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INCENTIVES AND WAGE RIGIDITY

Edward P. Lazear

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ABSTRACT

With the growth of the literature on incentive compensation has come the belief by some that incentive pay may be less rigid than pay that is not designed to effect incentives. Some have gone so far as to argue that this may explain differences in unemployment rates across countries. It is shown that there is no direct link between incentives and wage rigidity. Many compensation schemes that provide incentives have the reverse effect: That is, they tend to make wages more rigid than would be the case were incentives not an issue at all. This paper explores the relationship between wage rigidity and the provision of incentives in a variety of circumstances.

Edward P. Lazear
Graduate School of Business
University of Chicago
1101 East 58th Street
Chicago, IL   60637

312-962-7464

The notion that compensation may be structured to affect worker productivity is not new. Traditionally, piece rates have been the most common form of incentive pay. Recently, more elaborate bonus systems have begun to creep into the American labor scene. Concurrent with the growth of creative compensation practices has been the development of a literature that describes the incentive effects which are associated with existing or hypothetical payment schemes.[1]

A similar, but distinct literature has considered wage rigidity that results when labor contracts are used as an alternative to a spot market. Most of the work in this literature centers around the idea that workers want to insure themselves against a variable wage stream. Others concentrate on the nature of contracts when information is asymmetric--either the worker or firm (or both) has information to which the other party is not privy.[2]

This essay examines incentive arrangements to determine whether they contribute wage rigidity to an economy. Specifically, the attempt by employers to induce workers to produce efficiently may change the variability of wages over the business cycle, life cycle and across individuals. International comparisons have revealed differences in wage flexibility across countries.[3] Can these differences be explained by the extent to which the countries use incentive compensation? Or, turning it around, are measured "business cycle" variations in wages mere reflections of worker incentive schemes?

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[1]The literature is extensive. Some of the more frequently cited papers are Ross (1983), Becker and Stigler (1984), Stiglitz (1975), Lazear (1979), Fama (1980), and Holmstrom (1982).

[2]This literature has mushroomed over the past five years. Some of the more important or more recent papers are Baily (1974), Azariadis (1975), Green and Honkapohja (1981), Green and Kahn (1981), Grossman and Hart (1981), Hall and Lilien (1979), and Hall and Lazear (1984).

[3]Gordon (1982) found that the variability of wages in Japan exceeds that in the United States. Although little evidence exists, much has been made of the widespread nature of the Japanese bonus system.

The conclusion is that there is no simple relation of incentives to wage flexibility. Some incentive contracts add wage variance and reduce inflexibility. Others have the opposite effect. After rigidity is defined, the approach is to "prove by counterexample," discussing a number of incentive schemes. Although the list is by no means exhaustive, it covers most of the important ones and provides enough variety to demonstrate that there exists no clear link between incentive provision and wage rigidity.

I. Definition of Rigid Wages

In order to obtain a concise definition of rigid wages, it is useful to start with a simple model. Consider the simplest technology where output, q, is the sum of effort, u, and luck, e:

$$(1) \qquad q = u + e .$$

Assume initially that the variance of e is zero so that luck is not a factor. This is relaxed below.

Output sells at price V so that the firm's profit function is

$$\text{Profit} = Vq - Y$$

where Y is the compensation of labor, the only factor of production. In a world of competitive factor and product markets, the zero profit constraint must hold so that

$$(2) \qquad Y = Vq .$$

Wage rigidity is defined relative to what would occur in a spot market. There are two variables that are of interest. Changes in V may occur over business cycles or may reflect secular effects on the value of output. Changes in u can be thought of as differences across individuals with respect to work efficiency or distaste for effort exertion.

In a spot market with full information, equations (1) and (2) imply that

$$(3) \qquad a. \quad \partial Y/\partial V = u + V(\partial u/\partial V)$$

$$b. \quad \partial Y/\partial u = V .$$

Equation (3a,b) serves as the criterion against which results are compared to determine wage rigidity.

II. Fixed Effort and Variable Effort

Before considering any specific incentive scheme, it is useful to point out that the ability to vary effort contributes income variation to an economy, even if workers are homogeneous. To see this, examine (3a). There are two terms on the right-hand side. When the price of output changes, income changes because each unit of effort is now more valuable (captured by the u term), but also because the optimal level of effort changes (reflected in the $V \partial u/\partial V$ term). Appropriately, wages are more variable in a world where effort is not supplied perfectly elastically.

