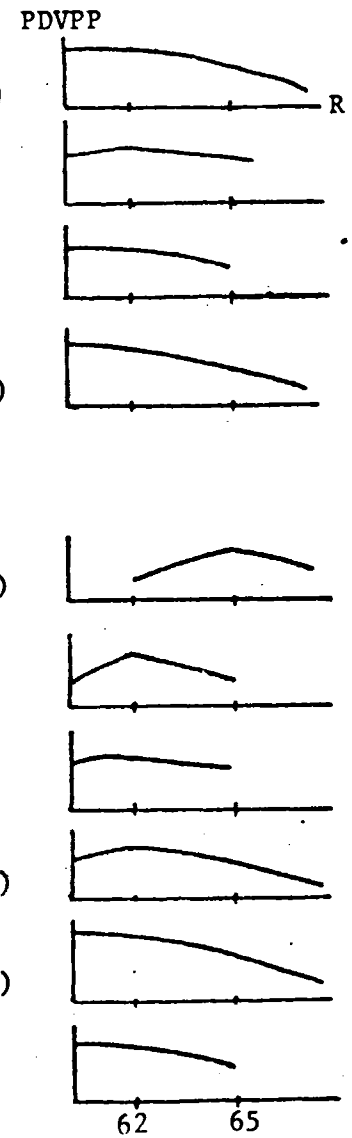
PRESENT VALUE OF NET PENSION BENEFITS FOR SAMPLE WORKERS AT

ALTERNATIVE RETIREMENT AGES: PLAN-LEVEL DATA

(standard deviations in parentheses)

	Retirement Age: 60	61	62	63	64	65	66	67	68
ttern Plans									
an 1	28,879 (10,184)	28,425 (9,168)	28,008 (8,739)	26,290 (7,894)	24,699 (7,285)	23,355 (6,638)	22,811 (6,289)	22,181 (5,933)	21,503 (5,461)
an 2	35,200 (15,159)	35,313 (14,257)	35,584 (13,959)	35,457 (12,587)	35,067 (11,581)	34,558 (10,459)	33,900 (9,276)	---	---
an 3	33,595 (9,038)	32,740 (8,391)	32,232 (8,088)	30,227 (7,490)	28,452 (7,066)	26,904 (6,832)	---	---	---
an 4	30,390 (10,683)	29,720 (9,947)	29,359 (9,440)	27,653 (8,430)	26,035 (7,806)	24,651 (7,225)	24,073 (6,734)	23,383 (6,300)	22,603 (5,878)
nventional Plans									
an 5	0	0	1,058 (2,647)	2,018 (3,483)	3,132 (3,979)	7,123 (1,648)	7,159 (1,380)	6,740 (1,186)	6,228 (1,056)
an 6	10,939 (6,934)	11,739 (7,101)	17,518 (9,629)	16,658 (8,934)	15,705 (8,260)	14,682 (7,591)	---	---	---
an 7	22,383 (25,950)	22,623 (25,474)	22,537 (24,783)	22,286 (23,726)	21,921 (22,709)	21,297 (21,670)	---	---	---
an 8	30,621 (20,618)	32,201 (20,600)	32,929 (20,878)	31,969 (20,668)	30,980 (20,324)	30,193 (19,216)	28,776 (18,558)	27,146 (17,793)	25,383 (16,992)
an 9	17,655 (14,695)	17,488 (13,149)	17,292 (11,821)	17,037 (10,889)	16,690 (10,003)	16,902 (8,672)	16,190 (8,276)	15,812 (7,600)	15,358 (7,164)
an 10	19,256 (8,518)	17,341 (7,307)	15,480 (6,223)	14,970 (5,494)	14,492 (4,919)	13,876 (4,420)	---	---	---

Graphical Summary of Row Pattern



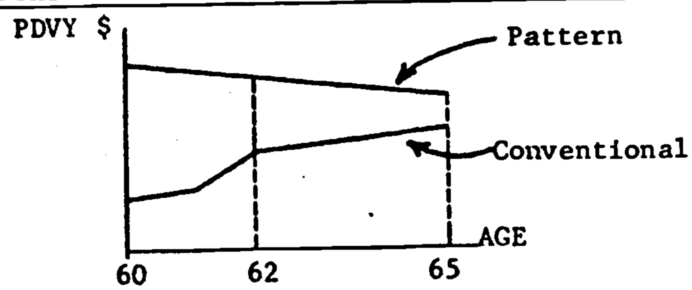
ote:
---: cannot be computed due to mandatory retirement provisions

