NBER WORKING PAPER SERIES

ECONOMIC DETERMINANTS OF THE OPTIMAL RETIREMENT AGE: AN EMPIRICAL INVESTIGATION

Gary S. Fields

Olivia S. Mitchell

Working Paper No. 876

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge MA 02138

April 1982

Fields is Professor of Economics and Labor Economics, New York State School of Industrial and Labor Relations, Cornell University. Mitchell is an Assistant Professor of Labor Economics, New York State School of Industrial and Labor Relations, Cornell University, and Faculty Research Fellow at the National Bureau of Economic Research. Both authors are equally responsible for the contents of this paper; first mention is determined randomly. We wish to thank Ronald Ehrenberg, Daniel Feenberg, Alan Gustman, and Richard Ippolito for helpful comments, as well as the participants at the Cornell and Harvard Labor Workshops and the Harvard Social Insurance Seminar. Vivian Fields and Jeff Avizinis provided able computational assistance. Research support was received from the U.S. Department of Labor, Cornell University, and the National Bureau of Economic Research. The research reported here is part of the NBER's research program in Labor Studies. Any opinions expressed are those of the authors and not those of the National Bureau of Economic Research.

NBER Working Paper #876
April 1982

ECONOMIC DETERMINANTS OF THE OPTIMAL RETIREMENT AGE: AN EMPIRICAL INVESTIGATION

ABSTRACT

This paper examines how the structure of earnings and pension opportunities affects retirement behavior. We use a life cycle model of labor supply, paying special attention to the institutional features of private pensions and Social Security benefits. This theoretical formulation is used to develop comparative dynamic predictions and to guide empirical modelling. Data from a new survey of workers and their income alternatives are used to implement the empirical model. Along the way, we highlight a number of interesting and little known facts about older workers' income. Contrary to popular opinion we find that private pensions are not always actuarially neutral; Social Security benefits do not typically decline (in present value terms) the longer retirement is deferred; and for many people, retirement income approaches and even exceeds net labor income. On the basis of empirical estimates of retirement paramaters, we conclude that (1) people with higher base incomes retire earlier, and (2) those who have more to gain by postponing retirement, retire later. These findings are relevant to proposed reforms of the Social Security system as well as pension programs.

Gary S. Fields
New York State School of
Industrial and Labor Relations
Cornell University
Ithaca, NY 14853

Olivia S. Mitchell
New York State School of
Industrial and Labor Relations
Cornell University
Ithaca, NY 14853

and

NBER
1050 Massachusetts Avenue
Cambridge, MA 02138
(617) 868-3911

1. Introduction

Social Security and pension reforms are under current policy discussion.[1] It is of interest to determine how older workers' retirement behavior responds to the structure of earnings and pensions. However, the empirical record on this issue is in substantial disagreement as to the magnitudes and even the signs of key economic variables. This paper provides new estimates of the effects of earnings, private pensions, and Social Security retirement behavior, and seeks to resolve some of the contradictions encountered to date in the empirical literature.

Existing theoretical retirement models are quite well developed.[2] They typically focus on the decision variable over which older individuals have most control, the age of retirement. The better theoretical studies also recognize the most important institutional features of the economic environment facing older individuals, such as the structures of available earnings and retirement income streams. Empirical studies of older workers' labor-leisure choices have developed along somewhat independent lines. Many studies have shown that economic variables such as earnings and retirement income do influence retirement behavior. However their results are often contradictory, because (1) they usually do not focus on the life cycle of the optimal retirement problem, and (2) they usually do not take explicit account of the complexities of pension and earnings structures. The present paper remedies these deficiencies by developing an empirical retirement model derived directly from economic life cycle theory, recognizing the special institutional features of wages and pension structures available to older workers.

---

1 See, for instance, the Report of the 1979 Advisory Council on Social Security (1980).

2 A review of recent studies is contained in Mitchell and Fields (1982).

Implementing an empirical retirement model imposes especially stringent data requirements, since the analyst must know each individual's lifetime budget set. In this study we use a new longitudinal data set containing individuals' earnings histories and formulas determining their private pension and Social Security benefits available at each possible retirement date. While roughly similar data were utilized in two previous studies [1], no previous researchers have evaluated workers' full lifetime budget constraints using the net earnings, private pensions and Social Security benefits available at each alternative retirement age. Therefore one contribution of this paper is to spell out in detail for the first time the form and shape of lifetime income profiles. We find, contrary to popular and professional opinion, that private pensions are not always actuarially neutral; that Social Security benefits typically increase in present value terms the longer retirement is postponed; and that for many people in our sample, retirement income approaches and even exceeds net labor income.

In addition, this paper combines information on chosen retirement ages and budget constraints to infer how individuals respond to retirement incentive structures. Several empirical models are discussed; the most complete, in our view, is also that which confirms predictions from economic theory. Less complete specifications often found in the literature are also examined and are found to produce biased results.

Section II contains a theoretical discussion of the life cycle retirement problem and provides comparative dynamic predictions. Section III reports on the data set used in empirical analysis, and reviews our findings about the lifetime budget constraint facing older workers. Results from empirical retirement models are presented in Section IV and conclusions appear in Section V.

