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I. INTRODUCTION

Lifecycle earnings are determined by factors that govern the experience productivity profile, factors that alter the spot market relationship between compensation and productivity, and compensating differentials that reduce earnings relative to total compensation. Early papers by Becker, Mincer, and others provided a human capital explanation for observed patterns of earnings. Generally, these papers ignored other forms of compensation and assumed that earnings were equal to productivity at each point in time net of any further investment in human capital. The exception to this latter assumption is the case of investment in firm-specific human capital that is financed jointly by the worker and firm.

These models predict nonlinear earnings profiles that rise relatively rapidly early in life, peak, and then decline in the final working years. Workers with similar initial endowments and similar patterns of investment are predicted to have similar earnings throughout their worklives. Earnings are equal to productivity if all skills represent general human capital. Workers with some firm-financed specific human capital are paid less than their productivity; however, this wage may exceed wage offers from other firms. In these models, there are no incentives for firms to lay off older workers or to reduce their wages dramatically except as productivity declines. In addition, firms may attempt to reduce turnover rates and related training costs by sharing with workers some of the returns to specific training.

Over the past two decades, these human capital models have been estimated using numerous data sets and alternative statistical techniques. For the most part, they explain observed earnings profiles well and today human capital theory forms the backbone of labor compensation theory.

The use of implicit contracts by firms to modify worker behavior has been suggested as another determinant of lifetime earnings. Lazear (1979, 1981) and others have argued that the existence of monitoring costs will preclude the instantaneous review of workers output. If the rate of pay is established at the beginning of a contract period and workers are evaluated only at discrete intervals, then workers will have an incentive to cheat on the firm by shirking and performing at less than the agreed upon level of effort. To reduce worker malfeasance, firms offer lifetime compensation structures that pay workers less than their productivity earlier in their careers and then overpay them in the final working years. Such contracts must have an end point at which time the present value of lifetime compensation equals the present value of lifetime productivity.

These contracts are said to occur in firms that adopt mandatory retirement policies where the age of mandatory retirement is the terminal point of the contract. At this age, workers are being paid more than their productivity and the firm has a strong incentive to force the worker to leave the firm. Lazear also argues that pension coverage indicates the existence of a lifetime contract, with the age of normal retirement being the end of the contract. These models predict that workers covered by mandatory retirement and/or a pension will have earnings growing more rapidly than productivity throughout their worklives. Because of the lack of data on lifetime earnings, these models rarely have been estimated. Therefore, the predictions from these models await further confirmation.

Typically, studies adopting the contracting model use pensions only as a residual form of compensation to equate the value of lifetime compensation to the value of total lifetime productivity. Rarely is the specific link between earnings and the pension benefit formula formally modelled. As a result, the true relationships among productivity, earnings and pensions is not considered.[1]

In this paper, we use data from the Retirement History Study (RHS) and the accompanying Summary Earnings Histories as well as the National Longitudinal Survey of Mature Males (NLS) to estimate growth rates of earnings for respondents during their final two decades of worklife. We will be able to test directly the predictions of the lifetime contracting models by comparing the growth rates of earnings of those persons covered by mandatory retirement and pensions to the growth rates of those persons not participating in such contracts. The empirical specification will also enable us to distinguish between two theories concerning the evaluation of the accrual of pension benefits.

The structure of the paper is as follows. In Section II, a theoretical model of lifetime earnings allowing for the existence of employment contracts is described. Pensions as a form of compensation are described in Section III. Two methods of evaluating pension accruals are examined along with their implications for earnings growth. Pension compensation is explicitly introduced into a contracting model in Section IV. In Section V, we develop an empirical specification based on the theoretical model that allows a direct test of the contracting model and the competing theories concerning the evaluation of pension accruals.

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[1]Exceptions to this criticism are papers by Burkhauser and Quinn (1983) and Lazear (1983).

II. CONTRACTING MODELS AND THE GROWTH OF EARNINGS

The fundamental principal of wage theory in a competitive market is that workers are compensated in accordance with their value to the firm as measured by their marginal product. In a riskless world without information costs, the compensation per period should equal the marginal product (MP) of the worker. In a lifecycle context, the worker is viewed as entering the labor market with a specific level of productivity MP(0). This MP(0) is determined by the existing quantity of human capital at time zero and may be augmented over time by new investments. The rate of new investment is expected to be relatively large early in life, then decline as the worker ages, and perhaps stop some time prior to retirement. Of course, skills may depreciate with time and if the rate of depreciation exceeds the rate of new investment, productivity and earnings will decline.

The human capital model predicts that earnings are relatively low early in life, rise throughout most of a person's worklife, and then level off during the final working years. These predictions concerning the lifetime earnings profile conform to the observed pattern of earnings and yield important implications for public policy relative to reducing poverty and race/sex differences in earnings.

Contracting models offer a different rationale for the observed increase in earnings with increases in labor market experience. An example of the structure of these models is to assume that the worker enters the labor market with productivity of MP(0) and does nothing to augment this stock throughout his worklife so that productivity at retirement is also MP(0). Furthermore, this level of productivity can only be achieved if the worker exerts a high level of effort which implies a greater disutility from working than if the worker supplies a low level of effort. However, a low level of effort yields a realized productivity of MP(0)*; MP(0) > MP(0)*.

In a spot market where contracting and payment occurs at the beginning of the period but effort is observed only at the end of the period, firms will only agree to pay at the low effort level of productivity. Consider the alternative: a firm contracts for a high level of effort and sets W = MP(0). The worker accepts the contracts and then cheats on the firm by supplying a low level of effort, MP(0)*. At the end of the period, the worker is found to have failed to meet the terms of the contract and is not rehired. Upon termination the worker sells his services to another firm that because of his reputation will contract with him only at the low level of effort rate. In this example, the worker always has an incentive to cheat and if he cheats, the firm always loses. Thus, if contracts are limited to a single period, compensation will be set at the low level of effort, W = MP(0)*.

