Volume Title: Pensions, Labor, and Individual Choice

Volume Author/Editor: David A. Wise, ed.

Volume Publisher: University of Chicago Press

Volume ISBN: 0-226-90293-5

Volume URL: http://www.nber.org/books/wise85-1

Publication Date: 1985

Chapter Title: Labor Compensation and the Structure of Private Pension Plans: Evidence for Contractual versus Spot Labor Markets

Chapter Author: Laurence J. Kotlikoff, David A. Wise

Chapter URL: http://www.nber.org/chapters/c7130

Chapter pages in book: (p. 55 - 88)

3 Labor Compensation and the Structure of Private Pension Plans: Evidence for Contractual versus Spot Labor Markets

Laurence J. Kotlikoff
David A. Wise

What are the incentive effects of private pension plans? What is the cost in pension benefits of job turnover? How important is vesting? Is there a cost in pension benefits of forgoing the early retirement option? Do pension stipulations encourage early retirement? By analyzing the stipulations of pension plans, we are able to develop considerable evidence directed to these questions. At the same time, the structural features of private pension plans permit new and potentially strong inferences concerning the contractual nature of labor market agreements and the role of pensions in assisting such arrangements.

Understanding the contractual arrangements between workers and firms is important for a host of economic issues ranging from the degree of wage flexibility over the business cycle to the availability of human capital insurance within the firm. Discriminating between "spot" and "long-term contract" views of the labor market is also critical for evaluating numerous questions specific to private pensions. One such question is whether workers and employers fully appreciate how complex pension plan provisions alter a firm's total compensation package. Evidence that labor markets closely accord to the predictions of a spot market would suggest rather small information problems. Equally productive workers, in this case, receive identical total annual remuneration regardless of their current employer or the specifics of the employer's pension plan.

A second question involves proper disclosure and valuation of a pension plan's net financial liabilities. In a spot market setting an employer's

Laurence J. Kotlikoff is professor of economics, Boston University, and research associate, National Bureau of Economic Research, David A. Wise is John F. Stambaugh Professor of Political Economy, John F. Kennedy School of Government, Harvard University, and research associate, National Bureau of Economic Research.

We thank Gary Heaton for masterly and very extensive computer programming and Douglas Phillips for excellent research assistance.

net liability corresponds simply to the accrued value of vested pension benefits. Additional pension liabilities projected to arise from future employment, in such a setting, are matched dollar for dollar by future projected revenues associated with the worker's continued employment. The excess of projected over accrued liabilities should not, therefore, affect a firm's valuation and suggests no case for estimating and disclosing projected pension liabilities. Under a long-term contract arrangement, on the other hand, revenue from continued employment need not match the accrual of future pension liabilities, plus the payment of tenure wages, and the disclosure of projected rather than accrued liabilities is potentially more relevant for firm financial valuation.

A third question is the effect of pensions on labor mobility and hiring practices. In a spot market environment the particular and quite peculiar rates of pension benefit accrual with age described here would have no consequences for labor mobility, since offsetting increases or reductions in direct wage compensation would leave the worker indifferent between staying on the current job or switching to another job offering an identical amount of total compensation. A spot market would also entail flexibility in wage compensation sufficient to permit hiring equally productive old and young, black and white, male and female workers, despite differences in their accrual of vested pension benefits reflecting age, race, and sex-specific mortality probabilities. Long-term contractual agreements, in contrast, may leave less flexibility to accommodate differences in individual circumstances.

Given knowledge of a worker's current and previous level of earnings, and the benefit and retirement provisions of his pension plan, one could, in principle, directly test the spot market hypothesis by checking whether, in each year, the sum of the increment to a worker's accrued vested pension benefits plus his wage compensation equaled his marginal product.[1] Unfortunately, a worker's marginal product is unobservable and difficult to estimate. In addition new government data linking pension plan provisions and the earnings histories of participating workers have not yet been released.[2] These data limitations restrict, but by no means preclude, inferences about spot versus contractual labor market arrangements.[3]

While little is known about the typical profile of marginal productivity by age, it seems safe to assume that this schedule does not exhibit sharp discontinuities. In addition, while there is currently no publicly available means of matching particular earnings histories with particular pension plans, there is considerable information available concerning the typical shape of age-earnings profiles.

This paper calculates the pattern of accrual of vested pension benefits for alternative, but realistic, age-earnings profiles. These accrual profiles are computed for a large sample of plans contained in the Bureau of Labor Statistic's 1979 Level of Benefits Survey (BLS–LOB). These new pension data, based on a survey of 1469 establishments with 3,386,121 pension participants, provide extremely detailed information concerning pension benefits, vesting, and early retirement formulas, all of which are key inputs to the calculation of pension accruals.

The sum of the assumed age-earnings profile, measured in constant dollars, and the associated real pension accrual profile equals, under the spot market assumption, the age-marginal productivity profile. Hypothetical age-marginal productivity profiles derived in this manner exhibit rather sharp discontinuities at two critical ages, the age of full vesting, for plans with cliff vesting, and the early retirement age, for plans permitting early retirement on better than actuarially fair terms. For a large fraction of pension plans making reasonable assumptions concerning age-earnings profiles and interest rates, we find discontinuities as large as 50% of wage compensation depending on the worker's age at hire. An alternative statement of these findings is that for smoothly shaped age-marginal product schedules, wage compensation must potentially fall or rise by roughly 40% of the wage at the age of cliff vesting and other critical ages to satisfy conditions of spot market equilibrium. These figures appear sufficiently large to rule out the hypothesis of spot clearing for a large segment of the United States labor market.

In addition to the potentially large discontinuities in pension benefit accruals, the pattern of accruals also sheds considerable light on the role of pensions in discouraging worker turnover. In many instances even workers who change jobs with no loss in wage compensation and commence employment in a new firm with an identical pension plan lose a large amount in pension benefits.

The accrual patterns also permit inferences about incentives that pensions provide for early retirement. Under our actuarial assumptions we find positive pension accruals on average throughout the work span, that is, worker separation at any time prior to normal retirement typically involves a loss of remuneration in excess of the loss in wage compensation. These findings appear to differ from those of Lazear (1983), who finds that after the age of early retirement, continued work typically involves a loss in pension benefits. Part of the difference in results is due to differences in interest rate and nominal wage growth assumptions. In addition, we do not consider in this paper benefits for all plans covered by the LOB survey. In particular, all plans used in this analysis base benefits on wages.

As Lazear's (1983) insightful study points out, the present expected value of accrued pension benefits represents a form of severance pay for workers who choose to separate from the firm. Such severance pay would naturally arise in contractual settings in which workers are paid (in wages) less than their marginal products. The severance pay may be thought of as the return of the worker's bond, which he puts up to guarantee the quality and quantity of his work effort. As the worker ages, the value of this "severance pay" rises, according to our findings. In a contractual setting the implication of our finding of positive average pension accrual at all ages prior to normal retirement is that real wages represent a lower bound for the average marginal product of workers covered by our sample of plans. It is important to emphasize, however, that we find large deviations from the average, with large negative accruals after the age of early retirement under the provisions of many plans.

Finally, an additional implication of our findings is that compensating differential studies of the trade-off between wages and pension benefits, if they are to be meaningful, cannot be based on cross-section evidence at a point in time. To understand the relationship between compensation in the form of wages versus pension benefits, one must consider the receipt of both over a long period of employment.

The next section describes procedures used to calculate pension benefit accrual and presents illustrative accrual rates for a standard earnings-based defined benefit plan, but one that is not integrated with social security. This plan is also used to demonstrate the sensitivity of accrual rates to assumptions about wage inflation and interest rates. Section 3.2 presents evidence concerning age-earnings profiles, suggesting, in particular, that for fully employed workers between ages 55 and 65 who remain in a given firm, nominal earnings grow on average at rates commensurate with, if not greater than, inflation. The assumption of positive nominal wage growth after age 55 is crucial for generating positive pension benefit accrual between 55 and 65. Section 3.3 describes the BLS–LOB data set in more detail and examines the heterogeneity of accrual profiles for our sample of 1183 plans.[4] We conclude the section by drawing inferences from these data concerning the weight of evidence in favor of contractual as opposed to spot labor markets. Section 3.4 summarizes principal findings and suggests areas for future research.

3.1 Pension Benefit Accrual Formulas and Illustrative Graphs of Accrual Profiles

3.1.1 Accrual Formulas

To begin, consider the benefit accrual profiles shown in figure 3.1. The nominal wage growth incorporated in the top profile assumes moderate life-cycle growth in real wages plus a 6% rate of inflation. A 3% real interest rate (or 9% nominal rate) is also assumed. The lower graphs are based on 6% and 9% real (12% and 15% nominal) interest rates, respectively. In the paragraphs below we describe features of pension benefit formulas that produce the unusual shapes of these profiles.