---

1 Burkhauser (1979) examined a UAW pension plan, while Burtless and Hausman (1981) focus on Civil Service retirement.

II. Theoretical Framework

A. The Model

Several theoretical discussions in the literature recognize that retirement behavior can be fruitfully modelled in the context of a life cycle framework, where the decision variable is the number of periods of work before retiring.[1] The individual is assumed to maximize lifetime utility, a function of consumption and leisure in all remaining periods, subject to a lifetime budget constraint. The constraint is determined by the monetary payoffs to work (earnings) and nonwork (pension income from both private pension plans and Social Security). This lifetime perspective suggests that retirement patterns depend on: earnings at each age, the stream of private pension and Social Security benefits available at each possible retirement age, and the form and structure of preferences toward income and leisure.

While theorists have begun to analyze this problem, empirical studies focusing on retirement have taken a rather different tack. Instead of asking what determines workers' retirement ages, existing studies have focused exclusively on cross sectional labor force participation patterns of older workers. Indirectly, these two empirical issues are related, of course. However, from a policy perspective, it is of great interest to model directly the determinants of retirement ages. This perspective will prove useful in evaluating proposed reforms of Social Security and pension systems. It is also useful in illustrating some shortcomings in existing empirical models.

---

1 One of the earliest studies on the economics of retirement and pensions is Feldstein's (1974) work; Sheshinski's (1978) piece generalizes the model as do Crawford and Lilien (1981). These and other theoretical contributions are reviewed in Mitchell and Fields (1982).

In the present analysis, we posit that individuals maximize lifetime utility (U), a positive function of the present value of lifetime consumption (C) and leisure, measured here by the length of the retirement period (RET). As in most analyses of retirement behavior, we assume that older individuals find it advantageous to work full time until some age and then retire completely.[1] Our model also assumes that individuals know their lifetime budget sets and survival probability at each age.[2]

Under these conditions, and assuming that lifetime consumption must equal lifetime income, the individual confronts the following problem:

(1) $\text{Max } U = U\ (PDVY, RET)$

subject to

(2) $PDVY = PDVE + PDVP.$

PDVY is the present value of lifetime income, and can be decomposed into the sum of lifetime earnings net of taxes and pension contributions (PDVE), and net income from pensions (PDVP).[3] The sum of earnings (E_t) over the work period is:

---

1 This is clearly a simplifying assumption and could be relaxed in future research. Only one published study, that by Boskin and Hurd (1978) has addressed the part-time work option. Unpublished papers examining this issue include those by Reimers (1977), Gustman and Steinmeier (1981), Sammartino (1981), and Clark and Johnson (1980). Fewer than 10% of the individuals in our sample reported any earned income after accepting their company's pension, and only one individual earned enough income to attain the Social Security earnings ceiling (in only one year). Incorporating part-time work arrangements would greatly increase the complexity of the lifetime budget constraint, and is apparently not required for the workers represented in our data (described below).

2 Crawford and Lilien (1981) analyze a theoretical model where changes in uncertainty are allowed to affect retirement behavior. In the empirical work below we assume individuals discount future income streams by the relevant mortality probabilities.

3 Throughout this section the term "pension" is used to denote the sum of (net) private pension and Social Security income.

(3) $$PDVE = \int_{o}^{R} E_t \, e^{-r\,t} \, dt. \quad \text{where} \quad E_t > 0 \text{ for all } t.$$

E_t should be expressed net of income taxes and of pension contributions, if any. PDVP is the discounted sum of net pension benefits (P_t) received during the retirement period (from retirement R to death T, appropriately discounted for mortality):

(4a) $$PDVP = \int_{R}^{T} P_t \, e^{-r\,t} \, dt.$$

A retiree's pension in year t is a function of the year itself (t), the age he retires (R), and a pension amount factor (F):

(4b) $$P_t = P(t, R, F).$$

The year itself (t) enters in, because pension benefits may vary with time, as for instance in the cases of indexed Social Security benefits and union-negotiated increases in retirement benefits for persons already retired. The age of retirement (R) appears, because a person who retires later often receives larger annual pension benefits than he would if he retired earlier. In some pension plans the factor (F) is a positive function of earnings; hence:

(4c) $$\frac{\partial P}{\partial t} \geq 0, \quad \frac{\partial P}{\partial R} \geq 0, \quad \frac{\partial P}{\partial F} \geq 0.$$

The other argument of the lifetime utility function is the length of the retirement period (RET). RET is the difference between expected lifetime (T) and age of retirement (R):

(5) $$RET = T - R.$$

Combining equations (1) through (5), the first order condition for a maximum is obtained as an implicit function for the optimal retirement date, R, expressed in terms of the effect of working the Rth year:

$$(6)\qquad \frac{\partial U}{\partial\, PDVY}\left[E_R\, e^{-r\,R} - P_R\, e^{-r\,R} + \int_R^T \frac{\partial P(t,R\,,F\,)}{\partial R^i}\, e^{-r\,t}\, dt\right] - \frac{\partial U}{\partial\, RET} = 0.$$

At the optimal retirement age, an individual equates the utility value of working one more year with the utility loss experienced by postponing retirement. He gains the Rth year's earnings as well as higher pension benefits in later years, which just offsets the loss in the Rth year's pension income and leisure. In general terms, then, the optimal retirement date is a function of two types of variables. The first is the term in square brackets representing the price of leisure, or the change in discounted income as retirement is postponed. The other variables ($\frac{\partial U}{\partial PDVY}$ and $\frac{\partial U}{\partial RET}$) reflect taste factors. A general solution for the optimal retirement age should thus have the following form: [1]

(7) R = f (price of leisure, tastes for income and leisure).