The data on observed job tenure indicates that many workers remain with a single employer for several years (Hall, 1982). The theory of implicit contracts attempts to explain this quasi-permanent relationship by arguing that workers and firms enter into implicit contracts that benefit both parties. The primary objectivies of these contracts are to limit employee turnover and to motivate workers to produce a greater level of output. To encourage the worker not to cheat or shirk on the job, he is paid less than MP(0) during early working years on the promise that compensation will exceed MP(0) in later years. For the promise to be meaningful, the worker must be protected from future wage reductions and layoffs or compensated for these risks.

These relationships between earnings and productivity are shown in Figure 1. Initial productivity (MPO), which can be achieved only with a high level of worker effort, is shown by the line AB. Productivity that is achieved with a low level of effort (MPO*) is shown by the line CD. Without contracting, workers will be paid W = MPO* in each period. With contracting, workers are paid according to the profile shown in EF. The result is that workers are paid less than their productivity in the early working years on the promise that if they provide a high level of effort they will be retained and paid in excess of their productivity in the final working years. The present value of EF must equal the present value of AB, which, of course, exceeds the present value of CD, or

$$\int_0^R MP(t)e^{-rt}dt = \int_0^R W(t)e^{-rt}dt, \tag{1}$$

where R = retirement age and r = interest rate. Generalizing this model to allow for productivity growth yields

$$\int_0^R MP(0)e^{(g'-r)t}dt = \int_0^R W(0)e^{(g-r)t}dt, \tag{2}$$

where g' = growth rate of productivity and g = growth rate of earnings. The worker accepts the contract if the utility of the higher present value of earnings based on high effort exceeds the disutility from providing high rather than low effort.

Since workers receive compensation in excess of MP(0) in later working years, there must be a terminal point for the contract. This could be the normal retirement age for the pension plan or the age of mandatory retirement. Firms do not arbitrarily renege on the contract because they wish to continue to make such contracts with younger workers. If a firm underpaid young workers and then did not honor the implied terms of the contract, future cohorts of new workers would not accept the contract offer.

The contracting model predicts that earnings rise more rapidly than productivity over time, $g > g'$. Empirically, this can be tested by estimating the rate of growth of earnings as a function of coverage by such a contract. If coverage by a pension plan or mandatory retirement provisions is used as a proxy for an implicit contract, then we can estimate the growth rate of earnings as a function of whether the worker is covered by one of these contracts.[2] The contracting model also predicts that if the worker seeks to continue on the job past the termination of the contract, the firm will offer a wage that is substantially below the last wage prior to the end of the contract. If the worker is willing to accept a decline in earnings, the firm should be willing to retain him.

IV. PENSIONS AND THE GROWTH OF EARNINGS

The preceding discussion concentrated on the relationship between productivity and earnings as if the only form of compensation were cash earnings. Pensions have been included as part of compensation in some contracting models. For the most part, these papers have used pensions as a residual payment in the years following retirement. The pension payment is merely the repayment of the bond that the worker posted earlier in life, which is equal to the difference in the present value of lifetime productivity and earnings,

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[2]Lazear (1979) reverses this relationship and estimates coverage by a pension or mandatory retirement as a function of the difference between actual and predicted wage growth where the wage variable is based on retrospective data and the initial wage is not related to the current job but the worker's first job.

$$\int_R^T P(t)e^{-rt}dt = \int_0^R MP(0)e^{(g'-r)t}dt - \int_0^R W(0)e^{(g-r)t}dt. \qquad (3)$$

These models have tended to ignore the direct link through pension benefit formulas between earnings and future pension benefits. In this section, we describe the actual relationship between pensions and earnings and examine two competing theories for the evaluation of pension wealth. The concept of pension compensation is introduced and integrated into the contracting model. The result of this extension of the contracting model yields a series of testable hypotheses concerning the earnings profile.

A worker covered by a pension plan is exchanging his labor for current earnings and the promise of future income in the form of pension benefits. The value of future pension benefits depends on the implied nature of the labor contract, survival probabilities, and government regulations. Two methods of calculating the pension wealth of a worker have been proposed: the legal method and the projected earnings method. The legal method determines the benefit that a worker is legally entitled to receive based on current earnings and pension characteristics. A clear discussion of this method is found in Bulow (1982). The projected earnings method assumes a form of implicit contracting in which the worker expects to continue to be employed with the same firm until retirement. For a detailed development of this model, see Ippolito (1985). Once pension wealth is determined at some point in time, these methods are then used to calculate the change in pension wealth with continued work or pension compensation. They both assume that pension compensation plus earnings equal productivity in each period.

