Why Do Labour Contracts Offer Guaranteed Annual Wage Increments?

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Abstract: Academic contracts in the UK are characterised by wages that rise with annual increments and guaranteed future employment. In a model based on the arrival of outside offers, it is shown how such seniority wages can arise in both competitive labour markets and when the employer enjoys some monopsony power. The model is then reinterpreted to introduce risk about future productivity. In this framework, it is shown that seniority wages can co-exist with the rational offer of a tenure contract by the firm.

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I. Introduction
An interesting feature of wage contracts for tenured academic staff in UK universities is that they formally embody the principal that wages should increase with seniority. Individuals are hired at, or near, the bottom of a wage scale that has 17 different wage levels each separated by approximately 5%. Once hired, lecturers are guaranteed the right to move at least one step up this pay ladder each year. Of course this whole scale is renegotiated annually, resulting in additional wage increases, superimposed on the automatic increments. Many other UK public sector labor contracts employ a similar wage ladder, for example those of civil servants, local government employees, school teachers and health service workers. Although employment of these groups is very secure, contracts of university lecturers are particularly interesting because tenure guarantees to the individual, over some range, both increasing wages and future employment. Thus, although the evidence for seniority wages from econometric studies has been mixed [1; 2], we have in these contracts a clear cut case to explain, and one with the additional wrinkle of guaranteed future employment.

In this paper we adopt an explicitly multi-period framework in order to investigate guaranteed wage increments over time. A critical feature of the model is the assumption that consumption is allocated across periods according to the life-cycle hypothesis. Multi-period contracts are therefore evaluated by the lifetime utility which they yield. It should be emphasized that even for contracts where wage increments are guaranteed, there still remains residual uncertainty about future earnings since the possibility exists that a worker may receive a better outside offer. In section II this uncertainty is motivated by incomplete search and in section III by the fact that ability only becomes known after the first period of employment. These essentially represent different interpretations of the same model. The analysis of section II assumes that all workers are offered a tenure contract and it is shown that seniority wages arise naturally in such a framework. This in followed in section III by a joint analysis of seniority wages and the firm's decision whether to offer a tenure contract. In this case, seniority wages can again arise and, importantly, tenure contracts can actually be more profitable for the firm than contracts with no tenure. Two reasons for tenure emerge in this model. It acts as insurance for workers against the income risk they face and it allows employers to benefit from the tie-in caused by the existence of relocation costs for workers who choose to switch employer.

There is no pre-existing rationalisation of seniority wages that is consistent with the stylised facts we wish to explain. The conventional explanation of increasing
wages is human capital theory [3] and this could in principle also explain guaranteed future employment at higher wages if human capital were acquired at a common and predictable rate for all workers in each grade. However, this does not seem a reasonable explanation in the context of university employment, where the vast majority of human capital is acquired early in career and, as far as research output is concerned, most likely declines over time. There are a number of alternative theories of seniority wages that build on the assumption of asymmetric information rather than human capital. These include moral hazard [10], adverse selection [15], and uncertainty on the part of firms about workers' productivity [7]. However, none of these is consistent with a precommitment to both higher future wages and guaranteed employment. For example, one explanation for wage/experience scales that rise faster than productivity is that workers' efforts cannot be directly controlled, or measured and rewarded, so a worker earns less than his marginal product when young, and correspondingly more when old, in order to discourage shirking. This is proposed by Lazear [10] and the idea is developed further in Malcolmson [11]. However in Lazear's model it is essential that shirking workers, if caught, be sacked, and in Malcolmson's that they are not promoted, so this cannot explain the commitment to increasing wages for tenured academics.

Kuhn [9] develops an interesting model of why trade unions might choose such a pay ladder, based on the idea that seniority wages may be an effective way for a union to extract rents that accrue to the firm's owners, analogously to the use of non-linear price schedules in product markets. However, seniority is assigned by the union rather than earnt over time and, as the analysis is essentially single period, there is nothing explicit in this model which implies automatic pay rises over time for individual workers and employment is in no way guaranteed. Indeed uncertain employment is at the heart of this model.

