Moral Hazard and Merit Rating Over Time: An Analysis of Optimal Intertemporal Wage Structures

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I. Introduction

A fundamental problem that has been the focus of much work in agency theory has been the design of contracts to provide insurance to risk-averse agents and to elicit appropriate levels of effort.[1] In the context of insurance, the problem is viewed as one of moral hazard whereby the insured agent will reduce the level of his precautions to prevent an accident if he is insured against the adverse outcome. In the labor market context, the problem is one of providing effective work incentives while at the same time promoting the risk-sharing element of contracts. The overall structure of the analyses is quite similar whether or not the focus is on the insurance market, the labor market, or principal-agent problems in general. For concreteness, this paper addresses the labor market incentives problem.

The labor market problem is complicated by the firm's inability to observe the worker's ability and effort and also by stochastic elements that impede a firm's attempts to make more indirect inferences using output to assess the worker's productivity-related efforts. This combination of uncertainty and the need to create incentives takes on added importance in the case of workers who are risk-averse. The presence of risk aversion often mitigates the emphasis the firm can place on incentive creation, as there is a desire on the part of workers to have stable income streams. Complete equalization of one's income level across states to promote insurance will, however, remove the differential rewards needed to provide an incentive for individuals to expend effort.

This inevitable tradeoff between the work incentive and insurance function of contracts has been studied in detail for single-period contracts. The focus of my analysis here will be on how these influences affect the multi-period wage structure. Although there has been research on the multi-period incentives problem[2] and on the role of moral hazard in multi-period contexts,[3] there is no literature on the optimal design of a merit rating system over

1. For general reviews of these issues, see Arrow [1] and Pratt and Zeckhauser [9]. Other research dealing with this class of issues includes the papers by Arrow [2], Ehrlich and Becker [3], Pauly [7, 8], Shavell [11, 12], Spence and Zeckhauser [13], and Viscusi [15].

2. The most recent paper of this tyre is that of Rogerson [10].

3. See, in particular, Viscusi [15].

time for situations in which the principal is learning about the agent's riskiness over time, which is the fundamental element involved in merit rating.

After introducing the analysis of worker effort in section II, I analyze the properties of the multi-period wage structure in section III and explore the implications for multi-period wage contracts in sections IV and V. Consideration of the multi-period structure issues will prove to be consequential for two reasons. First, the steepness of the earnings profile will be altered over time depending on the worker's initial productivity. Second, the relative rewards across states in period 2 following any particular outcome will also be affected. In short, the entire structure of subsequent compensation becomes altered so as to generate more effective work incentives in the initial period.

II. The Work Effort Decision

Consider a situation in which the worker's productivity is uncertain given any level of work effort on his behalf. I will assume that in each period either the worker's productivity is high or he is unproductive, with a lower level of productivity. The particular state of productivity that occurs is a stochastic event influenced by his work effort, but not completely determined by it. Both the employer and worker share this uncertainty about the worker's future productivity, and each of them can monitor the productivity state that occurs. The role of the worker's effort is to enhance the probability $p(e)$ that state a will prevail, in which case the worker is productive, where

$$p' > 0 \text{ and } p'' < 0$$

in the initial period. Within such a binary productivity outcome format, there is no loss of generality in setting the worker's output at 1 if the productive state a prevails and at 0 if the unproductive state b holds.

For simplicity, I will assume that there are only two periods to the worker's choice problem. This time horizon is long enough to permit the role of learning but sufficiently short so that it is possible to find a closed form solution to the worker choice problem. In the second period the worker must make a similar effort choice except that the assessed probability that the worker will be productive may be different based on the information acquired about the worker's productivity in period 1. In a situation of heterogeneous workers, whether or not the worker is productive initially will provide information regarding the worker's underlying ability. In addition, the level of work effort cannot be monitored directly so that to create effective incentives rewards will be based on observed performance, not worker input.

