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10 Employee Retirement and a Firm's Pension Plan

Laurence J. Kotlikoff and David A. Wise

In previous work we analyzed the incentive effects of the provisions of private pension plans.[1] The incentive effects were described by the accrual of pension wealth resulting from an additional year of work, treating the addition to pension wealth as a form of compensation in units comparable to the wage. We found that the provisions of almost all plans implied a large loss in pension wealth for work past the age of 65. Often this loss was more than 40 percent of the wage that would be earned for the additional work. In some plans wage earnings after 65 would be entirely offset by the concomitant loss in pension wealth. The typical plan also provided a substantial incentive to retire at the age of early retirement provided in the plan. This was often as young as 55. In addition, the typical plan provides a strong incentive not to retire before the early retirement age. Although this work documented the incentive effects inherent in the timing of the accrual of pension benefits, no attempt was made to estimate the actual effects of these incentives on retirement. That is, we considered the effect of pension benefit accrual on compensation by age, but not the effect of compensation on continued labor force participation. Indeed, based on the data used for that analysis there was no way to relate the plan provisions to retirement or to departure rates from the firm.

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In this paper, the relationship between pension accrual and retirement is analyzed based on the experience in a large Fortune 500 firm engaged in sales. Its name may not be disclosed. The data are the employment and earnings histories between 1969 and 1984 of all workers who were employed by the firm in any of the years between 1980 and 1984. The provisions of the firm pension plan are such that persons of the same age face very different pension accrual profiles and thus pension compensation at a given age. Hence, different individuals face very different incentives for continued work versus retirement.

The paper begins with a detailed description of the pension plan and the incentive effects inherent in its provisions. The incentive effects of the provisions are described in terms of their effects on the budget constraints facing employees over their working lives. For completeness, the accrual of Social Security benefits is described together with pension benefit accrual.

The evaluation of the incentive effects of plan provisions requires the estimation of wage earnings. The procedure used to estimate these profiles is described in section 10.2.

We then show the relationship between wage earnings, pension wealth accrual, and Social Security accrual, on the one hand, and departure rates from the firm, on the other. It is apparent from this relationship that the effect of the pension plan provisions on departure rates is very substantial. In subsequent analysis we will develop a model that will allow us to predict the effect of changes in the provisions on departure rates. That is not possible based only on the relationships presented here. But the detail shown here provides information that is often lost in formal statistical models.

The analysis makes clear that an estimation of the effects of pension plans on labor force participation of older workers can only be done by taking account of the precise provisions of individual plans. Simply knowing that an employee has a private pension plan tells nothing about the labor force incentive effects of the plan's provisions. While a great deal of effort has been directed to estimating the effects of Social Security provisions on labor force participation, much less attention has been given to the effects of private pension plans. The data presented here suggest that pension plans are likely to have a much greater effect than, for example, the recent changes in Social Security benefits.

10.1 The Firm Pension Plan

10.1.1 The Plan's Provisions

The firm has a defined benefit pension plan with earnings-related benefits and a Social Security offset. The plan's early and normal

retirement ages are 55 and 65, respectively, with vesting after ten years. Actuarially reduced benefits are available starting at age 55 for *vested terminators*—vested workers who leave the firm prior to age 55. *Early retirees*—workers who retire between ages 55 and 65—are eligible to receive less than actuarially-reduced benefits. For workers who retire after age 65 there is no special actuarial benefit increase.

In addition to the more favorable benefit reduction afforded to early retirees, they also receive a supplemental benefit equal to their Social Security offset between the time they retire and the time they reach age 65. Hence, in comparison to a vested terminator who leaves the firm at age 54 and starts collecting benefits at age 55, an early retiree who leaves at age 55 enjoys a smaller benefit reduction and also receives a supplemental benefit until age 65. Not surprisingly, the profile of vested accrued benefits by age jumps sharply for most workers at age 55. Thus there is a large bonus for remaining with the firm until age 55.

The formula for the basic benefit before reduction for early retirement and before any applicable Social Security offset is the average earnings base times x percent times the first N years of continuous service, plus y percent times the rest of continuous service:

$$\text{(1)}\quad \begin{aligned} &\text{Benefits} = (\text{Earnings Base})\,[(x)(\text{Service})], \\ &\qquad \text{if Service is less than } N \text{ years.} \\ &\text{Benefits} = (\text{Earnings Base})\,[(x)(\text{Service}) + (y)(\text{Service} - N)], \\ &\qquad \text{if Service is greater than } N \text{ years.} \end{aligned}$$

The parameters x and y are both less than 0.05, and y is less than x. N lies between 15 and 30. The average earnings base is calculated based on earnings between the start year and the year of either vested termination or retirement. The start year has traditionally been increased by two years every other year, varying from k to $k + 1$ years before the current year, where k is between 5 and 10. In our accrual calculations, we assume a one- or two-year increase in the start year every two years. Excluding the two lowest years of earnings (except that the number of earnings years used cannot be reduced below 5), the earnings base is calculated as the average annual earnings from the start year to the year of vested termination or retirement.

The Social Security adjustment (SSADJ) is p (p lies between 0.5 and 1) of the Social Security benefit (SSB) calculated by the firm times the ratio of completed service to the amount of service the worker would have if he or she stayed until age 65, less Z (Z lies between \$1,000 and \$5,000) times the ratio of continuous service as of 1 January 1976 to the continuous service the worker would have if he or she stayed until age 65:

$$(2) \qquad \text{SSADJ} = p\text{SSB}\frac{S}{S + (65 - A)} - Z\frac{S(76)}{S + (65 - A)}.$$

Here, S is years of service, $S(76)$ is the years of service the worker had in 1976, and A is the worker's current age. The first term is smaller the younger the age of retirement, which reduces the adjustment. But if the worker has pre-1976 service, the second term is also smaller the younger the retirement age, and this increases the adjustment.

SSB, the firm's calculation of the worker's age 65 Social Security benefit, is based on the worker's earnings to date with the firm. In the SSB formula, earnings last year are extrapolated forward, assuming no growth factor, until the worker reaches age 65. The average of past earnings with the firm as well as extrapolated future earnings is then entered into a three-bracket progressive benefit formula to determine SSB.

For early retirees the factor by which benefits are reduced depends on age and service. For example, if the worker retires at age 55 with 20 years of service the reduction is 50 percent; it would be only 33 percent if the worker had 26 or more years of service. For workers with 30 or more years of service, the reduction drops to zero at retirement ages between 60 and 64.

The pension accrual can vary widely for workers of the same age but with different service and for workers with the same service but of different ages. These accrual differences reflect the fact that many of the features of the benefit and Social Security formulas involve either age or service or both. Indeed, it is fair to say that the firm's benefit formula could hardly be better designed from the perspective of maximizing service and age-related differences in accruals. This variation comes at the cost of a fairly complicated set of provisions that may not be fully understood by individual workers.

10.1.2 Pension Accrual

To describe the effect of the provisions on pension wealth, the accrual profiles for persons born in different years and hired by the firm in several different years have been calculated for the calendar period beginning in 1980. For each employee group defined by year of birth and year of hire, accruals are calculated through age 70; the number of years of accruals presented thus depends on the age of the employee in 1980. One profile is graphed in figure 10.1a to illustrate the derivation of such profiles. Profiles for different employee and age groups are compared in subsection 10.1.4.

Figure 10.1a shows the pension accrual profile for male managers born in 1930 and hired by the firm in 1960. By 1980, they were 50 and had 20 years of service with the firm. (To calculate pension accrual,

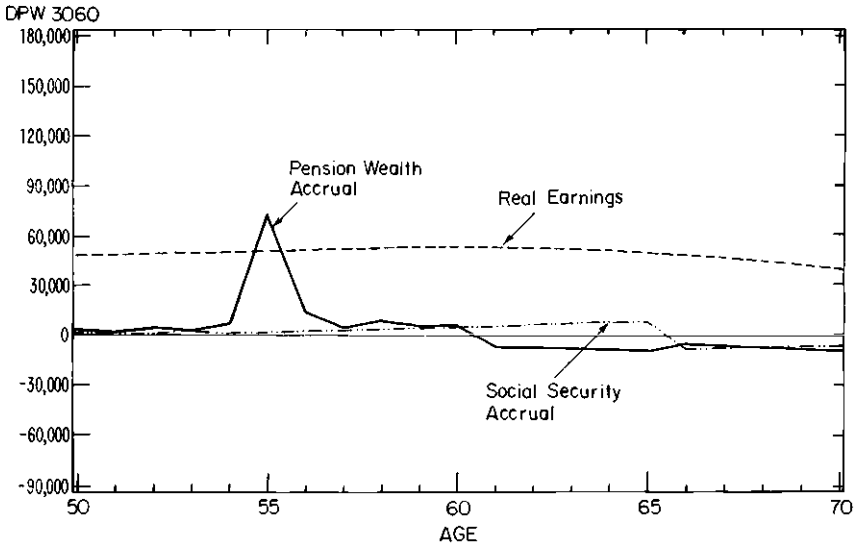

Fig. 10.1a Pension wealth accrual, SS accrual, and wage earnings for male managers born in 1930 and hired in 1960, in real 1985 dollars

we have used the convention that a person hired in a given year has one year of experience in that year. Thus in some of the tables shown below, the person used in this example would be assumed to have 21 years of experience in 1980.) The accrual is the change in the discounted value of future pension benefit entitlements for an additional year of employment. The accrual of Social Security benefits is shown on the same graph. Predicted wage earnings for each year are also shown. These predictions are based on actual average earnings of firm employees, by age and years of service. The prediction method is described and the results are discussed in detail in section 10.2. All of the numbers presented in this section are in real 1985 dollars.

At age 50, in 1980, the typical male manager has wage earnings of about $48,446 per year. Compensation in the form of pension accrual is $2,646, or about 5.5 percent of wage earnings. If the manager were to retire at this age, he would be entitled to benefits at age 65, based on his earnings in the 7 or 8 preceding years. The benefits would not be available until age 65 and thus would have a relatively low present value at age 50.

As described above, normal retirement benefits could be taken earlier, as early as age 55, but they would be reduced actuarially so that the present discounted value of the benefits remains unchanged. The reduction in the benefit would be just enough to offset the fact that benefits would be received for more years. If the person remains in

the firm until age 55 and then retires, however, benefits are available immediately and the reduction in benefits for early retirement is less than the actuarial reduction. In addition, the worker who remains until age 55 and then retires is eligible to receive a supplemental benefit until age 65 equal to his Social Security offset. Thus there is a very large increase in pension wealth at age 55, $72,527, corresponding to the large spike in figure 10.1a. In effect, there is a bonus of $72,527 for remaining in the firm from age 54 to 55.

After age 55, pension accrual falls, to about 10 percent of the wage at age 60 (in 1990). Accrual is higher than just before age 55 primarily because the early retirement reduction factor if the worker remains until 55 is less than it would be if he left the firm before 55. (If he leaves before 55, the reduction is actuarially fair.) But as the worker ages beyond 56, this effect is partially offset by the fact that an additional year of service adds a smaller percent to benefits. Pension accrual is in fact negative beginning at age 61 (in 1991). Indeed, between ages 61 and 65 the loss in pension benefits is equivalent to about 20 percent of wage compensation.

The loss in compensation between ages 60 and 61 is equivalent to a wage cut of about 14 percent. The worker has 30 years of service at that age and, because of the plan's early retirement reduction factors, is already eligible for full retirement benefits. Thus no increase in benefits will result for working another year from the application of one fewer year of early retirement reduction, as was the case before 30 years of service. In addition, for each year that benefits are not taken between ages 55 and 65, the receipt of benefits for a year without the Social Security adjustment (reduction) is foregone. This advantage is lost at age 65 (in 1995). Thereafter, the loss in benefits from working an additional year is smaller because this foregone opportunity is no longer available. In addition, the accruals depend on the Social Security adjustment and to a small extent on the updating of the years used in the calculation of the earnings base.

Social Security accruals for the male managers considered in figure 10.1a range from about $1,000 to $8,000 between ages 50 and 65. After 65, Social Security accrual becomes negative, about −$8,500 at age 66.

In summary, the typical manager in the firm, marking about $48,000 per year in wage earnings at age 60, would lose about $42,000 in pension wealth were he to continue working until age 65. Thus, in addition to the expected concentration of retirement at age 55, we would expect a large proportion of this group to retire before 65. After age 65, Social Security benefit accrual also becomes negative. At 66, the loss in private pension benefits and Social Security benefits together amounts to about 32 percent of wage earnings at that age. This suggests a concentration of retirement at 65 as well.

The data in figure 10.1a are shown in the standard budget constraint form in figure 10.1b. Total compensation, including wage earnings, Social Security wealth, and pension wealth, is graphed against age, beginning in 1980. The vertical axis shows the total resources that the person would acquire from employment with this firm. Accumulated earnings before 1980 are ignored in the graph.

There is a discontinuous jump in the graph at age 55. For reasonable preferences for income (that can be used for consumption) versus retirement leisure, one would expect to see a large proportion of workers facing this constraint retiring at age 55 and most retiring prior to age 65.

Additional graphs showing wage earnings, pension accrual, and Social Security accrual over the working span are shown in figures 10.2a and 10.2b; again, the first shows accruals by year, and the second shows cumulated amounts in the standard budget constraint form. These graphs pertain to a male manager who is hired in 1980 at age 20, and who continues working with the firm until age 70. For such workers, the pension accrual at age 55 is $168,000, equivalent to 164 percent of the wage at that age. Wage earnings for this group reach a maximum at age 59. Pension benefit accrual becomes negative at age 61, and Social Security benefit accrual becomes negative at age 65. In the first year of work after age 65, the loss in pension benefits and Social Security benefits together amounts to $40,000, about 45 percent of wage earnings at that age. Thus the lifetime budget constraint shows an upward discontinuity at age 55 and a decline in the rate of wage increase around

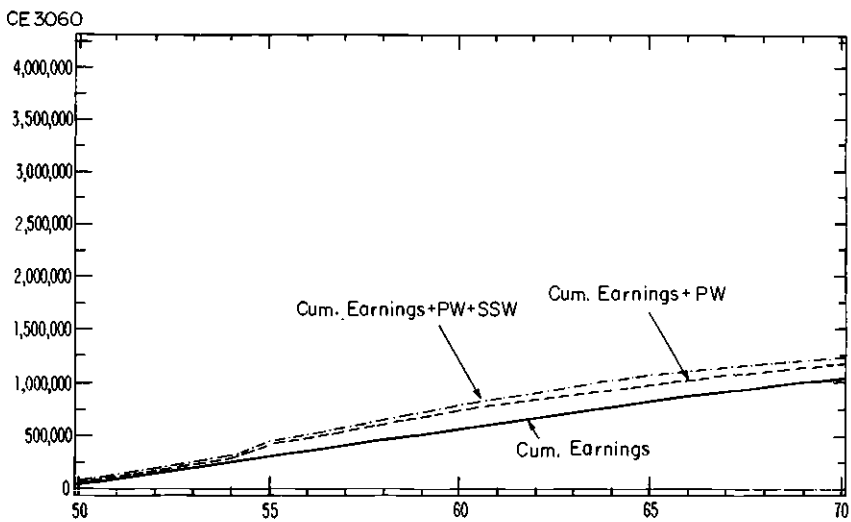

Fig. 10.1b Cumulated total income from employment versus year of retirement, male managers born in 1930 and hired in 1960

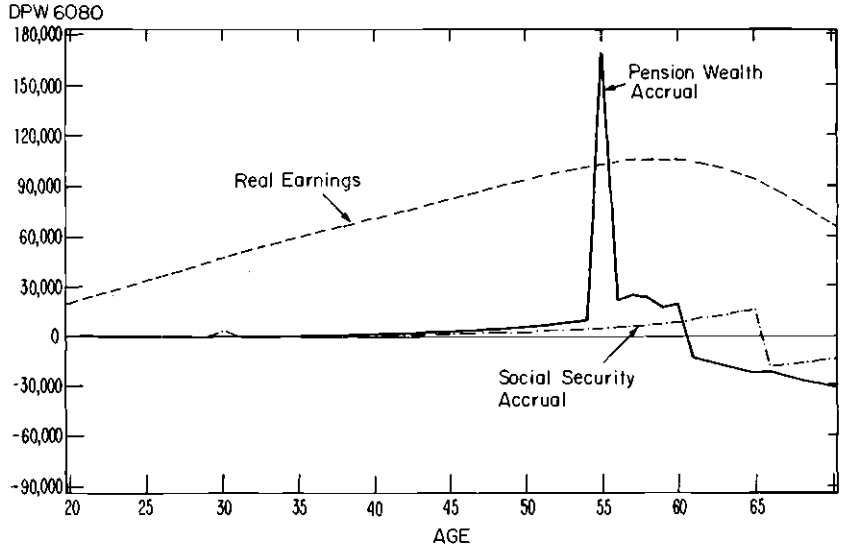

Fig. 10.2a Pension wealth accrual, SS accrual, and wage earnings for male managers born in 1960 and hired in 1980, in real 1985 dollars

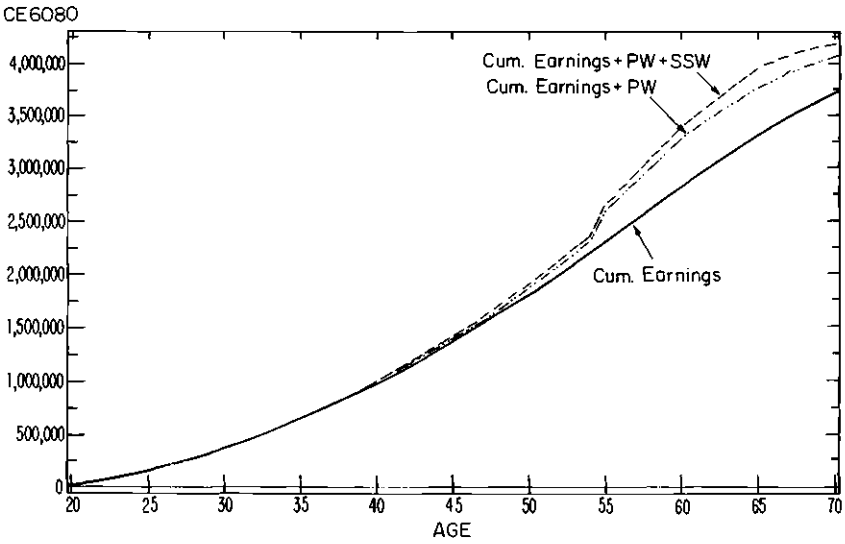

Fig. 10.2b Cumulated total income from employment versus year of retirement, male managers born in 1960 and hired in 1980

age 60. The decline is especially abrupt after age 65.[2] Retirement at age 55, between 55 and 65, and possibly at 65 would seem to be quite likely for workers facing budget constraints like this one.