Using the legal method, the value of pension compensation is determined by assuming that the labor contract is valid for a single period. Of course, the contract may be renewed, but the worker acts as if he will be terminated at the end of each period. Therefore, he is willing to pay only for those pension benefits that the firm is legally required to pay should the worker leave the firm at the end of the contract period.[3] To illustrate the implications for earnings profiles, a brief discription of this model is required. First, assume that a worker is covered by an earnings-based defined benefit formula

$$B(t) = \alpha SY, \tag{4}$$

where B(t) = benefit at retirement, assumed to remain fixed until death, α is a generosity factor, S is a salary average based on last year's earnings, and Y is years of service. Using the legal method, the worker calculates retirement benefits based on earnings to date and current years of service. If fully vested, this is the benefit to which he is legally entitled if he leaves the current job. The present value of this benefit is

$$V(A) = B(t) \cdot H(A), \tag{5}$$

where H(A) is the expected value of a life annuity of one dollar per year beginning at age R discounted to age A. Substituting for B yields

$$V(A) = \alpha W(0) e^{gt} Y \cdot H(A). \tag{6}$$

Prior to the age of eligibility, pension compensation is the change in V due to an additional year of work which is

$$V_y = B_y \cdot H(A)$$

or

$$= [\alpha W(0) e^{gt} + \alpha g W(0) e^{gt} \cdot Y] H(A). \tag{7}$$

Equation 7 shows that pension compensation is a function of an additional year of credited service and the growth rate of earnings. After the age of

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[3]The justification of this model and the related mathematics can be found in Bulow (1982), Clark and McDermed (1986) and Kotlikoff and Wise (1985).

eligibility, the worker must give up current benefits to continue working, so that

$$V_y = B_y H(A) - B.$$

Therefore, pension compensation will drop sharply when the worker becomes eligible to begin receiving benefits. Only Clark and McDermed (1986) have explicitly considered the post-eligibility earnings response using this model; however, the wage increase is a clear implication of the model developed by Bulow (1982).

Even though the model assumes that total compensation grows at the same rate as productivity, earnings will grow more slowly than productivity. This is due to the rapid growth in the proportion of total compensation that goes to pension compensation as the worker ages.[4] As shown in Figure 2, prior to the normal retirement age (R), pension compensation (MP-W) increases with age more rapidly than earnings or productivity. After R, pension compensation drops sharply and may become negative. With the spot market assumption, this requires that earnings increase sharply and exceed productivity if employment continues after the normal retirement age (Clark and McDermed, 1986). Thus, this model can be tested by comparing growth rates of earnings for persons covered by a pension plan with those of persons not covered. The expectation is that pension participants will have slower earnings growth.

The projected earnings method is an alternative way of calculating pension wealth and pension compensation. The methodology assumes that the worker and his employer enter into a long-run implicit contract. One aspect of this contract is the promise of a larger pension benefit if the worker stays with the firm than if he quits prior to the predetermined retirement

[4]This is demonstrated in Kotlikoff and Wise (1985).

age. If the worker thinks that the probability of quitting or being laid off is very low, then he may be willing to exchange current earnings for the prospect of receiving the larger stay pension. In many plans, the benefit received at retirement after a career completed with the same firm is based on the final earnings prior to retirement. Thus, the projected earnings method assumes that the worker anticipates a full career with this firm and bases his wealth calculation on his expected pension benefits conditional on his staying with the firm (Pesando, 1985, and Ippolito, 1985).

In this model, the pension benefit is viewed as being based on expected final earnings rather than current earnings,

$$B(t) = \alpha W(0)e^{gR} \cdot Y, \tag{8}$$

and pension compensation is

$$V_y = \alpha W(0)e^{gR} \cdot H(A). \tag{9}$$

Comparing equation 9 to pension compensation using the legal method (equation 7), it can be shown that when years of service are small the projected earnings calculation yields a larger value for pension compensation; however, late in a person's worklife the opposite will be true.

Relative to the legal method, the worker pays more for pension coverage early in life and less in the final working years. As a result, earnings growth will be greater with the projected earnings method. Ippolito (1985) shows that when nominal wage growth equals the nominal interest rate, earnings will grow at the same rate as productivity. In this case, the worker receives a constant proportion of total compensation in the form of pension compensation. Although Ippolito does not consider post-eligibility employment, the projected earnings method also will imply a wage increase. This follows from the ending of the implicit contract and the requirement that the wage be equated to productivity in each period. This pattern of compensation growth is illustrated in Figure 3.

IV. PENSIONS AND EMPLOYMENT CONTRACTS

If pension coverage is assumed to imply a long-run labor contract, then pension compensation can be explicitly modelled in a contracting model that seeks to discourage employees from providing a low level of effort or quitting prematurely. This yields a series of interesting implications with testable hypotheses. This type of compensation profile and its two components, earnings and pension compensation, are examined in this section.

The legal method of evaluating pension wealth attributes to the worker only those benefits the firm is legally required to pay at retirement. Calculating pension compensation using this method gives the annual increment to pension wealth resulting from continued employment. This is a commitment the firm cannot easily violate and therefore cannot use as a threat to prevent employee cheating. The contracting model must then require that total compensation (earnings plus pension compensation) be less than productivity early in life but greater than productivity in the final working years.

For any given tilt in the total compensation profile caused by the contract, pension compensation will grow more rapidly than earnings. The exact relationships between earnings and productivity in the final working years and the rate of growth of earnings compared to the rate of growth of productivity is indeterminant without first specifying the pension benefit formula and the degree of the tilt of the total compensation profile relative to the productivity profile. For example, Figure 4 illustrates a contract that tilts the total compensation profile so that the worker is being paid in excess of his productivity in the final working years. Despite this tilt, earnings grow more slowly than productivity throughout the worklife. At the terminal point of the contract, total compensation exceeds productivity but earnings are less than productivity. In most pension plans, the gain from continued work drops sharply at the normal retirement age. The result of this decline is that unless earnings are increased, total compensation may fall below productivity if the worker remains on the job. The point here is that when the pension plan is formally modelled, total compensation declines at the terminal point of the labor contract if the worker continues to work. Firms may be willing to provide a spot market wage for work after this point, but, to equate earnings and productivity, this may require a wage increase for the older worker.