Vested pension benefit accrual at age a, $I(a)$, equals the difference between pension wealth at age $a + 1$, $Pw(a + 1)$, and pension wealth at age a, $Pw(a)$, accumulated to age $a + 1$ at the nominal interest rate r:

$$I(a) = Pw(a + 1) - Pw(a)(1 + r). \tag{1}$$

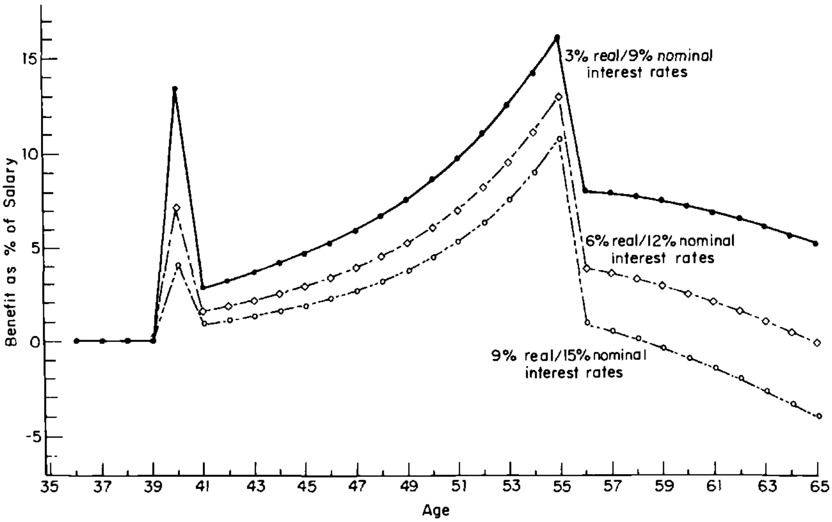

Fig. 3.1 Pension increments as a percentage of salary, by age, for a wage stream with 6% inflation discounted at real interest rates of 3%, 6%, and 9%.

Pension wealth at age a is defined as the expected value of vested pension benefits discounted to age a. Intuitively, $Pw(a)$ can be thought of as the worker's pension bank account. If $I(a)$ equals zero, the worker continuing employment with the plan sponsor at age a has exactly the same pension wealth at age $a + 1$ as an identically situated worker who terminates employment at age a. Pension accrual is thus the increment to pension wealth in excess of the return on the previously accumulated pension bank account.

If the labor market exhibits spot market equilibrium, $I(a)$ plus the worker's nonpension compensation at age a, $W(a)$, equals the worker's marginal product at age a, $M(a)$:

$$M(a) = W(a) + I(a). \tag{2}$$

Obviously, if $W(a)$ is a smooth function of age and $I(a)$ exhibits sharp discontinuities, $M(a)$ must exhibit sharp discontinuities at these same ages to satisfy (2).

The source of discontinuities in age accrual profiles is clarified by considering a sample earnings-related defined benefit plan with "cliff vesting" at 10 years of service. Vested accrued benefits are clearly zero prior to the age at which the worker has 10 years of credited service in the plan. Let $R(a, t)$ denote the ratio of $I(a)$ to $W(a)$ for a worker age a with t years of tenure. Then $R(a, t)$ is zero for $t < 9$. If a person age a with nine years of service works an additional year, the ratio of the increment to the wage $W(a)$ is

$$(3) \qquad R(a, 9) = \frac{B(a, t)A(55)(1 + d)^{-10}(1 + r)}{W(a)}^{-[55 - (a + 1)]}.$$

In (3), $B(a, t)$ is the retirement benefit available to the worker who terminates employment with the plan sponsor at age a after t years of service but who delays receipt of pension benefits until the plan's normal retirement age. The normal and early retirement ages assumed for this stylized plan are 65 and 55, respectively. Terminating workers are, however, eligible for early retirement benefits. Our hypothetical plan reduces benefits by d percent for each year that early retirement precedes normal retirement. The benefit reduction rate, d, could be greater than, equal to, or less than the actuarial fair rate. Today most plans offering early retirement appear to stipulate smaller than actuarially fair reduction rates; consequently, the formulas presented here assume that workers always gain by receiving their vested accrued benefits at the earliest possible date.

The function $A(55)$ is the actuarial discount factor that transforms benefit flows initiating at age 55 into expected stocks of pension wealth at age 55. Expectations here are taken with respect to longevity. Thus $A(55)$ is the annuity value of a dollar's worth of pension benefits to be received each year until death, beginning at age 55. For simplicity assume that the probability of dying prior to age 55 is zero. Hence the present value at age a of $A(55)$ is $A(a) = A(55)(1 + r)^{-(55 - a)}$ for $a \leq 55$. If pension benefits are determined as a constant λ times the product of final year's earnings and service, and there is no offset for receipt of social security benefits, $B(a, t)$ is simply

$$(4) \qquad B(a, t) = \lambda W(a)t,$$

and

$$(5) \qquad R(a, 9) = \lambda(1 + d)^{-10}(1 + r)^{-[55 - (a + 1)]}A(55)10 \cdot \frac{W(a + 1)}{W(a)}.$$

$R(a, t)$, for t increasing pari passu with age, is zero prior to t equals 9 and jumps at t equals 9 to the value given in (5). Cliff vesting thus produces spikes in the accrual profile such as that in figure 3.1 at 10 years of service. Between the age at cliff vesting and age 55, pension wealth $Pw(a)$ is given by

$$(6) \qquad Pw(a) = \lambda W(a)(1 + d)^{-10}(1 + r)^{-(55 - a)}A(55)t,$$

and the increment to pension wealth $I(a)$ divided by the wage $W(a)$ is given by

(7)
$$R(a, t) = \lambda(1 + d)^{-10}(1 + r)^{-[55 - (a + 1)]}A(55)t \left[\frac{W(a + 1)}{W(a)} \frac{t + 1}{t} - 1 \right].$$

Equations (7) and (5) suggest a drop in $R(a, t)$ as a increases to $a + 1$ concurrent with an increase in t from 9 to 10. Equation (7) will be positive if the term in brackets exceeds zero. This will be the case if the percent increase in the wage plus the percent increase in years employed $(1/t)$ is greater than zero. Assuming the term in brackets is positive and is roughly constant, $R(a, t)$ will increase exponentially due to the exponential decline in the discount factor, $(1 + r)^{-[55-(a+1)]}$, as a approaches 55.

If the value of d is considerably less than actuarially fair, a discontinuity in $R(a, t)$ occurs at the early retirement age, 55. At ages 55 and 56 we have

$$Pw(55) = \lambda W(55)(1 + d)^{-10}A(55)t \tag{8}$$

and

$$Pw(56) = \lambda W(56)(1 + d)^{-9}A(56)(t + 1). \tag{9}$$

Hence,

(10)

$$R(55, t) =$$

$$\lambda(1 + d)^{-10}(1 + r)A(55)t\left[\frac{W(56)}{W(55)}\frac{t+1}{t}\frac{A(56)}{A(55)}\frac{(1+d)}{(1+r)} - 1\right].$$

Assuming wage growth at 54 is close to that at 55 and $A(56)$ approximately equals $A(55)$, then $R(55, t)$ primarily differs from $R(54, t - 1)$ because the first term in the bracket in (7) is now multiplied by $(1 + d)$, while the second term, -1, is multiplied by $(1 + r)$. Since r exceeds d by assumption, $R(55, t)$ can easily be less than $R(54, t - 1)$. Indeed, this change in the functional form of $R(a, t)$ can produce sharp drops in accrual rates at the early retirement age for a host of pension plans and a range of realistic economic assumptions. Figure 3.1 illustrates such discontinuities.

It is important to realize that the early retirement reduction, lower wages, and one less year of tenure yield lower benefits at 55 than at 56. The early retirement reduction reduces benefits at the rate d. But if benefits were taken at 55 they could accrue interest at the rate r. Thus by forgoing the early retirement option of receiving benefits at 55, a cost is incurred that depends on the difference $r - d$. If this loss is not offset by the increase due to wage growth and one year of additional tenure, there will be a drop in the benefit accrual rate between 55 and 56.

The same considerations pertain to benefit increments between 56 and 65. Recall that we have assumed a less than fair early retirement reduction so that benefits accrued before 55 are valued assuming receipt of benefits at the age that yields maximum pension wealth. The optimum time to receive benefits accrued between 55 and 56 is 56, between 56 and 57 is 57, and so forth. But to gain benefits from working another year, it is necessary to forgo the option of immediately taking accrued benefits at an advantageous reduction rate.

Between ages 56 and 65, $R(a, t)$ equals

$$(11)\quad R(a, t) = \lambda(1 + d)^{-(65-a)}(1 + r)A(a)t \left[\frac{W(a+1)}{W(a)}\frac{(t+1)}{t}\frac{A(a+1)}{A(a)}\frac{(1+d)}{(1+r)} - 1\right].$$

In contrast to the $R(a, t)$ formula in (7) applying to the period between cliff vesting and early retirement, (11) indicates that the actuarial reduction factor—rather than the interest rate r—imparts an upward tilt in the $R(a, t)$ profile between early and normal retirement, as long as the term in brackets is positive. In (11) as in (7) and (10) the accrual rate, $R(a, t)$ is an increasing function of the rate of nominal wage growth. Larger nominal interest rates reduce accrual rates at all ages, with a negative interaction with age prior to early retirement.

Finally, while equation (7) is unlikely to be negative, wide differences between wage growth and the interest rate r can yield negative increments in pension wealth after the early retirement age. To a first approximation, the bracketed term in equation (11) will be positive if $\Delta W/W + 1/t > r - d$ where $\Delta W/W$ is the percent increase in wages and $1/t$ the percent increase in tenure. It is easy to see, however, that low wage growth and high interest rates will yield negative increments. Thus actuarial increments after the early retirement age are very sensitive to assumed values for wage growth and the interest rate.