10.1.3 Decomposition of Pension Accrual

The calculations underlying the pension accrual in figures 10.1a and 10.1b are explained in this section. The wage earnings and other dollar values in this section are in current dollars, however, while the graphs are in constant 1985 dollars. The nominal interest rate assumed throughout this analysis is 0.09, and the real interest is assumed to equal 0.03.

The calculations are shown in table 10.1 for male managers who were born in 1930 and hired by the firm in 1960, the same group whose accrual profile is illustrated in figures 10.1a and 10.1b. Columns (1) through (4) are self-explanatory. Column (5) is the average earnings base used to calculate pension benefits. The normal retirement benefit is shown in column (6). It is calculated using the formula in equation (1) above. The Social Security benefit in column (7) is calculated by the firm based on earnings projected forward to age 65. Column (8) is the Social Security adjustment shown in equation (2). Column (9) is column (7) minus column (8). Column (10) is 1 minus the early retirement adjustment, the proportion of the benefit that remains after the adjustment. Once the person has worked for 30 years there is, according to the firm's early retirement reduction provisions, no reduction even though the person is only 60 years old at that time.

Column (11) is column (10) times column (6). It is the benefit that a person who retired early would receive between the early retirement age and age 65. After age 65, benefits are based on the adjusted retirement benefits, reduced by the early retirement reduction factor. These benefits are shown in column (12), which is column (10) times column (9).

The annuity value of a dollar received each year from 65 until death is shown in column (13). It accounts for the probability that a person will be alive at each year in the future. The probability that a person will live from the current age until 65 is shown in column (14). The current value of a dollar that will be received at age 65 is shown in column (15). At the current age, the present value of the pension benefits that the manager can receive at age 65 is shown in column (16), and is given by column (12) $\times$ column (13) $\times$ column (14) $\times$ column (15).

If the manager retires at age 55 or later, he will receive benefits until age 65 that are not reduced by the Social Security adjustment. He receives the normal retirement benefits in column (6) reduced only by the early retirement reduction factor, column (10), and shown in column (11). The present value of these benefits from the year of first collection until age 65 is shown in column (17). These benefits plus those that

Table 10.1 Calculation of Pension Benefits and Wealth Accrual

Year (1)	Age (2)	Yrs. Svc. (3)	Wage (4)	Avg. Earn. Base (5)	Normal Ret. Ben. (6)	SS Ben. (7)	SS Adjmt. (8)	Adj. Ret. Ben. Factor (9)	Early Ret. Reduct. Ben. (10)	Reduced Normal Ret. Ben. (11)	Reduced Adj. Ret. Ben. (12)	Annuity Value (13)	Prob. Survive to 65 (14)	Discount 65 to Current Age (15)	Present Value Ret. Ben. from 65 (16)	Present Value Ret. Ben. to 65 (17)	Pension Wealth (18)	Pension Accrual (19)	Pension Accrual Wage (20)
1979	49	20	32,393	24,788	9,915	10,227	3,846	6,069	1.00	9,915	6,069	7.999	0.8196	0.2519	10,023	0	10,023	0	0.0
1980	50	21	37,109	27,501	11,550	10,626	4,276	7,274	1.00	11,550	7,274	7.999	0.8243	0.2745	13,167	0	13,167	2,057	6.4
1981	51	22	41,266	29,221	12,857	10,921	4,673	8,185	1.00	12,857	8,185	7.999	0.8294	0.2993	16,250	0	16,250	1,741	4.7
1982	52	23	44,055	32,165	14,796	11,060	5,000	9,796	1.00	14,796	9,796	7.999	0.8351	0.3262	21,346	0	21,346	3,334	8.1
1983	53	24	45,661	33,664	16,159	11,128	5,293	10,866	1.00	16,159	10,866	7.999	0.8415	0.3555	26,004	0	26,004	2,510	5.7
1984	54	25	48,426	38,018	19,009	11,248	5,620	13,388	1.00	19,009	13,388	7.999	0.8485	0.3875	35,216	0	35,216	6,205	13.8
1985	55	26	50,919	39,451	20,120	11,341	5,937	14,183	0.67	13,480	9,503	7.999	0.8562	0.4224	27,494	89,947	117,441	72,527	149.8
1986	56	27	54,674	44,313	23,043	11,528	6,316	16,727	0.73	16,821	12,210	7.999	0.8648	0.4604	38,891	105,041	143,932	14,607	28.7
1987	57	28	58,564	45,896	24,325	11,719	6,707	17,618	0.80	19,460	14,095	7.999	0.8742	0.5019	49,468	112,461	161,930	4,627	8.5
1988	58	29	62,556	49,248	26,594	11,911	7,107	19,487	0.87	23,137	16,954	7.999	0.8847	0.5470	65,637	121,970	187,606	10,187	17.4
1989	59	30	66,616	52,526	28,890	12,099	7,513	21,377	0.93	26,867	19,880	7.999	0.8963	0.5963	84,994	126,740	211,734	6,645	10.6
1990	60	31	70,697	55,797	31,246	12,289	7,929	23,317	1.00	31,246	23,317	7.999	0.9092	0.6499	110,219	128,422	238,640	7,202	10.8
1991	61	32	74,741	59,206	33,747	12,475	8,352	25,395	1.00	33,747	25,395	7.999	0.9235	0.7084	132,909	116,203	249,112	−10,097	−14.3
1992	62	33	78,682	62,875	36,468	12,658	8,781	27,687	1.00	36,468	27,687	7.999	0.9395	0.7722	160,676	98,801	259,477	−11,060	−14.8
1993	63	34	82,443	66,655	39,326	12,848	9,223	30,103	1.00	39,326	30,103	7.999	0.9574	0.8417	194,046	74,665	268,711	−12,953	−16.5
1994	64	35	85,930	70,545	42,327	13,047	9,682	32,645	1.00	42,327	32,645	7.999	0.9774	0.9174	234,174	42,327	276,501	−15,040	−18.2
1995	65	36	89,053	74,365	45,362	13,264	10,164	35,198	1.00	45,362	35,198	7.999	1.0000	1.0000	281,568	0	281,568	−18,181	−21.2
1996	66	37	91,700	78,046	48,389	13,757	10,575	37,814	1.00	48,389	37,814	7.824	1.0000	1.0000	295,848	0	295,848	−10,148	−11.4
1997	67	38	93,772	81,515	51,354	14,273	11,005	40,349	1.00	51,354	40,349	7.646	1.0000	1.0000	308,518	0	308,518	−12,804	−14.0
1998	68	39	95,164	84,687	54,200	14,813	11,455	42,745	1.00	54,200	42,745	7.466	1.0000	1.0000	319,112	0	319,112	−15,754	−16.8
1999	69	40	95,769	87,473	56,857	15,377	11,926	44,932	1.00	56,857	44,932	7.281	1.0000	1.0000	327,147	0	327,147	−18,978	−19.9
2000	70	41	95,509	89,780	59,255	15,972	12,421	46,834	1.00	59,255	46,834	7.093	1.0000	1.0000	332,181	0	332,181	−22,394	−23.4

will be received after age 65 and the present value of his pension wealth and are shown in column (18) (column [16] plus column [17]).

The change in pension wealth from one year to the next, $I(a)$, the pension accrual, is shown in column (19). The accrual at age a is given by

$$I(a) = Pw(a + 1) - Pw(a)(1 + r) \tag{3}$$

where Pw is pension wealth and r is the nominal interest rate (0.09). Again, these pension accruals, together with Social Security accruals and the wage, are graphed in figure 10.1a, but in 1985 dollars. The accrual as a percentage of wage earnings is shown in column (20).[3]

10.1.4 Variation in Accrual Profiles by Age and Year of Hire

The two accrual profiles discussed above pertain to persons who were born in a given year and who were hired by the firm in a given year. The profile in the calendar period beginning in 1980 may be quite different for persons of different ages and with different years of service. Thus, profiles have been calculated for several additional groups, fifteen in all, defined by year of birth and year of hire, as shown in table 10.2. Pension accruals for managers with these birth and hire years are shown in table 10.3. Those born in 1940 reach age 55 in 1995, and for each of these groups there is a discontinuous increase in pension wealth in that year. It is $29,639 for those with 15 years of service in that year and $82,953 for those with 25 years of service. Comparable jumps occur in 1985 for those born in 1930. Accruals are often negative for persons over 60.

Pension accruals provide a large incentive for some groups to stay in the firm for another year and a strong incentive for others to leave. For example, staying with the firm in 1985 brings pension accrual of $72,527 for 55-year-old managers with 25 years of service (born in 1930 and hired in 1960), but a loss of $14,936 for 65 year olds with 35 years of experience (born in 1920 and hired in 1950). Thus there is enormous variation in the effective compensation for continued service. One might expect, therefore, that some groups would be much more likely than others to retire in a given year.

Table 10.2 **Accrual Profile Groups**

Year of Birth	Year of Hire				
1960	1980				
1950	1980	1975			
1940	1980	1975	1970		
1930	1980	1975	1970	1960	
1920	1980	1975	1970	1960	1950

Table 10.3 **Accrual in Pension Wealth by Year of Birth and Year of Hire for Managers**

Year Born	1960	1950		1940			1930				1920				
Hired	1980	1980	1975	1980	1975	1970	1980	1975	1970	1960	1980	1975	1970	1960	1950
1980	0	0	0	0	0	508	0	0	835	2,686	0	0	1,178	5,146	442
1981	0	0	0	0	0	380	0	0	562	2,059	0	0	−616	−105	−9,132
1982	0	0	0	0	0	770	0	0	1,413	3,716	0	0	451	2,175	−5,043
1983	0	0	0	0	0	582	0	0	1,079	2,710	0	0	−2,739	−2,721	−13,235
1984	0	0	1,278	0	2,470	1,494	0	2,968	3,053	6,530	0	5,090	658	3,575	−2,995
1985	0	0	251	0	475	767	0	18,226	2,6481	72,527	0	−5,357	−5,328	−8,152	−14,936
1986	0	0	663	0	1,335	2,090	0	5,616	8,227	13,781	0	0	8,151	3,728	831
1987	0	0	353	0	651	994	0	2,593	3,691	4,118	0	0	2,108	−4,957	−10,017
1988	0	0	663	0	1,289	1,978	0	4,105	5,874	8,553	0	4,176	3,987	−1,882	−6,347
1989	1,008	2,158	767	4,037	1,479	2,323	22,194	3,745	5,342	5,263	0	5,038	2,968	−3,049	−7,920
1990	194	388	890	688	1,709	2,676	831	3,280	4,726	5,382	0	4,265	2,109	−3,889	−8,984
1991	341	690	1,051	1,297	2,174	3,168	1,060	1,685	2,376	−7,118	0	0	0	0	0
1992	418	845	1,260	1,601	2,675	3,820	609	1,389	2,029	−7,356	0	0	0	0	0
1993	504	1,016	1,485	2,021	3,202	4,515	−89	683	1,312	−8,127	0	0	0	0	0
1994	606	1,220	1,756	2,603	3,851	5,351	−908	−155	419	−8,902	0	0	0	0	0
1995	716	1,441	2,043	29,639	40,727	82,953	−2,067	−1,384	−3,515	−10,152	0	0	0	0	0
1996	843	1,695	2,555	7,130	9,538	9,898	5,217	3,628	−939	−5,346	0	0	0	0	0
1997	987	1,986	2,992	7,349	9,672	11,334	4,579	2,855	−1,652	−6,363	0	0	0	0	0
1998	1,153	2,422	3,499	7,437	9,641	10,665	3,902	2,041	−2,384	−7,386	0	0	0	0	0
1999	1,342	2,969	4,085	7,377	9,426	7,844	3,186	1,187	−3,129	−8,394	0	0	0	0	0
2000	1,558	3,492	3,900	7,140	6,196	8,643	2,423	−1,882	−3,874	−9,344	0	0	0	0	0
2001	1,807	4,095	4,481	4,432	2,198	−6,178	0	0	0	0	0	0	0	0	0
2002	2,093	4,790	5,149	3,750	1,206	−7,237	0	0	0	0	0	0	0	0	0

2003	2,517	5,587	5,904	2,870	−15	−8,380	0	0	0	0	0	0	0	0	0
2004	3,037	6,502	6,763	1,791	4,378	−9,658	0	0	0	0	0	0	0	0	0
2005	2,918	95,433	117,775	−2,553	−8,981	−11,004	0	0	0	0	0	0	0	0	0
2006	3,361	11,955	14,674	−1,993	−4,042	−6,843	0	0	0	0	0	0	0	0	0
2007	3,872	13,705	16,840	−2,784	−4,988	−7,994	0	0	0	0	0	0	0	0	0
2008	4,461	13,022	15,944	−3,601	−5,955	−9,155	0	0	0	0	0	0	0	0	0
2009	5,139	9,809	11,879	−4,436	−6,930	−10,299	0	0	0	0	0	0	0	0	0
2010	5,910	10,923	13,211	−5,265	−7,875	−11,375	0	0	0	0	0	0	0	0	0
2011	6,792	−6,583	−8,668	0	0	0	0	0	0	0	0	0	0	0	0
2012	7,801	−7,785	−10,184	0	0	0	0	0	0	0	0	0	0	0	0
2013	8,940	−9,069	−11,809	0	0	0	0	0	0	0	0	0	0	0	0
2014	10,223	−10,418	−13,531	0	0	0	0	0	0	0	0	0	0	0	0
2015	168,439	−11,848	−15,345	0	0	0	0	0	0	0	0	0	0	0	0
2016	21,859	−8,684	−12,662	0	0	0	0	0	0	0	0	0	0	0	0
2017	25,137	−9,994	−14,317	0	0	0	0	0	0	0	0	0	0	0	0
2018	23,904	−11,319	−15,955	0	0	0	0	0	0	0	0	0	0	0	0
2019	17,968	−12,627	−17,524	0	0	0	0	0	0	0	0	0	0	0	0
2020	19,964	−13,849	−18,933	0	0	0	0	0	0	0	0	0	0	0	0
2021	−12,355	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	−14,649	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2023	−1,7087	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2024	−19,659	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2025	−22,287	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2026	−21,570	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2027	−24,026	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2028	−26,391	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2029	−2,8576	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2030	−30,436	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 10.4 **Pension Wealth by Year of Birth and Year of Hire for Managers**

Year Born	1960	1950		1940			1930				1920				
Hired	1980	1980	1975	1980	1975	1970	1980	1975	1970	1960	1980	1975	1970	1960	1950
1980	0	0	0	0	0	2,356	0	0	3,747	17,190	0	0	20,270	69,954	157,647
1981	0	0	0	0	0	2,741	0	0	4,313	19,221	0	0	19,347	68,974	145,742
1982	0	0	0	0	0	3,654	0	0	5,969	23,790	0	0	20,361	73,204	144,173
1983	0	0	0	0	0	4,493	0	0	7,480	28,076	0	0	18,515	74,336	137,819
1984	0	0	1,393	0	2,692	6,327	0	3,235	11,149	36,475	0	5,549	20,077	81,625	140,844
1985	0	0	1,740	0	3,350	7,494	0	23,271	40,597	117,141	0	0	15,322	77,017	131,943
1986	0	0	2,513	0	4,901	9,985	0	30,051	50,713	135,785	0	0	24,639	83,260	136,584
1987	0	0	2,969	0	5,750	11,351	0	33,728	56,172	144,117	0	0	27,634	80,214	129,531
1988	0	0	3,775	0	7,317	13,828	0	39,157	64,165	157,520	0	4,552	32,763	80,434	126,280
1989	1,098	2,352	4,718	4,400	9,136	16,751	24,192	44,347	71,802	167,710	0	10,173	36,925	79,385	121,217
1990	1,341	2,842	5,821	5,274	11,257	20,142	25,781	49,175	78,983	178,316	0	15,109	40,267	77,390	114,850
1991	1,750	3,675	7,132	6,837	13,946	24,166	27,668	52,407	83,814	175,617	0	0	0	0	0
1992	2,256	4,700	8,707	8,776	17,257	29,015	29,115	55,404	88,399	172,570	0	0	0	0	0
1993	2,869	5,940	10,572	11,227	21,234	34,755	29,840	57,713	92,326	168,587	0	0	0	0	0
1994	3,610	7,439	12,785	14,382	26,033	41,572	29,695	59,178	95,397	163,658	0	0	0	0	0
1995	4,493	9,220	15,373	47,095	71,162	133,166	28,282	59,343	94,264	157,222	0	0	0	0	0
1996	5,539	11,329	18,594	56,201	83,574	147,728	34,770	64,980	95,910	155,849	0	0	0	0	0
1997	6,772	13,814	22,381	65,802	96,481	164,262	40,746	69,931	96,824	153,324	0	0	0	0	0
1998	8,220	16,844	26,827	75,768	109,717	180,531	46,151	74,133	96,962	149,607	0	0	0	0	0
1999	9,915	20,558	32,040	85,956	123,101	194,197	50,931	77,527	96,299	144,698	0	0	0	0	0
2000	11,894	24,946	37,197	96,169	133,336	209,110	55,012	77,669	94,800	138,605	0	0	0	0	0
2001	14,201	30,116	43,135	103,721	139,506	208,294	0	0	0	0	0	0	0	0	0
2002	16,884	36,190	49,968	110,745	144,770	206,303	0	0	0	0	0	0	0	0	0