Determining the effect of a change in the earnings or pension on an individual's retirement age is feasible using comparative dynamics on equation (6). Results from this analysis are summarized in Table 1. In general, we find that increases in earnings and pension streams have ambiguous effects on retirement. Ceteris paribus, more income should induce more leisure consumption (if leisure is a normal good), so that higher earnings and pensions can cause earlier retirement. However, if more income is gained as retirement is postponed, higher income streams can also elicit more years of work through an intertemporal substitution effect. The only unambiguous sign is that of a

---

[1] The price of leisure term differs conceptually from that used in previous studies because it reflects the change in the present value of total net income associated with later retirement, rather than just the change in pension wealth or earnings alone.

Table 1.

Comparative Dynamics

Parameter Change	Effect of Parameter Change on i'th Individual's:					
	Change in Marginal Utility of Income $\left(\frac{\partial U}{\partial PDVY}\right)$	Earnings at Retirement Age (E_R)	Pension at Retirement Age (P_R)	Rate of pension increase as Retirement is Postponed $\left(\int_R^T \frac{\partial P}{\partial R}\right)$	Change in Marginal Utility of Leisure $\left(\frac{\partial U}{\partial RET}\right)$	Net Effect on the Age of Retirement (R)
$\uparrow$ earnings (E_R)	$\downarrow$	$\uparrow$	$\uparrow$ or zero	$\uparrow$ or zero	$\uparrow$	Ambiguous
$\uparrow$ pension intercept (P_R)	$\downarrow$	zero	$\uparrow$	zero	$\uparrow$	Earlier
$\uparrow$ pension slope $(\partial P/\partial R)$	$\downarrow$	zero	$\uparrow$	$\uparrow$	$\uparrow$	Ambiguous

change in the pension amount (P_R), which raises the worker's income stream without changing the slope of his lifetime budget set. In this case alone will a higher pension unambiguously induce earlier retirement.[1]

The preceding paragraph addressed effects of changes in the budget set for a specific individual. Of course we would expect that the same patterns would hold in looking across a sample of individuals in a survey data set such as the one discussed below. In addition, if individual preferences differ, workers with higher marginal utility for income would be more likely to work longer (retire later) than those with a lesser marginal preference for income. Utility parameters cannot be observed directly, however, so they must be proxied in empirical analysis.

B. Implications for Empirical Specifications

The general retirement model embodied in equation (7) has several implications for empirical researchers wishing to evaluate the retirement response to budget set parameters.

1. The age of retirement is a function of earnings and pension opportunities in every period.[2] Most previous empirical studies use only current variables to explain retirement status; even the best studies focus only on two

---

1 Some of these results have been noted in the theoretical literature; for instance Burbidge and Robb (1980), Sheshinski (1978), Hemming (1977) and Fields and Mitchell (1981) recognize that many of these effects are theoretically ambiguous in sign. However empirical discussions have sometimes overlooked these ambiguities, claiming for instance that higher pensions always induce earlier retirement.

2 This holds even if the dependent variable is a cross-sectional labor force participation measure, as noted by Heckman and McCurdy (1980) in a different context.

of several alternative retirement ages,[1] rather than looking at the complete budget set. In addition, many studies include only a subset of earnings and retirement income opportunities, and omit taxes and contributions from consideration altogether. A complete specification of the lifetime budget set requires that total net income available from postponing retirement be examined.

2. The age of retirement is a non-linear function of earnings and pension parameters. There are two kinds of nonlinearity to consider. The first type arises because the expression defining the optimal retirement age, equation (6), is in general quite complicated. A very simple example demonstrates this point: take the case of a wealth maximizer facing linear earnings and pensions functions, whose discount rate is zero: $U = PDVY$, $E = m + nt$, and $P = p + q\,R$. In this case the optimal retirement age can be solved for explicitly as a function of the base earnings (m) and pension (p) as well as the change in annual earnings (n) and pension (q) as retirement is postponed:

$$(8) \qquad R = \frac{m-p+qT}{2q-n}.$$

The effect of a change in any one variable is not, even in this simple model, independent of the levels of other variables. One could, of course, linearize the determinants of retirement as:

$$(9) \qquad R = b_0 + b_1\,m + b_2\,n + b_3\,p + b_4\,q,$$

but this formulation ignores the dependence of earnings effects on pension levels (and vice versa).

---

1 E.g., Burkhauser (1979) and Gordon and Blinder (1980).

A more serious problem arises when pensions are functionally related to earnings. This dependency is characteristic of Social Security and is also relevant to many private pension schemes. In this event, because earnings increases are automatically translated into pension increments, the coefficient on earnings obtianed by regressing retirement on an earnings parameter is not the ceteris paribus impact of labor income.

These types of interactions imply that retirement is not a linear function of earnings and pension parameters entered separately. However, existing empirical studies usually include labor and pension income as separate arguments in linear models of older workers' behavior.