While the preceding formulas suggest the general shape of accrual rate profiles, there are few earnings-based plans with features as simple as the one considered here. In addition to more complicated rules for plan participation and vesting that often involve age as well as service requirements, there are a variety of methods of computing earnings bases, including career averages, and averages of earnings, possibly highest earnings, over a specified period or number of years. Reduction rates for early retirement are often a specified function of age, if not length of service. Some plans allow no further accrual after a given number of years of service. Roughly 30% of defined benefit participants belong to plans that are integrated with social security. There are two, not necessarily independent, important forms of "integration." One involves a "step rate" benefit formula that uses a different value for the percentage of the product of earnings times service for levels of earnings below and levels above specified values. The second is referred to as an "offset" formula that reduces pension benefits by some fraction of the participant's basic social security benefit. Many of the offset plans set ceilings on the extent of the offset. A minority of plans, in particular those with social security offset formulas, provide supplemental benefits for early retirees prior to their receipt of social security benefits. The supplemental benefit formulas can also be fairly involved, incorporating both the participant's age and service in the calculation. There are also plans that use one benefit formula to compute early retirement benefits and a different formula to determine normal retirement benefits. In addition to these earnings-related plans, a significant number of plans covering over 40% of defined benefit participants calculate benefits independent of the participant's earnings history (Kotlikoff and Smith 1983, table 4.5.1). These formulas can also be quite complex. There are other plans that are earnings related but provide differing flat benefit amounts based on the participant's earnings bracket. Finally, there are plans that specify minimum and maximum benefit levels.

Each of these additional features can significantly alter the profile of accrual rates by age, especially the extent of discontinuities in the profile. Our analysis in Section 3.4 of pension plans in the BLS–LOB sample takes account of a great number of these complexities. Two important exceptions in the current paper are plans with non-earnings-related benefit formulas and plans with supplemental benefit formulas. These plans will be considered in future research.

The assumption of constant nominal interest rates implies a quite different pattern of pension accrual than would occur with variable interest rates. Changes in long-term nominal interest rates produce capital gains and losses on previously accumulated pension wealth that do not directly affect pension accrual. However, as indicated in equations (5), (7), (10), and (11), accrual rates are also a direct function of the currently prevailing long-term interest rates. A time path of varying interest rates around a constant mean would produce a much more discontinuous age-pension accrual profile than those of figure 3.1 and other diagrams in this paper.

3.1.2 Illustrative Graphs of Accrual Profiles

Figure 3.2 depicts three accrual rate profiles for a worker who begins participating at age 30 in a defined benefit plan similar to that described above. The plan calculates normal retirement benefits as 1% of average earnings over the last five years of service times years of service. Benefits are reduced by 3% for each year that early retirement precedes normal retirement. Cliff vesting occurs after 10 years. The early and normal retirement ages are 55 and 65, respectively.

Nominal wage growth is determined by two factors, a cross-sectional profile of "merit" increases by age and an assumed economy-wide rate of wage inflation. The merit profile involves approximately a 50% growth in real wages between ages 30 and 50 and very little growth from 50 to 65. The rate of wage inflation incorporates both across-the-board increases in labor productivity and the price level. The three profiles in figure 3.2 differ both in their assumed rate of wage inflation and nominal interest rates. The 2% wage inflation profile discounts pension benefits at a 5% nominal

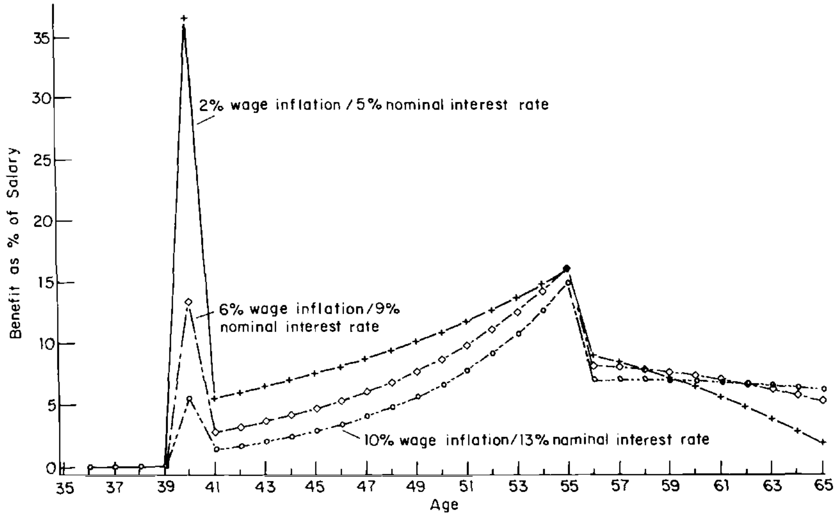

Fig. 3.2 Pension increments as a percentage of salary, by age, for wage inflation of 2%, 6%, and 10%. Note: Benefits are discounted at a 3% real interest rate.

rate, while the 6% and 10% wage inflation profiles use 9% and 13% nominal interest rates, respectively.

These assumptions about wage growth and nominal interest rates produce "vesting spikes" ranging form 5% to 37% of wages at age 40. The intermediate wage and interest rate assumption produces a 14% spike at cliff vesting. All three profiles indicate reductions in the accrual rate of about 8 percentage points at age 56. In order to reconcile these profiles with the dictates of spot market equilibrium, one must believe that marginal products rise abruptly by an additional 5% to 37% exactly at age 40 and then fall by an additional 3% to 31% exactly at age 41. In addition, an abrupt decline in the worker's marginal product of close to 8 percentage points exactly at age 56 that occurs neither before nor after 56 is required for the theory of spot equilibrium.

One response to these profiles is that straight wage compensation, rather than increasing smoothly through time, could adjust to meet the spot market. Figure 3.3 suggests the implausibility of this view. Here accrual rate profiles for workers joining the pension plan at ages 30, 40, and 50 are presented based on the intermediate wage and interest rate assumptions of figure 3.2. The vesting spikes for the three profiles are 14%, 36%, and 66% of the corresponding wage at ages 40, 50, and 60. While vesting at these latter ages is much less common than prior to age 40, Kotlikoff and Smith (1983, table 3.6.5) report that over a quarter of current defined benefit pension recipients retired with 20 or fewer years of service.

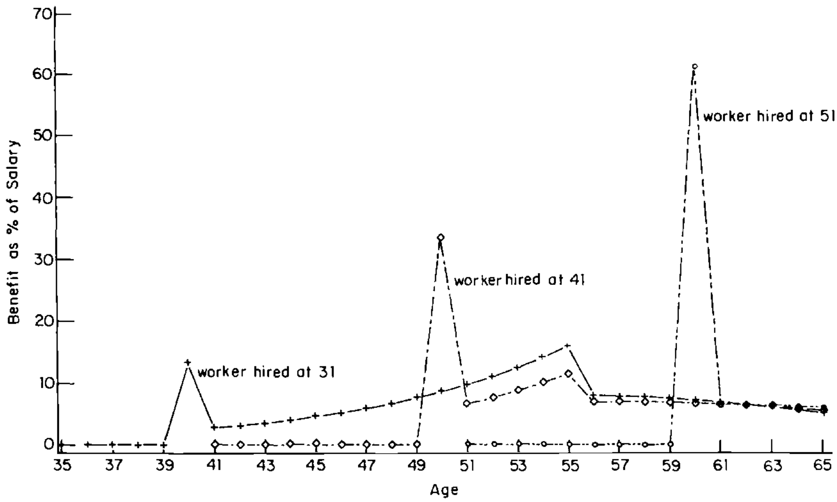

Fig. 3.3 Pension increments as a percentage of salary, by age, for an employee beginning work at 31, 41, 51. Note: 6% wage inflation, 3% real interest rate.

Figure 3.3 is constructed under the assumption that the workers of the same age receive identical wage compensation. Thus the diagram indicates the potential loss in accrued pension benefits for workers who switch jobs but receive the same wage compensation in the new job and are covered by the same pension plan. We present below a similar diagram, based on a plan like our base plan but without the early retirement option. In this case, the loss is substantially greater.

Figure 3.4 highlights the importance of the early retirement benefit reduction formula for pension accrual. The profile labeled "early retirement option" repeats the accrual profile from figures 3.2 and 3.3 based on intermediate economic assumptions. The "retirement at 65 only" profile indicates the pattern of accrual rates for the same plan but excludes the early retirement option. This profile could also be labeled "actuarially fair accrual rates" since, by definition, an actuarially fair early retirement reduction formula produces an accrual profile that is independent of the age at which benefits are first received.

To the extent that retirement benefits provide an incentive to continue working, the incentive is much greater without the early retirement option than with it. It is important to realize that the difference is only a matter of the pattern of accruals; for workers who retire at normal retirement, the total accumulation of accrued benefits is independent of whether the plan does or does not have an early retirement option.