The worker's productivity in the initial period will influence the perceived probability that the worker will be productive in the second period. The subscript s will denote the values of variables conditional on an initial successful job experience, and the subscript f will denote variable values conditional on an unfavorable first-period outcome (i.e., a failure).

Using information on the distribution of worker abilities and the relation between work effort and productivity, both the employer and worker form a conditional probability $p_s(e_s)$ that the worker who expends effort e_s will be productive in period 2 after an initial success (i.e., state a), where

Table I. Summary of Wage Contract Notation

	Period 1	Period 2 after Success	Period 2 after Failure
Wage in State *a*	w_a	x_a	y_a
Wage in State *b*	w_b	x_b	y_b
Probability that State *a* Occurs	$p(e)$	$p_s(e_s)$	$p_f(e_f)$

$$p_s' > 0 \text{ and } p_s'' < 0 .$$

Similarly, after an initial failure where the worker is unproductive in period 1, the chance of being productive in period 2 is governed by $p_f(e_f)$, where

$$p_f' > 0, p_f'' < 0,$$

and

$$p_f(e_f) < p_s(e_s)$$

if $e_s = e_f$.[4]

To provide workers with appropriate incentives the firm establishes a contingent contract whereby the worker is paid a wage that varies depending both on his productivity and possibly on the period as well. No restrictions will be placed on this wage structure since the focus of the article is on what factors will govern the nature of the wage contract. In the initial period the wage payments in states *a* and *b* are w_a and w_b. Following an initial success, the wage pair is given by x_a and x_b for these two states, and following an initial failure they are y_a and y_b. The rewards structure is summarized in Table I.

The assumption that the firm can vary the wage rate based on the worker's past and previous productivity is in the general spirit of the kind of wage flexibility arguments underlying agency theory models. For example, the analysis of optimal contracts in the presence of cyclical risks by Hall and Lazear [4] involves a similar range of complexities in terms of the design of efficient contracts. Complete leeway in terms of the firm's ability to set worker wages may not always be present if the wage is tied to the job rather than the worker.[5] In such a context, one could recast the model in terms of the firm's ability to assign workers to jobs (and consequently set wages) costlessly, but the degree of discretion the firm may have in practice may be limited. To the extent that such impediments exist, one can view the analysis here as providing an efficient markets reference point which ideally firms should attempt to achieve if it is not too costly to do so.

Worker preferences $Z(M, e)$ for different outcomes depend positively on the monetary reward M and negatively on the level of effort e. I will assume that this utility function is additively separable and is of the form[6]

$$Z(M,e) = U(M) - E(e).$$

4. The situation of shared information is also assumed to be one of firm-specific information. Experimentation that also influences the worker's productivity elsewhere can be modeled similarly, as in Viscusi [14].

5. See Williamson, Wachter, and Harris [16] for an extensive discussion of the sources of impediments to efficient wage contracts.

6. The implications of additive separability for multi-attribute utility functions are explored in Keeney and Raiffa [5].

The worker is assumed to be risk-averse with respect to monetary gambles, or

$$U' > 0 \text{ and } U'' < 0.$$

In addition, there is increased disutility associated with higher levels of effort, or

$$E' > 0 \text{ and } E'' > 0.$$

Since the effort allocation is common to both states, the worker's expected utility V in period 1 is given by

$$V = p(e)U(w_a) + [1-p(e)]U(w_b) - E(e).$$

The expected utility in period 2 following a productive outcome in period 1 is given by

$$V_s = p_s(e_s)U(x_a) + [1-p_s(e_s)]U(x_b) - E(e_s),$$

and following an unproductive outcome it is

$$V_f = p_f(e_f)U(y_a) + [1-p_f(e_f)]U(y_b) - E(e_f).$$

In each period the worker's task is to select his optimal level of effort. In period 1, however, this effort not only affects the level of V, but it also influences the chance that the pertinent second period rewards will be governed by V_s or V_f. Because of these interdependencies, one must solve the work effort problem with standard dynamic programming methods.