3. Effect of earnings and pensions on the age of retirement will depend on taste parameters in complicated ways. To see this, we can derive the optimal retirement date for an individual who values leisure as well as income. Consider for instance a worker with a Cobb-Douglas utility function of the form:

$$U = (PDVY)^{\alpha} \quad (RET)^{(1-\alpha)}. \tag{10}$$

Even if the worker faced linear earnings and pension streams $E = m+nt$ and $P = p + qR$, the optimal retirement age would be a quite complex function of the parameters of the utility function and budget constraint:

$$R = \frac{\{-[(n-2q)T - \frac{1}{\alpha}(m-p+qT)] \pm \sqrt{[(n-2q)T - \frac{1}{\alpha}(m-p+qT)^2 - 4[(1-\alpha)(\frac{1}{2}n-q)(mT+qT^2 - \frac{1}{\alpha}pT]}\}}{2(1-\frac{1}{\alpha})(\frac{1}{2}n-q)}. \tag{11}$$

It is evident from expression (11) that the effects of pensions and earnings on retirement will in general depend on the individual's taste parameters. This has not been recognized in previous empirical analyses of retirement, which typically assume additive separability between income parameters and tastes of the form.

$$R = \beta_1 \text{ (Economic Variables)} + \beta_2 \text{ (Taste Parameters)} \quad .$$

4. Looking across a sample of people, retirement ages will vary for two reasons. First, workers' budget constraints may differ and second, their tastes for income and leisure may be different. Most previous studies have recognized that workers' current incomes differ, but frequently fail to recognize that people also differ in the amount that they could gain by postponing retirement.[1] These variations in budget constraints across people arise because they face different earnings and pension functions. Section III examines these variations in our data directly. If, in addition, workers differ according to the way they value income and leisure, taste variations must also be incorporated in an empirical evaluation of how retirement ages responded to income changes. Empirical retirement analysis to date has also not focused on this sort of variation.[2] In Section IV below, we address this issue directly.

---

1 Burkhauser (1979) recognizes that pension benefits change as retirement is postponed, and that this amount varies across workers. However, that paper does not take into account the fact that the other components of workers' total lifetime budget sets --- discounted earnings and Social Security benefit streams --- also change as retirement is postponed.

2 Gordon and Blinder (1980) and Zabalza et al (1980) both utilize models where workers' preferences for retirement are allowed to vary across people. This is similar in spirit to the work by Burtless and Hausman (1978) in another context. In all cases, however, the authors (continued on next page)

III. Data Description and the Lifetime Budget Constraint

One reason that previous researchers have not examined the lifetime budget constraint of older workers in great depth is that information on total retirement income is extremely difficult to obtain. The most frequently used source, the Retirement History Survey, does not provide formulas for computing private pension benefits at alternative retirement ages; other data sets tend to be deficient in other respects. The analysis in the present paper utilizes a new data set which contains all the elements required to construct the requisite income streams for each worker. This section describes the data source and the structure of the lifetime budget set. Then, in Section IV, we show that variations in the budget constraint are indeed associated with ages of retirement in the ways predicted by theory.

A. Data Source and the Sample Under Analysis

In 1978, the U.S. Department of Labor selected a sample of private pension plans that filed Summary Plan Descriptions (SPDs) under the Employee Retirement Income Security Act of 1974 (ERISA). The SPDs contained information on pension formulas used to determine retirement benefits. Each sample plan also provided data on all pension recipients including the birth year and year of retirement. Employer-provided data were then merged with individual Social Security records to obtain earnings histories and basic demographic information.

---

2 (continued from preceding page) focus on the probability of being in the labor force at a single survey date, rather than on the age of retirement of central concern here.

Establishing the exact pension formulas proved unexpectedly complicated, and has led us to analyze the workers in one particular pension plan in this paper.[1] The structure of pension benefits in this company is sketched in subsection B below. The resultant lifetime budget set is discussed in subsection C.

Working with this one pension plan, for which the structure of pension benefits is well understood, we set out to produce a sample of retirees for whom age of retirement could be related to earnings, private pension income, and Social Security benefits. We sought to avoid sample truncation bias arising from two sources. One such source is that persons who had retired from the firm, but who already had died by 1978, were not included in the recipient file. This suggested choosing a sample young enough to minimize sample truncation on account of mortality. On the other hand, individuals who were elegible to retire, but who had not yet retired, were not included in the pension recipient file either. This argues for choosing a sample that is old enough to minimize sample truncation on account of incomplete work spells. The compromise adopted here focuses on one age group of workers born in 1909 and 1910. These individuals were thus 68 or 69 years old in 1978 when the survey data were gathered, and had passed the mandatory retirement age at the firm in question, assuring that their work spells were completed. Some (unknown) amount of mortality bias remains but it is expected to be small.

While the survey is quite informative on retirees' behavior, it contains no information on spouses' work status. Since this omission is much more serious for women than for men, the analysis was limited to males only. The resultant sample consists of 390 males born in 1909 and 1910, who retired between the ages of 60 and 68.

---

[1] In future work we plan to extend the analyses to other companies.