In addition to within-plan income differences, there are also across-plan differences in income opportunities. Because the pension structures are quite complex, it is useful to derive expected benefits for the identical "illustrative worker" in all ten plans; the results appear in Table 3.[1] One striking feature is that the pattern plans in our sample tend to structure their benefits so that they actively discourage work beyond age 60. A pattern plan employee who defers retiring until age 65 will in fact receive lifetime pension benefits which are about 18% lower than at age 60. On the other hand, conventional plans' present value streams are set up so that the worker who defers retirement until age 65 will receive about 17% higher pension benefits than if he left at age 60. Thus, between ages 60 and 65, conventional plan improve benefits by about the same proportion that pattern plans reduce them. In general, patterns plans tend to encourage early retirement, while conventional plans encourage remaining on the job until age 62 and offer a flat payout schedule thereafter (See Figure 3). We can conclude that in some plans, the present value of retirement income is quite low for an early retiree, but rises if retirement is postponed; for other plans, the structure is reversed so that early retirement is rewarded most highly, and continued work is penalized by the pension plan.

In the next section we explore how these differences in income opportunities across workers and plans influence retirement age decisions.

FIGURE 3

Present Value of Pension Benefits in Pattern and Conventional Plans



[1] The illustrative worker is an individual with earnings and years of service based on sample averages.

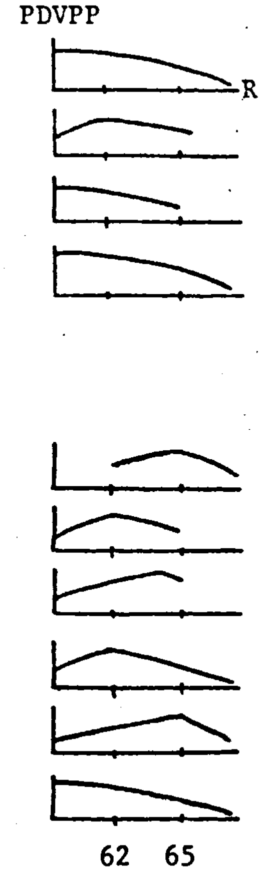
TABLE 3.

PRESENT VALUES OF NET PRIVATE PENSION BENEFITS FOR ILLUSTRATIVE WORKER AT

ALTERNATIVE RETIREMENT AGES: PLAN-LEVEL DATA

	Retirement Age: 60	61	62	63	64	65	66	67	68
I. Pattern Plans									
Plan 1	$28,181	27,586	27,189	25,455	23,787	22,195	21,706	21,140	20,500
Plan 2	36,030	36,146	36,599	36,341	35,730	34,987	34,081	------	------
Plan 3	28,176	27,571	27,189	25,455	23,787	22,195	------	------	------
Plan 4	28,176	27,571	27,189	25,455	23,787	22,195	21,706	21,140	20,500
I. Conventional Plans									
Plan 5	0	0	9,300	10,027	10,087	10,497	9,461	8,891	7,951
Plan 6	13,527	14,176	20,471	19,364	18,173	16,869	------	------	------
Plan 7	16,410	16,709	16,841	16,977	17,028	16,893	------	------	------
Plan 8	20,012	20.256	20,270	19,335	18,359	17,246	16,190	15,081	13,841
Plan 9	14,851	15,079	15,290	15,504	16,318	17,174	16,563	15,866	15,109
Plan 10	19,491	17,354	15,193	14,230	13,742	13,198	12,605	11,592	10,950

Graphical Summary of Row Pattern



Notes: Underlined numbers are row maxima. Dashes indicate retirement is mandatory in that plan at that age.

Notes: Based on pension algorithms as applied to illustrative worker; see text.