2003	20,105	43,304	57,817	117,006	148,850	203,005	0	0	0	0	0	0	0	0	0
2004	23,984	51,616	66,824	122,269	157,833	198,220	0	0	0	0	0	0	0	0	0
2005	27,844	157,100	197,093	122,952	152,517	191,845	0	0	0	0	0	0	0	0	0
2006	32,295	174,574	218,662	124,257	152,424	189,811	0	0	0	0	0	0	0	0	0
2007	37,429	194,452	243,204	124,738	151,301	186,468	0	0	0	0	0	0	0	0	0
2008	43,351	214,150	267,468	124,345	149,092	181,767	0	0	0	0	0	0	0	0	0
2009	50,180	230,907	287,992	123,032	145,761	175,690	0	0	0	0	0	0	0	0	0
2010	58,041	249,344	310,538	120,773	141,301	168,260	0	0	0	0	0	0	0	0	0
2011	67,087	249,226	309,879	0	0	0	0	0	0	0	0	0	0	0	0
2012	77,489	247,793	307,546	0	0	0	0	0	0	0	0	0	0	0	0
2013	89,425	244,918	303,375	0	0	0	0	0	0	0	0	0	0	0	0
2014	103,100	240,494	297,212	0	0	0	0	0	0	0	0	0	0	0	0
2015	289,618	234,391	288,904	0	0	0	0	0	0	0	0	0	0	0	0
2016	321,636	231,555	283,275	0	0	0	0	0	0	0	0	0	0	0	0
2017	358,138	227,214	275,686	0	0	0	0	0	0	0	0	0	0	0	0
2018	394,330	221,307	266,097	0	0	0	0	0	0	0	0	0	0	0	0
2019	425,077	213,809	254,529	0	0	0	0	0	0	0	0	0	0	0	0
2020	458,866	204,763	241,094	0	0	0	0	0	0	0	0	0	0	0	0
2021	458,390	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	455,392	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2023	449,660	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2024	440,956	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2025	429,144	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2026	417,780	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2027	403,414	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2028	386,063	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2029	365,842	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2030	343,022	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 10.5 **Social Security Accrual by Year of Birth and Year of Hire for Managers**

Year Born	1960	1950		1940			1930				1920				
Hired	1980	1980	1975	1980	1975	1970	1980	1975	1970	1960	1980	1975	1970	1960	1950
1980	0	1,696	2,286	398	455	467	936	982	1,022	1,071	2,936	3,000	3,057	3,125	1,263
1981	0	235	338	474	567	635	1,121	1,240	1,291	1,356	3,726	3,808	3,880	2,013	4,053
1982	0	289	421	571	676	742	1,346	1,462	1,524	802	4,460	4,557	4,644	4,843	4,878
1983	0	364	522	730	863	954	1,730	1,893	1,978	2,137	5,850	5,982	3,317	6,383	6,431
1984	0	293	390	588	273	734	1,394	1,489	1,525	1,673	4,893	4,974	5,206	5,332	5,361
1985	0	129	382	612	767	760	1,471	1,578	1,611	1,777	5,023	1,436	5,307	5,483	5,510
1986	0	419	440	751	910	919	1,822	1,949	2,003	2,200	−5,991	−5,837	−6,118	−6,463	−6,540
1987	0	520	560	971	1,165	1,199	2,385	2,577	1,232	2,914	−5,587	−5,443	−5,706	−6,028	−6,100
1988	0	588	608	1,098	1,294	1,334	2,725	2,930	3,129	3,313	−5,208	−5,074	−5,319	−5,618	−5,686
1989	0	664	664	1,242	1,441	1,488	3,117	3,338	3,566	3,774	−4,856	−4,731	−4,959	−5,238	−5,301
1990	3,965	737	729	1,404	1,609	1,663	3,568	3,810	4,072	4,308	−4,530	−4,413	−4,627	−4,887	−4,945
1991	358	801	804	690	1,801	1,863	4,090	2,095	4,661	4,929	0	0	0	0	0
1992	382	875	889	1,865	2,022	2,092	4,696	5,103	5,349	5,653	0	0	0	0	0
1993	416	961	985	2,096	2,273	2,353	5,402	5,878	6,158	6,504	0	0	0	0	0
1994	456	1,060	1,093	2,361	2,562	2,653	6,330	6,815	7,169	7,589	0	0	0	0	0
1995	503	1,173	1,216	2,665	2,892	2,994	6,924	7,376	7,801	8,257	0	0	0	0	0
1996	556	1,301	1,355	3,015	3,271	3,387	−6,909	−7,275	−7,825	−8,497	0	0	0	0	0
1997	616	1,448	1,512	3,418	3,709	3,839	−6,444	−6,784	−7,298	−7,925	0	0	0	0	0
1998	683	1,614	1,689	3,885	4,213	4,361	−6,006	−6,324	−6,802	−7,387	0	0	0	0	0
1999	758	1,803	1,891	4,426	4,797	4,965	−5,600	−5,896	−6,343	−6,888	0	0	0	0	0
2000	841	2,018	2,119	5,052	5,472	5,662	−5,224	−5,501	−5,917	−6,425	0	0	0	0	0
2001	935	2,263	2,378	5,779	6,256	6,471	0	0	0	0	0	0	0	0	0

2002	1,040	2,542	2,674	6,628	7,169	7,413	0	0	0	0	0	0	0	0	0
2003	1,158	2,861	3,010	7,624	8,241	8,518	0	0	0	0	0	0	0	0	0
2004	1,291	3,225	3,394	8,900	9,648	9,986	0	0	0	0	0	0	0	0	0
2005	1,440	3,641	3,832	9,684	10,496	10,863	0	0	0	0	0	0	0	0	0
2006	1,607	4,119	4,334	−10,010	−11,207	−11,747	0	0	0	0	0	0	0	0	0
2007	1,796	4,668	4,912	−9,335	−10,452	−10,956	0	0	0	0	0	0	0	0	0
2008	2,009	5,302	5,578	−8,702	−9,743	−10,212	0	0	0	0	0	0	0	0	0
2009	2,251	6,034	6,346	−8,114	−9,085	−9,522	0	0	0	0	0	0	0	0	0
2010	2,524	6,878	7,232	−7,569	−8,475	−8,883	0	0	0	0	0	0	0	0	0
2011	2,834	7,858	8,259	0	0	0	0	0	0	0	0	0	0	0	0
2012	3,188	8,999	9,454	0	0	0	0	0	0	0	0	0	0	0	0
2013	3,590	10,337	10,855	0	0	0	0	0	0	0	0	0	0	0	0
2014	4,049	12,137	12,766	0	0	0	0	0	0	0	0	0	0	0	0
2015	4,571	13,201	13,885	0	0	0	0	0	0	0	0	0	0	0	0
2016	5,169	−14,510	−15,516	0	0	0	0	0	0	0	0	0	0	0	0
2017	5,858	−13,532	−14,471	0	0	0	0	0	0	0	0	0	0	0	0
2018	6,651	−12,614	−13,489	0	0	0	0	0	0	0	0	0	0	0	0
2019	7,566	−11,761	−12,577	0	0	0	0	0	0	0	0	0	0	0	0
2020	8,622	−10,972	−11,733	0	0	0	0	0	0	0	0	0	0	0	0
2021	9,844	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	11,265	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2023	12,933	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2024	15,222	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2025	16,557	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2026	−18,659	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2027	−17,401	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2028	−16,220	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2029	−15,124	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2030	−14,109	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 10.6 **Social Security Wealth by Year of Birth and Year of Hire for Managers**

Year Born	1960	1950		1940			1930				1920				
Hired	1980	1980	1975	1980	1975	1970	1980	1975	1970	1960	1980	1975	1970	1960	1950
1980	0	1,849	2,491	3,818	4,854	5,277	9,217	10,544	11,703	13,137	30,795	32,286	33,612	35,218	33,536
1981	0	2,082	2,828	4,287	5,412	5,905	10,325	11,765	12,966	14,452	34,476	36,037	37,425	36,976	37,540
1982	0	2,453	3,364	5,025	6,295	6,873	12,070	13,676	14,977	15,716	40,267	41,976	43,496	43,251	43,869
1983	0	2,988	4,121	6,102	7,588	8,297	14,633	16,505	17,971	18,925	48,898	50,847	49,546	52,631	53,335
1984	0	3,444	4,734	7,021	8,232	9,476	16,820	18,881	20,454	21,613	56,463	58,589	57,482	60,844	61,612
1985	0	3,765	5,398	8,055	9,499	10,801	19,305	21,590	23,281	24,682	64,896	63,223	66,278	70,009	70,846
1986	0	4,328	6,031	9,101	10,760	12,109	21,837	24,326	26,123	27,779	60,203	58,651	61,485	64,946	65,722
1987	0	5,017	6,811	10,417	12,334	13,759	25,054	27,823	28,206	31,742	55,816	54,377	57,005	60,214	60,934
1988	0	5,800	7,667	11,909	14,094	15,603	28,734	31,804	32,415	36,252	51,720	50,387	52,821	55,795	56,462
1989	0	6,689	8,607	13,599	16,062	17,666	32,944	36,342	37,218	41,390	47,889	46,654	48,909	51,662	52,280
1990	4,321	7,681	9,645	15,514	18,270	19,978	37,764	41,522	42,708	47,255	44,305	43,162	45,248	47,796	48,367
1991	4,834	8,771	10,795	16,706	20,752	22,576	43,294	44,984	49,000	53,969	0	0	0	0	0
1992	5,387	9,973	12,069	19,213	23,543	25,495	49,638	51,820	56,218	61,658	0	0	0	0	0
1993	5,992	11,303	13,484	22,040	26,686	28,780	56,928	59,691	64,518	70,489	0	0	0	0	0
1994	6,659	12,778	15,058	25,238	30,235	32,487	65,441	68,810	74,160	80,757	0	0	0	0	0
1995	7,396	14,418	16,809	28,856	34,242	36,670	74,839	78,796	84,760	92,041	0	0	0	0	0
1996	8,212	16,245	18,762	32,960	38,778	41,400	69,429	73,099	78,632	85,387	0	0	0	0	0
1997	9,115	18,283	20,941	37,618	43,918	46,757	64,370	67,773	72,903	79,166	0	0	0	0	0
1998	10,117	20,559	23,375	42,917	49,752	52,832	59,643	62,796	67,549	73,352	0	0	0	0	0
1999	11,230	23,107	26,098	48,957	56,391	59,741	55,229	58,149	62,550	67,923	0	0	0	0	0
2000	12,464	25,960	29,145	55,848	63,950	67,602	51,096	53,798	57,869	62,841	0	0	0	0	0
2001	13,836	29,161	32,562	63,728	72,579	76,568	0	0	0	0	0	0	0	0	0

2002	15,362	32,758	36,398	72,757	82,448	86,815	0	0	0	0	0	0	0	0	0
2003	17,059	36,803	40,709	83,126	93,763	98,557	0	0	0	0	0	0	0	0	0
2004	18,948	41,360	45,561	95,178	106,932	112,229	0	0	0	0	0	0	0	0	0
2005	21,054	46,502	51,030	108,431	121,404	127,251	0	0	0	0	0	0	0	0	0
2006	23,402	52,306	57,197	100,587	112,621	118,045	0	0	0	0	0	0	0	0	0
2007	26,021	58,874	64,169	93,258	104,415	109,444	0	0	0	0	0	0	0	0	0
2008	28,948	66,320	72,065	86,413	96,751	101,410	0	0	0	0	0	0	0	0	0
2009	32,222	74,775	81,023	80,016	89,589	93,904	0	0	0	0	0	0	0	0	0
2010	35,884	84,387	91,198	74,029	82,886	86,877	0	0	0	0	0	0	0	0	0
2011	39,989	95,342	102,782	0	0	0	0	0	0	0	0	0	0	0	0
2012	44,595	107,848	115,995	0	0	0	0	0	0	0	0	0	0	0	0
2013	49,770	122,167	131,108	0	0	0	0	0	0	0	0	0	0	0	0
2014	55,592	138,854	148,734	0	0	0	0	0	0	0	0	0	0	0	0
2015	62,149	157,176	168,081	0	0	0	0	0	0	0	0	0	0	0	0
2016	69,541	145,806	155,922	0	0	0	0	0	0	0	0	0	0	0	0
2017	77,894	135,183	144,562	0	0	0	0	0	0	0	0	0	0	0	0
2018	87,349	125,260	133,950	0	0	0	0	0	0	0	0	0	0	0	0
2019	98,068	115,986	124,033	0	0	0	0	0	0	0	0	0	0	0	0
2020	110,241	107,308	114,753	0	0	0	0	0	0	0	0	0	0	0	0
2021	124,092	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	139,882	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2023	157,939	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2024	179,001	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2025	202,114	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2026	187,497	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2027	173,836	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2028	161,075	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2029	149,149	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2030	137,991	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 10.7 **Wage Earnings by Year of Birth and Year of Hire for Managers**

Year Born	1960	1950		1940			1930				1920				
Hired	1980	1980	1975	1980	1975	1970	1980	1975	1970	1960	1980	1975	1970	1960	1950
1980	20,405	24,053	33,021	27,894	34,020	40,712	31,825	34,945	38,666	48,446	35,723	35,788	36,519	40,186	47,598
1981	22,852	26,082	34,967	29,403	35,354	41,853	32,739	35,666	39,226	48,813	36,006	35,902	36,470	39,794	46,774
1982	25,312	28,057	36,807	30,819	36,586	42,898	33,548	36,289	39,693	49,098	36,188	35,919	36,323	39,280	45,765
1983	27,757	29,965	38,542	32,141	37,720	43,858	34,256	36,819	40,074	49,300	36,276	35,845	36,080	38,642	44,568
1984	30,615	32,271	40,774	33,869	39,342	45,410	35,390	37,818	40,977	50,156	36,819	36,215	36,277	38,446	43,828
1985	34,479	34,543	42,948	35,535	40,904	46,913	36,447	38,741	41,803	50,919	37,271	36,488	36,362	38,092	42,847
1986	36,331	36,774	45,069	37,140	42,409	48,374	37,427	39,588	42,551	51,579	37,632	36,660	36,333	37,574	41,624
1987	39,155	38,960	47,139	38,685	43,859	49,794	38,331	40,358	43,216	52,122	37,900	36,728	36,181	36,885	40,157
1988	41,933	41,092	49,158	40,163	45,250	51,168	39,152	41,042	43,785	52,524	38,066	36,679	35,895	36,014	38,445
1989	44,653	43,166	51,128	41,572	46,580	52,493	39,886	41,633	44,249	52,765	38,124	36,507	35,467	34,956	36,499
1990	47,309	45,183	53,056	42,913	47,850	53,766	40,530	42,127	44,599	52,826	38,067	36,205	34,891	33,713	34,339
1991	49,904	47,147	54,951	44,187	49,059	54,987	41,083	42,517	44,827	52,690	0	0	0	0	0
1992	52,429	49,052	56,809	45,387	50,198	56,140	41,533	42,790	44,914	52,329	0	0	0	0	0
1993	54,889	50,900	58,636	46,509	51,262	57,216	41,873	42,935	44,847	51,724	0	0	0	0	0
1994	57,292	52,698	60,438	47,553	52,247	58,206	42,099	42,946	44,616	50,861	0	0	0	0	0
1995	59,645	54,444	62,216	48,514	53,142	59,093	42,200	42,809	44,207	49,725	0	0	0	0	0
1996	61,954	56,140	63,969	49,382	53,935	59,860	42,166	42,513	43,607	48,307	0	0	0	0	0
1997	64,230	57,786	65,695	50,151	54,615	60,487	41,988	42,048	42,805	46,602	0	0	0	0	0
1998	66,481	59,380	67,389	50,812	55,166	60,954	41,656	41,403	41,794	44,615	0	0	0	0	0
1999	68,717	60,920	69,047	51,353	55,573	61,236	41,161	40,570	40,568	42,359	0	0	0	0	0
2000	70,946	62,398	70,655	51,760	55,816	61,307	40,493	39,542	39,125	39,852	0	0	0	0	0
2001	73,178	63,814	72,206	52,023	55,879	61,148	0	0	0	0	0	0	0	0	0
2002	75,415	65,151	73,676	52,123	55,739	60,728	0	0	0	0	0	0	0	0	0