B. The Private Pension Structure in Company X

The pension structure in Company X is negotiated every three years and written into a contract with the United Automobile Workers union (UAW). The formula negotiated in the early 1970s, when the workers in our sample were about 60 years of age and were presumably deciding when to retire, varied depending on age and/or years of service. To illustrate, the following rules applied to an individual who started work at Company X at age 30:

i. If he retires after age 60, but before age 62: his pension benefit is $6,000 per year until age 62 and $5,400 per year from 62 to 64; thereafter, it is [$90 x yrs. of service less (.04 * the difference between the retirement age and 62)] + $63.60.

ii. If he retires after age 62, but before age 65: his pension benefit is $5,400 per year until age 65; thereafter, it is [$90 x yrs. of service] + $63.60.

iii. If he retires at age 65 or later: his pension benefit is [$90 * yrs. of service] + $63.60.

Table 2 presents several streams of annual pension benefits available to a hypothetical worker at selected retirement ages, based on these rules.

One remarkable feature of this private pension structure is that at age 62, a retiree actually gets <u>less</u> in initial pension benefits per year than at age 61. The same sort of benefit decrease occurs if the worker postpones retirement from age 64 to 65. A partial explanation may be found for this by recognizing that the pension plan is *de facto* integrated with Social Security. In other words, though benefits are not formally reduced when Social Security recipiency begins, the perception is clearly that workers can claim full Social Security benefits at age 65, and thus are provided with supplemental private benefits until Social Security commences. The fallacy of thinking that annual pension benefits are monotonically increasing functions of time worked is clearly indicated in these numbers.

Table 2.

Streams of Pension Benefits at Alternate Retirement Ages for a Hypothetical Worker Who Joined Company X at Age 30

(Based on Union Contract in Effect in 1972)

	The pension benefit he gets at each age is:									
	60	61	62	63	64	65	66	67	68	
If he retires at age 60:	6000	6000	5400	5400	5400	2547.60	2547.60	2547.60	2547.60	etc.
If he retires at age 62:	0	0	5400	5400	5400	2943.60	2943.60	2943.60	2943.60	etc.
If he retires at age 65:	0	0	0	0	0	3213.60	3213.60	3213.60	3213.60	etc.

C. The Lifetime Budget Set

Space permits us to only briefly summarize the specific assumptions that went into the creation of the lifetime budget set.[1] Previous empirical analysts have not recognized the importance of modelling older workers' expectations about the institutional environment they are likely to face in the future. In contrast, our approach develops each individual's budget constraint assuming that his best estimate of changes in future earnings, taxes, Social Security and pension opportunities would be forecast on the basis of actual changes expecrienced during the decade prior to retirement.[2] It was also assumed that individuals considering retirement prospects would discount future income promises by the probability of not surviving to that age. In addition, all future income streams were discounted at a nominal rate of 5%.[3]

---

1 Details are available from the authors on request.

2 Both Social Security and private pension benefits had been increasing at positive real rates throughout the 1960's, so that the constant nominal (declining real) benefit stream assumed in other studies would clearly be inconsistent with expectations. Formulating other models of expectations is left to future work.

3 Sensitivity analyses with other discount rates produced budget constraints virtually identical in shape to those obtained with the 5% rate.

Earlier we noted that income opportunities for each possible retirement age have not been calculated previously in empirical work.[1] Mean values for the annual amounts appearing in the first three rows and in present discounted value (PDV) terms in the following three rows. Total lifetime income is given in Row (7).

Several features of the lifetime budget set stand out. First, examine Row (7). Discounted lifetime income always increases in real terms as retirement is postponed. The lifetime budget profile is monotonically increasing because in each year the sum of earnings plus (or minus) the change in future pension income is greater than the loss of the current year's pension if retirement is postponed. (See the term in brackets in equation (6)).

The components of the budget set also are of interest. For obvious reasons, people who retire later have higher cumulative real earnings (Row 7). Later retirement also translates into a higher stream of private pension benefits until age 64, as is evident in row (5); this pattern contrasts with Lazear's (1981) claim that private pension wealth falls as retirement is delayed. In general, we conclude that the private pension plan is not actuarially neutral; the PDV of net private pension income is an inverted-U-shaped function of age of retirement. Pension wealth does decline after age 64, in this plan; however, this relatively early peak to private pension wealth contradicts both Burkhauser and Quinn's (1980) proposition that pension wealth increases until mandatory retirement, since in this firm age 68 is the obligatory retirement age, and Bulow's (1979) claim that pension wealth declines each year retirement is postponed.

---

[1] Further, previous studies typically do not subract income taxes from earnings and private pensions, nor Social Security contributions from earned income. Both adjustments have been made here.

Table 3.

Elements of the Lifetime Budget Set for the Mean Individual in Company X; As Expected at Age 60

	60	61	62	63	64	65	66	67	68
Annual Variables at Age X:									
(1) Net earnings	7706	7866	8334	8676	8837	8978	9190	9435	9686
(2) First Year's Net Private Pension	4002	4160	3875	3977	4068	3281	3610	3976	4367
(3) First Year's Social Security*	1676	1842	2020	2393	2825	3305	3641	4007	4412
PDVs if the Individual Retires at That Age:									
(4) PDV Net Earnings	0	7316	14512	21450	27981	34100	39857	45276	50359
(5) PDV Net Private Pension	57533	58506	59092	60205	61425	55431	54893	54355	53629
(6) PDV Social Security	27898	31647	34689	38754	43031	47189	48597	49823	50912
(7) PDV Net Lifetime Income (=(4)+(5)+(6))	86331	97469	108293	120409	132437	136720	143347	149454	154900

* Social Security benefits are computed as of the year of first eligibility. Thus an individual retiring at age 60 would not begin receiving benefits until attaining age 62.