The remainder of the paper is organised as follows. Section II studies the model under uncertainty about future wage offers. The optimality of seniority wages for a firm offering a tenure contract is demonstrated. The issue of whether a firm would ever wish to offer a tenure contract is integrated with the issue of seniority wages in section III. Conclusions are given in section IV.
II. Contracts with Tenure

In this section we assume a two-period tenure contract is granted to new hires and study the characteristics of the associated wage profile. The offer of tenure contracts has been justified in a number of ways in the literature. The most obvious approach has been to treat it as a device designed to protect academic freedom and allow researchers to pursue ideas that may be in conflict with the beliefs of the employer. An alternative suggestion is that tenure has evolved as a social custom [5] that reflects the collegiate roots of universities. In the economics literature the argument that tenure exists because of the inherent risk involved in following an academic career [6; 8] has found some favour. The basis of the argument is that the training required for academic work is long: from entering as an undergraduate to completing a doctorate takes a minimum of six years. Even after this training the financial rewards are not great but, more importantly, the level of performance in the job, in terms of the rate and quality of publication, is not fully realised until several more years have passed. A final argument for tenure has been provided by Carmichael [4] on the basis that it provides the security needed for those already in post to allow them to appoint new hires that will eventually be competitors with them for the limited funds of the university.

There are two key features of the models developed here. First we note that a worker who is offered a tenure contract may nevertheless be exposed to future income uncertainty since they can quit if they receive a better outside wage offer at the beginning of the second period. Secondly we assume that the lifetime expected income is optimally allocated between the two periods, subject to any capital markets constraints. The implication of this assumption is that the supply of labor in response to any particular wage offer will depend on the discounted value of lifetime expected utility which is implied by the contract.

The model is studied in the context of two formulations of the labor market. In the first, the firm is assumed to have some monopsony power, facing an upward sloping labor supply schedule (as a function of expected utility). This allows us to examine how Kuhn's idea that seniority wages may be viewed as an optimal price schedule might work in this model. The second assumes the labor market is competitive.

The Labor Market

Assume a labor market characterised by a wage dispersion, which is supported by imperfect information and costly search. Persistence of such a wage dispersion in equilibrium may be explained by heterogeneous firm marginal revenue product
schedules, see Reinganum [14]. There are many identical workers who live for two periods and they supply inelastically one unit of homogeneous labor per period. Workers in their first period (the "young") are observationally distinct from those in their second period (the "old"). At the beginning of each period, workers have the opportunity to costlessly search an exogeneously determined number of firms, $S$, after which further search becomes prohibitively expensive. Clearly $S$ must be small, relative to the number of firms, to support a wage dispersion. Workers' expectations at the beginning of the first period, over the best wage offer they will receive at the beginning of the second period, are described by a probability density function $f(z)$, which is assumed to be continuous on the interval $(z, \tilde{z})$, with distribution function $F(z)$.

Given the offer of a two period contract with wages $\{w_1, w_2\}$, it is assumed that the worker's expected lifetime income is optimally allocated between periods contingent upon the degree of access to credit markets. We consider the two limiting cases of perfect capital markets, with borrowing/lending at a fixed rate of interest, $r$, equal to the individual's time discount rate, and imperfect capital markets with no possibility of borrowing. It is assumed that the preferences of each worker can be represented by an additively time separable expected utility function. The expected utility of a wage offer, $V(w_1, w_2)$, is thus given by

$$V(w_1, w_2) = U(w_1 + b) + \left[ \frac{1}{1 + r} \right] F(w_2) U(w_2 - b[1 + r]) + \int_{w_2}^{\tilde{z}} U(z - b[1 + r]) f(z) dz,$$  \hspace{1cm} (1)

where $b$ is the first period borrowing which has to be repaid whether the individual remains with the first period firm (the second term on the right-hand side of (1)) or moves to a better job in the second period (the third term). The optimal level of borrowing, $b^*$, is chosen to satisfy the necessary condition

$$\frac{\partial V}{\partial b} (w_1 + b^*) = \int_{w_2}^{\tilde{z}} U'(z - b^*[1 + r]) f(z) dz - F(w_2) U'(w_2 - b^*[1 + r]) = 0.$$  \hspace{1cm} (2)

At the beginning of the first period the contract is chosen, out of the $S$ offered, which maximizes expected utility and at the beginning of the second period the worker quits if the best outside offer, $z$, is better than the firm's second period contract wage, $w_2$. We now turn to characterise the optimal labor contract which a single firm, hiring in this market, would offer.
Contracts with Monopsony Power

Consider a firm which hires labor in the market described above to maximize the present discounted value of profits, $\pi$, over the two periods. Assume that labor is the only input and that there is a linear production technology. We choose the units of measurement so that 1 unit of labor produces 1 unit of output. The firm receives price, $p$, per unit of output with certainty in both periods.