In summary, integrating pensions as a form of compensation into a contracting model and evaluating these benefits using the legal method alters the predictions concerning the earnings profile relative to lifetime productivity. No longer are earnings necessarily expected to grow more rapidly than productivity prior to the normal retirement age and the wage a firm is willing to offer for work past the normal retirement does not have to fall relative to wages prior to this age.

Evaluating pension benefits using the projected earnings method also alters the basic predictions of the contracting model concerning the path of earnings. The projected earnings method fits neatly into the implicit contract model since it is based on the concept of long-term job tenure. Each period the worker pays for a pension that he will receive conditional on his remaining with the firm and fulfilling the contract. This value exceeds the pension he will receive if he leaves the firm. In essence, the worker is posting a bond in each period during his early working years. As the value of the bond grows, the costs of quiting or shirking and being fired rises. The absolute magnitude of the accumulated bond peaks sometime prior to the terminal point of the contract. The bond or the loss from leaving then declines and reaches zero at the age of normal retirement (Allen, Clark, and McDermed, 1988).

If benefits are evaluated using the projected earnings method, the predictions about the relationship between total compensation and productivity are the same as contracting models that ignore pensions. Since the worker pays for the projected benefit in the form of lower wages in each period, earnings plus the pension benefit as derived by the projected earnings method equal productivity. The projected benefit or stay pension exceeds the leave pension; therefore in terms of the compensation the worker will receive if he quits or is fired, he is underpaid in the early working years but overpaid in the final years prior to the normal retirement age. Because of this relationship, there is no further need to tilt the compensation profile relative to the productivity profile. As noted above, Ippolito argues that the projected earnings method implies that earnings grow at the same rate as productivity. For work after the normal retirement age, pension compensation drops and earnings must rise to maintain the assumption of total compensation equal to productivity.

The use of the projected earnings method for calculating pension benefits in conjunction with a labor contract also alters the predictions of the contracting model concerning the relationship of earnings to productivity. This model predicts that earnings rise at the same rate as productivity throughout the worklife and must be increased for work after the normal retirement age.

V. EMPIRICAL ANALYSIS OF EARNINGS GROWTH

The preceding theoretical discussion of lifetime earnings identified several rationales for earnings growth and each of these models yields predictions concerning the rate of growth of earnings. The primary predictions are shown in the table below:

Summary of Theoretical Predictions

	Labor Contract: Pension not formally modeled	Pension Evalutated with Legal Method: Spot Market	Pension Evaluated with Projected Earnings Method	Labor Contract: Pension formally modeled
Growth Rate of Earning for Persons Covered by Contract Relative to Uncovered	greater	lower	same[a]	ambiguous
Change in Earnings at End of Contract	fall	rise	rise	ambiguous

[a]This prediction is dependent on assumptions concerning the lifetime pattern of quits and layoffs, mortality rates, and the difference between wage growth and interest rates.

To test these theories we begin with a standard human capital earnings model

$$W_{it} = f(X_i, P_t, \eta_{it})$$

where W_{it} is the ith worker's annual nominal earnings, X_i is a vector of observed productivity-related and job characteristics for the ith worker, P_t is the overall level of prices, and η_{it} is a stochastic error term. We assume that W_{it} is log-linear with respect to X_i and P_t and that the logarithm of η_{it} is normally distributed. Included in X_i are characteristics that influence pension compensation. The effect of these factors on the level of an individual worker's wage will vary with years of service. We also allow the effect of the individual characteristics on the wage level to vary with years of service. Given these assumptions, the empirical specification for the earnings function is

$$\ln W_{it} = \alpha' X_i + \beta' T_{it} \cdot X_i + \gamma P_t + u_{it}, \tag{10}$$

where T_{it} is the length of job tenure at time t and u_{it}=exp(η_{it}). The disturbance in the earnings function for worker i is specified to be

$$u_{it} = \phi_i + \epsilon_{it},$$

where ϕ_i represents unobserved person-specific factors. The transitory component, ϵ_{it}, is assumed to be correlated over time according to a first order autoregressive process. This leads to the following specification for the error term

$$E(u_{it}) = \phi_i,$$

$$E(u_{it}u_{jt}) = 0 \text{ for } i \neq j,$$

$$\epsilon_{it} = \rho\epsilon_{i,t-1} + \upsilon_{it},$$

$$\upsilon_{it} \sim N(0,\sigma_\upsilon^2),$$

$$\epsilon_{i0} = \frac{\upsilon_{i0}}{\sqrt{1 - \rho^2}}, \text{ and}$$

$$E(\epsilon_{i,t-1}\upsilon_{it})=0 \text{ for all t.}$$

The growth in nominal earnings from time period 0 to time period R for individual i is estimated by taking the difference between the logarithm of final earnings, W_{iR}, and the logarithm of initial earnings, W_{i0}. Assuming that the parameters of the model are constant and that years of service is the only X characteristic that changes between time period 0 and time period R, the wage change equation is

$$\Delta \ln W_i = \alpha_T \Delta T + \beta' \Delta T_i \cdot X_i + \gamma \Delta P + v_i, \tag{12}$$

where $v_i = \epsilon_{iR} - \epsilon_{i0}$. The differencing removes the estimation bias arising from the unobserved individual fixed effects, ϕ_i, but if ρ is not zero, the error term is heteroskedastic. The variance of v_i will be a function of the autocorrelation coefficient, ρ, and ΔT_i,

$$E(v_i^2) = \sigma_\upsilon^2 \left[\frac{(\rho^{\Delta T}-1)^2}{1-\rho^2} + \sum_{s=0}^{\Delta T-1} \rho^{2s} \right]. \tag{13}$$

Nonlinear least squares estimates of ρ obtained by regressing the squared residuals from (12) on ΔT according to (13) are used to obtain individual specific estimates of the variance of v_i. These weights are then used to obtain weighted least squares estimators for the parameters of (12).