Unlike for the private pension plan, the lifetime stream of Social Security benefits continues to rise in present value terms as retirement is postponed, as row (6) indicates. In other words, as workers postpone retirement, their rising real earnings combine with Social Security benefit rules to raise annual Social Security benefits at a faster rate than expected remaining lifetime declines. Thus, contrary to the popular belief that the Social Security System is actuarially neutral until age 65 and actuarially disadvantageous thereafter, we find that deferring retirement produces successively higher values of Social Security wealth.[1]

Another conclusion from Table 3 is that the budget constraint is not linear. The gains to deferring retirement range from a high of about $12,000 for working the 63rd year of life, to a low of about $6,600 for working the 65th year. This is a function of the non-linearities in the private pension plan, Social Security and net earnings profiles and the interactions among them. These interactions have not been recognized in previous attempts to construct the lifetime budget set facing older workers.

A final observation on Table 3 is that the average ratio of pension benefits to earnings (referred to as the "replacement rate" in the literature) varies a great deal across ages. In our data the ratio of net private pensions to net earnings ranges from 37 to 53%, while the Social Security replacement rate spans the range from 24 to 47%. The mean ratio of total net retirement income to net earnings in our sample stands at 74% for retirement at age 60, and rises to 91% if the worker waited until age 68 to retire.[2] To our knowledge no previous study has found replacement rates of this magnitude, because no analysis has focused on after-tax total income.

---

1 Recent reforms in the Social Security rules may have modified this pattern; see Blinder, Gordon and Wise (1980) and Burkhauser and Turner (1981).

2 One sixth of the workers in our sample would have received retirement income greater than or equal to 95% of net earnings had they retired at age 62; over one third would have experienced a replacement ratio of this magnitude if they had waited until age 68.

IV. Empirical Determinants of Retirement Behavior

The theoretical model of determinants of retirement presented in Section II suggested several lessons for empirical analysis. One conclusion we drew is that retirement must be modelled as a function of total income changes as retirement is postponed. A natural way to summarize this information in empirical work is to measure the change in the present vllue of income available at the earliest possible retirement age and at the age of mandatory retirement.[1] In empirical work below, we refer to this variable as YSLOPE, and treat it as a price -- it is the amount of income foregone in favor of leisure if the worker retires earlier rather than later.

This formulation has several advantages over those available in the literature. Because it includes net earnings, net private pensions and Social Security, it is a more complete specification of the budget set than in any previous empirical retirement study, since data limitations have prevented other analysts from combining all three elements of the lifetime budget constraint into a total income term. This approach also incorporates the functional dependence of changes in retirement income on earnings prior to retirement, in contrast to previous formulations. Finally, the coefficient of YSLOPE in a retirement model has a natural interpretation: it represents the (uncompensated) effect of a change in the value of additional leisure on the age of retirement. In general therefore, YSLOPE may be associated with later retirement (if the substitution effect dominates) or earlier retirement (if the income effect is stronger). As with most

---

1 Other approximations to the slope of the lifetime budget constraint as retirement is postponed could be computed since the budget set is nonlinear, but sensitivity analysis we have performed indicates that this would not materially affect results as described below.

regressions of a quantity on its own price, we expect a negative relationship even though we are looking at uncompensated effects. In the age-of-retirement model, those who forego more income by retiring earlier would, we hypothesize, tend to work longer, producing a positive coefficient on YSLOPE.

In Section II it was also suggested that differences in tastes could explain some additional variation in retirement ages, ceteris paribus. Of course, workers' marginal utility parameters are not directly observable, and thus must be proxied by other variables. The best proxy available to us is income. If leisure is a normal good, one would expect that higher income would be associated with earlier retirement for three reasons. Because of an ordinary income effect, higher income people would buy more leisure. Also, because of diminishing marginal utility of income, higher income people would value extra income less than would poorer people. Thirdly, in a household production context, higher income people are apt to own more goods to complement their retirement years (e.g., sailboats, multiple homes for various seasons) and hence have higher marginal utility of leisure years than do lower income persons. In the analysis below, we control for such taste variation with YBASE, the worker's total income at the earliest possible retirement age (age 60 for this sample). It is hypothesized to have a negative coefficient in an age-of-retirement regression.[1]

The results in Table 4 clearly demonstrate that retirement behavior is responsive to the structures of earnings and retirement incentives. Column 1 reports the relationship between the age of retirement and the variable we claim

---

[1] We assume that remaining variation is distributed independently of included variables. We also explored models where other demographic variables such race were incorporated, but they proved to be virtually identical to those discussed below. In other samples one might wish to incorporate additional taste proxies; however, our data set is quite homogeneous since it includes only blue collar workers covered by a UAW contract, employed by one firm, all born in the same period. It is therefore not surprising that demographic variables proved insignificant in empirical analysis.

is the theoretically correct "price" term, YSLOPE, as well as the variable proxying for the marginal utility of income, YBASE. It is evident that people who have more income retire earlier, confirming the hypothesis that retirement years are a normal good. In addition it appears that the substitution effect dominates the income effect, since people who have more to gain by postponing retirement indeed retire later, ceteris paribus. Both effects are statistically significant with the theoretically anticipated signs.

