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Chapter Author: Edward P. Lazear, Robert L. Moore

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6 Pensions and Turnover

Edward P. Lazear and Robert L. Moore

Over the past few years, a number of authors have attempted to examine the effects of pensions on retirement and worker turnover in general. Lazear (1982, 1983a, 1983b), Wolf and Levy (1984), Kotlikoff and Wise (1987), Mitchell and Fields (1984), and Frant and Leonard (1987), among others, have investigated the pattern of pension accruals and the effects of various pension provisions on worker behavior. While that literature has made definite progress toward understanding the relation of pensions to turnover, it has suffered from two basic problems.

First, for the most part (Mitchell and Fields [1984] is an exception), the empirical analyses have been unable to match workers with the exact plans in which they are enrolled. For example, in Lazear (1982, 1983b), all that was available was information on the plans, with no information on worker behavior. Even aggregate statistics on average age of retirement and the age distribution of the work force were absent. As such, it was impossible to assess the impact of the various plans on worker turnover.

Second, the specifications used in the literature are not quite correct and lead to inappropriate inferences. What most researchers do when attempting to look at the effect of pensions on turnover is to examine the value of the pension conditional on retirement at some chosen date. Thus, the pension value (or accrual amount) associated with the eighteenth year of work is based on some assumed date of retirement. Often that date is the year itself. Lazear (1982, 1983b) presented the

Edward P. Lazear is the Isidore Brown and Gladys J. Brown Professor of Urban and Labor Economics at the Graduate School of Business, University of Chicago, senior fellow, Hoover Institution, and a research associate of the National Bureau of Economic Research. Robert L. Moore is an associate professor of economics, Occidental College.

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expected present value of the pension for every age of retirement between 55 and 75. Although that information is useful and forms the starting point for this analysis, it is not the correct independent variable to use when trying to estimate the effect of pensions on worker turnover. As it turns out, the pension value, calculated in that fashion, is generally more discontinuous than the value that affects behavior. It is no surprise that trying to relate the raw pension values to worker turnover is not especially fruitful. The following example illustrates the point.

Consider a stylized military plan that vests after 20 years and provides a zero credit for any years worked after year 20. This results in a very discontinuous pension pattern. The pension value associated with retirement before 20 years of service is zero and is positive at 20 years. Beyond that, the pension value falls because fewer years are paid out and no credit adjustment is made. If $P(t)$ is the pension value associated with retirement after t years of tenure, then $P(t) = 0$ for t less than 20. Since $P(t)$ does not vary until year 20, it cannot affect turnover differentially during that period. But in reality, one would expect that the effect of this pension formula on turnover would be greater in year 19 than in year 2. Workers who have only been with the firm for 2 years still have 18 years to wait for the pension to vest. The option value of staying an additional year varies with tenure even though $P(t)$ does not.

The most obvious way to see this is to imagine that data were available only on workers whose tenure was less than 19 years. If $P(t)$ were the dependent variable, then it would be zero for all of these workers. Yet, as workers get closer to year 20, it must be true that the force of the pension on turnover rates increases. The approach that we develop picks this effect up in a smooth and more theoretically appropriate fashion. The effect of pensions on turnover could be estimated even if no workers had ever gone past the date of vesting (say, because the plan is new and workers are young). More important, the approach is dynamic; it takes into account that workers look toward the future. The current year's pension accrual is relevant, but not sufficient. The pension available 3 years hence may exert a stronger influence on this year's work decision than the current pension accrual.

This paper does two things: First, it derives the appropriate pension variable to use in a regression that relates turnover to pensions. Second, it constructs a new data set and applies the approach to those data. The data include explicit information on the pension formula and also on the workers who are currently employed. Their starting dates, birthdates, sex, marital status (in some cases), and salary history for 11 years are provided. Although no information on workers who have left the firm is available, under certain assumptions it is sufficient to examine the tenure distribution of current employees. Additionally, we have information on six different plans and their workers so that there is enough variation to obtain estimates of the effects of pensions on turnover.

The primary empirical conclusion is that pensions have a strong effect on turnover. In these data, eliminating the average worker's pension would double the turnover rate. We hasten to add that this conclusion is tentative. The current state of our data allows us to obtain estimates only under quite strong assumptions. Still, as a first guess, the results show the potential importance of the effect of pensions on turnover.

6.1 Theory: The Option Value of Working

To focus on the relevant variable, we ignore any wage payments and suppose (obviously unrealistically) that total compensation consists of pensions. Define $P(t)$ as the expected value in year t dollars of the pension flow that is available to the worker if he severs his ties to the firm at the conclusion of year t. Further, define $V(t)$ as the value associated with working during year t in year t dollars. This option value can be defined recursively:

In year T, the final year, the option value of work is

$$V(T) = P(T) - [P(T - 1)](1 + r),$$

where r is the rate of interest. This is the difference between what the worker receives in pension value if he works until time T as compared with time $T - 1$. The value of working year $T - 1$ is, correspondingly,

$$V(T - 1) = \max[P(T - 1), P(T)/(1 + r)] - [P(T - 2)](1 + r).$$

The first term says work in year $T - 1$ gives the worker the option of taking the pension available after year $T - 1$ or of going on to work year T and getting $P(T)$, discounted back to year $T - 1$ dollars. If the worker does not work year $T - 1$, he can have the pension $P(T - 2)$, which must be multiplied by $1 + r$ to put it in year $T - 1$ dollars. Note that this information assumes (relaxed below) that the worker can, with certainty, opt to work year T and receive that pension. In year $T - 2$, a similar formula gives

$$V(T - 2) = \max[P(T - 2), P(T - 1)/(1 + r), P(T)/(1 + r)^2] - P(T - 3)(1 + r),$$

or using the first term of $V(T - 1)$, this can be rewritten as

$$V(T - 2) = \max \{P(T - 2), \max [P(T - 1), P(T)]/1 + r\} - P(T - 3)(1 + r).$$

Define $M(t) = \max[P(t), M(t + 1)/(1 + r)]$, and $M(T) = P(T)$, so that we can write generally

$$(1) \qquad V(t) = M(t) - [P(t - 1)](1 + r).$$

Equation (1) and the definition of $M(t)$ make more obvious the intuition of the earlier example and previous paragraph. Consider a very similar example where $P(10) > 0$, but $P(t) = 0$ for $t < 10$. If $P(11) < P(10)$, $\max [P(10), M(11)/(1 + r)] = P(10)$. But $\max[P(9), M(10)/(1 + r)] = M(10)/(1 + r) = P(10)/(1 + r)$, not $P(9)$, which equals zero. Similarly, $M(8) = P(10)/(1 + r)^2$, and so forth. Thus, the $V(t)$ series is much smoother between $t = 9$, 10 than the $P(t)$ series.

The importance of this formulation can be seen even more clearly if the pension formula is such that pensions continue to accrue after year 10. In the previous example, there is a spike in $V(t)$, but it comes between 10 and 11, not between 9 and 10. This is because the value of staying to year 11 is negative. If accruals occur after year 10 so that the maximum value is achieved by retiring, say, at year 30, the spike at 11 goes away for the most part as well. There is a discontinuity only to the extent that $P(9)$, which is subtracted to get $V(10)$, is zero, where $P(10)$, subtracted to get $V(11)$, is not. But the difference between 0 and $P(10)$ is small compared with $M(10)$ or $M(11)$ in most practical situations. As will be seen below, the only time that these magnitudes are not small is when the worker is old at the year 10 vesting point. Then the option value spikes are important.