The monopsony power of the firm, and workers' uncertainty about future wage offers, can both be motivated in a number of ways. One assumption used below is that the labor market is characterized by search and information costs. This both implies some monopsony power for firms and some second period wage uncertainty for workers, if they undertake search at the beginning of each time period. However, one could equally well motivate the future wage uncertainty by an appeal to uncertain promotion prospects. The monopsony power of the firm could be due to it being the only employer for a certain class of skilled labor, as in the case of universities where the initial motivation for this problem was found. Thus it is hoped that this basic idea has some generality of application beyond that formally modeled below.

The monopsony power implies the labor supply schedule of young workers to the firm is an increasing function of the expected lifetime utility offered by the contract. The probability that this firm's offer is the best of the $S$ which a random searcher has received increases with the level of the wage offer. The firm sets a contract and employs all who accept it. The determination of the (single) wage offer that the firm will make to any old workers who are searching is not studied here since it involves no new issues. The optimal contract for each age group is independent of that offered to the other under the preceding assumptions that marginal revenue product is constant and identical for both groups and that the two groups are observationally distinct. It should be noted now, for it will be used later, that this specification guarantees the monopsonist strictly positive profits from employment of young workers under a conventional single wage policy, providing that $p$ is greater than the wage offer that will elicit at least one unit of young labor.

The discussion in the introduction suggests that the wage offer made to the young will in general be an offer of first period employment at $w_1$, followed by a second period at $w_2$. Second period outside offers are assumed unobservable by the firm, and hence $w_2$ cannot be made contingent upon these [12]. We make this assumption because we want to explain the observed non-state contingent commitment to higher future wages.
The problem for the firm is to choose the two-period wage contract \( \{w_1, w_2\} \) which maximizes profits, \( \pi \), where

\[
\pi = \left[ p - w_1 \right] N(V(w_1, w_2)) + \left[ \frac{1}{1 + r} \right] \left[ p - w_2 \right] F(w_2) N(V(w_1, w_2)).
\]  

(3)

We have assumed first period employment is sufficiently large that the quit rate \( 1 - F(w_2) \) is effectively non-stochastic and hence the results here are independent of the firm’s attitude to risk. \( N(V(w_1, w_2)) \) is the upward sloping labor supply curve discussed above, so \( N(\cdot) > 0 \).

The first order conditions for profit maximization are

\[
\frac{\partial \pi}{\partial w_1} \equiv \left[ p - w_1 + F(w_2) \left( p - w_2 \right) \right] N' \frac{\partial V}{\partial w_1} - N = 0,
\]

(4)

and

\[
\frac{\partial \pi}{\partial w_2} \equiv \left[ p - w_1 + F(w_2) \left( p - w_2 \right) \right] N' \frac{\partial V}{\partial w_2} + \left[ N \left[ \left( p - w_2 \right) f(w_2) - F(w_2) \right] \right] \left[ 1 + r \right] = 0.
\]

(5)

Solving (4) and (5) yields

\[
\left[ \frac{\partial V}{\partial w_2} \right] \left[ \frac{\partial V}{\partial w_1} \right] = \left[ F(w_2) - \left( p - w_2 \right) f(w_2) \right] \left[ 1 + r \right].
\]

(6)

Consider first the solution with perfect capital markets. In that case the worker’s choice of borrowing is characterized by (1) and (2). Employing the envelope theorem

\[
\frac{\partial V}{\partial w_1} = U'(w_1 + b^*),
\]

(7)

and

\[
\frac{\partial V}{\partial w_2} = \left[ F(w_2) U'(w_2 - [1 + r] b^*) \right] \left[ 1 + r \right].
\]

(8)

Substituting (7) and (8) into (6) gives

\[
\left[ F(w_2) U'(w_2 - [1 + r] b^*) \right] \left[ U'(w_1 + b^*) \right] = F(w_2) - \left[ p - w_2 \right] f(w_2).
\]

(9)

The first proposition follows directly from (9).