If the worker is productive initially, in period 2 he will pick e_s to maximize his value of V_s. The condition governing the choice of e_s^* is that

$$0 = p_s'[U(x_b) - U(x_a)] - E_s'. \tag{1}$$

Equation 1 defines the value of e_s^* that leads to the optimal V_s^*. The worker continues to expend effort until the increased expected utility from raising the chance that state a prevails is just offset by the added disutility associated with greater work effort. Similarly, for the optimal e_f, one has the requirement that the worker set

$$0 = p_f'[U(y_a) - U(y_b)] - E_f'. \tag{2}$$

The value of V_f^* represents the expected utility evaluated the e_f^* value that satisfies equation (2).

The worker's initial effort choice is to pick the effort level to maximize his discounted expected utility W over both periods. Let the discount factor β be the inverse of one plus the interest rate. Consequently, he will

$$\max_e \; W = V + \beta p(e)V_s^* + \beta[1-p(e)]V_f^*,$$

or he will pick e to maximize his current expected utility plus the influence his present effort has on discounted expected future utility through its effect on the probability that the worker is initially productive.

The resulting optimal effort condition is that[7]

$$0 = p'[U(w_a) - U(w_b) + \beta(V_s - V_f)] - E'. \tag{3}$$

7. The second-order conditions are also satisfied here and for e_s and e_f above as well.

Work effort is increased until its marginal disutility just equals the increased probability that the productive state a will occur, multiplied by the added immediate and deferred rewards associated with this outcome. Since V_s exceeds V_f, the dynamic aspects of the wage structure will give the worker an incentive to work harder than he otherwise would.

The within-period incentive effects show a consistent pattern in all three cases. Upon total differentiation of equations (1–3), one can show that boosting the wage associated with a productive work outcome enhances the productivity-related incentive in that period, or

$$\partial e/\partial w_a > 0,\ \partial e_s/\partial x_a > 0, \text{ and } \partial e_f/\partial y_a > 0,$$

and raising the state b wage lowers the incentive to be productive:

$$\partial e/\partial w_b < 0,\ \partial e_s/\partial x_b < 0, \text{ and } \partial e_f/\partial y_b < 0.$$

Workers respond in the expected fashion to contemporaneous wage incentives.

The influence of deferred compensation on immediate incentives is somewhat different. Here the principal concern for generating work incentives is not which state prevails in the second period but how this payment is linked to whether or not the worker is productive in period 1. As a result, both wage payments in period 2 following an initial success will boost worker effort, as

$$\partial e/\partial x_a > 0 \text{ and } \partial e/\partial x_b > 0.$$

Similarly, higher wages after an unproductive experience lower initial effort, or

$$\partial e/\partial y_a < 0 \text{ and } \partial e/\partial y_b < 0.$$

It is these linkages of subsequent wages to the initial effort decision that will establish the rationale for manipulating the temporal wage structure as an incentive-generating device.

The relative magnitude of the incentive efforts cannot be ascertained in general. For example,

$$\partial e/\partial w_a = [p'U'(w_a)]/(-\partial^2 W/\partial e^2),$$

and

$$\partial e/\partial x_a = [\beta p_s U'(x_a)]/(-\partial^2 W/\partial e^2).$$

Without further restrictions on the relation between effort and the probability that the worker will be productive as well as other features of the choice problem, one cannot ascertain whether w_a or x_a will be more important in inducing worker effort. That there should be such an ambiguity in and of itself is somewhat surprising since it suggests that future compensation contingent on the worker's initial productivity may be more effective than present compensation contingent on the worker's initial productivity. Similar ambiguities pertain to the other wage variables as well. In situations where the period 2 chance of being productive p_s is high, the value of x_a will be more important (and x_b will be less important). Increases in the responsiveness p' of the initial productivity probability to current effort will boost the role of w_a. The other wage parameters take on importance that varies in similar fashion. Deferred compensation does not play a role that is necessarily dominant or subsidiary, but its relative importance will depend on the particular circumstances.