III. RETIREMENT RESPONSES TO INCOME OPPORTUNITIES

A. Results from the Linear Model

Table 4 contains a first set of findings on the question of how earnings, pensions and Social Security benefits affect retirement patterns. We find that the predictions suggested by our previous research are confirmed in Column 1. The coefficient on YBASE is significantly negative, indicating that persons with more base income retire earlier. In addition, the effect of YSLOPE is positive, indicating that individuals who have more to gain by postponing retirement, do in fact retire later. Sixteen percent of the variance in retirement ages is accounted for by just these two variables--a high R^2 for micro data. Thus we conclude that our earlier regression findings for the employees covered by one particular pension plan are supported in this extended sample.

Having established the overall qualitative robustness of the regression results, we turn our attention to the specific quantitative magnitudes of the regression coefficients to determine whether the workers in the ten plans exhibit basically the same quantitative responses to lifetime income opportunities. One set of tests is based on the pooled sample. Using all 8733 workers, we introduce dummy variables allowing first for plan-specific intercept shifters (Column 2) and then also for plan-specific slope shifters (Column 3). In both models we see that the plan dummies are significantly different from zero by conventional standards. From this we conclude that the workers in different pension plans are differentially responsive to economic incentives associated with deferred retirement.

It might be thought that in addition to the parameters of the budget constraint (as measured by YBASE and YSLOPE), variations across firms in retirement ages might be associated with differences in demographic characteristics

TABLE 4.

RETIREMENT AGE REGRESSIONS FOR POOLED SAMPLE (n=8733)
(t statistics in parentheses)

	Dependent Variable: Age of Retirement		
	(1)	(2)	(3)
Variable:			
Constant	64.17* (748.94)	64.52* (626.56)	65.40* (125.71)
YBASE	-.039* (32.71)	-.034* (24.15)	-.103* (5.30)
YSLOPE	30.41* (23.60)	29.07* (22.92)	55.43* (6.84)
Intercept Dummies		✓	✓
Slope Dummies			✓
R^2	.16	.27	.33

*Statistically significant at the .05 level.
✓Statistically significant by conventional F tests.

of the workers or with characteristics of the firms themselves. Variables to test these conjectures are not abundant in our data set; for some plans we did have a few additional descriptors of the workers (race, marital status) but these had no significant impact on the findings noted above. As for firm-side variables, we were able to develop dummy variables measuring the existence of a union, whether all employees were blue collar, whether the firm was in the manufacturing sector, and whether mandatory retirement parior to age 68 was in effect. When these variables are regressed on plan-level coefficients estimated obtained from Column 2 of Table 4, we find that unionized firms have somewhat later retirement ages and blue collar workers retire significantly earlier, holding constant the budget constraint as measured here. These findings are consistent with non-pecuniary attributes of the job playing a role in determining retirement ages: in particular, unions may increase the attractiveness of the workplace, while blue-collar jobs are less appealing to the older worker. Since we cannot yet identify very many of the factors differentiating workers' retirement patterns across plans, the only available option is to treat these worker and firm traits as unobservables and to develop models incorporating unmeasured systematic differences across employees. This is accomplished to a great degree by means of the discrete choice models explored next.

B. Results from the Discrete Choice Models

The jumping-off point for discrete choice modeling is the basic multinomial logit (MNL) model. Because of the potential for differences in unobservables across firms signalled in the previous section, and because early mandatory retirement provisions were in effect in some firms, but not in others, we examine the ten pension plans one by one rather than in a pooled model. Plan-by-plan results for the MNL model appear in the left hand columns of Table 5.

TABLE 5.