In contrast to the "early retirement option," the actuarially fair "retirement at 65 only" profile exhibits a 6% rather than a 14% value for R

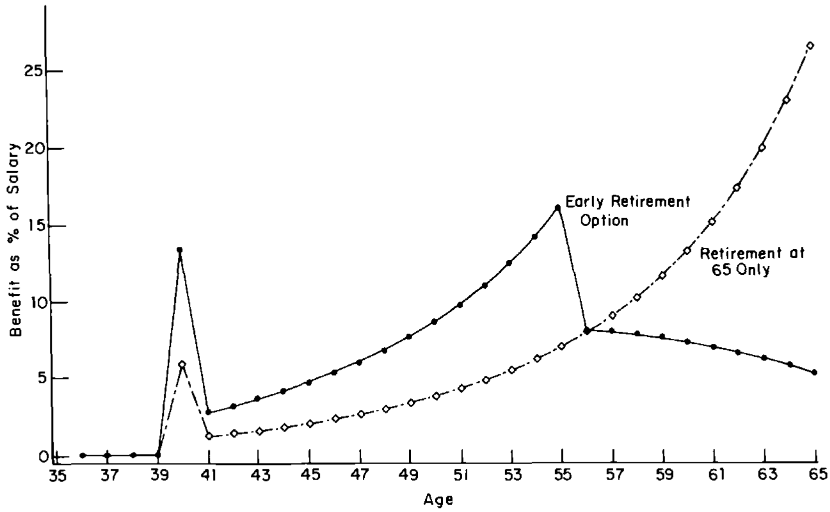

Fig. 3.4 Pension increments as a percentage of salary, by age, for plans with an early retirement option versus retirement at 65. 6% wage inflation, 3% real interest rate.

(*a*, 10) at cliff vesting. In addition there is no discontinuity at age 55 in the latter profile. While these features of the actuarially fair profile are less troubling for the spot market hypothesis, the very rapid rate of benefit accrual between 55 and 65 presents other difficulties for this view of the labor market. The merit schedule built into the nominal wage profile implies a quite limited growth in real wages of workers after age 55. If anything, this schedule appears to provide for too much growth in real wages after 50. As described in the next section, cross-sectional profiles of earnings by age decline slightly after age 50 for virtually all classification of workers by occupation and major industry. Since a 3% growth in real wages due to economywide productivity growth is above historic averages, one might reasonably infer that real wage growth after age 55 is below 3%. The actuarially fair profile of figure 3.4, however, entails increases in total real pension remuneration of almost 20% of real wages between ages 55 and 65. Needless to say, it is difficult to accept the spot market implication that, in addition to productivity-induced real wage growth, workers at age 65 are 20% more productive than they are at age 55. Thus the plan examined in figure 3.4 indicates that the difficulty in reconciling pension accrual rates with a spot market is not simply the result of early retirement benefit provisions.

Figure 3.5 and figure 3.1 above demonstrate the sensitivity of the accrual profiles to assumptions about nominal wage growth and nominal interest rates. Figure 3.5 repeats figure 3.4 under the assumption of a 10% interest rate but no growth in wages by age. For the profile with the early

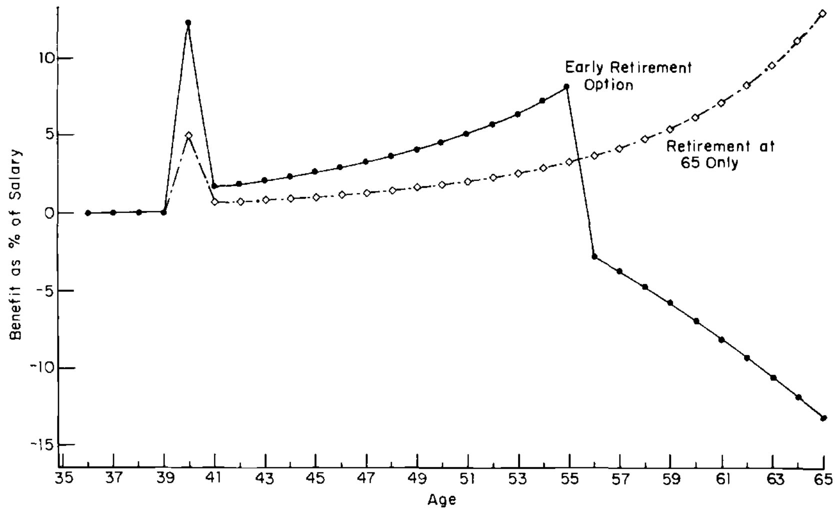

Fig. 3.5 Pension increments as a percentage of salary, by age, for plans with an early retirement option versus retirement at 65. 0% wage inflation, 10% real interest rate.

retirement option accrual rates after age 55 are substantially negative, approaching −15% of salary at age 65. With no early retirement option, on the other hand, accrual rates are always positive. The bottom profile in figure 3.1 incorporates 6% nominal wage growth but a 15% nominal interest rate. The intermediate profile in figure 3.1 is based on 6% wage growth and a 12% nominal interest rate. It yields increments at 65 that are approximately zero. These figures indicate that a considerable gap between nominal interest rates and wage growth rates is needed to produce negative accrual rates.

Finally, we illustrate in figure 3.6 the cost of job change with no early retirement option. It should be compared with figure 3.3. The plans represented in the two diagrams are the same except that in figure 3.6 the early retirement reduction schedule is assumed to be actuarially fair (or, that there is no early retirement option). Again, the top line of this graph shows the accrual rate under our plan for a person who starts work at age 30 (with 6% wage inflation and a 3% real interest rate). A person with one job change would accumulate benefits up to age 41 according to the top curve but then would accumulate benefits according to the curve labeled "age 41." Note that no benefits would be accumulated for the first 10 years. The difference in accumulated pension benefits at age 65 reflects both the difference in the areas under the two accrual paths and the interest rate used in accumulation of these flows. This difference could be very substantial and depends, of course, both on when job changes occur and how frequently they occur. It is important to note that the loss in accrued

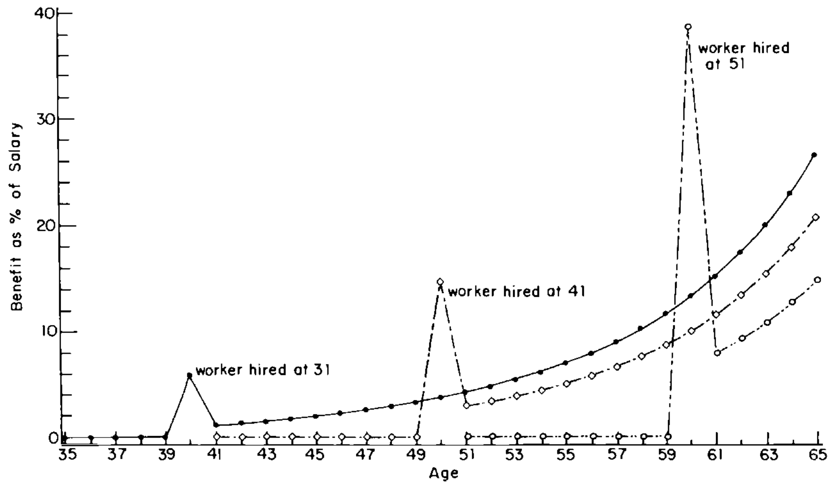

Fig. 3.6 Pension increments as a percentage of salary, by age, for an employee beginning at 31, 41, 51, with no early retirement option. Note: 6% wage inflation, 3% real interest rate.

benefits from job change in this example is not due solely to vesting; in figure 3.6, accrual in years after vesting occurs is larger for a worker remaining on the same job for 35 years than for a worker who changes jobs (literally pension plans). This lower accrual beyond vesting for later plan entrants results from the interaction of tenure and wage growth in earnings-based defined benefit pension formulas. To see the nature of this interaction, consider a plan with immediate vesting that pays 2% of final year's salary times years of service. For a worker experiencing positive wage growth who is employed for 30 years and retires at 60 the pension benefit is 2% of the age 60 salary times 30. If this same worker with the same wage growth were to change jobs each year, joining an identical plan, his benefit would equal 2% times the sum of the 30 annual salaries. Assuming positive wage growth, the pension benefit of the former worker, which is based on the age 60 salary, will exceed that of the latter worker whose benefit is primarily based on the lower earnings received in earlier years of his career.

3.2 Wage Rate Profiles

To calculate average pension benefit increments by industry-occupation group, for a given length of employment, we need estimates of age-wage profiles for each group. It is particularly important that assumptions about the wage profiles of older workers be as realistic as possible. Without lengthy longitudinal records on individuals, we have no completely satisfactory way of estimating age-wage profiles. The Retirement History Survey (RHS), however, does provide some longitudinal data for older workers.[5] We first discuss evidence from these data and then present estimated age-wage profiles based on the Current Population Survey (CPS) data. For older workers the two sources of data seem to provide roughly consistent evidence.

The age-wage profiles appropriate for determining pension accrual are clearly those pertaining to workers staying in the same firm. Thus tenure as well as age should be included in the analysis of earnings by age. Our accrual profiles also assume full-time employment. Hence, wage rates per unit of time is the appropriate earnings concept for our purposes. While conventionally computed age-earnings profiles sometimes show a downward trend for older workers, this appears due, in part, to a reduction in hours worked and in part to the mix of full-time and part-time workers in the sample.