III. Optimal Multi-Period Wage Structures

The Firm's Decision Problem

Workers' effort responses with respect to different parameters of the labor contract will be taken into account by a firm when making its choice of the wage structure. In this section I will first formulate the firm's objective function and then explore the optimality conditions and their implications for the firm's wage structure.

In each period, the firm's expected profits equal the difference between the expected output (i.e., the probability that the worker is productive multiplied by his productivity, which is 1) and the expected wage bill. In period 1, expected profits are

$$\pi_1 = p - pw_a - (1-p)w_b ;$$

in period 2 following an initially productive outcome, expected profits are

$$\pi_s = p_s - p_s x_a - (1-p_s)x_b ;$$

finally, second period expected profits following an unproductive outcome are

$$\pi_f = p_f - p_f y_a - (1-p_f)y_b .$$

The Multi-Period Optimality Conditions

The appropriate wage structure will hinge in part on whether the worker remains with the firm in period 2. Following an initial successful outcome, it will not be optimal for either the employer or the worker to terminate the watch.[8] The worker's expected productivity has increased, and there is assumed to be no change in his external job prospects because any information acquired about the worker's productivity is assumed to be firm-specific. The worker will not quit provided that the firm does not lower the wage level—a result that will be shown to be true below.

The worker may, however, quit after an unfavorable outcome since the employer may lower his wage to take into account the worker's lower expected productivity. For the initial model to be considered, I will assume that the alternative wage is not sufficiently attractive to induce worker quitting. Relaxing this assumption has only a minor effect.[9]

The firm's profits per worker over the two periods are given by

$$\pi = \pi_1 + \beta p \pi_s + \beta(1-p)\pi_f ,$$

or

$$\begin{aligned}\pi = p + \beta p p_s + \beta(1-p)p_f - pw_a - (1-p)w_b - \beta p p_s x_a \\ - \beta p(1-p_s)x_b - \beta(1-p)p_f y_a - \beta(1-p)(1-p_f)y_b .\end{aligned}$$

In competitive equilibrium, the value of π will be driven to zero.

The firm's task is to design a wage structure that will maximize the worker's discounted

8. This result is derived more formally for the specific information case considered here in Viscusi [14].

9. In particular, if workers can quit and go to another firm, it provides a utility floor after an unfavorable job experience and removes y_a and y_b as choice variables. The spirit of the remaining results is unaffected.

expected utility, subject to the effort reaction functions derived in section II and the zero profit constraint, where λ is its shadow price. More specifically, the firm will

$$\max_{\substack{w_a, w_b, x_a, \\ x_b, y_a, y_b}} G = V + \beta p V_s + \beta(1-p) V_f - \lambda \pi .$$

Differentiating with respect to each of the six wage variables leads, after some simplification, to the following conditions:

$$U'(w_a) = -\lambda [1 - (1/p)(\partial \pi / \partial e)(\partial e / \partial w_a)]; \tag{4}$$

$$U'(w_b) = -\lambda [1 - (1/(1-p))(\partial \pi / \partial e)(\partial e / \partial w_b)]; \tag{5}$$

$$U'(x_a) = -\lambda [1 - (1/p_s)(\partial \pi_s / \partial e_s)(\partial e_s / \partial x_a) - (1/\beta p p_s)(\partial \pi / \partial e)(\partial e / \partial x_a)]; \tag{6}$$

$$U'(x_b) = -\lambda [1 - (1/(1-p_s))(\partial \pi_s / \partial e_s)(\partial e_s / \partial x_b) - (1/\beta p (1-p_s))(\partial \pi / \partial e)(\partial e / \partial x_b)]; \tag{7}$$

$$U'(y_a) = -\lambda [1 - (1/p_f)(\partial \pi_f / \partial e_f)(\partial e_f / \partial y_a) - (1/\beta (1-p) p_f)(\partial \pi / \partial e)(\partial e / \partial y_a)]; \tag{8}$$

and

$$U'(y_b) = -\lambda [1 - (1/(1-p_f))(\partial \pi_f / \partial e_f)(\partial e_f / \partial y_b) - (1/\beta (1-p)(1-p_f))(\partial \pi / \partial e)(\partial e / \partial y_b)]. \tag{9}$$

Equations (4) and (5), which are the first-order conditions for the choice of first-period wages, are also noteworthy in that they are identical to the wage structure efficiency conditions that would prevail if the firm were myopic in its wage policy. The only difference in the myopic results is that π pertains to single period profits rather than profits over both periods, and the shadow price λ may differ. A principal role of equations (4) and (5) below will be to provide a reference point to ascertain how the multi-period wage structure differs.