PLAN-BY-PLAN LOGIT COEFFICIENTS
(standard errors in parentheses)

	Plan #1		Plan #2		Plan #3		Plan #4		Plan #5	
	MNL	OL	MNL	OL	MNL	OL	MNL	OL	MNL	OL
PDTY (α)	14.15* (1.30)	14.28* (.45)	18.50* (1.50)	13.92* (1.55)	12.42* (1.01)	15.95* (1.15)	7.98* (.39)	8.05* (.35)	14.77* (.85)	4.97* (.87)
RET (β)	13.71* (1.19)	13.85* (1.39)	16.80* (1.48)	17.59* (1.59)	18.65* (1.31)	25.03* (1.65)	10.10* (.36)	9.63* (.37)	15.71* (1.00)	4.49* (1.00)
N (σ)		-.15 (.72)		.48 (.31)		-2.09* (.30)		1.65* (.20)		6.86* (.56)
ln L	-730.35	-730.33	-901.07	-899.88	-1361.09	-1336.41	-5646.51	-5612.95	-604.92	-507.58
Ratio α/β	.79	1.03	1.03	1.08	1.10	.64	.67	.84	.94	1.11

	Plan #6		Plan #7		Plan #8		Plan #9		Plan #10	
	MNL	OL	MNL	OL	MNL	OL	MNL	OL	MNL	OL
PDTY (α)	0.94* (.33)	2.11* (.26)	11.85* (2.82)	8.46 (2.91)	8.22* (.64)	8.63* (.67)	21.30* (3.80)	32.64* (6.84)	1.23* (.66)	3.10* (.61)
RET (β)	-1.09 (.60)	2.55* (.69)	-.65 (3.12)	.67 (2.99)	10.51* (.78)	11.12* (.84)	14.69* (2.40)	22.29* (4.53)	-7.17* (.90)	.20 (.83)
N (σ)		2.46* (.23)		1.37* (.50)		-.96* (.47)		-1.42* (.65)		3.95* (.21)
ln L	-1917.33	-1863.99	-226.70	-222.84	-1362.03	-1359.94	-198.33	-196.06	-1626.04	-1438.39
Ratio α/β	n.s.	.95	n.s.	n.s.	.78	.78	1.45	1.46	n.s.	n.s.

*t > 1.96

n.s. = one component not significantly different from zero.

For all ten plans, the MNL results indicate that the income opportunities for different retirement ages (PDVY) are significant determinants of retirement patterns. In eight of the ten plans, workers also appear to value leisure years (RET) significantly. However, before accepting these findings based on the MNL model, it is necessary to test the validity of its underlying assumption--the Independence from Irrelevant Alternatives (IIA).

One test of IIA was suggested by Hausman and McFadden (1981). It is a Chi-square test statistic comparing the estimated MNL coefficients from the full sample with new coefficients obtained from estimating a MNL model on a subsample of individuals who chose a specific subset of alternatives.[1] Such calculations for the subsets age 60 through 65, and 60 through 62, appear in Panel A of Table 6. The calculated value of the test statistic surpasses the critical value in all but one firm for which the test could be performed.[2] This is strong evidence against IIA: tastes for leisure are not uniform in the older population.

The second IIA test compares the predicted frequency distribution of retirement ages under MNL, where IIA is required, with the predicted distribution obtained from the ordered logit model, where IIA is relaxed. By this test, reported in Panel B of Table 6, the calculated test statistic surpasses the critical Chi-square value in six of the ten plans. Thus IIA should also be rejected in the majority of the cases by this second test.

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[1] The Hausman-McFadden statistic is defined as

$$T = (\theta_R - \theta_u)'[cov(\theta_R) - cov(\theta_u)]^t (\theta_R - \theta_u)$$

where θ_u is the coefficient vector estimated for the full model; θ_R is the coefficient vector estimates among individuals chosing a subset of tne total choice set; cov(θ) refers to the relevant parameter covariance matrix; and t denotes a generalized inverse. The test statistic is interpreted such that a value of T larger than a Chi-square critical value rejects IIA; degrees of freedom are computed as

$$df = tr[(cov(\theta_R) - cov(\theta_u))^t[cov(\theta_R) - cov(\theta_u)].$$

[2] The test cannot be performed where retirement was mandatory at age 65, or when no worker in a particular plan chose to retire before age 62.

TABLE 6.

Testing IIA With Plan-Level Data

	Pension Plan Number:									
	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
• Hausman-McFadden Statistics										
T Value for Subset*										
60 through 65	17.16	23.39	NA	147.32	112.68	NA	NA	183.47	15.24	NA
60 through 62	65.85	63.27	111.99	59.72	141.89	21.09	NA	58.74	NA	33.88

Critical value 10.6(at p = 0.005)
A = statistic could not be computed; see text.