3.2.1 Evidence from the Retirement History Survey

The RHS data are based on a sample of persons who were first surveyed in 1969 when they were between 58 and 63. These respondents were resurveyed every two years until 1979. Table 3.1 shows the means of hourly wages by age and year for persons who reported an hourly wage rate and who were not partially or fully retired in a given year. For a given calendar year, these data in general show little decline in wage rates at least through age 63 or 64. The number of observations per cell is fairly small since the cells only include older individuals who are still working. Possibly those whose wage rates would have fallen from one year to the next are less likely to be in the sample. Analogous calculations showing the median of annual salaries of persons who reported weekly, monthly, or annual salaries are presented in table 3.2. Here again, in the cross-section, there are relatively constant real salary levels through age 64 among persons who are not retired, although there seems to be some decline on average.

The accrual calculations require, however, nominal wage profiles. From both tables 3.1 and 3.2, it is clear that nominal wages of older workers increased rather rapidly over this period. A more precise indication of nominal increases is shown in table 3.3 for all persons who reported weekly, monthly, or annual salaries. The entry corresponding to age 58–60 and the year 1969–71 is the median salary increase between 1969 and 1971 over all persons who were 58 in 1969 and who reported salary figures in both 1969 and 1971. The other entries are calculated in an analogous manner. The table shows very substantial nominal increases over this period, on the order of 6% per year on average. (The entries pertain to a two-year interval.) Considering the average increments by age in the last column, there is

Table 3.1 Means of Hourly Wages for Non-Self-Employed Males, by Age and Year

	Year						
Age	1969	1971	1973	1975	1977	1979	All Years
58	3.03 (134)						3.03 (134)
59	3.36 (159)						3.36 (159)
60	3.14 (155)	3.25 (154)					3.19 (309)
61	3.05 (130)	3.36 (149)					3.21 (279)
62	3.12 (125)	3.50 (134)	3.89 (107)				3.48 (366)
63	2.91 (93)	3.30 (115)	4.10 (103)				3.44 (311)
64		3.41 (74)	3.53 (80)	4.03 (61)			3.63 (215)
65		3.44 (44)	3.15 (34)	3.54 (41)			3.39 (119)
66			3.45 (24)	3.59 (24)	4.62 (18)		3.82 (66)
67			3.24 (21)	2.83 (13)	3.48 (22)		3.24 (56)
68				3.85 (14)	4.34 (14)	4.42 (8)	4.17 (36)
69				3.60 (6)	2.71 (9)	3.82 (7)	3.30 (22)
70					3.25 (10)	4.45 (7)	3.74 (17)
71					4.25 (7)	4.16 (4)	4.21 (11)
72						3.21 (7)	3.21 (7)
73						4.42 (2)	4.42 (2)

Source: Retirement History Survey. Excludes people who say they are partially or fully retired. The number of observations used to calculate the associated value is recorded in parentheses.

Table 3.2 Medians of Annual Salary for Non-Self-Employed Males, by Age and Year

	Year						
Age	1969	1971	1973	1975	1977	1979	All Years
58	7494						7494
	(666)						(666)
59	7280						7280
	(733)						(733)
60	7280	8372					7800
	(683)	(485)					(1168)
61	7280	8100					7600
	(690)	(563)					(1253)
62	7280	8216	9850				8008
	(591)	(453)	(322)				(1366)
63	7225	8000	8800				7860
	(454)	(413)	(339)				(1206)
64		8000	9100	10088			9000
		(403)	(303)	(246)			(952)
65		7800	8200	9480			8320
		(179)	(151)	(146)			(476)
66			8944	9200	11600		9663
			(110)	(107)	(76)		(293)
67			8320	8942	11830		9048
			(91)	(90)	(56)		(237)
68				9284	8541	6600	8998
				(70)	(48)	(18)	(136)
69				8913	10089	4225	9360
				(54)	(42)	(8)	(104)
70					7850	3750	6703
					(30)	(12)	(42)
71					8525	4160	7380
					(23)	(10)	(33)
72						3016	3016
						(13)	(13)
73						7800	7800
						(9)	(9)

Source: Retirement History Survey. Excludes people who say they are partially or fully retired. The number of observations used to calculate the associated value is recorded in parentheses.

Table 3.3 **Median Percentage Changes in Annual Salary for Non-Self-Employed Males, by Age and Year**

	Year					
Age	1969–71	1971–73	1973–75	1975–77	1977–79	All Years
58–60	13.0 (423)					13.0 (423)
59–61	12.5 (486)					12.5 (486)
60–62	12.5 (393)	12.6 (264)				12.5 (657)
61–63	11.7 (354)	11.0 (280)				11.1 (634)
62–64	11.3 (346)	11.7 (237)	13.3 (170)			11.5 (753)
63–65	10.4 (148)	11.1 (118)	11.1 (101)			11.1 (367)
64–66		12.9 (86)	12.1 (83)	10.5 (64)		12.2 (233)
65–67		9.5 (58)	12.5 (54)	11.4 (45)		10.8 (157)
66–68			10.8 (47)	12.8 (37)	12.9 (10)	11.8 (94)
67–69			6.4 (41)	10.1 (36)	6.2 (3)	8.3 (80)
68–70				10.6 (18)	29.8 (3)	13.3 (21)
69–71				12.5 (20)	17.5 (2)	12.5 (22)
70–72					13.1 (2)	13.1 (2)
71–73					15.4 (1)	15.4 (1)

Source: Retirement History Survey. Excludes people who say they are partially or fully retired. The number of observations used to calculate the associated value is recorded in parentheses.

some evidence that the increases declined somewhat with age. At least through 1977—after which our sample sizes are very small—it appears that salary increases for these older workers were in general keeping up with price increases. The percent increases in the Consumer Price Index (CPI) for the years 1969–77 were as shown in the unnumbered table on page 73.

Year	CPI
1969	6.1
1970	5.5
1971	3.4
1972	3.4
1973	8.8
1974	12.2
1975	7.0
1976	4.8
1977	6.8

In short, these data suggest substantial nominal wage increases for older workers, roughly consistent, on average, with overall inflation levels.

3.2.2 Wage-Tenure Profiles from the Current Population Survey

To estimate age-tenure profiles by industry and occupation group, we matched the May 1979 Supplement to the March 1979 CPS. The May Supplement provides tenure data, while the wage data come from the March tape. We were able to obtain the required wage, age, and tenure information for somewhat over 15,000 persons in the 24 industry-occupation groups distinguished in the LOB survey. Relevant cell sample sizes, however, were large enough to obtain "reasonable" estimates for only 16 groups, noted below.

After considerable experimentation with two-way tables showing average salary by age and tenure, we elected simply to obtain least-squares estimates of wage rates using the specification

$$W = a_0 + a_1 A + a_2 A^2 + b_1 T + b_2 T^2 + cAT, \tag{12}$$

where W is the wage rate, A is age, and T is tenure. To estimate wage levels by age for a person who entered a firm at, for example, age 30 we calculated

$$\hat{W} = \hat{a}_0 + \hat{a}_1 A + \hat{a}_2 A^2 + \hat{b}_1(A - 30) + \hat{b}_2(A - 30)^2 + \hat{c}(A)(A - 30), \tag{13}$$

for values of A between 30 and 65.

The estimated profiles for the total group, and by occupation over all industry groups, are presented in figure 3.7. These profiles are empirical counterparts of the "merit" scale used in the illustrative calculations in Section 3.1 above.

The cross-sectional age-earnings profile (13) for all groups combined increases by about 50% between age 30 and 52 when it reaches its maximum. Then it declines by about 10% over the next 13 years, or about .8% per year on average. Assuming a wage inflation rate of 6%, therefore, produces a nominal wage rate for older workers increasing at about 5%

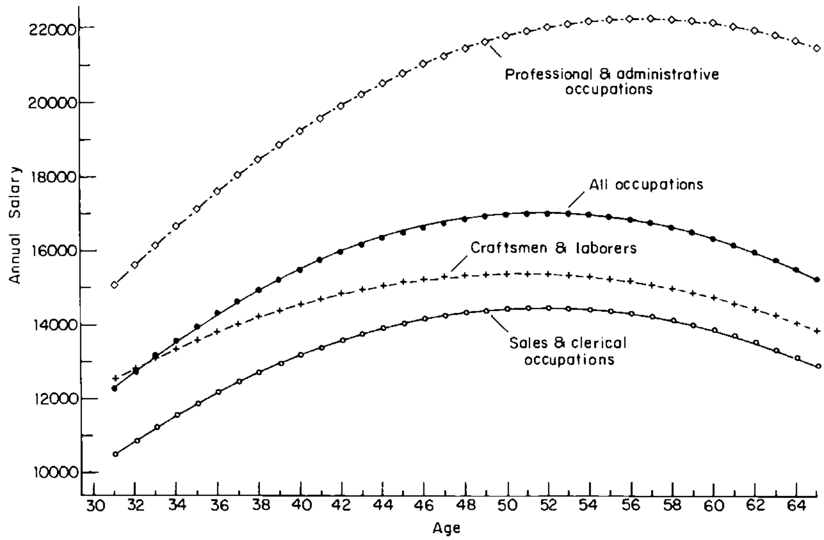

Fig. 3.7 Estimated real wage-tenure profiles by age

per year. For older workers this path of nominal wage growth seems to be in rough accord with the evidence from the Retirement History Survey.

In addition to the graphs of the cross-section wage profiles, summary indicators of their shapes are provided in table 3.4. It shows salary at age 30, maximum salary, the age of maximum salary, and salary at age 65, together with average percent increases between the end points and the maximum.