So far, we have assumed that the worker chooses and receives the branch of the maximand that is the largest. This is unrealistic for two reasons: First, the firm may sever the worker before he reaches the optimal date, t^*. Second, the worker receives wages and has alternative job possibilities as well.

To be more explicit, suppose that at time t, $R(t)$, the reservation wage, has the distribution function $G_t[R(t)]$. Suppose further that the worker does not know $R(t)$ before period t. Also, let there be an exogenous probability of separation, either due to unanticipated termination by the firm or for health reasons. Let that probability be denoted $F(t, A)$, where t reflects the worker's tenure and A his age. (This becomes important in the empirical section.) If the worker receives reservation value R_t in each year t that he does not work for the firm, and also W_t during each year that he does, then $M(t)$ must be redefined as

$$M(t) = \max\left[P(t) + \sum_{i=t+1}^{T} \frac{(R_i - W_i)}{(1 + r)^{i-t}},\right.$$
$$\left. F(t + 1, A + 1)M(t + 1)/(1 + r)\right],$$

and

$$(1') \qquad V(t) = M(t) - \left[P(t-1) + \sum_{i=t}^{T} \frac{(R_i - W_i)}{(1+r)^{i-t}} \right] (1+r).$$

The worker quits when $V(t)$ is negative. This can be rewritten. Define

$$Z(t) \equiv \frac{M(t)}{(1+r)} - \left[P(t-1) + \sum_{i=t+1}^{T} \frac{(R_i - W_i)}{(1+r)^{i-t}} \right] + W_t.$$

Then equation (1′) implies that the worker quits when

$$R_t > Z(t),$$

or he works with probability $G_t[Z(t)]$. Since everything in Z is known deterministically, or is unknown and in the future, expected values are relevant so that at time t, $Z(t)$ is merely a number that can be calculated once the distributions of the R's are known. Parameterization of the G function and observing the number of individuals who quit provide that information.

In the empirical section, it will be assumed that $R_t = W_t$ for all t, so that only $F(t, A)$ must be addressed.

The importance of treating the reservation value, R_t, correctly can be seen in the context of the standard work-leisure diagram. A number of researchers (e.g., Burtless and Hausman 1980; Hausman and Wise 1985) have used the work-leisure framework to analyze retirement decisions. Although that approach is instructive, it suffers from its static nature. This prevents analysis of many of the issues that are central to this paper. This can be seen in the context of figure 6.1.

A pension plan (ignoring wages) might result in a nonlinear budget constraint with shape ABCDE. This diagram allows us to talk about

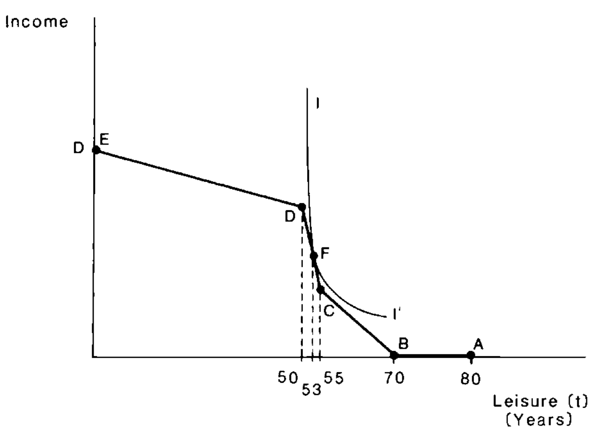


Fig. 6.1 Work/Leisure Diagram and Option Value Approach

the total number of years that an individual would choose to work if that were a one-time decision. It does not easily permit any uncertainty to be incorporated into the analysis. It cannot deal with when work occurs over the lifetime. For example, 30 years can be worked as one spell of 30 from age 20 to 50 or as two spells of 10 and 20 years separated by a 10-year hiatus. The timing is especially important for pension plans, many of which depend on dates worked either directly or indirectly by tying benefits to salary. This is particularly important for women. Finally, and most important in this context, is that the decision to leave the job is not always a decision to take leisure. More often, it is a choice of a new job over the old one. There is no way (without severely straining the interpretation of the utility function) to deal with that through a nonlinear budget constraint analysis.

The option value approach allows us to capture these effects and also nests the work-leisure analysis. But it is essential to build in the reservation wage, R_t, in an appropriate fashion. To see this, consider a worker who is deciding how long to work. If leisure has zero value, then indifference curves are functions with slope = $(1/(1 + r)^{70-t}$ at each point. (The analysis is the standard one of when to cut a tree.) Under these circumstances, it is impossible that F could dominate D. But it is clear that in the work-leisure context, F could be an optimum. This is because pure wealth maximization ignores the value of time between years 53 and 50. But if R_{51}, R_{52}, R_{53} were sufficiently high, and R_{54}, R_{55}, . . . sufficiently low (as reflected by the highly nonlinear indifference curve near F), then F could be an optimum according to equation (1′). Our view is that the option approach yields much more flexibility to analyze dynamic questions of timing of work and job switching, without sacrificing the implications of the work-leisure analysis.

6.2 Empirical Analysis

6.2.1 Data

The data consist of detailed plan descriptions and a personnel roll for six plans. The personnel data include the date of hire, birthdate, a salary history at the current firm for up to ten years, sometimes marital status, and in one case, whether the worker receives an hourly wage or salary. Additionally, accrued benefits and projected benefits have been calculated by the accounting firm that supplied the data, but those values were not used in our analysis.

Because of the proprietary nature of the data, the firms cannot be identified. However, some rough descriptions of the industry and workers are provided here along with a description of the individual plans.

Plan 1: National women's clothing retail stores, located in major urban areas; 2,083 active employees in pension plan on February 1, 1984.

Normal retirement annual flow is calculated as .0015 × (sum of annual earnings − $4,200) for each year employed. This is indexed at a CPI factor of no greater than 3 percent for past years. Early retirement can be taken at age 60 with 10 years of service. Postponed retirement is permitted, and retirement at dates other than the normal date is the actuarial equivalent of that received at age 65, conditioned on actual years of service and salaries. The plan vests after 10 years.

Plan 2: Large southwestern mining company. These workers are salaried, generally managers, who work either in the southwestern United States or in New York City; 357 active employees in the plan as of February 1, 1984.

The normal retirement annual flow is calculated as average of final 5 years' salaries = AVE. Then the flow per year is (.0175 AVE − .0125[$9,240]) × (years of service). There is a maximum flow of 2/3 of AVE. The hire date must occur before the worker turns 65. Early retirement is permitted at age 55, and late retirement to age 70 is permitted. There is an early retirement reduction of .0033 per month for each month that retirement occurs before age 60. The formula is slightly more complex for individuals who have 30 years of service by age 55 or who will reach 30 years before age 60. The plan vests after 10 years.

Plan 3: One of the companies under the corporate umbrella of the firm described in plan 2. All are salaried employees from the southwest; 821 active employees as of February 1, 1984.

The normal retirement annual flow is calculated as average of final 5 years' salaries = AVE. Then the flow per year is (.0175 AVE − .0125[$9,240]) × (years of service). Early retirement at age 55 is permitted, with the participant receiving a reduced pension actuarially equivalent to pension beginning at age 65, but for individuals who have 25 years of service (or more) and are age 60 or older at retirement, only 1/2 regular actuarial reduction is to be applied. Late retirement is permitted. The plan vests after 10 years.

Plan 4: These are the hourly rated employees of the company in plan 3 with job titles ranging from janitorial to electrician to miners. 999 active employees in plan as of February 1, 1984.