In addition, these equations are noteworthy in that they indicate that workers will not be fully insured against income risks since the marginal utility of w_a and w_b may differ. The optimal wage contract will sacrifice some of the risk spreading capability in order to preserve appropriate work incentives. Unlike the full insurance case, the marginal utility of income is not equalized across states. The general spirit of this result is consistent with the findings for related classes of agency theory models, such as that of Spence and Zeckhauser [13], among others.

The conditions for the optimal period 2 wage levels differ from their first period counterparts in equations (4–5) through the addition of the role of the second period wages in influencing initial incentives. Since higher wages x_a and x_b following a successful productivity experience both augment initial incentives, the levels of these wages is boosted and the associated marginal utility of the wage payments is lower than it would otherwise be.

The opposite result occurs in the case of y_a and y_b. Higher wage levels in this instance would dampen a worker's incentive to expend effort in the initial period. As a consequence, the backward disincentive effect of these wages will tend to reduce these wage levels below the amounts that would have prevailed if wage contracts were designed on a single period basis.

Because the increased incentive elicitation capability of multi-period contracts will boost the overall level of effort e, there will be a dampening of the marginal productivity of additional effort, $\partial\pi/\partial e$. To the extent that higher levels of w_a and w_b also have a diminishing effect on e as the other wage components are utilized, the overall impact will be to reduce the reliance on initial wage rates as the exclusive incentives mechanism.

IV. The Design of Efficient Wage Structures

Implications for the Temporal Wage Structure

The role of these incentive effects becomes more apparent upon taking ratios of the marginal optimality conditions. The tilting over time between the post-success state in the initial period is governed by

$$\begin{aligned} U'(x_a)/U'(w_a) = [1 &- (1/p_s)(\partial\pi_s/\partial e_s)(\partial e_s/\partial x_a) \\ &- (1/\beta p p_s)(\partial\pi/\partial e)(\partial e/\partial x_a)]/ \\ &[1 - (1/p)(\partial\pi/\partial e)(\partial e/\partial w_a)] \end{aligned} \tag{10}$$

and

$$\begin{aligned} U'(x_b)/U'(w_b) = [1 &- (1/(1-p_s))(\partial\pi_s/\partial e_s)(\partial e_s/\partial x_b) \\ &- (1/\beta p(1-p_s))(\partial\pi/\partial e)(\partial e/\partial x_b)]/ \\ &[1 - (1/(1-p))(\partial\pi/\partial e)(\partial e/\partial w_b)]. \end{aligned} \tag{11}$$

The final term in the numerators of equations (10) and (11) distinguish these equations from what would have been obtained by taking the ratio using their myopic counterparts in equation (4) and (5). Since both x_a and x_b have a positive effect on initial effort e, which in turn raises profits π, the multi-period feature of the contracting problem lowers the numerator in each case. The ratio of $U'(x_a)$ to $U'(w_a)$ will be lowered, as will the ratio of $U'(x_b)$ to $U'(w_b)$. Since the worker's marginal utility diminishes with the wage level, the ultimate effect is to boost the wage level in both states following a success so as to augment initial work incentives.