3.3 Accrual Rates from the BLS Level of Benefits Survey

The BLS-LOB (1979) establishments constitute a subsample of the 1979 National Survey of Professional, Administrative, Technical, and Clerical Pay. Based on the file's population weights, this subsample covers 17,965,282 private pension plan participants in the United States, which is slightly over half of all participants covered by private pensions. The subsample's universe consisted of all firms with over 100 employees with the exception of mining, construction, and retail trade establishments where the minimum firm size was 250 employees and service establishments where the minimum firm size was 50 employees. Sampled establishments were requested to report work schedules and information about 11 different types of fringe benefits. This information was provided for each of the three occupational groups. The BLS-LOB (1979) pension benefits tape consists of establishment records for each occupational group that detail features of pension benefit plans covering the particular occupational

Table 3.4 Summary Statistics on Wage Profiles by Industry and Occupation Group

Industry and Occupation	Salary at Age 30	Max Salary (Age)		Salary at Age 65	Average Percent Increase Age 30 to Maximum	Average Percent Decrease Maximum to Age 65
All	11848	17022	(52)	15216	2.0	−.8
All:						
Professional and administrative	14470	22232	(57)	21454	2.0	−.4
Sales and clerical	10112	14446	(52)	12890	1.9	−.8
Craftsmen and laborers	12228	15366	(51)	13866	1.2	−.7
Mining	18062	22676	(65)	22676	.7	−.0
Construction	15822	18036	(45)	13678	.9	−1.2
Manufacturing:						
Professional and administrative	16374	24634	(55)	23150	2.0	−.6
Sales and clerical	10670	14894	(56)	14380	1.5	−.4
Craftsmen and laborers	10960	14822	(52)	13294	1.6	−.8
Transportation:						
Professional and administrative	21466	25230	(65)	25230	.5	−.0
Sales and clerical	12284	16806	(48)	13128	2.0	−1.3
Craftmen and laborers	13938	17630	(64)	17628	.8	−.0
Wholesale Trade	12644	18416	(48)	12908	2.5	−1.8
Retail Trade:						
Professional and administrative	11268	18844	(48)	12620	3.7	−1.9
Sales and clerical	8528	11932	(46)	7518	2.5	−1.9
Craftsmen and laborers	10974	13538	(49)	11816	1.2	−.8
Finance	12072	19552	(59)	19194	2.1	−.3
Services:						
Professional and administrative	13326	19246	(54)	17936	1.9	−.6
Sales and clerical	9230	10822	(54)	10514	.7	−.3
Craftsmen and laborers	11220	12810	(50)	11950	.7	−.4

Source: May 1979 Current Population Survey.

group in question. Unfortunately firm identifiers are intentionally excluded from the computer record; hence, it is impossible to reconstruct the actual pension characteristics of the initial establishment. The data can, however, be used to estimate industry-wide or occupation-wide values of pension variables.

In this section we examine accrual ratios for 1183 earnings-based defined benefit plans. Earnings-based plans account for approximately 80% of BLS-designated usable plans from the survey and about 65% of plans weighted by pension coverage.[6] Each of the 1183 plans stipulates cliff vesting at 10 years, but the plans have different normal and early retirement ages. Other earnings-based plans with different vesting ages have accrual profiles similar to those that we shall describe, but for convenience of exposition we have not included them in our analysis here. Of the 1183 plans, 508 are integrated with social security under an offset formula.

Table 3.5 presents weighted average accrual ratios for the 1183 plans by early and normal retirement ages for workers hired at age 31. Our intermediate assumptions of 6% nominal wage growth and a 9% interest rate are used in conjunction with the industry-occupation-age-earnings profiles discussed in Section 3.2. The spike at the age of vesting varies with early retirement and normal retirement ages. It is 24% for plans with early and normal retirement at 55. Among the plans with early retirement at 55 the vesting spike declines with the age of normal retirement, with a vesting spike of approximately 12% for plans with normal retirement at 60 and a spike of about 7% for plans with normal retirement at 65. For plans with later early and normal retirement ages, the vesting spike is much smaller, ranging from a little over 3% to about 5%.

A total of 356 plans have the same early and normal retirement ages, that is, they do not permit early retirement. For example, there are 209 plans with both early and normal retirement at age 55. In this case, the accrual ratio is about 5% immediately after vesting and increases to about 15% by age 50. Between ages 50 and 55 the accrual ratio increases to almost 27%. A similar pattern is observed for the other plans in which the normal and early retirement ages are the same, but the accrual ratios just after vesting are no more than 1% in these cases. It may be noted that these plans correspond to our earlier description of plans with no early retirement provision, as depicted, for example, in figure 3.4. We have not calculated accrual ratios after the age of normal retirement, but it appears that accrual after the normal retirement age in most cases is very small and in some cases significantly negative. Hence, there appears to be a very substantial discontinuous drop in the rate of pension accrual after the normal retirement age for a significant fraction of private pension plans. In subsequent work we shall describe in detail the accrual rates of plans after the age of normal retirement.

Plans with early retirement typically exhibit a rather slow increase in accrual ratios after vesting until a few years before the age of early retire-

Table 3.5 **Weighted Average Accrual Rates for Percentage of Earnings Plans with 10-Year Cliff Vesting, by Early (E) and Normal (N) Retirement Age (N = Number of Plans)**

	E = 55, N = 55	E = 55, N = 60	E = 55, N = 65	E = 60, N = 60	E = 60, N = 65	E = 62, N = 62	E = 62, N = 65	E = 65, N = 65
Age	(N = 209)	(N = 152)	(N = 528)	(N = 78)	(N = 53)	(N = 19)	(N = 8)	(N = 50)
40	*.239*	*.115*	*.069*	*.033*	*.047*	*.036*	*.054*	*.037*
41	.046	.024	.013	.007	.010	.016	.009	.010
42	.052	.027	.016	.008	.010	.017	.010	.011
43	.059	.031	.108	.009	.013	.020	.011	.013
44	.067	.036	.020	.011	.015	.031	.013	.014
45	.077	.041	.023	.013	.017	.037	.014	.016
46	.087	.047	.026	.016	.019	.042	.015	.018
47	.099	.055	.031	.027	.022	.048	.017	.021
48	.113	.063	.034	.038	.025	.055	.019	.024
49	.128	.071	.040	.054	.029	.062	.021	.028
50	.145	.086	.046	.063	.034	.070	.023	.032
51	.163	.085	.042	.081	.040	.079	.026	.033
52	.184	.100	.062	.087	.051	.081	.029	.044
53	.209	.114	.072	.101	.060	.103	.032	.051
54	.235	.130	.083	.112	.068	.115	.036	.056
55	.269	*.151*	*.097*	.143	.083	.130	.039	.066
56		.110	.070	.163	.095	.146	.036	.069
57		.116	.074	.185	.107	.165	.039	.078
58		.120	.079	.215	.128	.188	.044	.091
59		.120	.081	.232	.147	.212	.049	.107
60		.215	.083	.259	*.168*	.245	.054	.121
61			.074		.119	.223	.060	.131
62			.070		.121	.252	*.066*	.148
63			.063		.122		.023	.167
64			.060		.123		.019	.190
65			.052		.121		.012	.216

Note: Plans with early or normal retirement supplements are excluded.

ment. There is often a sharp drop in the accrual ratio at that age, with either limited increases or gradual declines in accrual ratios thereafter. For example, of the 528 plans with early retirement at 55 and normal retirement at 65 the accrual ratio reaches about 10% at age 55 and then drops by about 30% to 7% at age 56. By age 65 the accrual ratio has fallen to 5%. The pattern exhibited by these plans is similar to the one described in figure 3.4 for a typical plan with a normal retirement provision.

A comparison of plans with and without a social security offset is presented in table 3.6, for plans with early retirement at 55 and normal retirement at 55, 62, or 65. There are two major differences in these plans: first, the within-group weighted average spike at vesting is very substantial for

Table 3.6 Weighted Average Accrual Rates for Percentage of Earnings Plans with 10-Year Cliff Vesting, and Early Retirement at Age 55, by Normal Retirement Age and Social Security Offset (N = Number of Plans)

	Normal Retirement at 55		Normal Retirement at 62		Normal Retirement at 65	
Age	Without Offset (N = 178)	With Offset (N = 31)	Without Offset (N = 124)	With Offset (N = 118)	Without Offset (N = 261)	With Offset (N = 267)
40	*.258*	*.084*	*.174*	*.024*	*.120*	*.016*
41	.050	.014	.036	.009	.022	.004
42	.057	.017	.041	.012	.025	.005
43	.064	.021	.046	.015	.029	.006
44	.072	.025	.052	.019	.033	.008
45	.082	.031	.066	.024	.037	.010
46	.093	.042	.067	.027	.040	.011
47	.105	.054	.077	.035	.048	.014
48	.119	.063	.089	.041	.051	.017
49	.134	.078	.103	.050	.058	.020
50	.151	.092	.115	.065	.065	.026
51	.171	.097	.131	.078	.072	.031
52	.193	.116	.146	.096	.080	.042
53	.218	.137	.169	.113	.090	.053
54	.246	.162	.190	.132	.101	.064
55	.278	.196	*.218*	*.156*	*.115*	*.078*
56			.099	.129	.080	.061
57			.101	.128	.080	.068
58			.111	.143	.079	.079
59			.107	.147	.077	.085
60			.100	.148	.073	.094
61			.096	.105	.076	.071
62			.090	.095	.066	.074
63					.054	.073
64					.047	.074
65					.032	.073

Note: Plans with early or normal retirement supplements are excluded.

plans without social security offset, ranging from 12% to 26% and is very small for plans with a social security offset with the exception of plans with normal retirement at age 55. In this case the average spike at vesting is about 8%. Second, the discontinuity in accrual ratios at the age of early retirement is much larger for plans without a social security offset than for plans with an offset. For example, among plans with normal retirement at age 62, there is a 55% drop in the accrual ratio between ages 55 and 56, while for plans with a social security offset the drop is about 17%.