2003	77,667	66,402	75,052	52,047	55,381	60,028	0	0	0	0	0	0	0	0	0
2004	79,931	67,550	76,307	51,779	54,783	59,027	0	0	0	0	0	0	0	0	0
2005	82,213	68,581	77,417	51,305	53,931	57,709	0	0	0	0	0	0	0	0	0
2006	84,502	69,471	78,349	50,609	52,810	56,063	0	0	0	0	0	0	0	0	0
2007	86,796	70,199	79,069	49,678	51,410	54,084	0	0	0	0	0	0	0	0	0
2008	89,081	70,739	79,543	48,503	49,727	51,778	0	0	0	0	0	0	0	0	0
2009	91,347	71,067	79,735	47,081	47,764	49,160	0	0	0	0	0	0	0	0	0
2010	93,567	71,151	79,604	45,408	45,526	46,251	0	0	0	0	0	0	0	0	0
2011	95,721	70,965	79,114	0	0	0	0	0	0	0	0	0	0	0	0
2012	97,774	70,478	78,230	0	0	0	0	0	0	0	0	0	0	0	0
2013	99,694	69,665	76,922	0	0	0	0	0	0	0	0	0	0	0	0
2014	101,438	68,503	75,168	0	0	0	0	0	0	0	0	0	0	0	0
2015	102,959	66,974	72,952	0	0	0	0	0	0	0	0	0	0	0	0
2016	104,202	65,062	70,267	0	0	0	0	0	0	0	0	0	0	0	0
2017	105,115	62,766	67,124	0	0	0	0	0	0	0	0	0	0	0	0
2018	105,638	60,090	63,546	0	0	0	0	0	0	0	0	0	0	0	0
2019	105,712	57,051	59,572	0	0	0	0	0	0	0	0	0	0	0	0
2020	105,277	53,675	55,254	0	0	0	0	0	0	0	0	0	0	0	0
2021	104,279	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	102,671	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2023	100,415	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2024	97,484	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2025	93,875	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2026	89,598	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2027	84,690	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2028	79,209	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2029	73,239	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2030	66,886	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 10.8 **Cumulated Earnings by Year of Birth and Year of Hire for Managers**

Year Born	1960	1950		1940			1930				1920				
Hired	1980	1980	1975	1980	1975	1970	1980	1975	1970	1960	1980	1975	1970	1960	1950
1980	20,405	24,053	33,021	27,894	34,020	40,712	31,825	34,945	38,666	48,446	35,723	35,788	36,519	40,186	47,598
1981	43,257	50,135	67,987	57,297	69,374	82,565	64,564	70,611	77,892	97,258	71,728	71,690	72,990	79,980	94,372
1982	68,569	78,192	104,795	88,116	105,960	125,463	98,112	106,900	117,585	146,356	107,916	107,609	109,312	119,259	140,137
1983	96,326	108,157	143,337	120,257	143,679	169,320	132,368	143,719	157,659	195,656	144,193	143,453	145,392	157,901	184,704
1984	126,941	140,428	184,111	154,126	183,022	214,730	167,758	181,537	198,636	245,812	181,012	179,669	181,669	196,348	228,532
1985	160,419	174,970	227,059	189,661	223,926	261,644	204,205	220,277	240,439	296,731	218,283	216,157	218,031	234,440	271,379
1986	196,750	211,745	272,127	226,801	266,335	310,017	241,631	259,865	282,989	348,310	255,915	252,817	254,364	272,014	313,003
1987	235,905	250,750	319,267	265,486	310,194	359,811	279,962	300,224	326,205	400,432	293,815	289,545	290,545	308,900	353,159
1988	277,838	291,797	368,425	305,649	355,444	410,979	319,114	341,266	369,990	452,956	331,881	326,224	326,440	344,913	391,604
1989	322,490	334,963	419,553	347,221	402,025	463,472	359,000	382,899	414,239	505,721	370,005	362,731	361,907	379,870	428,104
1990	369,799	380,146	472,609	390,134	449,874	517,238	399,530	425,026	458,838	558,547	408,072	398,936	396,799	413,582	462,442
1991	419,703	427,293	527,560	434,321	498,933	572,225	440,613	467,543	503,665	611,237	0	0	0	0	0
1992	472,132	476,345	584,369	479,708	549,132	628,365	482,147	510,333	548,579	663,567	0	0	0	0	0
1993	527,021	527,245	643,004	526,216	600,394	685,581	524,020	553,268	593,426	715,290	0	0	0	0	0
1994	584,313	579,942	703,442	573,770	652,640	743,787	566,118	596,214	638,043	766,151	0	0	0	0	0
1995	643,958	634,387	765,658	622,283	705,782	802,880	608,318	639,024	682,250	815,877	0	0	0	0	0
1996	705,913	690,527	829,626	671,666	759,717	862,740	650,484	681,537	725,857	864,183	0	0	0	0	0
1997	770,143	748,313	895,321	721,817	814,332	923,228	692,472	723,585	768,662	910,785	0	0	0	0	0
1998	836,623	807,692	962,710	772,629	869,498	984,181	734,128	764,987	810,456	955,400	0	0	0	0	0
1999	905,341	868,612	1,031,757	823,981	925,071	1,045,417	775,289	805,557	851,024	997,759	0	0	0	0	0
2000	976,286	931,010	1,102,412	875,741	980,887	1,106,724	815,782	845,099	890,149	1,037,610	0	0	0	0	0
2001	1,049,464	994,824	1,174,617	927,764	1,036,766	1,167,871	0	0	0	0	0	0	0	0	0
2002	1,124,879	1,059,974	1,248,293	979,886	1,092,505	1,228,598	0	0	0	0	0	0	0	0	0

2003	1,202,545	1,126,376	1,323,345	1,031,934	1,147,885	1,288,626	0	0	0	0	0	0	0	0	0	0
2004	1,282,476	1,193,926	1,399,652	1,083,712	1,202,667	1,347,652	0	0	0	0	0	0	0	0	0	0
2005	1,364,688	1,262,507	1,477,069	1,135,017	1,256,598	1,405,361	0	0	0	0	0	0	0	0	0	0
2006	1,449,190	1,331,987	1,555,417	1,185,625	1,309,408	1,461,423	0	0	0	0	0	0	0	0	0	0
2007	1,535,985	1,402,176	1,634,486	1,235,302	1,360,818	1,515,506	0	0	0	0	0	0	0	0	0	0
2008	1,625,066	1,472,915	1,714,028	1,283,805	1,410,544	1,567,283	0	0	0	0	0	0	0	0	0	0
2009	1,716,412	1,543,982	1,793,763	1,330,886	1,458,307	1,616,442	0	0	0	0	0	0	0	0	0	0
2010	1,809,979	1,615,133	1,873,366	1,376,293	1,503,833	1,662,692	0	0	0	0	0	0	0	0	0	0
2011	1,905,700	1,686,097	1,952,480	0	0	0	0	0	0	0	0	0	0	0	0	0
2012	2,003,474	1,756,574	2,030,709	0	0	0	0	0	0	0	0	0	0	0	0	0
2013	2,013,168	1,826,239	2,107,631	0	0	0	0	0	0	0	0	0	0	0	0	0
2014	2,204,605	1,894,742	2,182,799	0	0	0	0	0	0	0	0	0	0	0	0	0
2015	2,307,564	1,961,716	2,255,750	0	0	0	0	0	0	0	0	0	0	0	0	0
2016	2,411,765	2,026,778	2,326,016	0	0	0	0	0	0	0	0	0	0	0	0	0
2017	2,516,879	2,089,544	2,393,140	0	0	0	0	0	0	0	0	0	0	0	0	0
2018	2,622,516	2,149,634	2,456,686	0	0	0	0	0	0	0	0	0	0	0	0	0
2019	2,728,227	2,206,684	2,516,257	0	0	0	0	0	0	0	0	0	0	0	0	0
2020	2,833,503	2,260,359	2,571,510	0	0	0	0	0	0	0	0	0	0	0	0	0
2021	2,937,782	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	3,040,452	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2023	3,140,866	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2024	3,238,350	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2025	3,332,224	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2026	3,421,822	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2027	3,506,511	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2028	3,585,719	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2029	3,658,958	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2030	3,725,843	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

In some instances there are erratic fluctuations from one year to the next, from negative to positive to negative, for example. This typically occurs if an increase in benefits in one year is not followed by a comparable increase in the next. For example, suppose that the normal retirement benefit is higher in year a than in either year $a - 1$ or in year $a + 1$. Then the accrual from $a - 1$ to a will tend to be positive, but the accrual from a to $a + 1$ will tend to be negative. Dropping a low earnings year and adding a higher one in the calculation of the earnings base may create this effect. Other provisions in the pension calculation formula may do so as well. For convenience, total cumulated pension wealth is shown in table 10.4 for the same groups. Social Security accruals and cumulated Social Security wealth are shown in tables 10.5 and 10.6, respectively. Annual wage earnings and cumulated earnings are shown in tables 10.7 and 10.8.

Two of the profiles were shown in figures 10.1 and 10.2 above; several others are shown below. Young new hires will have rapid wage growth in the subsequent 20 years, but very little accrual of pension wealth. This is shown in figure 10.2 for persons born in 1960, 20 years old at the time of hire in 1980. Their incomes will rise from about $20,000 in 1980 to over $70,000 in the year 2000, when they are 40 years old. But even in 2000 their pension accrual will be only $1,558. Their total accrued pension wealth at age 40 will be only $11,894, a very small fraction (1.2 percent) of their total earnings over the period.

A manager hired in 1980, but born in 1940, will have much lower wage growth over the next 20 years, from about $28,000 in 1980 to under $52,000 at age 60 in 2000 (see figs. 10.3a and 10.3b). This person will also have little pension wealth accrual through age 54, when his total pension wealth will be less than $13,000. In 1995, however, when the person is 55 and eligible for early retirement, it will increase by almost $30,000 to a total of over $47,000. In the next few years accrual is less than $7,000 per year. The age 55 spike in accrual suggests a potential concentration of retirement among this group at age 55 (in 1995). But the actual pension that would be received is still very small, only about 12 percent of salary (from tables not shown). Thus retirement may be unlikely.

Managers of the same age, but hired 10 years earlier may be much more likely to retire in that year (see figs. 10.4a and 10.4b). They experience a much sharper increase in pension wealth in 1985, from just under $42,000 to over $133,000. The pension benefit to wage replacement rate at 55 for this group is about 26 percent. But accrual after 55 remains positive for this group; pension wealth increases to almost $209,000 by age 60. Thus pension wealth accrual may still provide a substantial incentive to remain with the firm.

In contrast, persons born in 1920 and hired by the firm at age 40 (in 1960) will have essentially no pension accrual in 1985, and, indeed, it

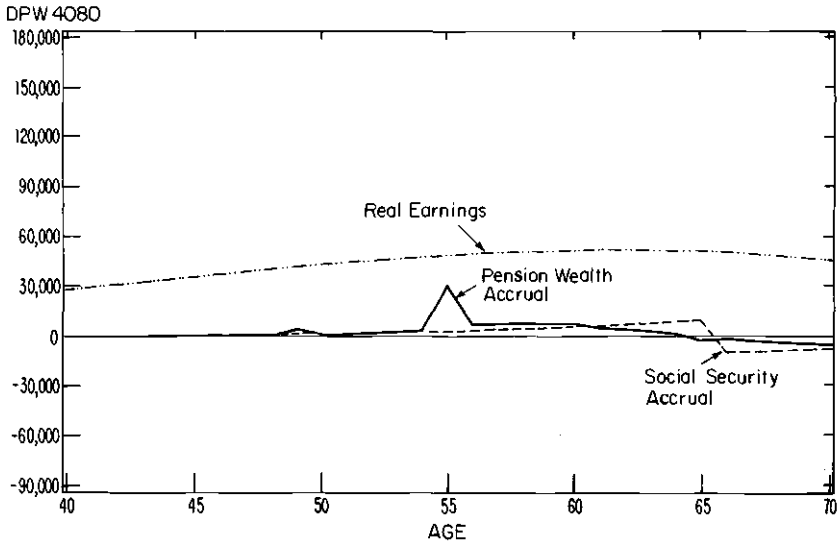

Fig. 10.3a Pension wealth accrual, SS accrual, and wage earnings for male managers born in 1940 and hired in 1980, in real 1985 dollars

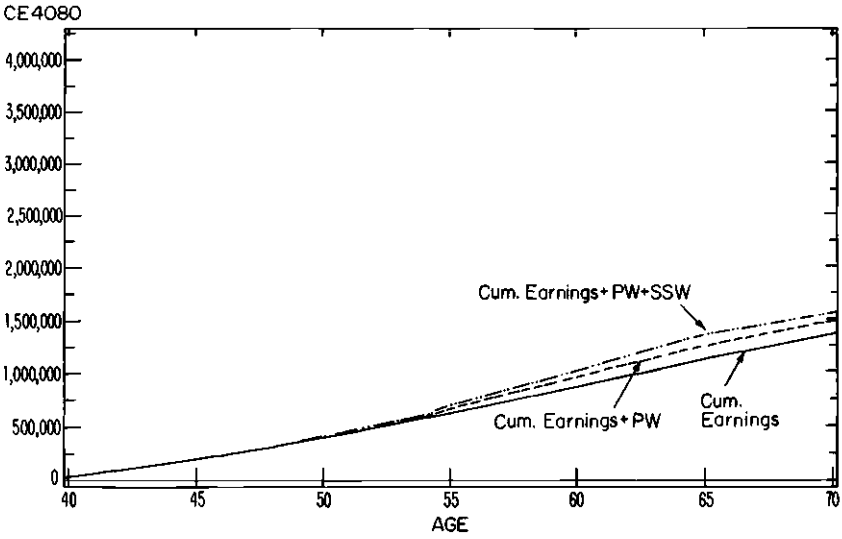

Fig. 10.3b Cumulated total income from employment versus year of retirement, male manager born in 1940 and hired in 1980

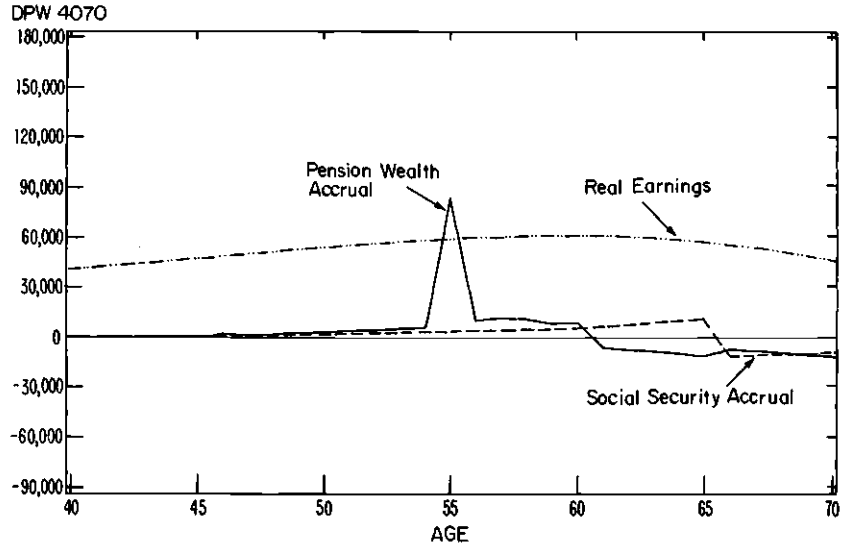

Fig. 10.4a Pension wealth accrual, SS accrual, and wage earnings for male managers born in 1940 and hired in 1970, in real 1985 dollars

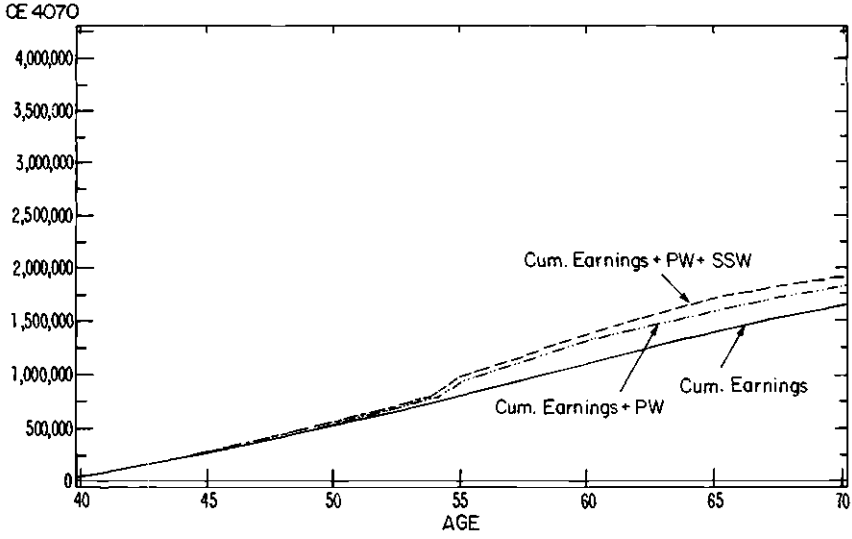

Fig. 10.4b Cumulated total income from employment versus year of retirement, male managers born in 1940 and hired in 1970

will become negative in a few years (see figs. 10.5a and 10.5b). Earnings for this group are declining as well. One might think that persons who are in this group and are still working would be likely to retire. But, if still working, they chose not to retire earlier, when compensation from continued work began to decline. They would have been eligible for early retirement at age 55 (in 1975), when they had been employed for 15 years.

At that time they would have faced earnings and pension accrual profiles like those shown in figures 10.6a and 10.6b. The group described in these graphs was born and hired 10 years later (in 1930 and 1970, respectively) and thus had 15 years of service at age 55 (in 1985), when pension accrual was at a maximum. Thereafter, accrual declines and becomes negative around age 65, after 25 years of service. That the group pictured in figure 10.5 did not retire earlier may suggest that their preferences are such that they are also not likely to retire in a given subsequent year either. They may want to work more than others and that may be why they did not retire when pension accrual and earnings started to decline. In addition, however, the group had not accumulated substantial pension wealth at any time, even before it began to decline, and thus they may always have been in a poor position to leave the labor force.