Normal retirement monthly flow (at age 62) is equal to $17 × (years of service up to 15) + $18.50 × (next 15 years of service) + $20 × (service years exceeding 30). There are three possible early retirement options: (1) at age 60 with the above amount reduced .0033 per month for each month prior to age 62; (2) with 30 years of service and no reduction, plus a monthly benefit of $300 until employee attains age

62, and a monthly benefit of $130 payable from 62 until eligible for unreduced Social Security benefits; (3) with the same benefit flow as in option (2) only the $130 supplement does not apply, under the "70/80" rule (the latter only by mutual agreement between employee and company. It requires either age 55 with sum of age + service = 70, or age less than 55 with sum of age + service = 80). Late retirement permitted. The plan vests after 10 years.

Plan 5: Salaried employees of the parent company of the major office/home furniture manufacturing firm described in plan 6. Titles run from manager to president/owner and include employees from locations in California, New Jersey, Tennessee, and various other states; 310 active employees as of February 1, 1984.

The normal retirement annual flow (at age 65) is the sum of two parts: (1) a prior service benefit = 1.25 percent of final 5-year average pay at 1/1/84 to $20,000 plus 1.75 percent of such average in excess of $20,000, all times the number of years of service as of 1/1/84, and (2) a future service benefit = 1.25 percent of pay up to Social Security earnings limit, plus 1.75 percent of pay in excess of limit, for each year of service beyond 1/1/84. Early retirement at 60 with monthly flow reduced .005 for each month that commencement of payments precedes 65. The plan vests after 10 years.

Plan 6: Major office/home furniture manufacturer. Includes both salaried employees (managers, executives, etc.) and hourly employees (machinists, loading dock workers, etc.) under the same benefit formula. Employees are located in Mid-Atlantic states; 1,390 active participants as of February 1, 1984.

Normal retirement annual flow (at 65) is sum of two parts: (1) 1.25 percent of final 5-year average pay at 1/1/78 up to $12,000, plus 1.75 percent of this average that exceeds $12,000 for each year of service to 1/1/78, and (2) 1.25 percent of pay up to Social Security earnings limit, plus 1.75 percent of pay exceeding such limit for each year of service after 1/1/78. Early retirement at age 55, with monthly pension flow reduced .005 for each month that precedes normal reitrement. The plan vests after 10 years.

6.2.2 Simulation of Plan Values

Given the plan descriptions, it is straightforward to compute the expected present value of pension benefits for any hypothetical employee who retires at a given age. To do this, life tables must be used and the 1980 Vital Statistics tables for males or females (depending on the sex of the hypothetical individual) were selected for this purpose.

We calculated the expected present value for 72 hypothetical employees for each plan, and for each of those employees, we computed $P(t)$, the pension value after t years of service in year t dollars, for t

ranging from 0 to the t that corresponds to age 85. Note that in all plans $P(t) = 0$ for t less than 10. The 72 employees were obtained by letting sex vary, letting wage growth vary from 0 to 3 percent, letting 1984 salary take on values of \$10,000, \$40,000, \$70,000, and \$100,000, and letting the age at which the employee started with the firm take on values of 25, 40, and 55.

Although it was instructive to look at these different kinds of workers, it turns out that the following patterns were observed. Male and female workers differ only slightly in pension values. Wage growth steepened the pension accrual path and shifted it upward. Higher salaries shifted $P(t)$ upward except in the case of plan 4, which does not depend on final salary. The most interesting variation relates to the age of the worker at initial employment date. In what follows, we present results that emphasize this distinction.

6.2.3 Options

Equation (1) defines the appropriate value to examine to understand the effects of pensions on turnover (ignoring wages and other compensation). Once $P(t)$ is defined, it is straightforward to derive $V(t)$. The only additional ingredient is the assumed turnover propensity, $1 - F$, for which we made the following assumptions:

F varies with tenure such that $F(1) = .7$, $F(2) = .8$, $F(3) = .9$, $F(4) = .95$, $F(t) = .98$ for $t > 4$. However, since the probability of turnover is also a function of age, especially after 55, we multiplied what would otherwise be the probability of continuation by $[1 - 1/(72 - \text{age at time } t)]$ so that the probability of continuation is F at 54, but falls to 0 at 71, irrespective of tenure. This assumption is admittedly arbitrary, but it captures the spirit of declining turnover rates with tenure and increasing turnover rates with age above 55.

Figure 6.2 best summarizes what can be learned from looking at $V(t)$ profiles so derived. It displays the $V(t)$ and $P(t)$ profiles for one hypothetical employee—a male, with wage growth equal to 3 percent, with a salary of \$40,000 and starting age of 25 ("a" panels), and 55 ("b" panels) in each of the six plans. The most striking point is that even though the pension does not vest until year 10, so that $P(t)$ is the same and equal to zero for all years less than 10, the $V(t)$ profile is upward-sloping in that range. Thus, the value of working year 8 exceeds the value of working year 1 not only because it brings the worker closer to the vesting year, but also because the optimal pension taking year is closer.

The empirical importance of this is perhaps obvious. Suppose, for example, that one had data only on workers who had less than 10 years of tenure. If $P(t)$ were used as the dependent variable, there would be no effect of pensions on turnover in any regression. On the other hand,

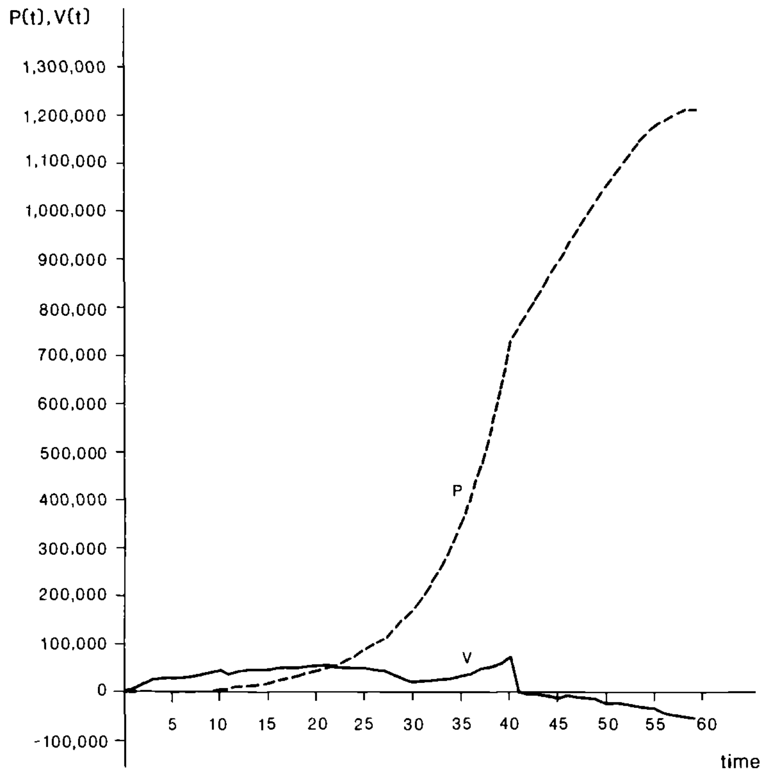
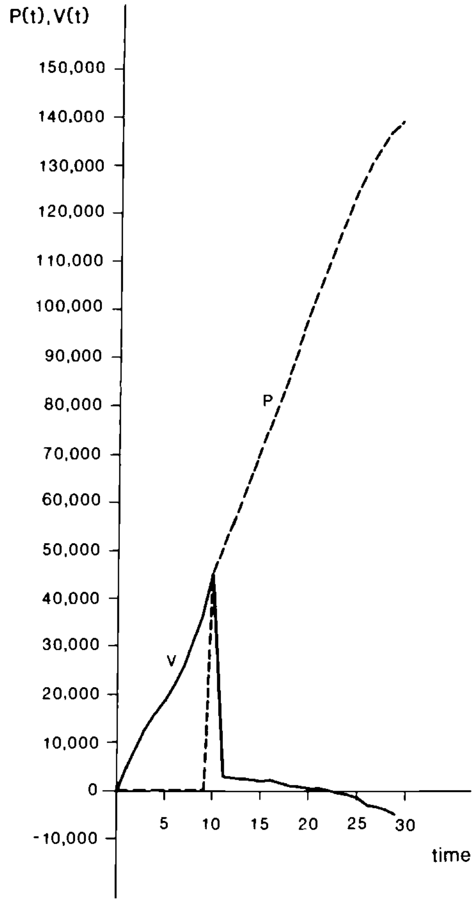