The smaller reduction in the accrual ratio at age 55 for these social security offset plans appears to be explained as follows. Because workers experience faster wage growth prior to their mid-fifties, their social security Primary Insurance Amount, a key determinant of the benefit offset, grows at a faster rate for younger workers. This factor plus the ceilings on the offset amount established by many of these plans means that social security offsets reduce accrual ratios prior to a worker's mid-fifties by a greater percentage than after his or her mid-fifties. As a consequence, the reduction in the accrual ratio at age 55 is proportionally smaller in offset plans than in nonoffset plans.

To demonstrate the wide variation among plans with the same early and normal retirement ages, we have reproduced in table 3.7 the accrual ratios for plans with normal retirement at 55 and early retirement at 65, together with the minimum and maximum accruals among these plans for each age. Almost half of the plans have these early and normal retirement ages.

Table 3.7 Weighted Average and Minimum and Maximum Accrual Rates for Percentage of Earnings Plans, with 10-Year Cliff Vesting with Early Retirement at 55 and Normal Retirement at 65

Age	Average	Minimum	Maximum
40	.069	.000	.388
41	.013	−.025	.072
42	.016	−.025	.081
43	.018	−.027	.092
44	.020	−.026	.104
45	.023	−.079	.118
46	.026	−.028	.133
47	.031	−.025	.164
48	.034	−.020	.169
49	.040	−.021	.191
50	.046	−.011	.215
51	.052	−.020	.243
52	.062	−.018	.274
53	.072	−.015	.309
54	.083	−.014	.348
55	*.097*	*−.005*	*.409*
56	.071	−.065	.431
57	.074	−.063	.355
58	.079	−.050	.252
59	.081	−.046	.309
60	.083	−.064	.351
61	.074	−.157	.347
62	.070	−.155	.334
63	.063	−.194	.320
64	.060	−.221	.471
65	.052	−.326	.350

Note: Plans with early or normal retirement supplements are excluded.

The average accrual ratios, as noted above, rise to about 10% by the age of early retirement and then fall to about 5% by the age of normal retirement at 65. But there is a very large variation among the plans. In particular, a large number of plans exhibit negative rates of pension accrual after the age of early retirement, while others have much higher accrual ratios than the average. For example, at 65 the accrual ratios range from a low of a negative 33% to a high of about 35%. These differences highlight the potential importance of joint consideration of wage rates and pension accruals, a task that we shall pursue in the future if appropriate data can be obtained.

Table 3.8 shows how average accrual ratios vary across industries. An important difference among the five industry groups is the proportion with specific early and normal retirement ages. Approximately 60% of plans in manufacturing have early retirement at 55 and normal retirement at 65, while in retail trade more than 90% are in this group. Over 60% of plans in manufacturing, on the other hand, have early retirement as well as normal retirement at 55. Very few plans in retail trade, finance, or services have normal retirement at 55.

Plans with early and normal retirement at 55 have approximately the same weighted average accrual patterns in each of the industry groups, with a spike at vesting close to 25% and the accrual ratio at 55 ranging between 20% and 27%. The typical plan with normal retirement at age 62 exhibits a substantial drop in the accrual ratio at the early retirement age of 55. The drop is about 35% in manufacturing and in finance and over 50% in transportation.

Plans with normal retirement at 65 typically exhibit an accrual pattern that is much flatter than the pattern exhibited by the other plans in each industry. These plans exhibit a drop in the accrual ratio at the age of early retirement that ranges from a low of 14% in services to a high of 35% in retail trade. The average accrual rate at 65 is −6% in retail trade and +11% in finance. It is approximately 6% in services and transportation and 7% in manufacturing.

Early and normal retirement supplements lead to widely varying accrual patterns, and we have not tried to summarize them here. We will, however, present details of these plans in a subsequent paper. We shall also describe in future work the accrual pattern of flat rate plans with benefits based only on years of service. Approximately 35% of the BLS-LOB pension plans weighted by coverage are of this type. They typically exhibit negative accrual ratios after the age of early retirement.

Job change can reduce pension benefits substantially. For 749 plans we calculated accrued benefits at age 65 for persons hired at 31, 41, and 51. In these calculations, we assume that a person does not become vested in another plan prior to joining the firm. For each plan we calculate accrued benefits, using the associated industry-occupation wage profiles, for each of the hiring ages. The comparison of benefits of persons hired at 31 with

Table 3.8 **Weighted Average Accrual Rates for Percentage of Earnings Plans with 10-Year Cliff Vesting, by Industry and by Early (E) and Normal (N) Retirement Ages**
(*N* = Number of Plans)

	Manufacturing			Transportation			Retail Trade			Finance			Services		
Age	E=55, N=55 (N=49)	E=55, N=62 (N=137)	E=55, N=65 (N=264)	E=55, N=55 (N=145)	E=55, N=62 (N=46)	E=55, N=65 (N=37)	E=55, N=55 (N=2)	E=55, N=62 (N=6)	E=55, N=65 (N=90)	E=55, N=55 (N=5)	E=55, N=62 (N=25)	E=55, N=65 (N=77)	E=55, N=55 (N=5)	E=55, N=62 (N=5)	E=55, N=65 (N=33)
40	*.220*	*.082*	*.056*	*.252*	*.156*	*.120*	*.021*	*.001*	*.080*	*.102*	*.061*	*.071*	*.266*	*.161*	*.068*
41	.040	.018	.011	.049	.035	.021	.020	.001	.014	.032	.017	.016	.049	.030	.013
42	.045	.022	.013	.056	.040	.024	.019	.001	.016	.039	.020	.019	.055	.033	.015
43	.052	.025	.015	.063	.045	.027	.018	.001	.018	.046	.023	.022	.063	.038	.017
44	.059	.030	.017	.072	.051	.030	.017	.002	.019	.055	.028	.025	.071	.042	.020
45	.067	.036	.020	.082	.073	.034	.015	.002	.021	.065	.032	.029	.080	.048	.023
46	.078	.040	.023	.092	.068	.035	.016	.002	.024	.077	.038	.032	.090	.054	.027
47	.091	.048	.027	.105	.077	.040	.016	.003	.026	.091	.044	.037	.102	.061	.030
48	.102	.058	.030	.118	.087	.045	.016	.003	.029	.106	.052	.043	.115	.069	.035
49	.116	.070	.036	.133	.099	.051	.094	.007	.032	.121	.063	.049	.129	.078	.041
50	.132	.078	.042	.151	.112	.059	.112	.015	.035	.144	.099	.057	.146	.088	.048
51	.150	.090	.047	.171	.130	.067	.127	.020	.039	.103	.115	.065	.164	.099	.065
52	.169	.101	.053	.193	.149	.080	.142	.022	.043	.148	.148	.090	.185	.112	.065
53	.192	.117	.063	.218	.178	.098	.165	.025	.047	.170	.168	.102	.209	.127	.076
54	.218	.133	.074	.246	.203	.111	.174	.081	.050	.199	.192	.120	.235	.143	.087
55	.250	*.157*	*.088*	.279	*.230*	*.127*	.198	*.099*	*.056*	.232	*.219*	*.143*	.266	*.161*	*.098*
56		.102	.069		.105	.094		.089	.035		.139	.094		.129	.084
57		.102	.074		.115	.098		.086	.034		.139	.098		.127	.089
58		.107	.081		.144	.104		.116	.028		.145	.106		.124	.102
59		.107	.085		.146	.109		.110	.020		.144	.112		.119	.110

Table 3.8 (continued)

Age	Manufacturing			Transportation			Retail Trade			Finance			Services		
	E=55, N=55 (N=49)	E=55, N=62 (N=137)	E=55, N=65 (N=264)	E=55, N=55 (N=145)	E=55, N=62 (N=46)	E=55, N=65 (N=37)	E=55, N=55 (N=2)	E=55, N=62 (N=6)	E=55, N=65 (N=90)	E=55, N=55 (N=5)	E=55, N=62 (N=25)	E=55, N=65 (N=77)	E=55, N=55 (N=5)	E=55, N=62 (N=5)	E=55, N=65 (N=33)
60		.103	.087		.147	.114		.099	.019		.140	.114		.113	.114
61		.083	.079		.119	.098		.072	.014		.076	.108		.144	.083
62		.075	.079		.106	.093		.047	.004		.067	.109		.178	.077
63			.077			.070			−.015			.110			.071
64			.076			.069			−.025			.113			.066
65			.074			.066			−.057			.110			.057

Note: Plans with early or normal retirement supplements are excluded.

those hired at 41 and 51 is made in two ways. The first is to sum age 65 accrued benefits over all plans for each age of hire and calculate the ratio of the sum of the benefits if persons were hired at 41 (or 51) to the sum if the same persons were hired at 31. The second comparison is the average of the ratios calculated for each plan, with each ratio weighted by the number of persons covered by the plan. The results are shown in table 3.9.