• Chi-Square Statistics										
MNL vs SOL**	691.65	0.60	36.72	52.61	1217.25	82.33	12.67	1.74	2.19	427.43

*Critical Value 22.0 (at p = 0.005)

Taken together, these tests suggest that the ordered logit (OL) model, in which IIA is not maintained, better suits the retirement problem. An examination of the OL coefficient estimates (right-hand columns for each plan in Table 5) indicates the importance of both income and leisure as determinants of retirement ages. PDVY is statistically nonzero in all ten plans, and RET enters significantly in eight of ten plans. The results are similar to MNL findings in some cases, e.g., the ratio α/β and the log likelihood ratio for plan #8 are virtually identical.[1] However, in other cases the results are quite different: for plan #5, the ratio α/β changes by about 18% and the log likelihood ratio rises by 16% when going to ordered logit. In addition, the fact that the coefficient (σ) is statistically nonzero in eight out of ten cases suggests that relaxing the IIA assumption makes a difference.

Focusing just on the OL results, we note that the relative importance of income versus leisure as measured by α/β varies across firms by a factor of about 2 1/2: from .64 in plan #3 to 1.46 in plan #9. These findings buttress our conclusions from the linear models: workers in all firms react to income and leisure opportunities in selecting retirement dates, but they differ across firms in the way they react to the income and leisure opportunities associated with deferred retirement.

Because OL coefficients are rather difficult to interpret directly, it is of interest to compute explicitly how sensitive retirement ages are to changes in budget set parameters. Six parametric changes in budget sets are considered:

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

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

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[1] Only the ratios of logit coefficients are identified, not the individual α or β coefficients.

Change C: The pension benefit at each age is increased by 10% of the age 60 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 5 are combined with these alternative budget sets in order to determine how each individual would be likely to alter his retirement date. Changes for the group as a whole are obtained by summing individual changes in predicted probabilities for each age.

Table 7 reports the findings for the preferred OL specification in Column 1; parallel estimates for the MNL model appear in the second column. A 10% increase in earned income is predicted to increase the average retirement age by about 0.1 years, or a little over a month. A rise in earnings has both income and substitution effects, and in this case, the substitution response appears to dominate. In constrast, raising retirement benefits by increasing either private pensions or Social Security would lower the retirement age by a little less than a month, on average.[1] Changing the value of early retirement benefits has a larger effect than altering the gain to deferring retirement, for both pensions and Social Security. This is because raising only early retirement benefits produces an income effect favoring more leisure consumption; raising the slope of the benefit stream elicits an additional substitution response in the opposing direction.

Several conclusions emerge from this analysis. First, we find that for

[1]Gordon and Blinder (1980) also find a greater retirement response to wages than to pensions and Social Security, though the data set they use did not contain as much information on benefit structures as is available here.

TABLE 7.

PREDICTED RESPONSES OF RETIREMENT AGES TO CHANGES IN BUDGET SET PARAMETERS: LOGIT RESULTS

	Effect of Change in Budget Set on Mean Retirement Age, in Years:	
10% Change In:	SOL Results	MNL Results
A. Base Earnings	+.11	+.08
B. Each Year's Earnings	+.14	+.10
C. Base Pension	-.12	-.09
D. Each Year's Pension	-.08	-.06
E. Base Social Security	-.13	-.10
F. Each Year's Social Security	-.06	-.05

every plan, higher earnings would result in later retirement, whereas higher pensions or Social Security Benefits would induce earlier retirement. Second, the ordered logit model provides larger estimates of behavioral responses to changes in income parameters, as compared to the MNL approach. This arises from the fact that the OL setup allows nearby retirement ages to be "closer" to the date initially chosen, than does the MNL model. Consequently, when the budget constraint changes, the OL responses are on average 30% larger as compared to the responses estimated assuming IIA. Third, the difference that OL makes varies across plans; looking across the ten plans we find less of a quantitative difference between OL and MNL than had been detected in our earlier work on a single plan. This is the only quantitative difference between our findings in the larger sample and earlier results. Fourth, we conclude that retirement ages are responsive to budget set parameters, but the degree of responsiveness is relatively small. In general, rather large changes in policy variables such as taxes or benefits would be required in order to elicit substantial changes in retirement ages.[1]