Fig. 6.2 Panel Ia. Pension Values (P) and Option Values (V) for Hypothetical Worker Hired When "Young" (Plan 1)

if $V(t)$ were used, it is expected that a negative coefficient would be obtained since $G(R)$ increases in R. As $V(t)$ rises with t, the probability of turnover decreases. (This should be true even holding the normal effect of tenure on retirement constant.)

A second point that is clear from looking at the $V(t)$ profiles is that the downward spike in $V(t)$ at the vesting year is much more important for the old workers than for the young workers. The reason is that young workers are likely to wait to take their pension until some year far after 10 years. For example, for plan 1, the likely retirement date is 40 years of tenure. For old workers, the likely retirement date is much closer since the probability of exogenous reasons for quitting is higher.

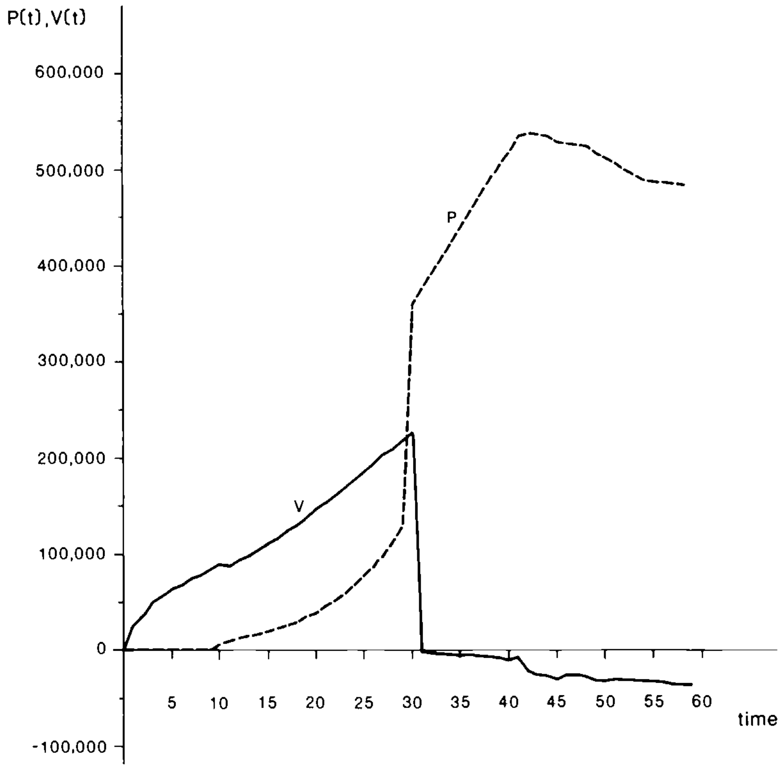
At the empirical level, this implies that there should be a much greater proportion of old workers who quit immediately following the vesting year than young workers. It would not be surprising to find no effect of vesting on young workers since this discontinuity is so small.



Panel Ib. Pension Values (*P*) and Option Values (*V*) for Hypothetical Worker Hired When "Old" (Plan 1). *Figure 6.2 continues on next page.*

The third point comes from comparing the *P*(*t*) profiles to the *V*(*t*) profiles. For workers who begin employment with the firm when young, there is sometimes a discontinuity in the *V*(*t*) profile that is not mimicked by the *P*(*t*) profile. For example, in plan 1 (panel Ia), there is a very large discrete jump downward at the 40th year of tenure. The *P*(*t*) profile is much smoother at that point. This implies that there should be significant retirement at $t = 40$. This would be the prediction if *V*(*t*) were the independent variable, but it would appear as noise if *P*(*t*) were the independent variable.

The last point is that the distinction between workers who start when old and those who start when young is lost if the *P*(*t*) profile is used.



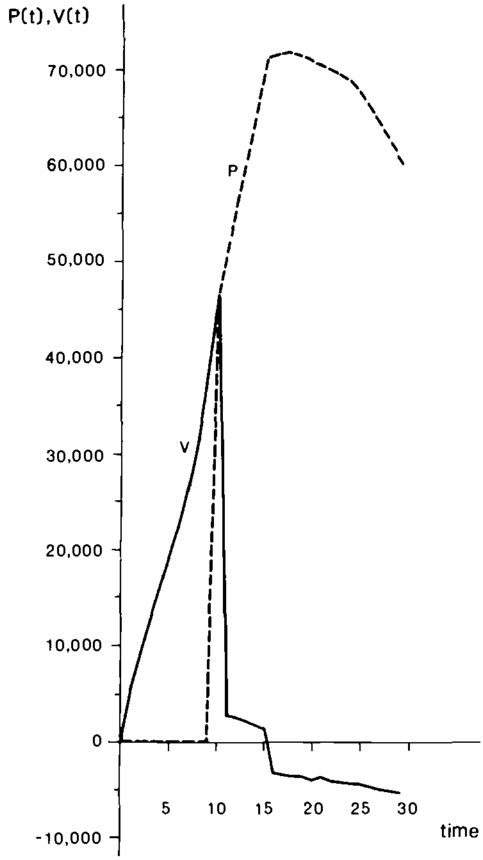
Panel IIa. Pension Values (P) and Option Values (V) for Hypothetical Worker Hired When "Young" (Plan 2)

The shape of the $P(t)$ profile is basically quite similar in the "a" panels of figure 6.2 as it is in the "b" panels. This comes back to the earlier point that the incentives to remain on the job are different for old and young hires. That is obscured by looking at the $P(t)$ profile.

6.2.4 Regressions: Turnover and Pensions

The formulation in equation (1) says that the value of working another year can be calculated from the pension stream, conditional on retirement at a given date. Given a density of reservation prices at each age/tenure level, the higher the option value the less likely a worker is to leave in that given year. This can be modeled more rigorously as follows:

Recall that if the reservation price R at tenure t and age A is distributed as $G(R;\, t, A)$, then the probability that the worker chooses to continue is



Panel IIb. Pension Values (P) and Option Values (V) for Hypothetical Worker Hired When "Old" (Plan 2). *Figure 6.2 continues on next page.*