**Proposition 1**

When workers are risk neutral the profit-maximising contract will specify seniority wages with \( w_2 > w_1 \). In particular, second period wages will equal marginal revenue product but first period wages will be less than marginal revenue product.
Proof
Risk neutrality implies $U(\cdot)$ is constant. From (9) it then follows that $w_2 = p$. Since the monopsony power of the firm implies that it makes strictly positive profits, it follows from (3) that $w_1 < p$.

The intuition for this result is that the worker's second period expected surplus can be effectively "sold", bundled with first period employment, by lowering the first period wage. Therefore, $w_2$ is chosen so that second period joint firm-worker surplus is maximized. This is somewhat analogous to the well-known result, 0i [13], that in a product market a monopolist should capture consumers surplus by an entry fee, and thereafter price output at marginal cost. This contract provides a useful benchmark since it maximizes the joint expected surplus of a firm and its workers. It is an efficient contract, but leaves the worker exposed to uncertainty in the second period. If workers are risk averse there may be insurance gains in modifying it.

The outcome when workers are risk-averse is summarised in Proposition 2.

Proposition 2
If workers are risk averse workers the profit-maximising contract will specify seniority wages. The second period wage will exceed marginal revenue product and the first period wage will be less than marginal revenue product.

Proof
From the first-order condition for the choice of $b$ it follows that

$$U(w_1 + b[1 + r]) = U'(\chi - b[1 + r])F(\chi)[1 - F(\chi)] + F(w_2)U'(w_2 - b[1 + r]),$$

for some value $w_2 < \chi < z$. Risk aversion implies

$$U'(\chi - b[1 + r]) < U'(w_2 - b[1 + r]),$$

hence

$$U'(w_2 - b*[1 + r]) > U'(w_1 + b*).$$

From (9) it can be seen that (12) implies $w_2 > p$. Positive profits require, from (3), that $p > w_1$ and hence $w_2 > w_1$. Risk aversion serves to lower the first period wage, and raise the second period wage, compared to risk neutrality. This makes part of the lower first period wage look like an insurance premium against not finding a better job in a later period, and is thus a distinct component of seniority wages from the monopsony power. Thus
we would expect it to be observed even in a competitive labor market. We investigate the truth of this observation in the following subsection.

It is widely argued that consumers have limited ability to borrow against human capital and, accordingly, we now consider the other polar case where no borrowing is possible. When workers have no access to credit, a worker may save in the first period but not borrow, so \( b^* \leq 0 \). In this case the maximization of utility is subject to the constraint \( b^* \leq 0 \). It is straightforward to show that this constraint binds, since \( b^* > 0 \) in the unconstrained problem, and we may therefore proceed to analyse this case by setting \( b^* = 0 \). Set \( b^* = 0 \) in (9) and suppose \( w_2 \leq w_1 \), which implies \( U'(w_2) \geq U'(w_1) \) under risk aversion. This implies, from (9), that \( p \leq w_2 \). But if \( w_2 \leq w_1 \), then it must be true that \( p \leq w_1 \). This is inconsistent with firm's profit being strictly positive, which it must be under the technology and market assumptions made in this section. Hence \( w_2 > w_1 \) which implies, from (9), if \( b^* = 0 \), that \( p > w_2 \). Therefore, with imperfect capital markets, the form of the profit-maximising contract remains as described in Proposition 2.

**Competitive Labour Market**

We now amend the labor market described in the previous subsection by assuming that the search costs at the beginning of the first period are zero. The set-up for the second period is unchanged. If it seems little forced to have zero search costs for young workers, and positive for old, it might be emphasized that the principal objective here is to isolate two distinct forces at work in the preceding section. Also the search framework was only one justification for second period wage uncertainty. If second period wage uncertainty is due to uncertainty about the individual's productivity in other jobs and this uncertainty is resolved at the beginning of the second period, then it is quite consistent with this that the first period should be competitive. The purpose here is to capture in an uncluttered framework the everyday feature that workers in practice typically recognise, when they accept one job, that they may receive a better offer at some date in the future, and this holds true even if they found their first job in a competitive labor market. For example, their promotion to higher grades within the same firm may be uncertain.