This specification allows us to test directly the theoretical predictions of the effect of pensions and mandatory retirement on earnings growth. As shown in (12), the rate of growth of nominal earnings depends on individual-specific characteristics that influence growth in productivity, pension characteristics that influence pension compensation, and the change in the overall price level. Samples of workers from the Retirement History Study and the National Longitudinal Survey of Mature Males are used to estimate the effects of these components on nominal earnings growth between 1953 and 1981.

The RHS is a national sample of persons aged 58 to 63 in 1969. Interviews were repeated in two-year intervals for ten years for those respondents who survived and could be located (Irelan, 1976). We use the 1969 through 1975 waves of the survey as well as the accompanying social security earnings data for the years 1953 to 1974 to analyze the growth in nominal earnings during this period. In 1969, 45 percent of the over 11,000 respondents are full time male workers employed in occupations other than agriculture and private household services. Fifty-eight percent of these full time workers are covered by pensions. Since most pension plans require ten years of service before benefits are fully guaranteed (U.S. Department of Labor, 1984), those respondents with less than ten years of service are eliminated from the analysis. The analysis for this sample is based on the change in nominal earnings between the year a worker has ten years of service and the year of retirement, the year of pension eligibility, or 1974. Earnings are reported social security earnings form the RHS social security earnings record.

Earnings for workers who reach the social security earnings maximum are estimated using the method developed by Fox (1982). The earliest social security earnings record used is 1953. Therefore, for workers who completed ten years of service prior to 1953, the first observed earnings corresponds to years of service in 1953.

The National Longitudinal Survey of Mature Males contains information from 1966 to 1981 on the labor market activities of a national sample of men aged 45 to 59 in 1966. Since 1971 is the first year that contains detailed information about employer retirement plans, only data from 1971 to 1981 are used. The working sample consists of workers who are, in 1971, employed full time in occupations other than agriculture, the armed forces, and private household services and who have at least ten years of service. In this sample, we analyze the growth in earnings between 1971 and the year of retirement, the year of pension eligibility, or 1981. Earnings are self-reported earnings from the sample.

Individual-specific characteristics included in the wage growth equations are education, health, and race. Besides pension coverage and mandatory retirement, other job characteristics included are industry, occupation, and union.[5] Descriptive statistics for the included workers in both samples are presented in Table 1. The typical worker in both samples is a production

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[5]We assume that once individual effects are controlled for there is no difference in productivity growth between workers who are covered by pensions or mandatory retirement and those who are not. If coverage by these contracts increases expected job tenure, workers may be more willing to invest in firm-specific human capital. Therefore, it is possible that they could have more rapidly rising productivity than noncovered workers. As a result, their earnings could grow less rapidly than their productivity but still rise more rapidly than the earnings of noncovered workers. This problem is somewhat reduced in these samples because workers are limited to long-term older workers who should have relatively small new investments.

worker in the manufacturing sector with less than 12 years of schooling. Over 70 percent are covered by pensions and over half have jobs with mandatory retirement. Most of the workers covered by mandatory retirement also have pensions. Of those covered by a pension in the RHS, 66.4 percent are observed working after they are eligible for either full or partial pension benefits. Only 39 percent of the NLS sample are observed working after eligibility.

The earnings profiles of workers in the RHS span an average of 11 years between 1953 and 1974. During this time, the average change in nominal earnings is approximately 43.4 percent and the average change in the overall price level during the period that these workers are observed is 28 percent. The average time span for the NLS sample is only 4.8 years. However, the average change in earnings is 32 percent and the average change in the overall price level is 30 percent.

The effects of employment contracts on earnings growth are estimated for the two data sets and the estimates of pensions and mandatory retirement coverage are shown in Table 2. For each survey, wage growth is estimated across two times spans. First, earnings growth is estimated using only the pre-eligibility years so that none of the workers are eligbile to receive a pension if they stop working. The second estimates include the pre-eligibility years plus one post-eligibility year for those workers who work after eligibility. This latter specification includes an eligibility variable that is predicted to be negative in the simple Lazear model and positive when pensions are formally modelled.

Results for wage growth prior to pension eligibility in the RHS are presented in column (1). In this sample, production workers in the manufacturing sector with less than 12 years of schooling and no pension have an estimated earnings growth of 2.5 percent for each year of service. In the absence of mandatory retirement provisions, the estimated effect of pensions on the growth rate of earnings (P*(1-MR)*ΔT) is .7 percent per year of service. Mandatory retirement with pensions or without pensions increases the growth rate of earnings by 1 percent. All of the estimated pension coverage and mandatory retirement effects are statistically significant at the 1 percent level.

If wages are indexed to inflation, then γ will be one. The estimated effect for the change in the logarithm of the consumer price index is statistically less than one. The results indicate that a little over 60 percent of the total change in the price level was passed on to workers in this sample. This suggests that 39.5 percent of the 43.4 mean change in earnings is attributable to inflation and 60.5 percent is the result of productivity growth. To assess the change in real wages, these effects should be examined together. Since the parameter estimate for the change in the price level is less than one, estimated real wages rise by less than the 2.5 percent per year shown by the tenure estimate. The combined effects of price changes and productivity increases predict a real wage increase of approximately 1.4 percent per year for an additional 11 years of service for the average worker in manufacturing not covered by a pension or mandatory retirement. Workers covered by pensions and/or mandatory retirement are predicted to have real earnings growth of approximately 2.2 percent per year. These estimates are generally consistent with the rising real wages in the United States economy between 1953 and 1972.