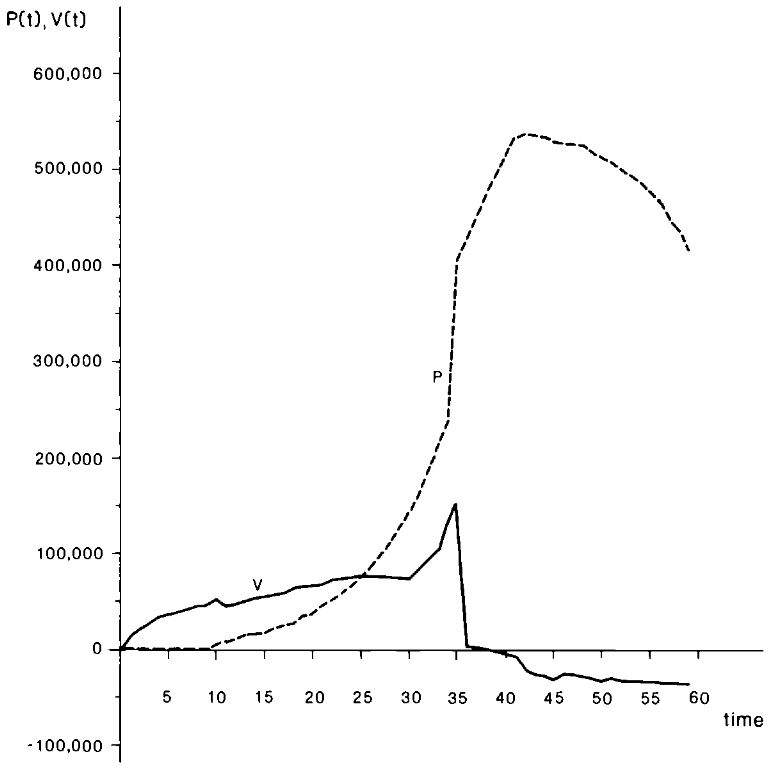
$$G(V_t;\ t,\ A).$$

Let us parameterize G such that $G(V_t;\ t,\ A)$ can be approximated by

$$G(V_t;\ t,\ A) = \exp(a_0 + a_1 V_t + a_2 t + a_3 A). \tag{2}$$

Having written equation (2) in this way implies that $F(t, A)$ is subsumed in G and suppressed. If N_0 workers are hired in each period, then today (1984), the tenure of those workers t = 1984 − start year. The number with t years of tenure is then

$$N(t) = N_0\{\exp[a_0 + a_1 V_1 + a_2 + a_3(A_{0+1})]\}\{\exp[a_0 + a_1 V_2 + a_2(2) + a_3(A_{0+2})]\} \ldots \{\exp[a_0 + a_1 V_t + a_2(t) + a_3(A_{0+t})]\}, \tag{3}$$



Panel IIIa. Pension Values (P) and Option Values (V) for Hypothetical Worker Hired When "Young" (Plan 3)

where A_0 is the age at which the workers are hired. (This ignores the fact that workers are hired at different ages. This is dealt with below.)

Taking logs, equation (3) can be written as

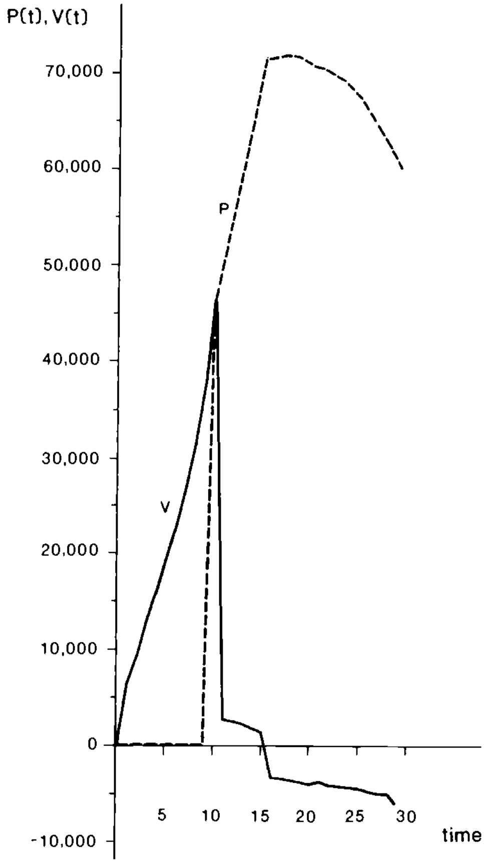
$$\ln N(t) = \ln N_0 + a_0 t + a_1 \sum_{i=1}^{t} V_i + a_2 \sum_{i=1}^{t} i + a_3 \sum_{i=1}^{t} (A_{0+t}),$$

or

$$\ln N(t) = B_0 + B_1 t + B_2\left(\sum_{i=1}^{t} V_i\right) + B_3 \left(\sum_{i=1}^{t} i\right) + B_4 \sum_{i=1}^{t} (A_{0+t}),$$

or

$$(4) \qquad \ln N(t) = B_0 + B_1 t + B_2 X + B_3 Y + B_4 Z,$$



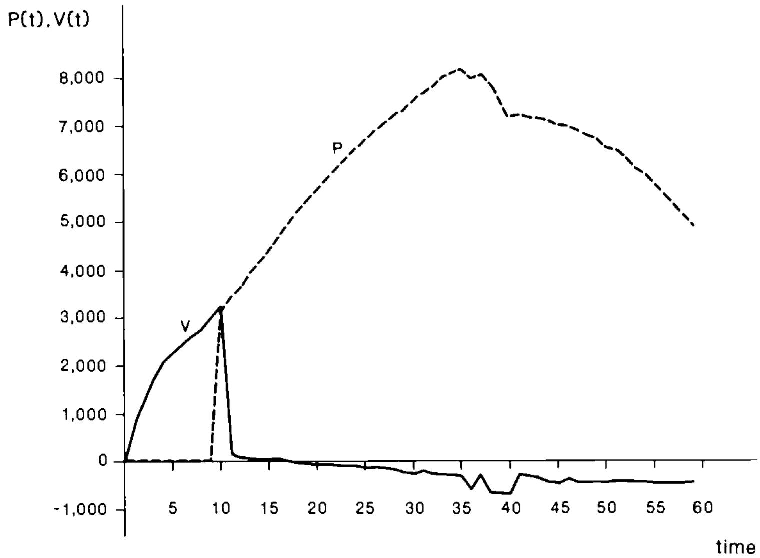
Panel IIIb. Pension Values (P) and Option Values (V) for Hypothetical Worker Hired When "Old" (Plan 3). *Figure 6.2 continues on next page.*

where

$$X \equiv \sum_{i=1}^{t} V_i,\ Y \equiv \sum_{i=1}^{t} i,\ Z \equiv \sum_{i=1}^{t} (A_{0+t}).$$

Equation (4) is the basic estimating equation. It allows for estimation of age-tenure specific hazard rates.

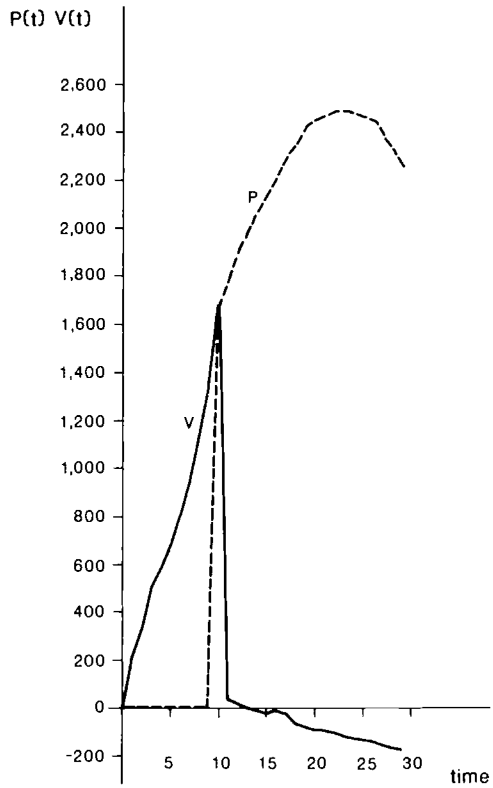
Implicit in the derivation of equation (4) is the assumption that all workers are alike in V, once t and A_0 is known. This would be true if there were no variation in salary history and if all workers began employment at the same age, A_0. Of course, in reality, these assumptions