Sensitivity analysis on the basic model reveals that most alternative formulations affect results very little if at all. Slightly different specifications of YSLOPE produce about the same elasticities as those reported above; Column (2) for instance uses the change in total income as retirement is postponed from 60 to 65 rather than 68, as in the first column. Interacting YBASE and YSLOPE in the third column proves less interesting. The signs and magnitudes of the effects are roughly similar to those in the first two columns, but multicollinearity introduced at this step increases standard errors. At conventional significance levels, the hypothesis that price and proxies for tastes interact (in the way specified by Column 3) must be rejected.

As we have argued earlier, a model compatible with a life cycle approach to the retirement problem is one that incorporates all income opportunities from alternative retirement dates and their interactions as in Columns (1-3). However, less complete specifications are often used in the literature because of data limitations or lack of a firm life cycle foundation, and it is of interest to inquire what we would find if other approaches had been used to address the age of retirement problem. Columns (4-6) speak to this question. The fourth equation reflects a rather widespread view that retirement depends on pension and Social Security wealth, and that these variables enter additively separably. As we have seen above, the dependence of retirement on pension and

Table 4.

Empirical Results: Determinants of

Retirement Ages: N=390

(Standard errors in parentheses)

Variable*	Mean	Parameter Estimates (1)	(2)	(3)	(4)	(5)	(6)
YBASE	86.07	-.011* (.004)	-.010* (.004)	-.026 (.017)			
YSLOPE	66.75	.044* (.006)	.061* (.010)	.025 (.022)			
YBASExYSLOPE	0.56			.002 (.002)			
PDVPEN65	55.73				-.040* (.006)		
PDVSS65	47.33				.020 (.023)		
NETERN60	7.39				.233* (.058)	.343* (.060)	
NETPEN60	3.88					-.649* (.115)	
SS60	1.68					.578 (.925)	
CHERN65	1.81					.239* (.035)	
CHPEN65	1.44					-.678* (.300)	
CHSS65	1.63					-1.04 (.833)	
PDVPEN60	57.18						-.054* (.010)
PDVSS60	28.89						.017 (.040)
ERNSLOPE	48.10						.058* (.010)
PENSLOPE	-3.26						-.071* (.030)
SSSLOPE	21.91						.110* (.040)
R^2		.17	.15	.18	.12	.20	.22

*Variable Definitions on next page

*Variable Definitions:

All variables expressed in thousands of dollars unless noted otherwise.

PDV	Present Discounted Value, computed as described in text
YBASE	PDVY at age 60
YSLOPE	PDVY68-PDVY60 for all but Column (2); PDVY65-PDVY60 for Column (2)
YBASE*YSLOPE	Interaction between the two variables (in millions of dollars)
PDVPEN65	PDV of net private pension benefits if worker retired at age 65
PDVSS65	PDV of Social Security benefits if worker retired at age 65
NETERN60	Annual net earnings level at age 60
NETPEN60	Annual net pension level at age 60
SS60	Annual Social Security level worker would eventually receive if he retired at age 60
CHERN65	NETERN65 - NETERN60
CHPEN65	NETPEN65 - NETPEN60
CHSS65	SS65 - SS60
PEVPEN60	PDV of net private pension if worker retired at age 60
PDVSS60	PDV of Social Security benefits if worker retired at age 60
ERNSLOPE	PDVERN68 - PDVERN60
PENSLOPE	PDVPEN68 - PDVPEN60
SSSLOPE	PDVSS68 - PDVSS60

Social Security wealth is somewhat ill-defined since the present values of pension and Social Security wealth change with retirement age. Nonetheless, we can arbitrarily select age 65 to compute discounted streams of retirement income, and also include the base level of earnings as an explanatory factor.[1] Alternatively, we might use base year pension and earnings levels as well as changes in these levels if the worker defers retirement until age 65; see column 5. The model in column 6 includes all the components of column 2 in present value terms but enters them linearly instead of collapsing them in the total income concept used earlier.

When analysts have used earnings levels in previous empirical studies, both positive and negative effects on retirement have been discerned.[2] Both Columns 4 and 5 suggest that higher base earnings induce more work and later retirement. This directly contradicts the evidence provided by the model of Column 1, where we found that a rise in base income from any source, including earnings, induces earlier retirement, as expected if leisure is a normal good. Thus, if we had used the ad hoc specifications in Columns 4 and 5 rather than the life cycle model of column 1, we would have reached the implausible conclusion that leisure is not a normal good.

Other types of increases in base income should also induce earlier retirement according to the conceptual model of Section II, but one would not

---

1 This equation is thus more complete than many previous models because both pension and earnings are included and are net of taxes and contributions. as well. It remains incomplete, of course, as compared to Column 1, for the reasons noted in the text.

2 Mitchell and Fields (1982) review findings from existing studies.

arrive at this conclusion based on previous results in the literature nor from the improperly specified models in columns 5 and 6. In fact columns 5 and 6, if believed, would indicate that raising pension and Social Security amounts at the earliest retirement age have conflicting effects: a more generous private pension level or stream appears to be significantly associated with earlier retirement but the opposite sign, though insignificant, is detected for Social Security. But, once again, these results are derived from a linear, non-interactive specification lacking theoretical justification.