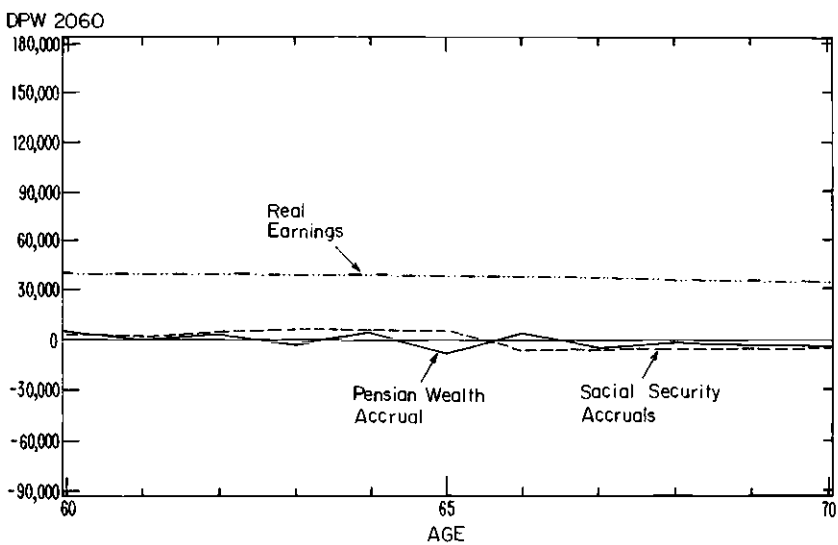

Fig. 10.5a Pension wealth accrual, SS accrual, and wage earnings for male managers born in 1920 and hired in 1960, in real 1985 dollars

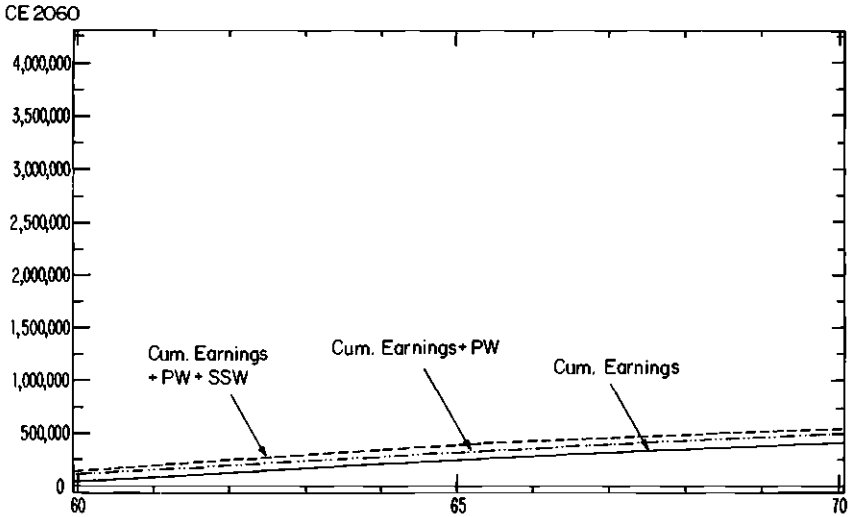

Fig. 10.5b Cumulated total income from employment versus year of retirement, male managers born in 1920 and hired in 1960

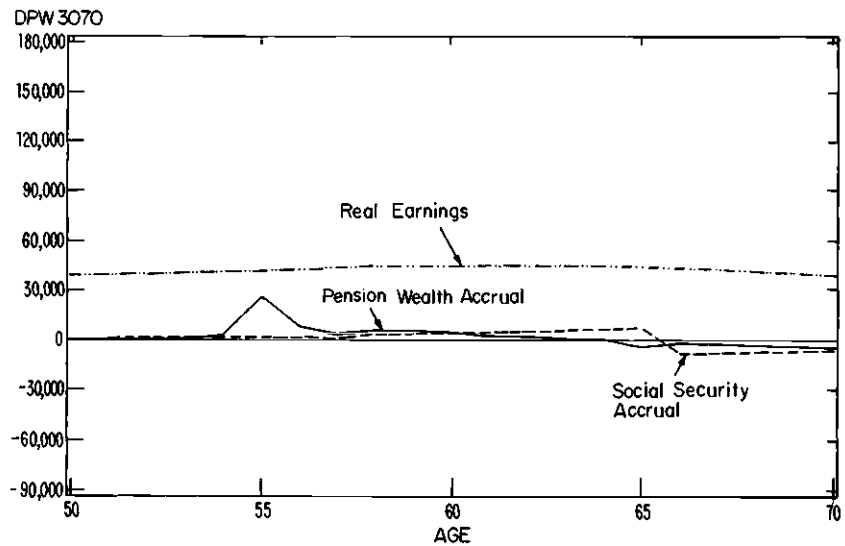

Fig. 10.6a Pension wealth accrual, SS accrual, and wage earnings for male managers born in 1930 and hired in 1970, in real 1985 dollars

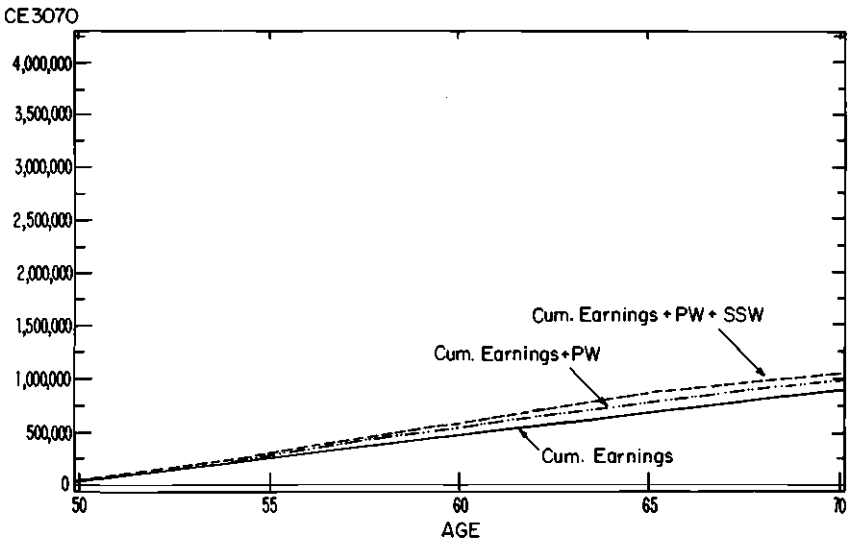

Fig. 10.6b Cumulated total income from employment versus year of retirement, male managers born in 1930 and hired in 1970

10.1.5 Variation by Employee Type

The pension accrual profiles for other employee groups look very much like those described above. Accrual is minimal during the first years of service. There is typically a discontinuous increase in pension wealth at age 55. And accrual typically becomes negative after 30 years of service, sometimes before that. Social Security accrual becomes negative after 65. The major differences among the groups stem from different age-earnings profiles. An illustration of the similarity and difference is provided by graphs like that in figure 10.2, but for different employee groups. These are shown in figures 10.7 through 10.11 for male managers, salesmen, saleswomen, male office workers, and female office workers, respectively. (The graphs for male managers are reproduced here for ease of comparison.) In each case the data pertain to persons born in 1960 and hired in 1980. Thus they all pertain to compensation over the life cycle for persons who remain in the firm. As is clear from the graphs, the accrual profiles are qualitatively similar; but there are some important differences.

First, managers earn more than the other employee groups. The wage earnings profiles also differ in shape. The peak earnings for managers occur at age 59. At age 66, if they still are in the labor force, 45 percent of their wage earnings are offset by negative pension and Social Security accrual. The earnings of salesmen peak much earlier, at age 50. At age 66, almost 95 percent of their wage earnings are offset by loss

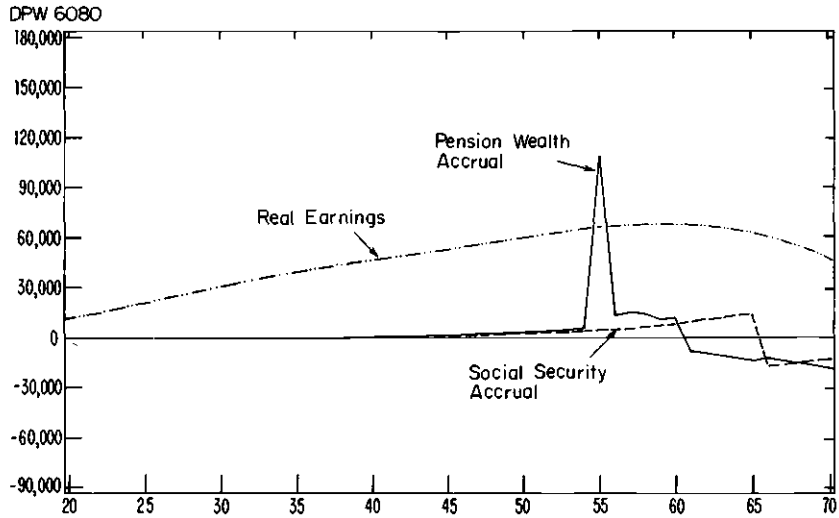

Fig. 10.7a Pension wealth accrual, SS accrual, and wage earnings for male managers born in 1960 and hired in 1980, in real 1985 dollars

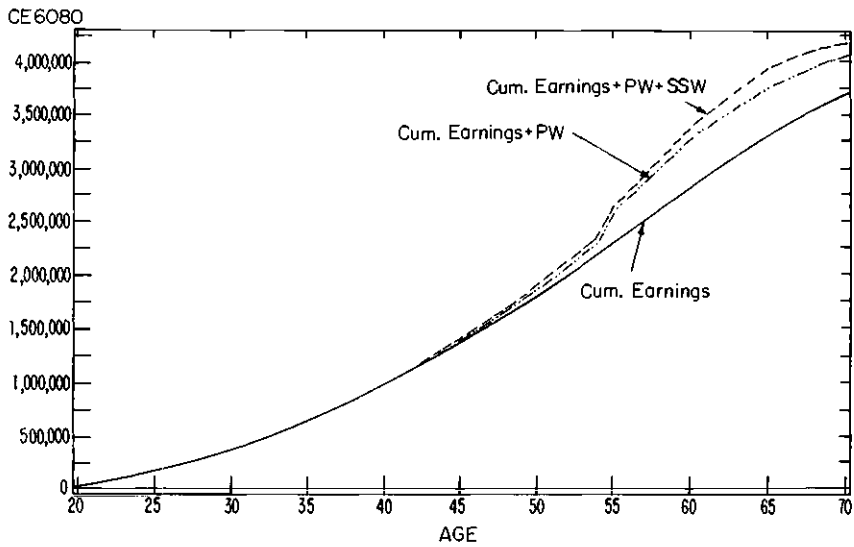

Fig. 10.7b Cumulated total income from employment versus year of retirement, male managers born in 1960 and hired in 1980

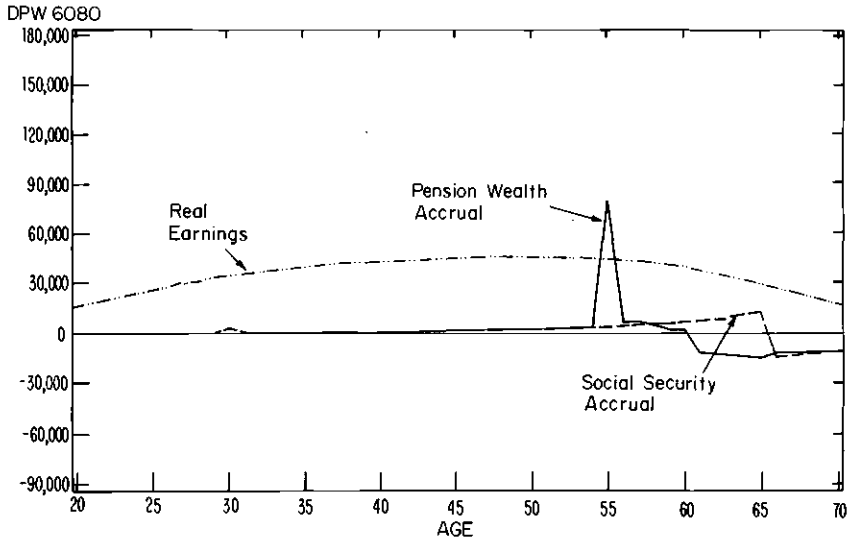

Fig. 10.8a Pension wealth accrual, SS accrual, and wage earnings for salesmen born in 1960 and hired in 1980, in real 1985 dollars

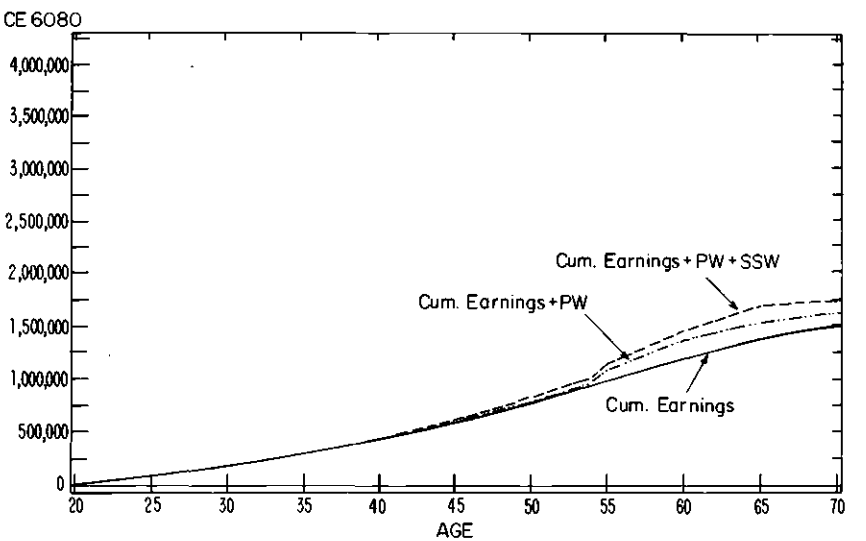

Fig. 10.8b Cumulated total income from employment versus year of retirement, salesmen born in 1960 and hired in 1980

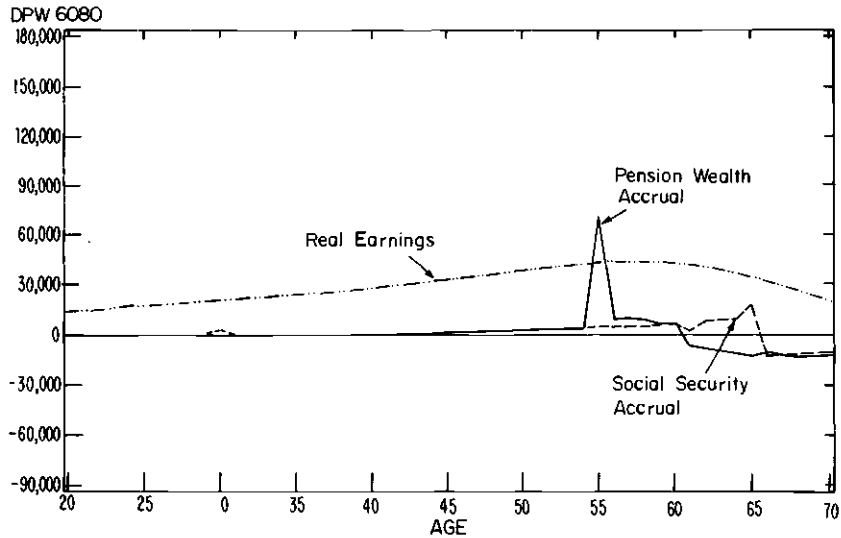

Fig. 10.9a Pension wealth accrual, SS accrual, and wage earnings for saleswomen born in 1960 and hired in 1980, in real 1985 dollars

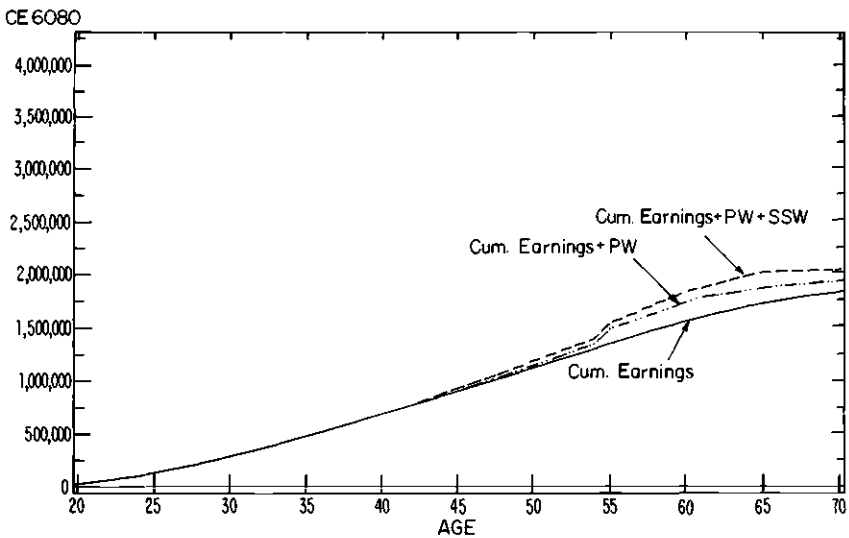

Fig. 10.9b Cumulated total income from employment versus year of retirement, saleswomen born in 1960 and hired in 1980