The results of pre-eligibility wage growth for the NLS are given in column (3) of Table 2. Most of the growth in nominal earnings is the result of changes in the overall price level. The estimated effect for the change in the logarithm of the consumer price index is not statistically different from one. The estimated effect of ΔT on earnings growth of -1.1 percent is not statistically different from zero. Taken together, these two estimates predict declining real wages for the NLS sample. Again this is consistent with the actual decline in real wages in the United States during this time. From 1971 to 1981, real wages in the nonagricultural sectors of the economy declined by about 6 percent. The estimates for pensions and mandatory retirement are similar to those for the RHS. Pensions with or without mandatory retirement increase the growth rate of earnings between .6 and .8 of 1 percent. However, only the mandatory retirement effect in the absence of pensions is statistically significant. Earnings are estimated to increase by almost 2 percent for each year of service for workers with mandatory retirement provisions and no pensions.

To test the effect on earnings of working past the age of eligibility, the length of the time span is increased in both samples to include earnings in the first year after a worker becomes eligibile for full or partial benefits. These results are shown in columns (2) and (4). The variable P*E indicates whether a covered worker has worked past the age of pension eligibility. Though not statistically significant, the results do show an increase in earnings of between 2.4 and 2.9 percent once the age of eligibility is reached.

Turning to the individual and industry effects shown in Table 3, we see that for workers in the RHS, individual characteristics have a statistically significant effect on earnings growth. Health, both recent and long-term, lowers the growth in earnings. Health limitations that have existed for more than five years have less effect than more recent ones. The estimated growth rate of earnings for nonwhite workers is about 1 percent more than that of white workers. Earnings for professional workers are estimated to grow about one half of 1 percent more than production workers. Government workers are also estimated to have higher earnings growth. As well, there appear to be significant differences in growth rates across industries. In all industries except trade, growth rates exceed that of manufacturing. In the NLS sample, the estimated individual effects are not statistically significant. Only industry and occupation have statistically significant effects on wage growth.

Workers who are covered by mandatory retirement but are not pension participants comprise a small subset of people in both samples (6 percent of the RHS and 9 percent of the NLS). They tend to be older production workers and have an average of approximately 30 years of job tenure. Over 70 percent of these workers have less than 12 years of schooling, over half are in the transportation industry, and over 55 percent have collectively bargained wages. Estimates from both samples show that these workers have significantly higher earnings growth. This result supports the Lazear conjecture that mandatory retirement serves as a proxy for implicit contracts and increases the growth of earnings relative to the growth of productivity.

In a recent paper, Hutchens (1987) concluded that workers in the NLS with jobs characterized by repetitive tasks tend not to be covered by pensions or mandatory retirement. He argued that repetitive jobs are more easily monitored and hence will be less likely to have mandatory retirement or pension coverage. The characteristics of workers in the NLS who we find to be covered only by mandatory retirement are characteristics that Hutchens associated with a greater likelihood of having repetitive jobs. Thus our finding that these are workers with mandatory retirement and high wage growth contradicts

Hutchens' conclusions concerning these workers.

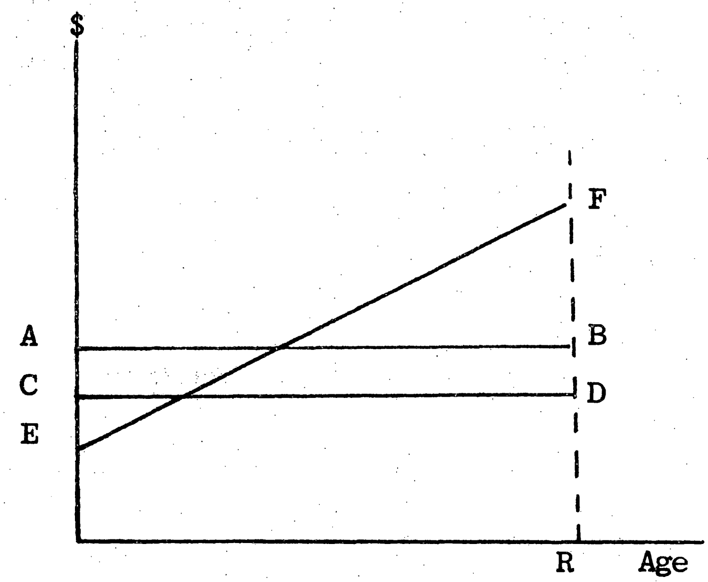
The preceding results provide evidence for the existence of implicit long-run labor contracts. The finding that earnings grow more rapidly for workers covered by pensions directly contradicts the predictions from the legal method of calculating pension wealth and supports the predictions from both the projected earnings method and the Lazear model. However the evidence that earnings increase after pension eligibility is consistent with a model that formally models the pension contract. Therefore, even though the growth of wages exceeds the growth of productivity, in terms of total compensation, older workers are not earning more than their productivity.

VI. CONCLUSIONS AND IMPLICATIONS

This analysis of earnings histories indicates that employment contracts can and do alter the earnings profiles of workers in predictable ways. Prior to eligibility, pensions increase the rate of growth of earnings. There is an additional increase in earnings when workers continue working past the early or normal retirement age. These results are consistent with the projected earnings method of calculating pension liabilities and contradict the predictions of the legal method of calculating pension wealth prior to the age of eligibility. Mandatory retirement provisions also seem to have an independent effect on the growth of earnings. This provides further evidence for implicit lifetime contracts.

The use of the projected earnings method of calculating pension liabilities has important implications for the cost of employment termination and labor mobility. Using pension compensation based on projected earnings allows firms to penalize early quitters and to protect against workers shirking on the job. Since the workers are paying for more pension wealth than will ultimately be received if employment with the firm is terminated, there are greater incentives for them not to leave voluntarily and not to shirk on the job.