The labor market now clears in the first period, under full information about contracts on offer at all other firms in the current period. The firm faces an infinitely elastic supply of young labor at an exogenously determined level of expected utility since workers compare expected utilities of contracts. Integrating the preceding model of the firm with this labor market implies that profits are linear in output and employment, and hence firm size is indeterminate. Rather than amend the model so
A sufficient condition for a unique firm size can be identified, we proceed by considering only a necessary condition which must be satisfied. This suffices to characterise the optimal wage contract \( \{w_1, w_2\} \) which necessarily must satisfy

\[
\{w_1, w_2\} \equiv \arg\max\left\{ \pi = p - w_1 + F(w_2)[p - w_2 \sqrt{1 + r}] \right. \quad \text{s.t.} \quad V(w_1, w_2) \geq \bar{V} \right\}.
\] (13)

Employing the restriction that \( b^* \) solves (2), the derivatives of the Lagrangean describing the optimization in (13) are

\[
\frac{\partial L}{\partial w_1} = -1 + \lambda U'(w_1 + b^*),
\] (14)

and

\[
\frac{\partial L}{\partial w_2} = \left[ p - w_2 \right] F'(w_2) - F(w_2) \sqrt{1 + r} + \lambda \left[ F(w_2) U'(w_2 - b^* \sqrt{1 + r}) \right] \sqrt{1 + r},
\] (15)

where \( \lambda \) is the lagrange multiplier on the minimum-utility constraint. Proposition 3 can then be proved.

**Proposition 3**

When workers are risk averse, the profit-maximizing contract specifies wages which increase with seniority. The second period wage will exceed marginal revenue product, and first period wage will be less than marginal revenue product.

**Proof**

Substituting (14) into (15) gives

\[
\frac{\partial L}{\partial w_2} \bigg| _{w_1 = w_2} = \left[ p - w_2 \right] F'(w_2) - F(w_2) \sqrt{1 + r} + \lambda \left[ F(w_2) U'(w_2 - b^* \sqrt{1 + r}) \right] \sqrt{1 + r}.
\] (16)

Consider a pair of wages such that \( \hat{w}_1 = \hat{w}_2 \) and note (i) that \( \hat{w}_2 \leq p \) for profits to be non-negative; and (ii) \( \hat{w}_1 = \hat{w}_2 \) implies \( b^* > 0 \) so \( U'(\hat{w}_2 - b^* \sqrt{1 + r}) > U'(\hat{w}_1 + b^*) \).

Now evaluating (14) at \( \hat{w}_1 = \hat{w}_2 \) gives

\[
\frac{\partial L}{\partial w_2} \bigg| _{\hat{w}_1 = \hat{w}_2, \hat{w}_1 \leq p} > 0.
\] (17)

This implies that the optimum must have \( w_1 < p < w_2 \). ||

Thus even in a competitive labor market, if risk averse workers have access to credit, seniority wages will be observed. If workers are risk neutral then the wage will equal marginal revenue product in each period. This is obvious from (16). The intuition for this result is the following: second period utility for the worker is \( \max \{U(w_2 - b^* \sqrt{1 + r}), U(z - b^* [1 + r])\} \). Since \( z \geq w_2 \), raising \( w_2 \) will reduce second period risk. Under risk aversion, marginal utility will be highest when the
worker remains with the firm a second period. Thus, from a position with \( w_1 = w_2 \), a marginal increase in \( w_2 \) and a marginal reduction in \( w_1 \) will result in first-order insurance gains, but second-order efficiency losses.

Now consider the case where the workers cannot borrow. The firm is a price taker in the output market, and hence equilibrium requires zero profits. This gives Proposition 4.

**Proposition 4**
If workers do not have access to capital markets, the only equilibrium is where wages are constant, and equal to marginal revenue product in each period.