Panel IVa. Pension Values (P) and Option Values (V) for Hypothetical Worker Hired When "Young" (Plan 4)

cannot be valid. It is conceptually possible to calculate the V vector for every worker in the sample; we take an intermediate approach. Workers are separated by plan and by starting age. Thus, there are eighteen groups: for each plan, workers were classified as having started work between ages 20 and 35, 36 and 50, and 51 and older. The results below throw out information on the intermediate groups and focus on workers who started when they were young or old. The $N(t)$ that appears on the left-hand side of equation (4) is the number of individuals in a given plan, within a given starting age category, that have tenure of t years. For the calculation of Z, it was assumed that A_0 was 25 if the workers began when young, and that A_0 was 55 if the workers began when old. Workers were assumed to earn $40,000 in 1984 and the wage growth rate was set at 3 percent. The discount rate for all purposes was 5 percent. The coefficient on X is then the effect of pensions on the probability of leaving. Note that, for now, nothing having to do with workers' wages is being held constant. Implicitly, it is assumed that $W_t = R_t$ for all t.

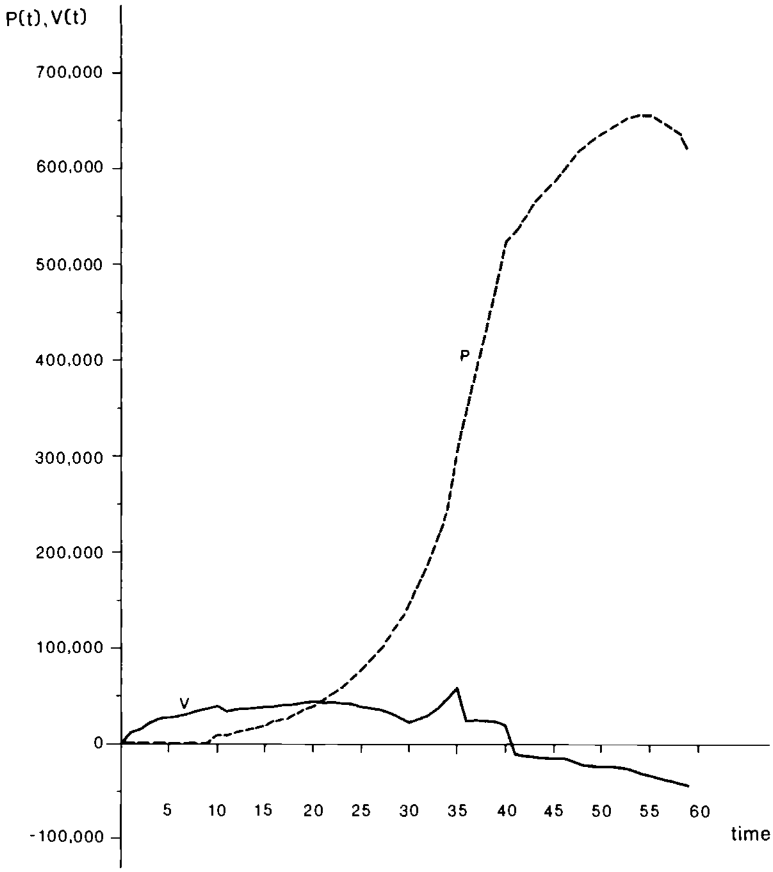
There are 366 observations, 61 for each plan. The 61 observations come from 45 tenure categories for workers who started employment at age 25 and 16 tenure categories for workers who started at age 55.



Panel IVb. Pension Values (*P*) and Option Values (*V*) for Hypothetical Worker Hired When "Old" (Plan 4). *Figure 6.2 continues on next page.*

The basic equation is reported in column 1 of table 6.1 (pp. 184–85). The variable of interest, *X*, has a negative coefficient. This is the opposite of what is expected. Higher *V(t)* should be associated with a lower propensity to leave. Comparison with other columns provides the reason for this anomalous result.

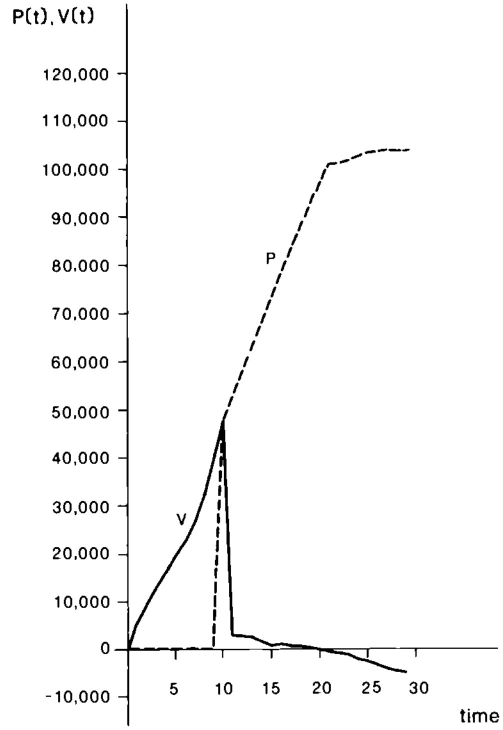
First, compare column 1 with column 2. "Old" is a dummy that equals 1 when the observation is associated with the group that started in the 50 and above category. Note that (Old)(*X*) has a positive coefficient that is more than an order of magnitude than the one on *X*. Evidently, *V* is not important for workers who start when young, but is important for those who start when old. For these old hires, *V* has an effect on turnover propensities. This is not a proper rationalization, however, because there should be no difference between old and young



Panel Va. Pension Values (P) and Option Values (V) for Hypothetical Worker Hired When "Young" (Plan 5)

workers that is not already captured by the calculation of V. There are some possible explanations.

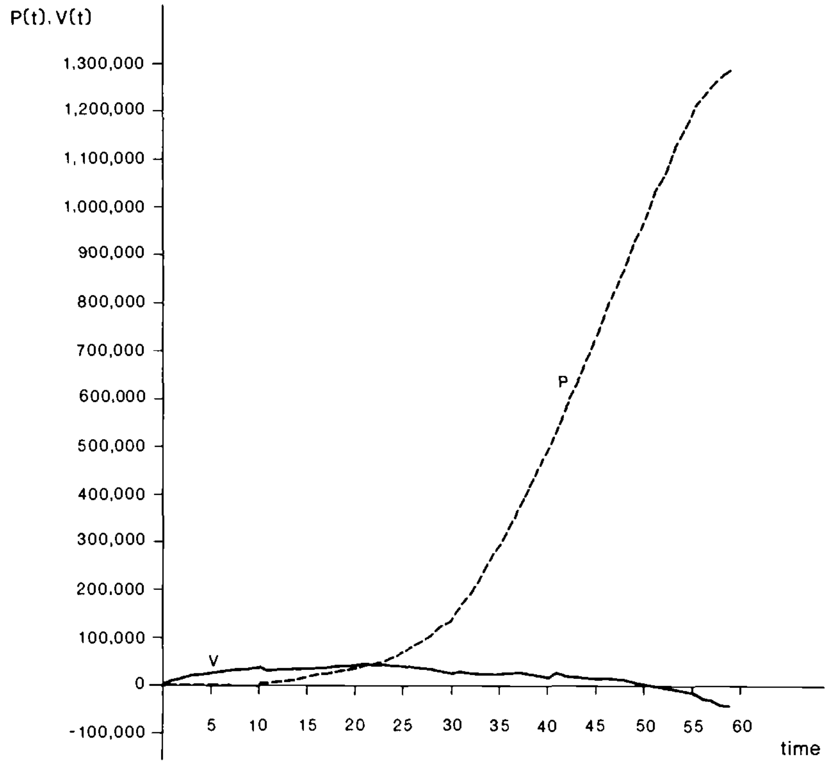
The most obvious is the selection of the wrong discount rate. Suppose that 5 percent is too low a discount rate. Then there is a variation in the V series for young workers that really should not be there relative to the variation for old. If a higher discount rate were used, V would not vary for the young and a larger coefficient on V would be the likely result. In fact, there exists some discount rate that would make the coefficient on (Old)(X) zero. All differences between old and young in turnover behavior would be captured by V. It is conceivable, but at least to our minds totally intractable, to simultaneously estimate the discount rate. (Note that Old by itself is simply a shifter, reflecting that



Panel Vb. Pension Values (P) and Option Values (V) for Hypothetical Worker Hired When "Old" (Plan 5). *Figure 6.2 continues on next page.*

a different number of individuals get hired in when old than when young. That is, N_0 for old hires is not the same as N_0 for young hires.)