The relative wage rate following an unproductive first period are determined through a similar procedure, as one has the result that

$$\begin{aligned} U'(y_a)/U'(w_a) = [1 &- (1/p_f)(\partial\pi_f/\partial e_f)(\partial e_f/\partial y_a) \\ &- (1/\beta(1-p)p_f)(\partial\pi/\partial e)(\partial e/\partial y_a)]/ \\ &[1 - (1/(1-p))(\partial\pi/\partial e)(\partial e/\partial w_a)], \end{aligned} \tag{12}$$

and

$$\begin{aligned} U'(y_b)/U'(w_b) = [1 &- (1/(1-p_f))(\partial\pi_f/\partial e_f)(\partial e_f/\partial y_b) \\ &- (1/\beta(1-p)(1-p_f))(\partial\pi/\partial e)(\partial e/\partial y_b)]/ \\ &[1 - (1/(1-p))(\partial\pi/\partial e)(\partial e/\partial y_b)]. \end{aligned} \tag{13}$$

In this case the deferred compensation has a disincentive effect in each instance, as both $\partial e/\partial y_a$ and $\partial e/\partial y_b$ are negative. The final terms in the numerators of equations (12) and (13) are consequently positive, implying that the relative marginal utilities of y_a and y_b compared to their period 1 counterparts will be greater. These higher marginal utilities in turn imply a lower wage level following an unproductive job outcome, as the overall wage structure following a period 1 failure is lowered to provide greater initial incentives for the worker to be productive.

In terms of the tilting of the wage structure over time, one would expect some tilting wholly apart from these incentive effects. If contracts broke even on a within period basis, wages would rise following a productive outcome since p_s exceeds p. Similarly, wages would fall after an unproductive outcome since p_f is below p. What the results here indicate is that this tilting of the wage structure will be augmented by the desire to use period 2 wages to create initial incentives. The wage increase following a success will be greater and the decline in the wage structure following a failure will be steeper than it would otherwise be. In effect, the extent of merit rating is by an amount that is more than is dictated by actuarially fair considerations.

The likelihood that the effective rates of insurance in the agent's contract would be modified based on the first period experience is not surprising. What is striking is that the extent of the modifications is greater than would be dictated by within period actuarially fair contracts.

The optimality of a discrepancy between the spot wage and the worker's productivity will emerge because of the nature of the dynamic incentives problem. In situations of uncertain worker productivity, the direction of these incentive-enhancing effects will depend on the worker's initial productivity and also on the need to promote the insurance function of contracts, which will be considered subsequently.

This tilting of the wage structure arises in other labor market contexts as well. For example, in Lazear [6] it is shown that the firm will offer a steeper age-earnings profile than is warranted in order to prevent worker shirking. In that model, the firm withholds some wages until future periods and terminates the worker if he shirks, leading him to lose the deferred wages. The analysis here indicates that this result generalizes to a situation in which there is underlying uncertainty about the worker's productivity coupled with risk aversion on the part of the worker. More important is that there is a considerable strengthening of the Lazear result. In his analysis, the contemporaneous wage was independent of the current output level so that it could only be through future wage adjustments that incentives could be created. The analysis presented here indicates that even when first period wages are made contingent on the worker's first period output level that it is desirable to use the second period wage structure as well to create work incentives.

Across-State Differences

If workers were risk-neutral, one could promote initial incentives quite effectively by making the wage w_a sufficiently greater than w_b. Extreme wage lotteries of this type are not desirable in general because of the presence of worker risk aversion, which creates a desire on the part of workers to have a wage structure with greater equality across different productivity outcomes. This need to promote risk spreading will mute the incentive effect of contracts as there is a need to make a tradeoff between the incentive effects and the insurance function, as was noted in section III. Here I will consider whether or not the wage structure dynamics lead to greater equalization of the wage structure across states.