**Proof**
It can again be shown that the constraint \( b = 0 \) is binding. From (16), the necessary condition for the firm's optimisation reduces to

\[
\left[ p - w_2 \right] f(w_2) - F(w_2) + F(w_2)U'(w_2)/U'(w_1) = 0,
\]

when \( b^* = 0 \). Assume that \( w_2 > w_1 \). From the above equality, this implies that \( p > w_2 \) and hence that profits are positive. Conversely, assume that \( w_2 < w_1 \). Then \( p < w_2 \) and profits are negative. Only the outcome \( w_1 = w_2 = p \) is consistent with the zero-profit outcome. 

**Discussion**
The intuition for these results starts from a consideration of the base line case of workers who are risk neutral, where their expected utility is maximized by maximisation of expected wage receipts. Introducing risk aversion implies the distribution of wage receipts matters. If workers have access to borrowing, and consumption is determined by lifecycle utility maximisation, then under either monopsony or in a competitive labor market, marginal utility of income is highest, because of repayment of first period borrowing, in the second period if the worker doesn't find a better second period job. This implies that they will trade-off some expected wage income, for a redistribution of wages into the state where they don't quit. On the other hand, under monopsony, if they have no access to capital markets, the marginal utility of income is highest in the first period, and therefore there needs to be a marginal re-distribution from the second to the first period, compared to the contract which maximizes expected wages. In a competitive labor market the wage contract for risk neutral workers implies the same wage in both periods. Thus if workers cannot borrow, their marginal utility of income is the same in both periods, if they don't quit, and there is no reason for wage redistribution. These intuitions bear
some resemblance to those in the insurance literature, where first-order insurance gains are obtained at the expense of second-order efficiency losses.

### III. Endogeneous Tenure Choice

In this section we extend the model to show how future income uncertainty may explain the decision of a firm to offer a tenure contract. In this way we provide a new explanation to tenure contracts, different to those discussed in the introduction to section II. In short, we now demonstrate how a minor modification of the model we have already considered can have tenure emerging as the preferred solution for both workers and firms. In addition, it will be shown that it is possible for tenure to arise in conjunction with seniority wages.

The structure that we adopt is the following. As in the second subsection of II, each worker searches the potential employees before accepting the best contract offered. At this stage, the ability of the worker in the occupation is unknown to either the worker or any of the firms. In the university context, the interpretation is that the workers have completed their Ph.D.s but have yet to prove their capability at achieving publications. The ability of each worker is realised during the first period and, at the end of this period, is public knowledge. The consequence of this structure is that the first period wage must represent the return to some average level of ability whereas it is possible for the second period wage to be conditional upon ability. We assume that the labor market is competitive so the optimisation for the firm is constrained, as in (11), by the utility level achievable elsewhere on the market.

There is one further modification that is introduced. We assume that it is not costless for a worker to move between jobs at the end of the first period. Such removal costs can be significant in practice. For a typical academic in the UK with five years of experience, the direct costs involved in selling one house and purchasing another plus the cost of removal of personal belongings can easily reach 25% of the annual salary of £20000. Although a new employer may choose to offset some of these direct costs there are additional indirect costs, most notably those involved with a spouse securing employment in a new location. As such, these moving costs reduce the freedom of movement within the system and provide a tie-in to the initial employer. As will become apparent, one aspect of tenure can then be interpreted as a mechanism to prevent employers from exploiting this tie-in. An alternative interpretation of this cost could be that of acquiring the specific human capital required to function effectively after a job switch.
To formalise this discussion, assume that each worker has an innate ability level, $a$, where $a \in [a, \bar{a}]$. Ability in the population of workers is randomly distributed and can be described by the density function $f(a)$ with cumulative distribution $F(a)$. At the beginning of period 1, ability cannot be observed but it becomes common knowledge at the end of this period. The measure of ability is chosen so that the value of a worker of ability $a$ to a firm is equal to $a$. If a worker wishes to change employer at the end of the first period, a moving cost of $c$ must be paid.