Figure 1. Earnings and Productivity: Lazear Contracting Model

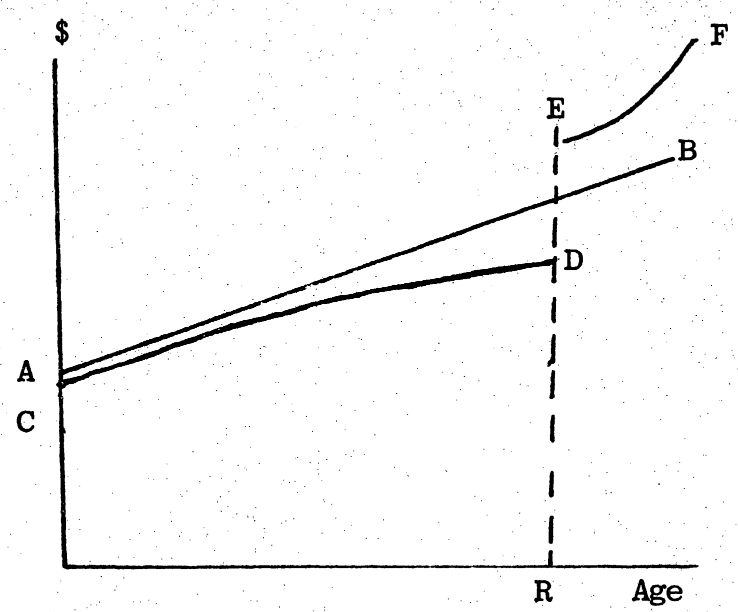


AB - High Effort Productivity

CD - Low Effort Productivity

EF - Wage Profile for Implicit Contract

Figure 2. Productivity, Earnings and Pension Compensation: Legal Method



AB = Productivity Profile

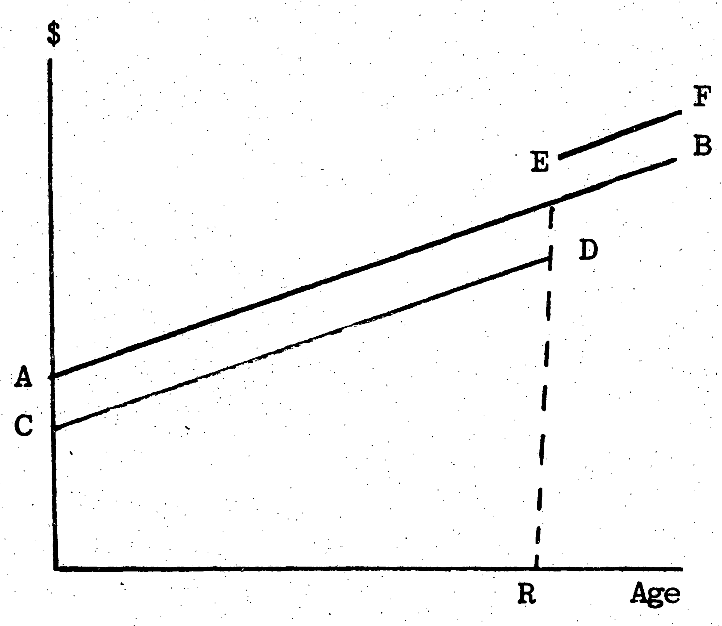
CD = Earnings Prior to Eligibility

EF = Earnings After Eligibility

AB - CD = Pension Compensation Prior to Eligibility

AB - EF = Pension Compensation After Eligibility

Figure 3. Productivity, Earnings, and Pension Compensation: Projected Earnings



AB = Productivity Profile

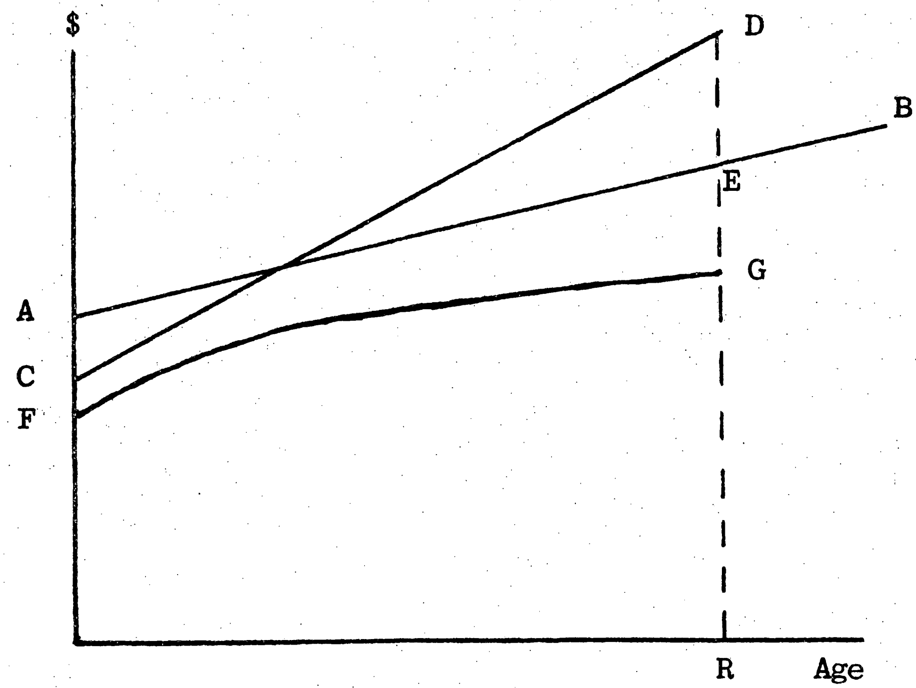
CD = Earnings Profile Prior to Eligibility