Consider first the wage structure following a successful period 1 productivity experience. The role of the multi-period contract structure considerations is to introduce the final term in equations (6) and (7). Since the wage x_a will exceed x_b to promote work incentives in period 2, the value of $U'(x_a)$ will be below $U'(x_b)$. The introduction of the dynamic incentive terms will narrow the marginal utility differences between the two states if

$$(1/\beta p p_s)(\partial\pi/\partial e)(\partial e/\partial x_a) < (1/\beta p(1-p_s))(\partial\pi/\partial e)(\partial e/\partial x_b), \tag{14}$$

to a condition that reduces to

$$U'(x_a) < U'(x_b).$$

The final terms will consequently dampen the marginal utility gap provided that the marginal utility of money is greater in state b. The final terms in equations (6) and (7) could never equalize the marginal utility difference since a strict equality would hold in equation (14) if $U'(x_a)$ equalled $U'(x_b)$. With these terms being identical, whether or not the ratio of $U'(x_a)$ to $U'(x_b)$ exceeded 1 would be governed by the myopic conditions, which lead to greater x_a and consequently lower $U'(x_a)$. Similarly, the dynamic aspects could never produce the result that $U'(x_b) < U'(x_a)$ since such marginal utilities would reverse the inequality sign in equation (14), making it even more desirable to raise x_a, making $U'(x_a)$ even lower than $U'(x_b)$. As a result, the multi-period wage structure concerns will narrow, but not completely eliminate the marginal utility gap between x_a and x_b.

After an adverse initial productivity experience, the gap between y_a and y_b will be widened by the dynamic incentive effects if the final terms in equations (8) and (9) satisfy

$$(1/\beta(1-p)p_f)(\partial\pi/\partial e)(\partial e/\partial y_a) > (1/\beta(1-p)(1-p_f))(\partial\pi/\partial e)(\partial e/\partial y_b),$$

or

$$U'(y_a) < U'(y_b).$$

Provided that y_a exceeds y_b, which would be implied by the myopic optimality conditions, the multi-period incentive component exacerbates the period 2 wage gap following an adverse productivity experience. The effect is in the opposite direction of the across state differences following a successful job experience because the y_a and y_b terms have a negative influence on initial effort e, whereas the x_a and x_b wages have a positive effect, thus accounting for the opposite signs that result.

The intuition underlying each result is quite similar. The incentive effect is driven in part by the marginal utility of income in a particular state. When marginal utility levels are high, altering the associated wage rate will have a greater effect on work incentives. In the absence of any dynamic influences, the state b wage will be lower than the state a wage and the associated marginal utility will be greater. Higher wage rates following a productive initial period will augment initial incentives and the higher $U'(x_b)$ bolsters this influence so that a narrowing in the period 2 wages results. Similarly, higher period 2 wages following an unproductive job outcome lower initial work incentives. The higher marginal utility associated with $U'(y_b)$ consequently implies a greater disincentive effect, implying that it is even more important to lower y_b in relation to y_a.

As in the case of wage tilting, the effects are in the opposite direction depending on the initial productivity outcome. The dynamic elements narrow the gap between $U'(x_a)$ and $U'(x_b)$ and widen the gap between $U'(y_a)$ and $U'(y_b)$. The concern with dynamic incentive effects promotes the risk spreading objective in one case and conflicts with this objective in the other situation.

V. Conclusion

In situations of uncertain worker productivity and risk aversion, labor market contracts have a dual objective of promoting incentives and risk spreading. A trade-off between these objectives is present in single period models as well as in the multi-period models that were the focus of this paper. When there is more than a single period, there will be a divergence between the within period expected productivity and the spot expected wage rate as the wage structure is utilized to promote the creation of work incentives. In effect, firms will merit rate workers on an actuarially unfair basis when viewed within the context of the second period.

No single type of influence results, as the impact differs depending on whether or not the worker is productive in the initial period. Following an initial period of being productive, the wage structure will slope upward more than it otherwise would and there will be a narrower within period gap in the wages across productivity states. Similarly, after an adverse productivity outcome, the drop in wages will be accentuated and the risk spreading properties of the second period wage contract reduced. The common element in each of these cases is a reliance on the wage structure to promote incentives. In addition, the intrinsic trade-off between risk and incentives that is present in single period models extends to multiple periods as there is a desire to sacrifice some of the risk spreading capability of period two compensation to bolster the work incentives in an earlier period.

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