First consider the outcome that arises in the absence of tenure. Assuming that the labor market is competitive with many firms competing for the available workers. Since all firms are essentially identical, in each time period they must all offer the same wages. The first step is to determine the wage offered in the second period when ability has become public knowledge. The value of a worker to a firm is given by their revealed ability $a$ and, if a worker were to move to a new firm, this is the wage they would receive. However, the employer which they joined in period 1 has a degree of monopoly power over their incumbent employees since a worker wishing to move between firms must pay a cost of $c$. In fact, the wage they need to pay to retain all their workforce is given by $a - c$ and this must be the equilibrium wage in period 2 as a function of ability. Although entry of new firms cannot upset this equilibrium wage in the second period, the consequence of entry is that expected profit for firms must be driven to zero. Since the second period wage is below the marginal value product of a worker, the first period wage must be sufficiently above to ensure zero profit. This reasoning implies that the non-tenure outcome is given by

$$\begin{cases} w_1^n = E(a) + c[1 + r], \\ w_2^n = a, \\ E(\pi^n) = 0. \end{cases}$$

From the structure of this non-tenure contract, the utility level that is obtained is given by

$$V = \int_a^{\bar{a}} U(w_1^n + b)f(a)da + \left[\frac{1}{1 + r}\right]\int_a^{\bar{a}} U(w_2^n - b[1 + r])f(a)da$$

$$= \int_a^{\bar{a}} U(E(a) + c[1 + r] + b)f(a)da + \left[\frac{1}{1 + r}\right]\int_a^{\bar{a}} U(a - c - b[1 + r])f(a)da$$

This is the minimum utility level that any tenure contract must supply in order for a firm offering tenure to attract any workers.
Turning to the case of tenure, the expected payoff to a worker of accepting a contract \( \{ w_1', w_2' \} \) is given by

\[
V(w_1', w_2') = U(w_1' + b) + \left[ \frac{1}{1 + r} \right] \int_a \left[ U(w_2' - b[1 + r])f(a)da + U(a - b[1 + r])f(a)da \right],
\]

where the worker will only choose to change jobs if revealed ability is greater than \( w_2' + c \).

Now assuming as we did above that the number of workers employed is sufficiently great that to allow the population proportions to be applied to the firm, the profit level of a firm offering a tenure contract will be

\[
\pi(w_1', w_2') = N \int_a f(a)da - w_1' + \left[ F(w_2' + c)[1 + r] \right] \int_a f(a)da - w_2',
\]

where only those receiving an offer in excess of \( w_2' + c \) will leave. As in the second subsection of II, we do not attempt to determine the scale of operation of the firm but instead characterize the optimal contract for a given level of operation.

The Lagrangean describing the optimization facing the firm can then be written as

\[
\mathcal{L} = \int_a f(a)da - w_1' + \left[ F(w_2' + c)[1 + r] \right] \int_a f(a)da - w_2' + \lambda \left[ V(w_1', w_2') - \pi \right].
\]

Given the context, the constraining level of utility is chosen to be equal to the expected utility that a worker can expect to achieve if they simply accept the non-tenure market-determined contract, \( w_i^n, i = 1, 2 \), in each period. This is given by (18). Since the optimisation of the firm is constrained by the utility level achievable by the worker in the absence of tenure, a net surplus is generated by the tenure contract if the maximized level of profits arising from (21) is positive. This will be one of the points of focus below.

From (21) the optimal tenure contract offered by the firm will satisfy the necessary conditions

\[
\frac{\partial \mathcal{L}}{\partial w_1'} \equiv -1 + \lambda V_1 = 0,
\]

(22)
and

\[
\frac{\partial L}{\partial w_2} \equiv \left[ F \left( w_2 + c \right) \left( 1 + r \right) \right] w_2 + c \left[ f \left( w_2 + c \right) - 1 \right] + \left[ f \left( w_2 + c \right) \left( 1 + r \right) \right] \int_a f(a) da - w_2 \right] \right] + \lambda V_2 = 0. \tag{23}
\]

Solving (22) and (23) characterizes the wage in the second period of the tenure contract as the solution to

\[
V_2/V_1 = \left[ F \left( w_2 + c \right) \left( 1 + r \right) \right] - w_2 + c \left[ f \left( w_2 + c \right) \right] - \left[ f \left( w_2 + c \right) \left( 1 + r \right) \right] \int_a f(a) da - w_2 \right] . \tag{24}
\]