Table 3.9 Accrued Benefits at Age 65 for Persons Hired at Aged 41 and 51, as Percentage of the Benefits of Persons Hired at Age 31

Plans Included and Age When Hired (*N* = Number of Plans)	Ratio of the Sum of Benefits	Weighted Average of the Plan Ratios
All plans (*N* = 749)		
Hired at 41	.82	.89
Hired at 51	.54	.62
Plans without social security offset (*N* = 488)		
Hired at 41	—	.79
Hired at 51	—	.50
Plans with social security offset (*N* = 261)		
Hired at 41	—	.86
Hired at 51	—	.52
Mining (*N* = 20)		
Hired at 41	.83	—
Hired at 51	.49	—
Construction (*N* = 7)		
Hired at 41	.79	—
Hired at 51	.48	—
Manufacturing (*N* = 346)		
Hired at 41	.80	—
Hired at 51	.50	—
Transportation (*N* = 86)		
Hired at 41	.95	—
Hired at 51	.78	—
Wholesale trade (*N* = 25)		
Hired at 41	.83	—
Hired at 51	.57	—
Retail trade (*N* = 127)		
Hired at 41	.65	—
Hired at 51	.31	—
Finance (*N* = 100)		
Hired at 41	.84	—
Hired at 51	.50	—
Services (*N* = 38)		
Hired at 41	.90	—
Hired at 51	.57	—

The aggregate benefits of persons hired at 51 are only about 50% of the benefits of those hired at 31. Persons hired at 41 would accumulate about 80% of the benefits of persons hired at 31. There is little difference between plans with and without a social security offset, based on the weighted average of plan ratios. Variation among occupations is not striking, but there is substantial variation across industries. Benefits if hired at 51 range from only 31% of the benefits if hired at 31 in retail trade to 78% in manufacturing. The ratio if hired at 41 ranges from 65% in retail trade to 95% in transportation.

Thus job change can impose a very large cost in pension benefits. While these calculations do not incorporate vesting on one job before changing to another, we believe that such calculations—more in line with the illustrations in Section 3.1—would not substantially alter the order of magnitude of the benefit losses. Because we used accrued benefits at age 65, the calculations also incorporate some negative accruals after the age of early retirement. It may be more appropriate to use maximum accrued benefits for each age of hire.

3.4 Concluding Comments

In our view the magnitude, patterns, and variations in pension accrual ratios are strikingly at odds with the view of spot clearing in labor markets. While market clearing in longer-term contracts seems the only equilibrium theory consistent with these findings, it strains our credulity to ascribe optimizing behavior to the choice of pension accrual profiles. It seems much more likely that employees and employers rough tune rather than fine tune in their choice of pension plans, if there is any tuning whatsoever.

In our future research we intend to examine the ratio of accrued vested benefits to straight wages after the age of normal retirement. Preliminary evidence suggests very sizable potential work disincentives after the normal retirement age because of a sharp decline in pension benefit accrual. We will also focus on the particular plan features having the greatest effect on accrual profiles. Plans with non-earnings-related benefit formulas as well as plans with early and normal retirement supplemental benefits will also be studied. Given the appropriate data, we wish to investigate the relationship between individual earnings profiles and associated pension plans. In particular, we would like to know the extent to which wages adjust in accordance with pension plan provisions. A second important issue is the extent to which pension accrual patterns affect retirement decisions as well as turnover prior to vesting, early retirement, and normal retirement.

Notes

1. This assumes no other explicit or implicit fringe benefits.
2. We are hopeful that the Department of Labor's extremely valuable survey of Private Pension Benefit Amounts will be released in the near future.
3. Bulow (1979) appears to be the first discussion of these discontinuities. Lazear (1981, 1983) presents empirical analysis of this issue.
4. The BLS-LOB survey contains 3248 plans of which the BLS labeled 2492 as "usable." Our master sample consists of 2343 of these 2492 plans, although this study only examines 1183 plans.
5. We make no use here of the truncated earnings data contained in the RHS social security earnings records.
6. The 1183 earnings-based plans with cliff vesting account for 51% of plans weighted by pension coverage.

Comment Zvi Bodie

Laurence Kotlikoff and David Wise try to accomplish two goals in their paper. The first is to describe the age-tenure profiles of pension benefit accruals over a worker's career implied by the provisions of actual defined benefit plans, and the second is to test whether those profiles are consistent with a "spot market" theory of labor contracting. According to this theory the total compensation—wages plus the present value of pension benefits—paid to a worker in each year of employment must equal the expected value of his marginal product in that same year. In the context of this theory, the present value of pension benefits earned through continued service during any year must be evaluated as if the worker's employment were to be terminated at year's end.

If wages follow a smooth trajectory over a worker's career, then the stipulations of a typical defined benefit plan with "cliff" vesting and early retirement benefits that are better than actuarially fair imply that the profile of earned pension increments will have two spikes in it, one in the year vesting occurs and one at the age of early retirement. Because Kotlikoff and Wise assumed that the age-tenure profiles of both wages and the unobservable marginal product are smooth, they interpret these spikes as strong evidence against the spot market theory.

I want to begin my critical comments by saying that I think Kotlikoff and Wise are to be congratulated for undertaking the enormous task of programming the stipulations of these plans and systematically analyzing

Zvi Bodie is professor of economics and finance at Boston University's School of Management and research associate, National Bureau of Economic Research.

them. Defined benefit plans are extremely complicated because there are so many dimensions along which they can differ, and I think the Kotlikoff-Wise paper helps us to understand the quantitative impact of these differences.

At the same time I have some reservations and questions about what they have done. My first three comments relate to the purely descriptive aspects of their work, while my last is directed at their tests of the spot market theory.

First, they have assumed for all 522 plans in their sample that if a worker terminates employment prior to the age of early retirement he is still entitled to early retirement benefits. I believe that this is not true for many, if not most, plans. This feature makes a big difference for the profile of pension increments. If a plan provides early retirement benefits only to participants who remain with the firm until early retirement age, then relative to the profiles shown by Kotlikoff and Wise in their figure 3.1, for example, (1) the spike at vesting (age 40) is smaller; (2) the spike at early retirement age (55) is much larger; and (3) the whole profile of pension increments up to age 54 is much lower.

Second, in generating their nominal wage trajectories Kotlikoff and Wise ignore secular growth in real wages that might arise from trend growth in labor productivity. In effect the pension increment profiles they show all implicitly assume that this growth rate is zero. While this may have been true for many sectors of the United States economy in the decade of the 1970s, it certainly was not true before then, and even if Kotlikoff and Wise think zero the most likely number, I believe it is still worth showing the effect of a positive growth rate.

Third, I find one aspect of the results reported in table 3.5 absolutely mystifying. The next to the last column in that table presents the minimum accrual rates among the plans in the sample. How can these be negative at all ages? I can understand their turning negative for some plans after the age of early retirement, but not earlier.

My remaining comments deal with Kotlikoff and Wise's methodology for testing the spot labor market theory. While I agree that the spikes in the profile of pension benefit accruals, particularly the one at early retirement age, are difficult to explain in the context of a strict spot market theory, I do not think that they have provided a real test of that theory in its less strict and perhaps more credible form.

Granting their assumption that the age-tenure profile of marginal product of labor is smooth, a real test of the theory would compare the wage and total compensation profiles of workers in firms with defined benefit pension plans to those of workers without such plans. Lacking appropriate data to perform such a comparison, Kotlikoff and Wise have simply assumed a smooth wage profile for workers with such plans (they fit a quadratic functional form to the wage data, thus guaranteeing smoothness) and therefore, given the vesting and early retirement provisions, the pension accrual and the total compensation profiles must exhibit spikes. A proper test of the spot market theory would also require information on the age-tenure profile of other forms of labor compensation in addition to wages and pension benefits.

Kotlikoff and Wise are aware of the shortcomings of their data set for testing the spot market theory, and they are attempting to get data on wage and benefit profiles for workers controlling for the characteristics of the pension plan they participate in. They also plan to explore further the disincentives to job change turnover implicit in the stipulations of the plans in their current data set. David Ellwood in his table 2.9 presents some illustrative calculations of the present value of lost benefits if a worker changes jobs, and they appear quite significant under reasonable assumptions about the rate of inflation.

In conclusion I again congratulate David Ellwood and Kotlikoff and Wise for a difficult job done well.

References

Bulow, J. 1979. Analysis of pension funding under ERISA. NBER Working Paper no. 402.

Lazear, E.P. 1981. Severance pay, pensions, mobility, and the efficiency of work incentives. Mimeographed. University of Chicago.

———. 1983. Pensions as severance pay. In *Financial aspects of the United States pension system,* ed. Z. Bodie and J. B. Shoven. Chicago: University of Chicago Press (for NBER).

Kotlikoff, L.J., and Smith, D.E. 1983. *Pensions in the American economy.* Chicago: University of Chicago Press (for NBER).

This Page Intentionally Left Blank