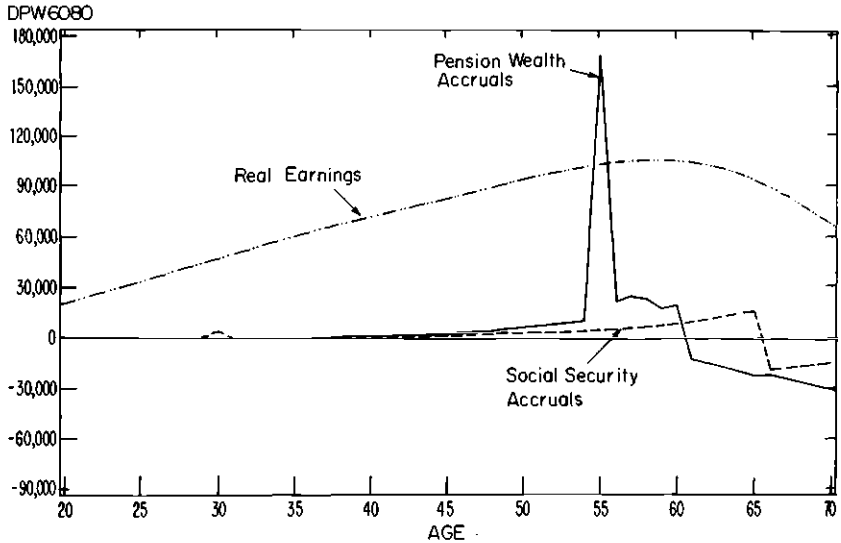

Fig. 10.10a Pension wealth accrual, SS accrual, and wage earnings for male office workers born in 1960 and hired in 1980, in real 1985 dollars

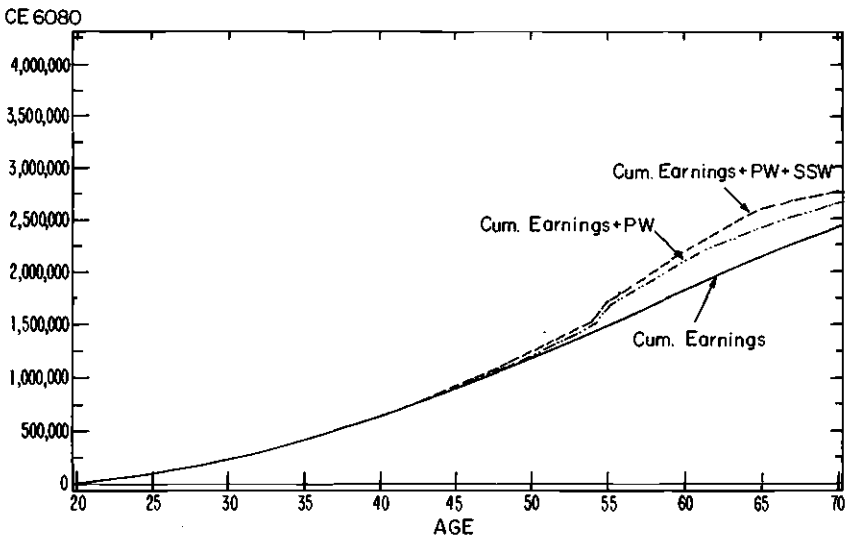

Fig. 10.10b Cumulated total income from employment versus year of retirement, male office workers born in 1960 and hired in 1980

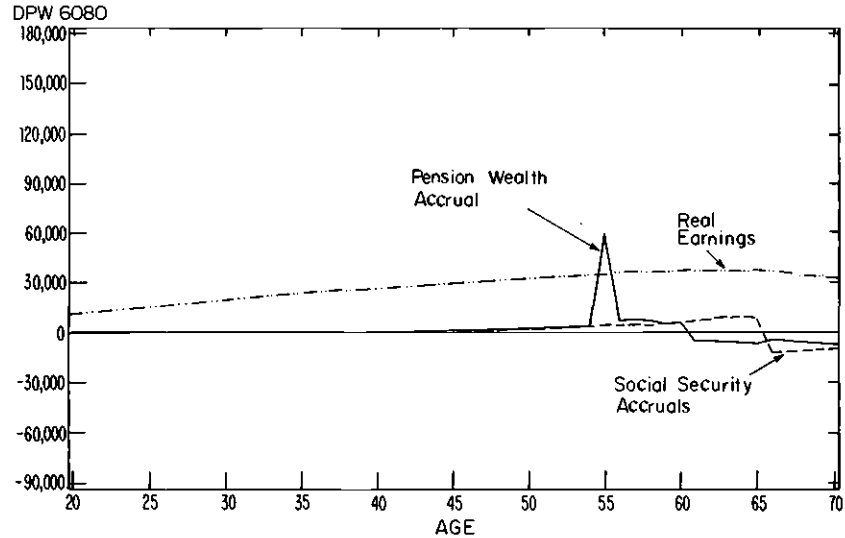

Fig. 10.11a Pension wealth accrual, SS accrual, and wage earnings for female office workers born in 1960 and hired in 1980, in real 1985 dollars

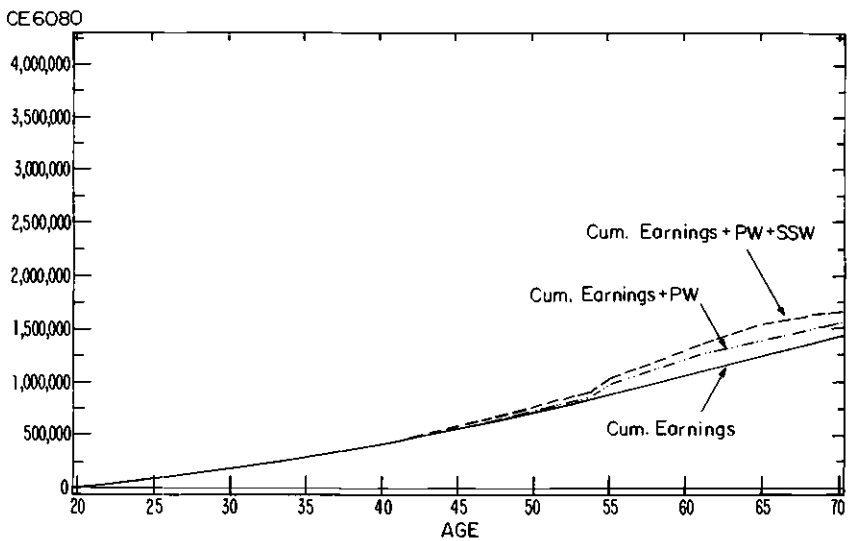

Fig. 10.11b Cumulated total income from employment versus retirement, female office workers born in 1960 and hired in 1980

in pension and Social Security wealth. Thus this effect creates a greater incentive for the salesmen than for the managers to retire after age 65.[4] The peak wage earnings for saleswomen occur at age 57; at 66 almost 75 percent of their wage earnings are offset by pension and Social Security wealth losses. The peak earnings for male and female office workers occur at ages 59 and 62, respectively. At age 66, 48 and 46 percent, respectively, of their earnings would be offset by loss in pension and Social Security wealth.[5]

The budget constraints for all groups show a discontinuous jump at age 55, but it seems most pronounced for managers. The budget constraint for salesmen is essentially flat after 65; their net compensation after 65 is virtually zero. The same is true for saleswomen. The net compensation of managers and male office workers is positive, but declining rapidly at age 65, and the budget constraints for these two groups become flatter after 65. The budget constraint nonlinearities seem to be the least pronounced for female office workers.

10.2 The Prediction of Earnings of the Firm's Workers

Data are available for each worker employed in the firm from the beginning of 1980 through the end of 1984. Most were in the firm in more than one year and many for all years. These years define the sample. Earnings for anyone in the sample are available beginning in 1969 if the person was employed then or beginning in the year that the person joined the firm if it was after 1969. Thus it is possible to follow the same person for up to 17 years. In particular, it is possible to estimate individual-specific earnings effects. By combining data for workers of different ages and with different years of service in the firm, it is possible to predict earnings. We use these predicted earnings in considering whether a person leaves the firm in a given sample year, like 1980. The probability of departure in a given year is related to how much the person would have earned during that year and on pension and Social Security accrual during that year. In future estimations, we will consider not only next year's earnings and pension and Social Security accrual, but also the effects of future earnings and pension and Social Security accrual.

Because earnings in the first and last years in the firm are likely to represent pay for only part of the year, they are excluded in the estimation of earnings. To be included, a person must have earnings data for at least three years. Workers with three years of data would have only one usable earnings observation. This group must be distinguished in the estimation procedure. Although persons with fewer than three years of earnings are not used in the estimation of earnings equations, they are included in the analysis of retirement discussed in section 10.3.

In this section the earnings estimation procedure is discussed first, then the results are presented. In addition to their use in the subsequent prediction of retirement, the earnings results are of considerable interest in their own right. It is rare to have access to earnings data for the same persons over such a long period. It is often claimed, for example, that real wage earnings decline late in a person's working life. We are able to determine with relative certainty whether this is true for this firm.

10.2.1 The Method

Earnings histories from 1969 are available for workers employed during the period 1980 through 1984. To explain the main features of the estimation procedure, figure 10.12 describes the earnings of two persons who are in the data set for seven years. The first person is age 40 to 46 over these seven years, and the second is age 45 to 51. (They could also have different years of service, but that is ignored in this example.) Earnings by age for the typical person in the firm are represented by the solid line in the middle of the graph. The first person has higher earnings than the average employee. His earnings exceed those of the typical person by an amount u_1, the individual-specific earnings effect for person 1. It may arise, for example, because this person works harder than the typical employee or because he has greater ability or more training. Earnings for person 1 fluctuate from year to year, however. The deviations with age from the central tendency of his earnings, indicated by the person 1 average, are indicated by n_{1t}, where t indicates the deviation in year t. Future earnings for person 1 must be estimated for our analysis. They are indicated by the dashed part of the line. They depend on u_1 and on the estimated re-

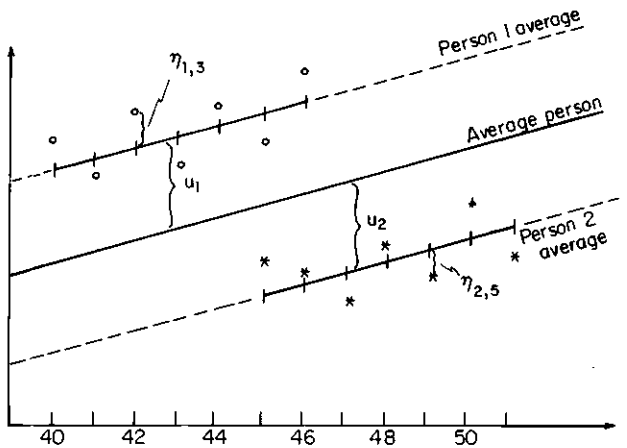

Fig. 10.12 Illustration of individual-specific earnings effects

lationship between age and earnings, which, aside from the individual-specific term, is assumed to be the same for individuals within a sex-occupation group. The earnings model is presented more formally in the following subsections.

Earnings Equation Specification

To simplify the presentation, we include only one right-hand variable, age. In practice, estimation is based on age and years of service. The exact specification is presented below. An earnings equation that captures the ideas discussed above is:

$$(4)\quad \ln E_{it} = \beta_0 + \beta_1 A_{it} + \beta_2 A_{it}^2 + \varepsilon_{it}$$

$$= \mu_{it} + \varepsilon_{it}.$$

$$\varepsilon_{it} = u_i + \eta_{it}.$$

$$\text{Var}(\varepsilon) = \text{Var}(u) + \text{Var}(\eta) = \sigma_\varepsilon^2,\ \text{Var}(u) = \sigma_u^2,\ \text{Var}(\eta) = \sigma_\eta^2.$$

$$\text{Cov}(u_i, \eta_{it}) = \text{Cov}(\eta_{it}, \eta_{it}) = 0.$$

$E \equiv$ Annual earnings,

$A \equiv$ Age,

$i \equiv$ Indexes individuals,

$t \equiv$ Indexes year (e.g., 1978, . . . , 1983),

$u_i \equiv$ Individual-specific earnings effect.

$$E_{it} = e^{\mu_{it}} e^{\varepsilon_{it}} = e^{\mu_{it}} e^{u_i} e^{\eta_{it}}.$$

$$E(E_{it} | \mu_{it}, u_i) = e^{\mu_{it}} e^{u_i} E(e^{\eta_{it}}) \doteq e^{\mu_{it}} e^{u_i} \left(1 + \frac{\sigma_\eta^2}{2}\right).$$

The last approximation is a reminder that because of the nonlinear relationship between earnings and age, the expected value of $\exp(\eta_{it})$ is not equal to 1, even though the expected value of η_{it} is 0.

In addition to the parameters β, the variances of u and η are also of interest. The first indicates the systematic earnings variation across individuals due to individual-specific effects. The second is a measure of the extent of nonsystematic variation. The method of estimation used here does not allow for the possibility that the individual-specific terms u may be correlated with age. For example, it may be that persons whose earnings are higher, because of the attributes u, are more likely to continue working at older ages. We did obtain such estimates using a differencing procedure. But for our purposes the procedure has two important shortcomings: First, it means that certain age and service

parameters are not identified. Second, it imposes the rate of salary increase by age that existed over the period of the data, because this relationship depends only on changes in earnings over the period of the data. (The method we use allows the effect of age to be determined in part by comparison of the earnings of workers with very different ages.) This increase is apparently low relative to longer term increases and, hence, may imply expected future increases with age and service that are too low. We also discovered that individual-specific terms based on the method that we have used are not correlated with firm departure rates.

Estimation Method

Estimation of equation (4) yields residuals

$$e_{it} = \ln E_{it} - \hat{\beta}_0 - \hat{\beta}_1 A_{it} - \hat{\beta}_2 A_{it}^2. \tag{5}$$

The estimated variance of e is given by

$$\hat{\sigma}_e^2 = \frac{\sum_{i,t} e_{it}^2}{\sum_i n_i - k}, \tag{6}$$

where n_i is the number of observations for person i, and k is the number of parameters (three in this example). To obtain estimates of additional parameters of interest we need to distinguish persons with more than one observation from those with only one.

Using Persons with $n_i > 1$. From the residuals for person i, the individual-specific effect for i is calculated by

$$\hat{u}_i = \frac{\sum_t e_{it}}{n_i}. \tag{7}$$

The variances of η and u are then given, respectively, by

$$\hat{\sigma}_\eta^2 = \frac{\sum_{i,t} (e_{it} - \hat{u}_i)^2}{\sum_i n_i - k - I}, \text{ and} \tag{8}$$

$$\text{Var}(u) = \text{Var}(e) - \text{Var}(n), \tag{9}$$

where I is the number of persons in the sample (in this instance those with $n_i \geq 2$), and

$$\hat{\eta}_{it} = e_{it} - \hat{u}_i. \tag{10}$$

For Persons with $n_i = 1$. If a person has only one observation, we cannot distinguish η_{it} from u_i, since we do not observe any variation

around an average. First note that if u and η are normally distributed, and thus ε is also, then

$$E(u|E) = E(u) + \rho_{u,\varepsilon} \frac{\sigma_u}{\sigma^\varepsilon} [\varepsilon - E(\varepsilon)]$$

$$= 0 + \rho_{u,\varepsilon} \frac{\sigma_u}{\sigma_\varepsilon} (\varepsilon - 0)$$

$$= \rho_{u,\varepsilon} \frac{\sigma_u}{\sigma_\varepsilon},$$

$$\text{Cov}(u,\varepsilon) = E[u(u + \eta)] = \sigma_u^2,$$

$$\rho_{u,\varepsilon} = \frac{\text{Cov}(u,\varepsilon)}{\sqrt{\text{Var}(u)} \cdot \sqrt{\text{Var}(\varepsilon)}} = \frac{\sigma_u^2}{\sigma_u \sqrt{\sigma_u^2 + \sigma_\eta^2}} = \frac{\sigma_u}{\sigma_\varepsilon},$$

$$\rho_{u,\varepsilon} \cdot \frac{\sigma_u}{\sigma_\varepsilon} = \frac{\sigma_u^2}{\sigma_\varepsilon^2},$$

where ρ is a correlation coefficient. Thus,

$$E(u_i|\varepsilon_{it}) = \frac{\sigma_u^2}{\sigma_\varepsilon^2} \varepsilon_{it} = \frac{\sigma_\varepsilon^2 - \sigma_\eta^2}{\sigma_\varepsilon^2} \cdot \varepsilon_{it}.$$

If σ_η^2 were 0 and we observed ε_{it}, we would assume it represented entirely an individual-specific effect u_i. If σ_u^2 were 0, we would assume the ε_{it} were equal to the random term η_{it}, and that there was no individual effect u_i. Letting e_{it} be the sample analog of ε_{it} and using the estimates in equations (2) and (4) for σ_ε^2 and σ_η^2, respectively, u_i for persons with only one observation is estimated by

$$\hat{u}_i = \frac{\hat{\sigma}_\varepsilon^2 - \hat{\sigma}_\eta^2}{\hat{\sigma}_\varepsilon^2} e_{it}, \tag{11}$$

and η_{it} by

$$\hat{\eta}_{it} = e_{it} - \hat{u}_i.$$

Predicted Earnings. For an estimation of the likelihood that a person will retire in the next year, we need to use predicted earnings in that year. For future analysis we will need to predict earnings in subsequent years as well. The predictions are given by:

$$\hat{E}_{it} = e^{\hat{\mu}_{it}} e^{\hat{u}_i} E(e^{\eta_{it}}) = e^{\hat{\mu}_{it} + \hat{u}_i} (1 + \hat{\sigma}_\eta^2/2), \qquad \text{for } n_i \geq 2. \tag{12}$$

$$\hat{E}_{it} = e^{\hat{\mu}_{it}} e^{\hat{u}_i} E(e^{\eta_{it}}) = e^{\hat{\mu}_{it} + \hat{u}_i} (1 + \hat{\sigma}_\eta^2/2), \qquad \text{for } n_i \geq 1.$$

For out-of-sample estimates, $\hat{\mu}_{it}$ would be predicted from future age, for example.[6]

The Estimated Components of Earnings. To consider how much earnings deviate from what might be predicted for that person, or from what that person himself might predict, it is useful to divide earnings into expected and unexpected components. We do that by defining

$$\ln E_{it} \equiv \hat{\mu}_{it} + \hat{u}_i + \hat{\eta}_{it} \,. \tag{13}$$

$\hat{\mu}_{it} + \hat{u}_i \equiv$ "permanent" or "expected" component.