IV. WHY DO RETIREMENT AGES DIFFER ACROSS PENSION PLANS?

A. Retirement Ages in Ten Plans

In contrast to previous sections, the focus here is on retirement age differences across pension plans, rather than across individuals. That retirement ages *do* differ across plans is demonstrated in Table 8: the overall retirement age across all ten pension plans is 63.7, but plan averages range from 61.8 to 65.7 years of age. Several explanations are possible: either the economic incentives for retirement differ systematically across plans, or workers'

[1] This conclusion is supported in our research with other data sets and other policy reform proposals; see Fields and Mitchell (1983b).

Table 8.

Average Retirement Ages By Plan

	($\bar{R}$) Retirement Age in Years
Overall Mean	63.70
Plan #1	63.27
2	63.53
3	61.82
4	62.77
5	64.67
6	63.18
7	64.71
8	63.17
9	65.69
10	64.17

preferences for income and leisure vary systematically across plans, or both factors may be important. While a larger sample would be necessary for a thorough investigation of these explanations, it is of interest to explore the suggestive evidence provided by the ten plans for which information is presently available.

B. Retirement Ages and Worker Preferences

Our earlier analysis used OL models to develop plan-specific estimates of the weights workers attach to income relative to leisure (α/β). In order to see whether retirement ages and workers' tastes are associated across plans, we correlate each plan's ratio of α/β with its average retirement age ($\bar{R}$).[1] We find that in fact this ratio covaries with retirement age almost exactly, producing a correlation coefficient between $\bar{R}$ and α/β of .94. This finding suggests that plans that have later average retirement ages are also those where workers on the average have stronger relative preferences for income versus leisure.

C. Retirement Ages and Income Opportunities

We now investigate whether differences in budget constraint parameters across plans help explain plan-level differences in retirement ages. This issue can be analyzed in two ways: (1) Do plans offering more income for early retirement have earlier average retirement ages (holding constant the rewards from deferring retirement)?, and (2) Do plans offering a greater reward for postponing retirement have higher average retirement ages (for a given early retirement benefit)?

One way to operationalize both questions is to determine the degree of association between average retirement ages ($\bar{R}$), the present value of income

[1]The ratio α/β was computed only where the underlying OL coefficients were statistically significant. We interpret this ratio as a measure of relative preference for income versus leisure, although it may reflect worker tastes for job characteristics as well.

available to an early retiree (YBASE), and the change in the present value of income if retirement is deferred until age 65 (YSLOPE). For our sample of plans the coefficient of partial correlation between retirement age and YBASE proves to be -.58, and between retirement age and YSLOPE +.30. Therefore we can conclude that some of the variation in retirement ages across plans is attributable to differences in income opportunities available to workers covered by the plans, though not as much as was attributed to differences in worker preferences.

D. Is There Sorting?

Firms and workers may sort themselves according to their respective preferences for continued work. Firms may differ according to the productivity value of additional seniority: presumably older workers are less productive per dollar expended in some industries than they are in others. Such firms would be expected to create incentives for older employees to leave at relatively young ages. One way to do this is to create pension benefits that are larger for workers who retire early. If workers are aware of the differential incentives offered by different employers, those individuals who have relatively high tastes for leisure would seek employment in firms offering higher early retirement benefits. Empirically, this leads us to expect that our measure of the relative strength of worker preferences for income versus leisure (α/β) should be negatively related with the pension plan's early retirement income level (YBASE). In fact the correlation of α/β and YBASE is -.45, suggesting that sorting of this type does indeed take place.

V. CONCLUSIONS AND IMPLICATIONS

The analysis reported here is based on a larger and richer data set than has been previously available to researchers studying retirement issues. Of course, the sample should be expanded even further before attempting to generalize beyond this group of employees and pension plans, and we expect future research to go in this direction. The evidence developed thus far suggests four major findings:

1. Older workers' income opportunities differ depending on when they retire, who they are, and what their pension rules are. For a given individual, payoffs to continued work are greater at some ages than at others; in general private pensions and Social Security appear not to be actuarially neutral. Even within a pension plan, income opportunities vary across workers as a function of seniority and salary histories used to compute retirement benefits. Acorss pension plans there are also large differences: in some firms, the present value of retiring early is low, but rises if the worker defers retirement; in other firms, the structure is reversed so early retirement is rewarded but continued work penalized.