Consider now the gain in lifetime income if retirement is postponed. According to theory, increases in the amount of income associated with postponing retirement should induce later retirement. This conclusion was borne out empirically in Regressions 1 and 2. However this conclusion would not have been reached from differently specified models. In column 5, faster earnings growth appears to induce later retirement, but more generous pension and Social Security adjustments as retirement is postponed appear to induce earlier retirement. On the other hand, regression 6 seems to indicate that workers retire earlier if the pension stream rises but later if earnings or Social Security streams increase. Not only are these findings mutually inconsistenet, but they are also at odds with models using the more conceptually appealing lifetime budget constraint which includes total income.

V. Conclusion

This paper suggest that older workers respond to the structure of earnings, private pensions and Social Security in ways that are consistent with a life cycle labor supply formulation. The implications of a life cycle model are drawn out in the context of the special institutional features characterizing retirement income, and comparative dynamic predictions are derived. This formulation provides guidance for empirical modelling of retirement behavior, which we incorporate in our estimation equations. Data from a new survey are used to implement the theoretically preferred empirical model; in addition a number of alternate empirical equations are estimated. In developing the data we highlight a number of interesting and little known facts about older workers' lifetime budget sets. Retirement ages among workers in our sample respond in a manner compatible with theory; alternative specifications similar to those found in the literature do not. We find: (1) Higher base income induces earlier retirement. (2) Those who have more to gain by postponing retirement, retire later.

References

Blinder, Alan S., Gordon, Roger H. and Wise, Donald E. "Reconsidering The Work Disincentive Effects of Social Security." National Tax Journal, December 1980.

Boskin, Michael J. and Hurd, Michael D. "The Effect of Social Security on Early Retirement." Journal of Public Economics, December 1978.

Bulow, J. "Analysis of Pension Funding Under ERISA", NBER WP No. 402, 1979.

Burbidge, J. B. and Robb, A. L. "Pensions and Retirement Behavior." Canadian Journal of Economics, August, 1980.

Burkhauser, Richard V. "The Pension Acceptance Decision of Older Workers." Journal of Human Resources, 1979.

Burkhauser, Richard V. and Quinn, Joseph. "Mandatory Retirement Study, Part I." Task Completion Report Submitted by the Urban Institute, June, 1980.

Burkhauser, Richard V. and Turner, John A. "Can Twenty-Five Million Americans Be Wrong?" National Tax Journal, December 1981.

Burtless, Gary and Hausman, Jerry. "Double Dipping: The Combined Effects of Social Security and Civil Service Pensions on Employee Retirement." NBER Working Paper No. 800, November 1981.

Burtless, Gary and Hausman, Jerry. "The Effect of Taxation on Labor Supply: Evaluating the Gary Negative Income Tax Experiment." Journal of Political Economy, 1978.

Clark, Robert L. and Johnson, Thomas. "Retirement in the Dual Career Family." Final Report SSA Grant No. 10-P-90543-4-02, June 1980.

Crawford, Vincent P. and Lilien, David M. "Social Security and the Retirement Decision." Quarterly Journal of Economics, August 1981.

Feldstein, Martin. "Social Security, Induced Retirement, and Aggregate Capital Accumulation." Journal of Political Economy, 1974.

Fields, Gary S. and Mitchell, Olivia S. "Pensions and the Optimal Age of Retirement." Department of Labor Economics Working Paper No. 27, Cornell University, March 1981.

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

Gustman, Alan and Steinmeier, Thomas. "Partial Retirement and the Analysis of Retirement Behavior." Unpublished paper, Dartmouth College, April 1981.

Heckman, James J. and McCurdy, Thomas E. "A Life Cycle Model of Female Labor Supply." Review of Economic Studies, January 1980.

Hemming, R. C. L. "The Effect of State and Private Pensions on Retirement Behavior and Personal Capital Accumulation." Review of Economic Studies, Vol. 44, No. 1, February 1977.

Lazear, Edward P. "Severance Pay, Pensions, Mobility, and the Efficiency of Work Incentives." Preliminary Draft, June 1981.

Mitchell, Olivia S. and Fields, Gary S. "The Effects of Pensions and Earnings on Retirement: A Review Essay," in Ehrenberg, R., ed., Research in Labor Economics, Vol. 5, JAI Press, 1982.

Reimers, Cordelia K. W. "The Timing of Retirement of American Men." Unpublished Ph.D. Dissertation, Columbia University, 1977.

Report of the 1979 Advisory Council on Social Security. U.S. Government Printing Office, 1980.

Sammartino, Frank. "A Theoretical Model of Lifecycle Labor Supply and the Pension Acceptance Decision." Unpublished paper, September 1981.

Sheshinski, Eytan. "A Model of Social Security and Retirement Decisions." Journal of Public Economics, December 1978.

Zabalza, Anthony, Pissarides, Christopher and Barton, M. "Social Security, and the Choice Between Full-Time Work, Part-Time Work, and Retirement." Journal of Public Economics, Vol. 14, No. 3. October 1980.