There are now two points that must be demonstrated. Firstly, it must be shown that there are circumstances in which seniority wages can emerge from (24). The reason why this is possible is clear. Since the second-period wage places an upper limit on the ability of employees that remain with the firm, the firm has an incentive to defer payment in a tenure contract to that period in order to raise the mean level of ability. The benefit from doing this is offset to some degree by the fact that all workers have to be paid the higher wage but, as long as ability distribution is not too concentrated at low levels, it should prove beneficial for the firm. The second fact that must be established is, as already noted, that a tenure contract with seniority wages can lead to positive profits for the firm. When it does, it strictly dominates the non-tenure contract.

To make our point that seniority wages and profitable tenure can co-exist, we calculate the outcome for the case of worker risk-neutrality. Adopting risk-neutrality biases the case as much as possible against tenure because the firm is unable to profit from offering insurance to the workers. So, if tenure is profitable in this case, it will be more so when workers are risk averse and would pay a risk premium to insure against the randomness in the second-period outcome. Using (7) and (8), with risk-neutrality (24) reduces to

\[
F \left( w_2 + c \right) w_2 = w_2 - \int_a f(a) da . \tag{25}
\]

Now assume that \( a = 0 \) and that \( f(a) = 2a/\bar{a}^2 \) so that \( F(a) = a^2/\bar{a}^2 \). Substituting into (25), the second-period wage must solve
The assumption of risk neutrality implies that the utility function is linear. From (18) the constraint that the tenure contract offers the same utility as that expected without tenure can be written as

\[ w_1' + \int_0^{w_2 + c} \left[ 2 a w_2' / \bar{a}^2 \right] da + \int_{w_2' + c}^{\bar{a}} \left[ 2 a [ a - c ] / \bar{a}^2 \right] da = \bar{a}/2 + \bar{a}/2 [1 + r] \].  

Finally, the expected profit from the employment of each worker is given by

\[ E\pi = 2 \bar{a}/3 - w_1' - \left[ w_2' + c \right] \bar{a}^4 [1 + r] \].  

Table I describes the solution of the system (26) - (28) for a range of parameter values. As can be seen from the table, both seniority wages and the existence of tenure are supported by these results. The explanation for this is that the moving cost ties the worker to the firm so that although the firm is rewarding some workers more than their marginal product, the marginal worker is being paid amount \( c \) less than marginal product. Although the firm still makes a loss in the second period, this is more than offset by the profit it achieves in the first period. Although we acknowledge the distribution function employed is unusual, this was chosen only for computational ease. After all, the main point was to establish that cases existed under which seniority and tenure could both be simultaneously rational.

\[ \text{Table I Placed Here} \]

**IV. Conclusions**

Although this paper was initially motivated by a puzzling property of contracts for University lecturers in the UK, it is hoped that the resulting model has served to isolate general forces at work in shaping labor contracts. If the employer has some monopsony power seniority may be an efficient way to extract worker's surplus, rather like non-uniform prices in output markets. Secondly, and quite independently of the competitive structure of the labor market, if life-cycle optimising workers have access to credit markets, they will have a preference for jobs with an increasing wage profile, out of that set of wage profiles which holds constant the expected wage bill to the employer. This insurance motivation was highlighted by the model where the labor market was competitive, and workers were risk averse.
We have also provided a formulation of uncertainty about future productivity combined with costs of relocation which provides motives for both seniority in wages and the provision of tenure in employment. It is possible for the firm to increase its profits by offering the workers some insurance against both uncertainty in the outcome and the need to relocate in the form of a second-period wage that exceeds that paid in the first-period. Although we have presented the costs as being connected with relocation, they could equally be treated as being caused by the need for retraining after a job switch (for instance by the need to learn firm-specific skills). Doing this naturally broadens the interpretations that can be given to the model.

References


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1 Formally, the move up from the 7th point is given after a review of performance but this is usually not rigorously applied. In addition, the final three points are given on special merit.

2 The argument does not work for a uniform distribution. The one we use could approximate the normal below the mean.