2. Differences in income opportunities at older ages influence retirement patterns significantly. Individuals with more income at age 60 retire earlier; however, retirement is delayed if the worker stands to gain more by working longer. In addition, the degree of responsiveness to income opportunities depends on the attractiveness of other, nearby retirement ages. Changes in earnings have a stronger impact on retirement patterns than would the same percentage change in private pension or Social Security benefits.

3. Tastes for leisure and income are not uniform either across older workers with a firm or across firms. The data reject a model that imposes IIA in favor of models which allow for within-individual taste correlation ("workaholism").

4. Average retirement ages vary widely across firms; some of this variation is attributable to differences in worker preferences, and some to differences in income opportunities. In addition, there is some evidence of worker sorting:

those individuals who place a high value on work and the income derived from working are found in firms which provide greater financial rewards for remaining on the job at older ages.

Overall, though many factors influence retirement behavior, our work shows that retirement patterns are closely linked to the economic incentives for deferring retirement. The policy implications of this finding are evident: government practices which alter the rewards for retirement will influence older workers' labor market behavior in predictable ways. For instance, reducing early Social Security benefits or raising the payroll tax (leaving all else the same) would encourage individuals to remain in the labor force, though our results indicate a relatively small response.[1]

Future research should inquire whether differences in response patterns identified here are correlated with other worker and/or firm characteristics, such as health or job requirements. Our findings on worker sorting also deserve further attention in future research. Evidence presented here suggested that firms and workers attempt to structure their pension structures in a mutually agreeable manner. Thus planners charged with making pension policy would do well to consider how specific reforms would alter existing structures, and to ascertain whether such reforms are in fact beneficial to firms and/or their employees.

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[1] A series of specific reforms in Social Security benefit and tax rules are explored in Fields and Mitchell (1983b) using a nationally representative data set on older workers.

REFERENCES

Bazzoli, G. B., "The Early Retirement Decision: The Influence of Health, Pensions, and Social Security," unpublished PhD dissertation, Department of Labor Economics, Cornell University, In progress.

Fields, G. S. and Mitchell, O. S., "Economic Determinants of the Optimal Retirement Age: An Empirical Investigation," NBER WP #876 (April 1982, Revised January 1983) [1983a].

Fields, G. S. and Mitchell, O. S., "Estimating the Effects of Social Security Reforms on Retirement Ages." Department of Labor Economics Working Paper, Cornell University (forthcoming 1983) [1983b].

Fox, A. "Alternative Means of Earnings Replacement Rates for Social Security Benefits." in Reaching Retirement Age, ORS, Social Security Administration Report No. 47, 1976.

Gordon, Roger H. and Blinder, Alan S., "Market Wages, Reservation Wages, and Retirement Decisions." Journal of Public Economics, Vol. 14, No. 2, Oct. 1980.

Gustman, Alan and Steinmeier, Thomas., "Partial Retirement and the Analysis of Retirement Behavior." NBER Working Paper No. 763, September 1981.

Hausman, J. and McFadden, D., "Specification Tests for the Multinomial Logit Model," MIT Department of Economics Working Paper No. 292, October 1981.

Lazear, Edward P., "Why is There Mandatory Retirement?" Journal of Political Economy. 1979.

McFadden, D., "Conditional Logit Analysis of Qualitative Choice Behavior." In P. Zarembka, ed., Frontiers in Econometrics. New York: Academic Press, 1974.

Mitchell, O. S. and Fields G. S., "Economics Incentives to Retire: A Qualitative Choice Approach." NBER WP #1096 (March 1983).

Small, K. "Ordered Logit: A Discrete Choice Model with Proximate Covariance Among Alternatives." Econometric Research Program Memorandum No. 292, Princeton University, December 1981.