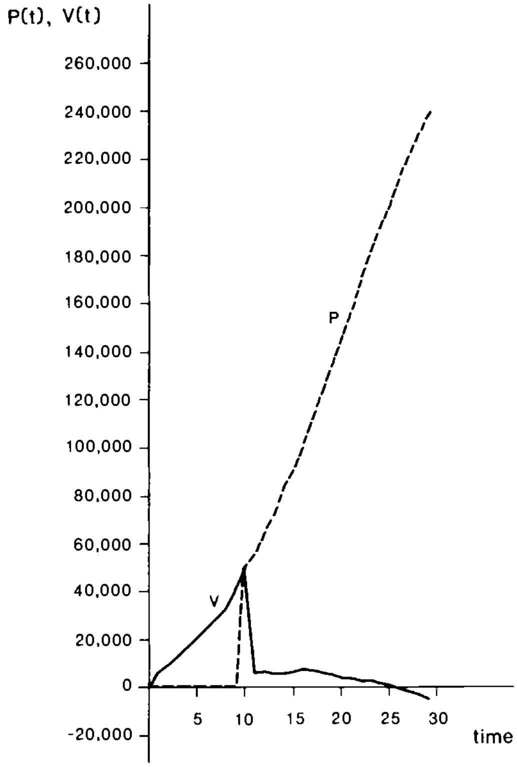
A second, and perhaps more important, factor in the explanation of the negative coefficient on V is that the equation estimated in column 1 ignores wages altogether. To take account of this, we must allow for wages and wage growth to shift the relationship in two ways. First, firms that pay higher average wages or offer more wage growth may have a different number of new hires, N_0. This may be because of a trade-off of fewer numbers of higher quality workers, or other factors. Second, given that the worker has joined the firm, wage levels and wage growth have an effect on retaining the worker. These shift G and are parameterized by adding W (wage level) and WG (wage growth) to equation (2). This implies that $(t)(W)$ and (t)(WG) belong in the estimating equation. These terms really relate to the average net difference between W_t and R_t. This is not quite correct, however. A more complete approach would build the parameterization of R into G directly. Then



Panel VIa. Pension Values (P) and Option Values (V) for Hypothetical Worker Hired When "Young" (Plan 6)

the discount rate and all coefficients could be estimated simultaneously. Given the tentative nature of our data, we have chosen not to undertake this difficult estimation.

Because of data problems, the wages for workers in plan 4 (a pattern plan that is independent of salary) are not reported correctly. As a result, all those 61 observations are dropped. The equation estimated in column 2 was reestimated without these 61 observations. These results are contained in column 4 and do not differ substantially from those of column 2. Column 5 reports the results when the wage variables are incorporated. (Wage growth for each plan was estimated in the usual manner.) As can be seen from the coefficient on $(t)(W)$, higher wage firms are less likely to lose their workers. The sign on V for young workers becomes positive, but is still statistically different from that for older workers.



Panel VIb. Pension Values (P) and Option Values (V) for Hypothetical Worker Hired When "Old" (Plan 6).

To assess the importance of the effect of V on turnover, differentiate $(1 - G)$ with the respect to V. Estimates from column 5 are used. The elasticity is 2.16 so that a 10 percent increase in V reduces the probability of turnover (for old workers) by 22 percent (evaluated at the means). The estimated probability of retention is .96 (at the means). What is perhaps more instructive is to compare what the probability of retention would be if V were zero. Under these circumstances, the retention rate would be about .91. This amounts to a doubling of the turnover rate (from 4 percent per year to 9 percent per year) and suggests the possibility of an important effect.

The estimated retention rate seems quite high. There are at least two possible explanations. First, these firms all have pension plans and may have atypical turnover rates as a result. Second, the process may not be stationary. For example, suppose that employment in these firms were declining over time. Then more workers would have been hired

Table 6.1 **Estimation of Equation (4) (Dependent Variable = N in 1984)**

Independent Variable	(1)	(2)	(3)	(4)	(5)	(6)
			N = 305			
Constant = $\ln N_0$	1.96 (.15)	2.87 (.18)	2.92 (.18)	2.94 (.20)	4.27 (.52)	1.96
W = average wage					-7.9×10^{-5} (1.2×10^{-5})	
t (coefficient = a_0)	.21 (.02)	.055 (.036)	.043 (.039)	.039 (.041)	.019 (.042)	.204 (.018)
WG (average amount of wage growth)					13.2 (6.9)	
$X \equiv \Sigma V_i$ (coefficient = a_1)	-1.75×10^{-7} (8.34×10^{-7})	-1.57×10^{-7} (7.78×10^{-7})		-2.47×10^{-7} (9.8×10^{-7})	1.57×10^{-7} (2.4×10^{-7})	
$Y \equiv \Sigma i$ (coefficient = a_2)	.00033 (.00082)					
$Z \equiv \Sigma(A_{0+t})$ (coefficient = a_3)	−.0056 (.0004)	−.0024 (.0007)	−.0024 (.0008)	−.0019 (.0008)	−.0015 (.0007)	−.0055 (.0004)
Old (dummy = 1 if observation from 55 year old group		−1.88 (.25)	−1.64 (.25)	−1.90 (.28)	−1.98 (.25)	

(Old)(X)		3.34×10^{-6}		2.53×10^{-6}	2.90×10^{-6}	
		(1.09×10^{-6})		(1.34×10^{-6})	(1.18×10^{-6})	
$P = P(T)$			3.84×10^{-7}			
			(4.9×10^{-7})			
(Old)(P)			8.02×10^{-6}			
			(3.64×10^{-6})			
(t)(W)					4.69×10^{-7}	
					(5.7×10^{-7})	
(t)(WG)					−.416	
					(.48)	
ΔP						4.41×10^{-6}
						(3.01×10^{-6})
R^2	.40	.48	.46	.47	.60	.39
SEE	1.06	.98	1.00	.96	.84	

NOTE: Standard errors in parentheses.
Number of observations = 366.

20 years ago than 10 years ago. This makes it appear that turnover rates are low because there is a large number of workers in the $t = 20$ category relative to those in the $t = 10$ category.

There are some other interesting results that come from table 6.1. As expected, the coefficient on Z (age) is negative and statistically significant, but not important in terms of magnitude. There must be some nonlinearity in this relationship that we have not explored. It is likely that, at young ages, increases in age actually reduce the probability of turnover, but at old ages the reverse is true. The effect of tenure on turnover rates cannot be discerned in these data independent of the pension effect. Column 1 reveals that the coefficient on Y is small and unimportant.