$\hat{\eta}_{it} \equiv$ "transitory" or "unexpected" component.

These definitions do not necessarily correspond to usual definitions of permanent versus transitory income, so the expected versus unexpected terminology may be better. In levels, the two components are given by

$$\begin{aligned} E_{it} &\equiv e^{\hat{\mu}_{it}+\hat{u}_i} \cdot e^{\hat{\eta}_{it}} \\ &= e^{\hat{\mu}_{it}+\hat{u}_i} + e^{\hat{\mu}_{it}+u_i}(e^{\hat{\eta}_{it}} - 1) \\ &= \begin{matrix}\text{permanent} \\ \text{component}\end{matrix} + \begin{matrix}\text{transitory} \\ \text{component}\end{matrix}. \end{aligned} \tag{14}$$

A More Detailed Specification of the Earnings Function

Earnings were predicted using the following variables:

Age
Age Squared
Age Squared times Service
Service
Service Squared
Service Squared times Age
Age times Service
Age Squared times Service Squared
Calendar Year Variables for 1969, . . . , 1979 and 1981, . . . , 1983.

The calendar year variables pick up changes in real earnings over time. Each of the year estimates is relative to the 1980 base.

Earnings Function Estimates

The estimated earnings function parameters are shown in table 10.9. The implications of the estimates are shown in figures 10.13a through 10.13e, distinguished by employee group. Figure 10.13a, for example, shows earnings profiles for managers by age of hire in 1980, where the nine profiles on the graph pertain to persons hired at successively older ages—from 20 to 60 in five-year intervals. Earnings are calculated through age 70 for each cohort. First, it is clear that, for any age, earnings increase substantially with years of service. Earnings at the

Table 10.9 Earnings Parameter Estimates by Employee Group (1980 $)[a]

Variable	Employee Group				
	Managers	Salesmen	Saleswomen	Male Office Workers	Female Office Workers
Constant	9.28	8.87	8.65	6.80	8.39
	(122.2)	(303.6)	(77.0)	(210.9)	(826.6)
A	0.021	0.037	0.042	0.16	0.45
	(4.8)	(23.5)	(7.0)	(83.3)	(71.6)
A^2	−.000082	−0.00041	−0.00051	−0.0019	−0.00057
	(−1.4)	(−20.7)	(−6.5)	(−77.2)	(−66.3)
$A^2 \cdot S$	0.000021	0.000064	−0.000047	0.000044	0.000029
	(3.0)	(19.7)	(−2.0)	(12.9)	(20.1)
S	0.18	0.20	−0.036	0.10	0.10
	(14.0)	(31.5)	(−0.9)	(17.5)	(48.7)
S^2	−0.01	−0.0044	−0.0086	−0.0060	−0.0031
	(−7.8)	(−11.5)	(−2.9)	(−19.8)	(−24.4)
$S^2 \cdot A$	0.00020	0.00017	0.00023	0.00018	0.00010
	(7.5)	(11.9)	(1.8)	(16.7)	(21.5)
$A \cdot S$	−0.0043	−0.0068	0.0040	−0.0033	−0.0030
	(−7.1)	(−23.8)	(2.0)	(−11.5)	(−26.3)
$A^2 \cdot S^2$	−0.0000016	−0.0000017	−0.0000016	−0.0000016	−9.035
	(−6.5)	(−12.7)	(−1.2)	(−15.7)	(−19.5)
1969	0.11	0.15	−0.027	0.031	0.039
	(9.4)	(31.4)	(−0.6)	(3.8)	(11.2)
1970	0.16	0.19	−0.014	0.063	0.058
	(14.1)	(38.8)	(−0.3)	(7.8)	(17.5)
1971	0.19	0.19	0.0036	0.062	0.036
	(17.2)	(39.6)	(0.1)	(8.0)	(11.5)
1972	0.21	0.21	−0.012	0.088	0.065
	(19.1)	(45.6)	(−0.3)	(11.6)	(21.3)
1973	0.21	0.21	0.0027	0.094	0.076
	(19.3)	(46.3)	(0.1)	(12.8)	(25.7)
1974	0.16	0.20	−0.0074	0.079	0.069
	(15.2)	(44.3)	(−0.2)	(11.0)	(24.6)
1975	0.10	0.14	−0.012	0.071	0.049
	(9.7)	(31.6)	(−0.4)	(10.2)	(18.0)
1976	0.15	0.16	0.042	0.12	0.11
	(14.2)	(36.0)	(1.6)	(17.5)	(41.1)
1977	0.14	0.16	0.094	0.10	0.084
	(13.6)	(36.1)	(4.2)	(15.4)	(33.6)
1978	0.18	0.18	0.13	0.09	0.078
	(17.7)	(41.9)	(6.7)	(14.3)	(32.3)
1979	0.13	0.10	0.064	0.058	0.044
	(13.5)	(24.6)	(3.7)	(9.0)	(18.8)
1980	—	—	—	—	—
1981	0.03	0.0091	0.025	0.021	0.013
	(3.0)	(2.1)	(1.5)	(3.3)	(5.6)
1982	−0.0086	−0.077	−0.033	0.033	0.012
	(−0.9)	(−18.0)	(−2.1)	(5.1)	(5.1)

(*continued*)

Table 10.9 (continued)

Variable	Employee Group				
	Managers	Salesmen	Saleswomen	Male Office Workers	Female Office Workers
1983	0.0028	−0.099	−0.041	0.073	0.066
	(−0.3)	(−23.0)	(−2.6)	(11.3)	(28.4)
1984	0.068	−0.11	−0.050	0.0078	0.032
	(7.0)	(−25.2)	(−3.3)	(1.2)	(13.8)
σ_ε^2	0.135	0.155	0.163	0.168	0.065
σ_u^2	0.083	0.140	0.110	0.150	0.06
σ_η^2	0.52	0.015	0.053	0.018	0.005

[a] t-statistics are in parentheses.

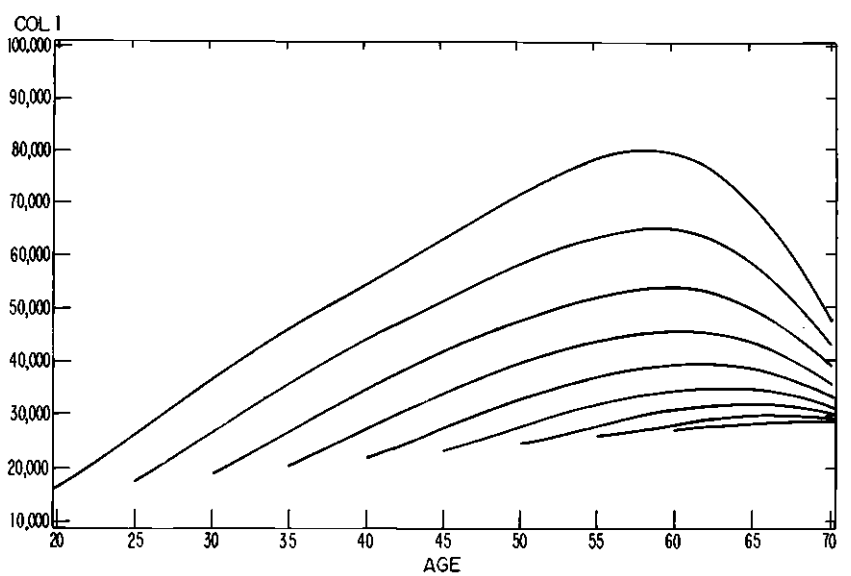

Fig. 10.13a Age-earnings profiles for persons hired in 1980, by age when hired, male managers

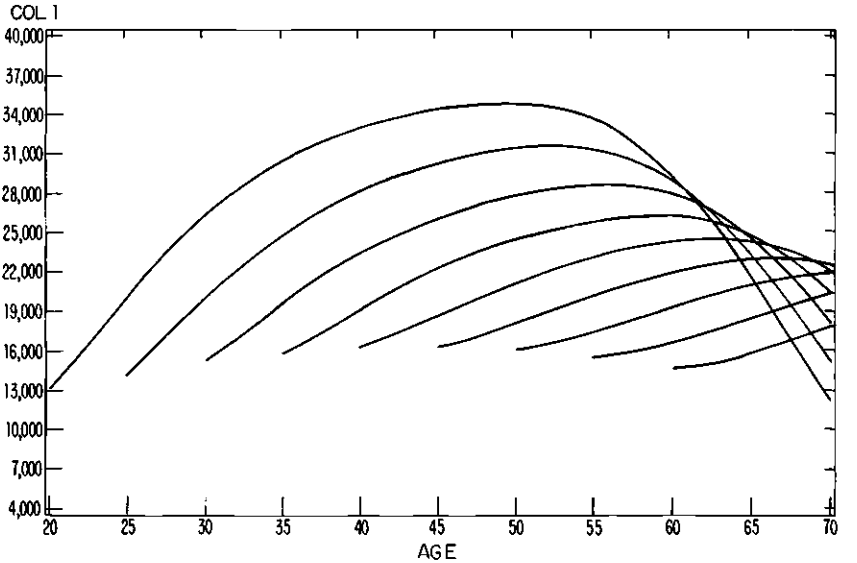

Fig. 10.13b Age-earnings profiles for persons hired in 1980, by age when hired, salesmen

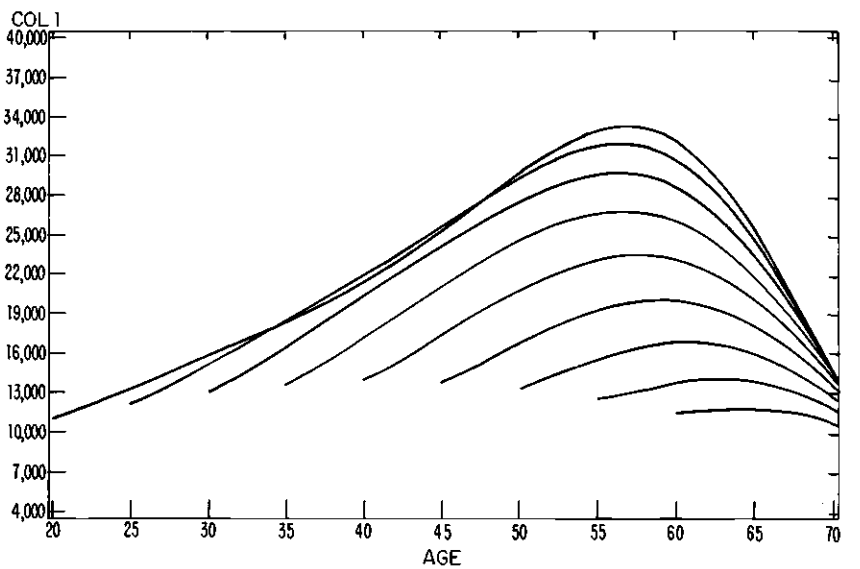

Fig. 10.13c Age-earnings profiles for persons hired in 1980, by age when hired, saleswomen

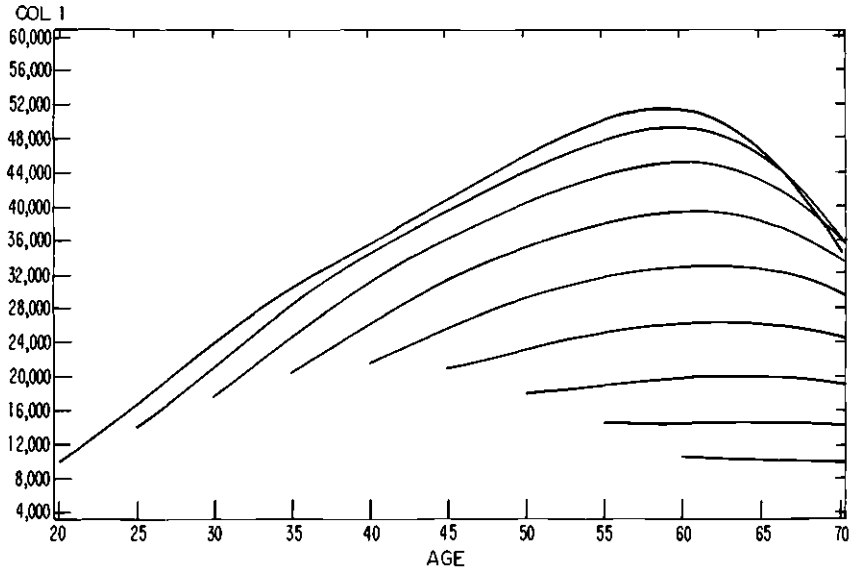

Fig. 10.13d Age-earnings profiles for persons hired in 1980, by age when hired, male office workers

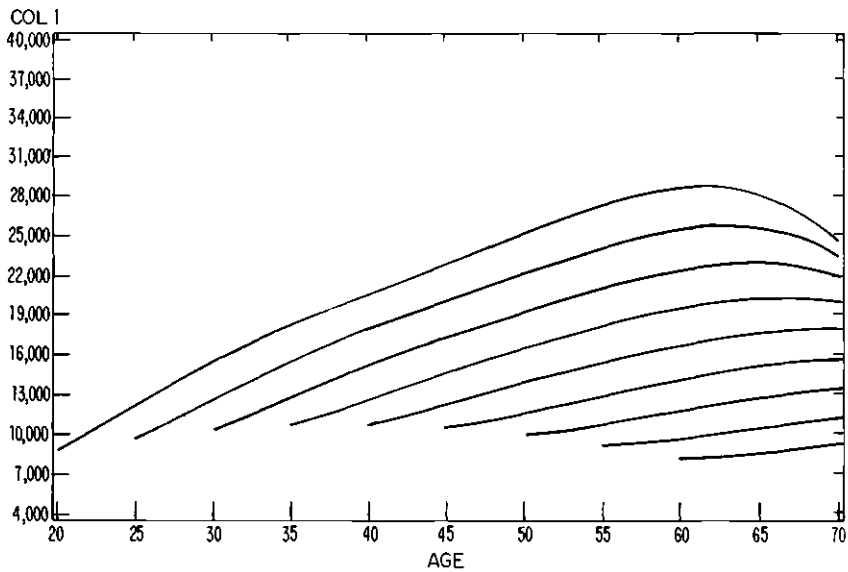

Fig. 10.13e Age-earnings profiles for persons hired in 1980, by age when hired, female office workers

time of hire increase with age, but the bulk of the difference in earnings is accounted for by years of service in the firm. For example, persons who are 55 and just hired earn much less than those who are 55, but have been working for the firm since age 20. Finally, the decline in earnings for older workers is much greater for long-term employees than for those who have been hired recently.

Similar patterns apply to other employee groups, but with some significant variations. The earnings of male office workers at the time of hire vary greatly by age, increasing and then declining rapidly (fig. 10.13d). The importance of these profiles for our work is that future expected earnings depend in an important way on the age and years of service of an employee, and on the employee group.

In our prediction of earnings beyond 1984, we use the 1984 year dummy and add a 1.5 percent real wage growth factor; that is, the predicted earnings for year t is the predicted earnings for 1984 times $(1.5)(t - 1984)$.

10.3 The Relationship between Retirement, Age, and Years of Service

In this section, the relationship of retirement to age and years of service is described. The intention is to consider the extent to which retirement behavior is consistent, by economic reasoning, with the budget constraints described in section 10.2. To do this, we consider in detail empirical hazard rates by age and years of service. These results will serve as a guide to future development and estimation of more formal models of retirement. They are the empirical regularities with which the models must be consistent. This extensive descriptive analysis supports several initial conclusions:

- The favorable early retirement benefits have a very strong effect on departures from the firm, increasing departure rates between ages 55 and 60 by possibly as much as 30 percentage points (e.g., from 14 to 44 percent).
- The loss in compensation due to negative pension accrual for many employees after age 60 and negative Social Security accrual after age 65 apparently also induces departure; only 58 percent of those employed at age 54 remain through age 59, and only 21 percent of those employed at 59 remain through 64. About half of the few remaining at 65 retire at that age.
- The special early retirement incentive offered in one year increased departure rates very substantially.