EF = Earnings Profile After Eligibility

AB - CD = Pension Compensation Prior to Eligibility

AB - EF = Pension Compensation After Eligibility

Figure 4. Employment Contracts and Legal Pension Compensation



AB = Productivity Profile

CD = Total Compensation Prior to Eligibility

EB = Total Compensation After Eligibility

FG = Earnings Prior to Eligibility

Table 1. Variable Definitions and Descriptive Statistics[a]

Variable	RHS Sample Mean	NLS Sample Mean
Age	60.233	54.472
	(1.667)	(3.554)
Education		
Ed.1 (less than 12 yrs)	0.593	0.592
Ed.2 (12 - 15 yrs)	0.310	0.305
Ed.3 (16 yrs +)	0.097	0.102
Nonwhite	0.084	0.315
Health Limitation		
Recent (less 5 yrs)	0.094	0.123
Long-term (5 yrs +)	0.096	0.094
Occupation		
Professional	0.236	0.206
Clerical	0.109	0.108
Production	0.655	0.686
Industry		
Mining & Construction	0.084	0.071
Manufacturing	0.445	0.449
Transportation	0.139	0.167
Trade	0.101	0.090
Finance, Insurance, & Real Estate	0.045	0.032
Services	0.114	0.096
Public Administration	0.073	0.096
Union		0.512
Government Worker	0.176	0.215
Pension Coverage Only	0.215	0.175
Pension & Mandatory Retirement	0.511	0.540
Mandatory Retirement Only	0.064	0.093
Work After Eligibility[b]	0.664	0.390
Final Tenure	27.055	26.706
	(9.865)	(7.631)
Change in Tenure	11.262	4.771
	(5.420)	(2.562)
Change in Log Earnings	0.434	0.321
	(0.403)	(0.435)
Change in Log CPI	0.279	0.297
	(0.128)	(0.207)
Sample Size	1,666	511

[a]Standard errors are in parentheses.

[b]Includes only workers covered by pensions.

Table 2. The Effects of Pensions and Mandatory Retirement on Wage Growth

Variable	RHS (1)	RHS (2)	NLS (3)	NLS (4)
Intercept	0.001 (0.028)	-0.051 (0.037)	0.048 (0.062)	-0.001 (0.056)
Change in Log CPI	0.614*** (0.128)	0.683*** (0.153)	1.116* (0.630)	0.847 (0.555)
ΔT	0.025*** (0.005)	0.025*** (0.025)	-0.011 (0.052)	0.012 (0.045)
P*(1-MR)*ΔT	0.007*** (0.002)	0.006*** (0.002)	0.008 (0.007)	0.003 (0.006)
P*MR*ΔT	0.010*** (0.002)	0.009*** (0.002)	0.006 (0.006)	0.006 (0.005)
(1-P)*MR*ΔT	0.010*** (0.004)	0.010*** (0.004)	0.016** (0.008)	0.014* (0.008)
P*E		0.024 (0.024)		0.029 (0.025)
R^2	0.298	0.308	0.500	0.522
ρ	0.842 (0.073)	0.919 (0.052)	0.912 (0.121)	0.924 (0.110)
Sample Size	1,284	1,328	436	515

[a]Statistical significance levels for the test that the parameter is zero are denoted by * for .10 level, ** for .05 level, and *** for .01 level.

Table 3. Individual and Industry Effects on Wage Growth[a]

Variable	RHS (1)	RHS (2)	NLS (3)	NLS (4)
Recent health Limitation	-0.075** (0.034)	-0.087*** (0.033)	0.012 (0.046)	0.045 (0.039)
Long-term health Limitation	-0.007*** (0.002)	-0.009*** (0.002)	-0.003 (0.006)	-0.003 (0.005)
Ed. 2	0.001 (0.002)	0.001 (0.002)	0.004 (0.005)	0.003 (0.004)
Ed. 3	0.002 (0.003)	0.000 (0.003)	-0.004 (0.007)	-0.002 (0.006)
Nonwhite	0.011*** (0.003)	0.009*** (0.003)	-0.001 (0.004)	-0.001 (0.004)
Professional	0.005** (0.002)	0.003* (0.002)	-0.001 (0.006)	0.004 (0.005)
Clerical	-0.001 (0.003)	-0.003 (0.002)	-0.014** (0.006)	-0.011* (0.006)
Government	0.009* (0.005)	0.015*** (0.005)	0.011* (0.006)	0.011** (0.006)
Union			-0.001 (0.005)	0.000 (0.004)
Mining & Construction	0.005* (0.003)	0.005* (0.003)	-0.016** (0.007)	-0.014** (0.007)
Transportation	0.011*** (0.003)	0.008*** (0.002)	-0.001 (0.005)	0.001 (0.005)
Trade	-0.006** 0.003	-0.004 (0.002)	0.004 (0.007)	0.002 (0.006)
Finance, Insurance, & Real Estate	0.007** (0.003)	0.008*** (0.003)	-0.028*** (0.011)	-0.027*** (0.010)
Services	0.004 (0.003)	0.004 (0.003)	-0.024*** (0.008)	-0.024*** (0.007)
Public Administration	0.003 (0.009)	0.016** (0.008)	-0.001 (0.010)	-0.007 (0.008)

[a]Except for recent health limitation, all variables are interacted with ΔT. Statistical significance levels for the test that the parameter is zero are denoted by * for .10 level, ** for .05 level, and *** for .01 level.

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