It is interesting to compare the "naive" approach, which uses P as the relevant variable, with the more sophisticated approach that uses V. Columns 3 and 6 do that. In column 3, P and (Old)(P) are entered as independent variables and X and (Old)(X) are deleted. They behave in a way similar to that of X and (Old)(X). This is not suprising because the correlation of P with X is .70. However, the interpretation of P is problematic. Do we expect a negative or positive coefficient on P? When P is high, should workers work that year or take the pension?

A better alternative specification enters $P(t) - P(t - 1)$, represented by ΔP in table 6.1, as the independent variable. This should have a clear positive effect on the number of workers in a given year. More workers should be willing to stay when the change in the pension value associated with working another year is high. (Note that there is no income effect unless the year is worked, so a positive effect is necessary.) Of course, this obscures the fact that there is a greater pension value to working year 9 than in year 1, which is captured by V. Again, V and the change in P, ΔP, are correlated at .4, so even if $P(t) - P(t - 1)$ were totally inappropriate, it would pick up the effect of V. In column 6, the change in P does have an effect in the right direction. (When both ΔP and X are entered, interacted with Old, (Old)(X) matters whereas (Old)[$P(t) - P(t - 1)$] does not. Both ΔP and X enter significantly, but are small. These results are not shown in table 6.1.)

One final problem that should be mentioned is that males and females are mixed in this analysis to obtain a large enough number of observations. Since they have different earnings and experience patterns, future research will separate males from females.

6.3 Conclusions and Summary

We have attempted to investigate the effects of pensions on worker turnover using a newly constructed data set, which contains microdata on actual employees under six different actual pension plans. An important distinction is made between $P(t)$, the *pension value* after t years of service, and the *option value,* $V(t)$, which we argue is the more appropriate value to examine to understand the effects of pensions on turnover.

The paper then calculates and contrasts the profiles of these values for hypothetical employees under the six different plans and some implications are drawn from these profiles. The analysis demonstrates that the effects of vesting are more important for workers who were old at the hiring date than for workers who were young at the hiring date. Although the $P(t)$ profile is flat prior to vesting, the $V(t)$ profile is more continuous. The $V(t)$ profile predicts different turnover behavior than the $P(t)$ profile.

The preliminary results of the actual effect of these (more appropriate) option values on turnover are presented. Assuming a stationary process, these results show that a 10 percent increase in the option value reduces the probability of turnover for old workers by 22 percent. Turnover rates are predicted to be twice as high for workers without pensions as for those with the average pension (a change from 4 percent to 9 percent per year). Finally, we investigate empirically the different implications for turnover of the two measures of pension values.

The results presented here should be regarded as tentative, at best. The data that we currently have do not provide any information on individuals who left the firm. Thus, all inferences about turnover must be drawn from an examination of the tenure distribution of current employees. In future research, after the required data have been obtained, that defect will be remedied. We have also taken a number of shortcuts. A full nonlinear model, which yields the discount factor and hazard function simultaneously, was described, but not estimated. Nevertheless, the fact that such strong effects of pensions on turnover are obtained suggests that this is an area well worth pursuing.

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Comment Michael D. Hurd

Defined benefit pension plans typically induce great year-to-year variation in the implicit compensation for a year's work. For example, the value of a pension conditional on separation can jump from zero to a substantial value in the year of vesting. Many previous investigators have viewed this as a spike in compensation and have studied its effect on turnover. The authors perform a useful service by pointing out that the value to a worker of a defined benefit pension plan is not simply the change in the present value conditional on separation. The value will depend on the shape of the pension plan over all possible retirement years. For example, even though a worker may not be vested, the plan becomes more valuable each year until vesting because the worker is a year closer to the vesting date. The authors attempt to quantify the change in value by what they call the option value of the pension plan. The option value is supposed to represent, as far as pension accrual is concerned, the reward from a year of work. To calculate the option value of work in year t, one first finds the retirement date which maximizes the expected present value in year t dollars under the assumption that the worker works during year t. The option value of the plan is this expected present value less the expected present value of the plan given retirement at $t - 1$. The option value has the desirable feature

Michael D. Hurd is a professor of economics at the State University of New York at Stony Brook and a research associate of the National Bureau of Economic Research.

of imputing a positive value to the plan even before vesting. The authors proceed to use the option value to explain the probability of turnover.

The term "option value" is somewhat unfortunate here. It suggests that the worker would be willing to pay at a maximum the option value to work another year. A simplified example shows that is not the case. Suppose the worker is not vested, and that the inflation and interest rates are zero. Then the option value is just the sum of the pension payments should the worker retire at the date when that sum is maximum. But that sum is not what the worker would be willing to pay to work another year, because the worker must work all the future years until the retirement date. Furthermore, if leisure has value, workers may not choose retirement at the date of maximum pension value; then, variations in maximum pension value will be irrelevant for study of turnover. The problem, as revealed in the authors' figure 6.1, is that the budget constraint is nonlinear, probably with nonconvex regions. Choice of retirement date then depends on the global properties of both the budget constraint and the indifference curves. It is simply not possible to summarize the situation with a single number such as the option value. The only internally consistent estimation method we have was developed in the labor supply literature; examples are cited by Lazear and Moore. The authors argue, however, that those methods, based on a global comparison of utility in a diagram like figure 6.1, are not adequate. Their first objection is that the model cannot allow for uncertainty. I do not see the force of this objection, as one could always specify that the budget constraint is offered with some probability. Their second objection is that the model is static, not allowing for interruptions in work. I believe this objection is rather weak. For example, to analyze retirement one could redefine the arguments of the lifetime utility function to be rest-of-lifetime income and leisure after the last reentry into the labor force. Their last objection is that the worker's decision is not simply whether to work or not, but involves choosing over several jobs. But several job choices can be included by constructing budget sets for each job and allowing the global utility-maximizing choice to be made. In that the option value approach evaluates the budget constraint at just one point, whereas the budget constraint should be evaluated to find the global maximum, I believe the approach of the authors is not the best to understand job quitting.

Even if the option value were the appropriate variable to explain the probability of quitting, the data available to the authors make it almost impossible to estimate the relationship. To understand how quits are affected, one needs observations on the leavers and the stayers, except under special circumstances. In these data, only the stayers are observed. If everything were static, estimation might be possible: essentially the original size and composition of the oldest cohorts are deduced from the size and composition of the younger cohorts. But there are 45 tenure categories, which means that the rates of hiring by age would have had to have been constant for 45 years, from 1939 to 1984; this seems unlikely in a growing economy. Without such stability, the number of people in each tenure category can reflect the growth or decline of the company rather than the reaction of the cohorts to the pension plans. Furthermore, even if the rate of hiring by age were steady over such a long period, the estimation method requires that the structure of the pension program remain the same over those years: such stability is necessary if one is to use the pension structure in 1984 to understand turnover rates over past years. Without information on the stability of the pension structure over past years, I am not sure we can have much confidence in an approach that requires it.

In my view, the data could be used in other ways. It should be possible to construct some simple tables which reveal facts about how tenure varies with provisions of the pension plans. For example, if a plan heavily penalizes work after 30 years of service, a table showing the extent of work past 30 years would give us an idea of the importance of that provision. Such tables would provide guidance in modeling and hypothesis testing which could be carried out on data more suited for turnover studies.

In summary, I think the authors have pointed the way toward a better modeling of the influence of pensions on turnover; yet, the data they have are not detailed enough to quantify the effect. Rather than producing some estimates that are difficult to interpret, I would prefer cross-tabulations and tables that describe the data and, in particular, how the age and tenure distributions vary by pension plan.