10.3.1 Empirical Hazard Rates

Hazard rates by age and years of service are shown for all employees combined in table 10.10. The yearly hazard rate is the proportion of

Table 10.10 **Empirical Hazard Rates, by Age and Years of Service, All Employee Groups (percent)**

	Years of Service													
Age	≤5	6–9	10	11–15	16–20	21–23	24	25	26	27	28	29	30	31+
40	15	8	5	7	4	3	0							
41	14	9	5	7	5	5	3	5						
42	14	10	8	8	4	2	2	2	0	0				
43	15	7	6	5	4	4	4	3	2	0	0	0		
44	13	8	5	7	3	2	3	1	1	1	0	0	0	
45	11	7	5	6	6	4	3	1	4	2	3	5	0	0.5
46	12	9	3	5	3	4	4	1	0	5	2	2	0	0
47	14	8	8	5	4	3	3	4	4	4	0	4	2	0
48	12	7	5	6	4	4	2	5	1	2	4	2	3	2
49	14	9	4	7	4	3	5	1	1	1	1	2	0	0
50	14	8	4	6	4	3	3	2	2	1	1	3	2	3
51	14	9	3	5	3	3	5	2	3	4	2	2	2	5
52	11	7	5	6	4	4	2	4	2	4	1	3	6	6
53	12	7	4	7	4	3	3	3	3	2	3	3	3	3
54	11	7	4	6	4	2	4	2	2	3	1	0	1	3
55	9	5	4	11	9	11	13	10	13	11	12	7	9	9
56	11	6	6	12	11	12	7	8	11	11	12	16	14	12
57	12	10	1	11	8	9	10	8	9	9	3	14	11	11
58	13	10	2	8	8	12	13	11	15	15	9	10	13	12
59	7	10	2	17	8	11	17	14	14	14	9	10	12	15
60	9	9	3	15	12	19	16	17	20	16	20	15	19	26
61	9	7	2	16	17	15	19	12	25	16	23	21	24	30
62	11	15	7	27	34	37	34	33	38	40	42	34	30	41
63	14	18	4	33	35	37	43	35	43	41	62	33	47	40
64	5	8	3	36	33	34	18	32	26	27	42	53	41	34
65	12	35	45	57	52	54	44	55	57	70	50	54	69	59
66	26	17	25	16	16	43	50	16	20	25	38	33	9	24
67	13	28	18	32	17	29	0	14	21	0	13	33	50	21
68	13	50	50	15	25	11	0	50	0	29	0	0	0	12

those employed at the beginning of the year that retires—strictly speaking, leaves the firm—during the forthcoming year. Several aspects of the data stand out. There is substantial turnover in the first 9 years of employment, especially during the first 5 years. On average, about 15 percent of those employed 5 years or less leave in a given year. The table shows rates only for employees 40 and older. The departure rates are somewhat higher for younger workers, 16 or 17 percent for those employed 5 years or less and 10 to 12 percent for those employed 6 to 9 years. There is a sharp decline in departure rates at 10 years of service, when employees are about to become vested in the pension plan. Before the early retirement age, 55, the typical decline is from 8 or 9 to 4 or 5 percent. After 55, when vesting carries with it eligibility for early retirement, it is much sharper, often from 10 percent or more to 3 percent or less.

The availability of early retirement benefits at 55 apparently has a substantial effect on retirement. Before 55 departure rates are typically around 2 percent. At 55, they jump to 10 percent or more. It is important to notice that the departure rates stay at that level until age 60, when there is another jump in the rate of departure. The jump at 60 corresponds to the age at which pension accrual becomes negative for many employees. (For those with 25 or more years of service, benefits increase at a smaller percent per year. After age 60 with 30 years of service, there is no early retirement reduction; full retirement benefits are available.)

To understand the potential importance of the early retirement benefits, suppose that if it were not for this inducement, the departure rates would remain at 3 percent until age 60 instead of the 10 or 12 percent rates that are observed. (Notice that the departure rates for employees aged 55 to 61 who are in their tenth year of service—not yet vested and hence not eligible for early retirement benefits—are also 2 or 3 percent on average.) Departure at 3 percent per year would mean that 14 percent of those who were employed at 55 would have left before age 60. At a departure rate of 11 percent per year, 44 percent would leave between 55 and 59. Such a difference, even if only for a small proportion of all firms, can have a very substantial effect on aggregate labor force participation rates. It is in part the dramatic fall in labor force participation rates for the older population that has motivated research such as ours.

The jump in departure rates at 60, especially noticeable for persons with 25 or more years of service, has just been mentioned above. There is another sharp increase in departure rates at 62 when Social Security benefits are first available. (There is no sharp kink in the budget constraint at this age because of the actuarially fair increase in Social Security benefits if their receipt is postponed until age 65.) The increase

at 62 is also noticeable for employees with less than 10 years of service and not yet vested in the firm pension plan. They can take Social Security benefits, of course.

Finally, there is a very sharp increase in the departure rate at age 65. At this age the loss in Social Security benefits with continued work induces a kink in the budget constraint. As described above, the budget constraint for many workers becomes essentially flat at this age, due to negative pension accruals and falling wage earnings, as well as the loss in Social Security wealth. The fall in wage earnings and pension wealth typically begins at an earlier age, as emphasized above. It is important to keep in mind that the large departure rates before 65 mean that most employees have left well before that age. Thus high departure rates at 65 indicate only that a large proportion of the few that continue work until 65 retire then. The cumulative hazard rates below highlight this point.

A more compact version of table 10.10 is shown in table 10.11 for salesmen. About 40.7 percent of employees are salesmen and women, about 56.2 percent are office workers, and only 3.1 percent are managers. Thus, for purposes of comparison, it is best to have in mind the accrual and budget constraint graphs for sales and office workers. These results confirm the findings for all employees discussed above. They may be summarized briefly:

Table 10.11 **Hazard Rates for Salesmen by Age and Years of Service**

	Years of Service						
Age	<10	11–15	16–20	21–25	26–30	—	—
<50	19	9	5	4	3	—	—
50–54	14	7	4	3	3	2	0
		—	—	—	—	—	
55	11	14	9	11	12	15	—
56–59	14	13	9	11	11	14	—
		—	—	—	—	—	
60	11	12	14	19	14	29	35
61	13	12	13	13	19	32	28
		—	—	—	—	—	
62	12	27	32	38	36	52	35
63	20	28	33	36	47	48	56
64	0	37	36	30	36	38	28
		—	—	—	—	—	
65	34	56	51	50	49	47	43
		—	—	—	—	—	
66	17	28	10	34	18	16	12
67	20	16	25	21	8	5	18

- There is a large increase in the departure rates at the early retirement age of 55, but only for vested employees, those with at least 10 years of service. For employees with 16 or more years of service, the jump in departure rates increases very noticeably with age.
- The departure rates remain at these higher rates through age 59.
- At age 60, the departure rates increase very precipitously for persons with 30 or more years of service, for whom full benefits are available; there is no longer an early retirement reduction and subsequent pension accrual is negative.
- When Social Security benefits become available at 62, the departure rates increase very sharply, but apparently only for those who are vested in the firm plan, contrary to the results for all employees taken together.
- Finally, there is a large increase in departure rates at 65, after which Social Security accrual rates become strongly negative.

Cumulative hazard rates for all employees are shown in table 10.12 for three years, together with the rates by age. The cumulative rates are actually one minus the percent who have departed. These departure rates were obtained by calculating hazard rates over the next four years separately for persons who were age 50 in 1980, age 51 in 1980, . . . , and age 63 in 1980. Those who were age 50 in 1980 were 51 in 1981, 52 in 1983, etc. Thus these calculations yield hazard rates in different years for employees of the same age. In particular, given employment at age 50, the cumulative rates show the percent still employed at older ages. (The cumulative rates for those aged 50 are all based on the 1980 departure rate of 0.031. The rates for those aged 51 are all based on the 1981 rate of 0.033. The 1983 rate for those aged 52 is based on the 1982 rate. The rate for those who were 65 in 1981 is based on the 1983 rate.)

Note first that departure rates of employees who have been in the firm for only 8 to 10 years, and are not yet vested, are very low at every age, as emphasized above. And again, the increase in the departure rates at 55, 60, 62, and 65 stands out. Based on the 1981 and 1982 departure rates, only 48 percent of those employed at 50 would still be employed at 60, and then 17 percent of these would leave. Only 10 percent would remain until age 65 and then about 50 percent of these would leave.

The data also show the effect of a special early retirement incentive that was in effect in 1982 only. The incentive program provided a bonus to employees who were eligible for early retirement in 1982; that is, those who were vested and were 55 years old or older. The bonus was equivalent to three months salary for 55-year-old employees and increased to 12 months salary for 60 year olds. At age 65, the bonus was

Table 10.12 **Cumulative and Yearly Hazard Rates by Calendar Year, Years of Service (YOS), and Age**

	Yearly Hazards						
	8–10 YOS	11+ YOS			11+ YOS		
Age	1980	1981	1982	1983	1981	1982	1983
50	7	3			97	97	97
51	9	3			94	94	94
52	3	5	5	5	89	89	89
53	0	4	4	4	85	86	86
54	4	3	4	2	83	83	84
		—	—	—	—	—	—
55	5	11	12	10	74	73	75
56	4	12	14	10	66	63	68
57	2	9	12	11	60	56	61
58	5	10	14	12	54	48	54
59	2	11	20	10	48	38	48
		—	—	—	—	—	
60	4	17	29	17	40	27	40
61	0	17	32	18	33	18	33
		—	—	—	—	—	—
62	8	36	48	31	21	10	23
63	14	37	54	37	13	5	14
64	11	29	49	26	10	2	11
		—	—	—	—	—	—
65	25	53	58	45	5	1	6

12 months salary for employees with 20 or fewer years of service and declined to 6 months salary for those with 30 to 39 years of service.

It is clear that the effect of the incentive was large. The departure rates for 1981 and for 1983 are virtually identical. But the rates were much higher in 1982. For example, the departure rate for 60 year olds was 17 percent in 1981 and in 1983, but 29 percent in 1982. For those age 63, the departure rate was 37 percent in 1981 and in 1983, but 54 percent in 1982. Of those employed at age 50, 40 percent would still have been employed after age 60 based on the 1981 and 1983 departure rates. Only 27 percent would remain after age 60 based on the 1982 rates.[7]

Even under the normal plan, only 10 percent of those employed at age 50 would still be employed at 65. Only 1 percent would remain until 65 with the special incentive.

10.4 Summary and Conclusions

The provisions of the pension plan in a large corporation have been described in detail. The implications of the provisions are described

by pension accrual profiles. The pension accrual profiles are set forth together with standard age-earnings profiles and Social Security accrual profiles in the form of lifetime budget constraints. The plan provides very strong incentives to retire beginning at age 55. After age 65, negative pension accruals and negative Social Security accruals effectively impose almost a 100 percent tax rate on wage earnings for many employees of the firm.

Departure rates from the firm have been compared with economic incentives inherent in the plan provisions. It is clear from this descriptive analysis that the inducements in the plan provisions to retire early have had a very substantial effect on departure rates from the firm. Indeed over 50 percent of those employed by the firm at age 50 leave before 60 and 90 percent before age 65. The jumps in departure rates at specific ages coincide precisely with the discontinuities and kink points in the worker compensation profiles that result from the pension plan provisions together with wage earnings profiles and Social Security accrual.

A great deal of effort has been devoted to estimating the effect of Social Security provisions on labor force participation. In particular, Hausman and Wise (1985), Burtless (1986), and Hurd and Boskin (1984) have attempted to estimate the effect on labor force participation of the increases in Social Security benefits during the early 1970s. It would appear from the results here that the effects of these across-the-board increases in Social Security benefits are likely to be small relative to the effects of the private pension provisions. For example, it seems clear that shifting the age of early retirement from 55 to 60 would have a very dramatic effect on departure rates. Leaving the early retirement age at 55 but eliminating negative pension and Social Security accruals thereafter would apparently also have a substantial effect on retirement rates. Precise estimates of the effects of such changes will be made in future work.

Notes

1. See Kotlikoff and Wise (1985, 1987).

2. The decline in this firm at age 65 is likely to be mild compared to that in many other firms in which the fall in pension accrual at age 65 is much greater than it is here. See Kotlikoff and Wise (1985, 1987).

3. For more algebraic detail on the calculation of pension wealth, see Kotlikoff and Wise (1985).

4. Managerial compensation is primarily in the form of salary, whereas the compensation of salespeople is in the form of commissions to a large extent. They may be more like self-employed or piece-rate workers. In particular, their earnings may be determined to a large extent by the number of hours that they

choose to work. This may also affect the relationship between compensation and retirement. Firm officials inform us, however, that most salespeople work only for the firm. To the extent that the number of hours that they work do not decline substantially with the wage, these graphs may reflect age-productivity profiles.

5. There should be no presumption that men and women classified by us as office workers are performing the same jobs. The classification does not assure that.

6. Simulated actual future earnings could be obtained by taking a random draw $\tilde{\eta}_{it}$ from the estimate distribution of η, $N(O, \hat{\sigma}_{\eta}^2)$, for each future year and using $E_{it} = e^{\hat{\mu}_{it} + \hat{a}_i} e^{\tilde{\eta}_{it}}$. If E_{it} were used in equation (4) instead of ln E_{it}, there is no need to use the nonlinearity correction.

7. This comparison may not be precise because the special incentive, were it to be prolonged, would alter the retirement rates prior to each of the ages considered in 1982.

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Comment Ariel Pakes

Larry and David have demonstrated, I think convincingly, that pension plan provisions can influence retirement behavior. Indeed, the empirical results in this paper make it clear that, at least in the firm studied here, retirement is responsive to jumps in pension accruals, and that the extent of the response depends positively on the magnitude of the jump. On the other hand, it is not clear whether they (or anybody else) can

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do as convincing a job on the second stage of the analysis, that is on obtaining interpretable estimates of the response coefficients of interest. To obtain such estimates will require a more detailed model. Since I have little to add to their descriptive work, I shall focus my comments on the modeling problems that are likely to arise in obtaining these estimates (even though many of these problems were noted in the presentation).

Models for stopping full-time employment, like all stopping models, should work off the differences between the perceived distributions of the stream of benefits from full-time employment and the benefits from the relevant alternatives. As other papers in this conference have illustrated, the relevant alternatives include both partial retirement and full-time leisure. There is, however, no information in this data on whether an individual who left full-time employment did so for partial retirement or for full-time leisure. Further, there is very little information available on individual characteristics. It would, therefore, be difficult to build a model which would allow us to determine the motivation for, and the benefits from, partial retirement from data and estimated parameters. Models which do not allow for partial retirement estimate the impact of pensions (and for that matter of Social Security) on retirement by comparing the benefits from full-time leisure to the benefits from full-time work. If partial retirement is an effective alternative, then the income differences the model attributes to "retiring" will be overstated, and responses to monetary incentives (such as to changes in pension accruals) will be inconsistently estimated. Moreover, when we consider the impact of pension schemes on labor force participation rates, the problems generated by this inconsistency will be compounded by the fact that many of the people we are counting as retired will in fact be employed—albeit only part of the time.

The age-earnings profiles estimated in this paper illustrate the confounding effects of retirement behavior on the interpretation of the parameters of interest. A stopping model of retirement behavior would predict that the people who are working at later ages are those whose returns from work (wages) are abnormally high (for those ages), while those who retire should have low returns. In the years where there is a lot of retirement we ought to find that this selection process increases the average wage of those continuing to work—even though every individual's wage profile may well be declining. Figure 10.1 illustrates this point. At age 55 there is a jump in pension accruals and a consequent sharp increase in the hazard for retiring. At age 62 there is a fall in pension accruals and a consequent prior increase in the retirement hazard. At both these ages Larry and David estimate an increase in the earnings-age profile. These increases may have little to do with the earnings-age profile of any individual in the sample. It is just that the retirees should be precisely those individuals whose earnings are low

and falling. If we were to estimate an age-earnings profile in conjunction with a stopping model of retirement behavior, the model itself would account for the selection induced by the endogenous retirement decision, and we might well find a falling profile. Clearly, without such a model we should be very careful how we interpret the profile's estimated parameters.

A comment on the process assumed to generate earnings is also in order. The assumption made here is that the unobservable, or disturbance, component of (log) earnings consists of a time-invariant individual-specific "random" effect, μ_i, plus an independent and identically distributed, $\eta_{i,t}$. Though this process has been used frequently in the past, I think it is inappropriate in the current context. It states that the unobservable component of earnings at age 60 has the same correlation with the unobserved component of earnings at age 59 as it does with the unobserved component of earnings at any other age (say 30). Though this may well be a good approximation for labor force participants in the prime of their working life, it is unlikely to be adequate in later ages when health and family status considerations are likely to play a dominant role in determining the value of these unobserved determinants of retirement behavior.

Use of the random-effect model will also create econometric problems. If $\tau_{R,i}$ is the random retirement time of individual i, and $P\{\tau_{R,i} = t\}$ designates the probability that $\tau_{R,i} = t$, then whatever model is eventually used will have an equation of the form:

$$P\{\tau_{R,i} = t\} = f(E_{it}, \tilde{E}_{it+\tau}, \ldots, \mathrm{PW}_{it}, \mathrm{PW}_{it+1}, \ldots; \beta),$$

where E_{it} is earnings in year t, $\tilde{E}_{it+\tau}$ signifies parameters of the distribution of earnings in year $t + \tau$ given the information of year t, PW denotes pension wealth, and β is a vector of parameters to be estimated. A crucial parameter of $\tilde{E}_{it+\tau}$ will be μ_i. However, μ_i will only be consistently estimated as the number of observed time-periods per individual grows large (the usual asymptotics for panel data problems is in dimension N, the number of individuals). In short panels, μ_i will be estimated with error. This creates an errors in variables problem. Moreover, since $P\{\tau_{R,i} = t\}$ is a probability statement, $f(\cdot)$ must be nonlinear, so the error must be inside a nonlinear function. To consistently estimate the parameters of a nonlinear errors in variables problem we need to know the entire distribution of the error and then integrate out with respect to it. Though this may be feasible, it seems unduly difficult, especially when the specification causing the problem is so much in doubt. The authors may well be better off making a more conventional Markov assumption on the disturbance in log-earnings.

One final suggestion. The authors correctly stress that there is a great deal of variation in the provisions of pension plans. One question that

arises and that these data seem, therefore, particularly well suited to analyze is: What forces underlie the structure of the pension plan? Indeed, when we do finally obtain adequate estimates of the effect of pension provisions on retirement and then experiment with the effects of alternative pension schemes, we will also want to ask ourselves what effects will changes in the pension scheme have on alternative aspects of individual behavior. The other aspects of behavior that pensions have marked effects on are likely to be precisely the same aspects that generated the shape of the current pension provisions.