Let us not take as given that workers adjust effort appropriately. After all, if no restrictions were placed on workers, and if income Y were totally independent of the level of effort, workers would choose to perform at the lowest possible level. The worker wants to choose u so as to maximize utility, assumed to be given as

(4)
$$\text{Max}_{u} \quad Y(u) - C(u)$$

where Y(u) is the income function that he faces (it may depend directly on q and only indirectly on u) and where C(u) is the cost of effort function. The first-order condition for an optimum is the standard

(4a)
$$Y'(u) = C'(u) \; .$$

If q can be observed perfectly, then the first best solution can be achieved by paying a "piece rate," i.e., letting $y = Vq = Vu$. The pure piece rate is virtually synonymous with a spot market in this context, so it is not surprising that differentiation of the piece rate income function duplicates equations (3a,b).

III. Imperfect Observability of Output

Few production environments lend themselves to costless and perfect measurement. Although the output of a salesman is measured easily, that of a vice president of finance is not. Firms often adapt to these difficulties by using some kind of sampling mechanism that requires only a periodic check of part of the worker's output. Without attempting to write down the optimal sampling rule, let us merely state that one possible incentive device is to sample the worker's output with some (optimally chosen) probability p. If the worker's output is not audited, then he receives one wage, W(V), specified in advance and potentially a function of V. If the worker is audited, then he is paid S(q, V).[4]

It is trivial to show that a first best wage scheme is to have W(V) = 0 and S(V, q) = Vq/p so that Y(u) = p Vq/p = Vq = Vu. An incentive scheme of this sort introduces cross-sectional wage variability where none would exist were output observed costlessly or were effort levels given exogenously. Suppose that all individuals have the same C(u) function. Equation (4a) ensures that they all select the same level of u. But incomes will vary: 1 − p of the individuals receive W(V) = 0 in income and p of the individuals receive Vu/p. If a piece rate with 100% sampling were employed, then all workers would receive Vu. So additional wage variation is a result. (W(V) = 0 should be interpreted as the amount produced at the minimum observable effort level.)

Over the business cycle, changes in the price of the product are reflected perfectly in the average wage across workers. But (1 − p) of the workers receive W(V) = 0 find that their wages are independent of the changes in product price whereas p of the workers find that their wage is especially sensitive to changes in product price. Compare $\partial Y/\partial V = (1/p)(u + V \partial u/\partial v)$

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[4]Becker (1968) and Becker and Stigler (1974) were among the first to consider these probabilistic incentive schemes.

with equation (3a). If p is small, most workers find that their wages are much more rigid than they would be in a world of exogenous effort with perfect information.

The additional variance that is associated with this particular incentive scheme is not a necessary consequence of either imperfect observability or of the desire to use an incentive compensation structure. For example, in this simple case, there is another first best compensation scheme that mimics a perfect information spot market exactly. Suppose that the worker is told that he will receive Vu if $u \geq u^*$, but will be penalized some amount X if it is detected that u has fallen below u^*. For any given p, there is a sufficiently large X such that workers always choose to product at $u = u^*$.[5] Under these circumstances, each worker's wage is always Vu, no cross-sectional variation in wages is introduced by this incentive plan, and (3a) and (3b) hold exactly for all workers so no additional rigidity is imposed. The point is that ensuring that appropriate incentive mechanisms are present does not imply that additional wage variation is introduced. Below, it will be shown that incentive wage schemes can actually reduce the amount of variation in an economy. First, it is useful to consider incentive schemes that employ the fact that workers are generally with the firm for more than one period.

IV. Life-Cycle Incentive Devices

A number of authors have considered how age-earnings profiles can be altered in order to provide incentive effects.[6] The nature of the imperfect observability of output usually takes a somewhat different form here. Suppose

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[5]This is the solution in Becker [1968] and Becker and Stigler [1974]. It is best understood in the life cycle context and is spelled out in more detail below.

[6]See Lazear (1979, 1981), Carmichael (1981), Shapiro and Stiglitz (1982), and Kuhn (1982).

that work takes place in two periods, but that output is not observed until the end of the period, and then only imperfectly, characterized for current purposes by occurring with probability p. All that is necessary, it turns out, is that one can observe that $u < u^*$ (or that $q < q^*$), the exact magnitude of the deviation being irrelevant.

One possible scheme that achieves a first best solution is to pay a wage W_0 in period zero and W_1 in period 1 if output in period zero was not observed to have fallen below q^*. If output in period zero is observed to have fallen below q^*, then the worker is terminated and is not permitted to work during period 1. For simplicity, assume that the discount rate is zero and that the alternative use of time in period 1 is zero. Then

(5)
$$W_1 = C(u^*)/p + x$$
$$W_0 = Vu^* - W_1 = Vu^* - C(u^*)/p - x$$

will ensure that a first best equilibrium is attained for any $x > 0$.

To see this, note that the worker always works at zero effort in period 1 because there is no benefit from doing otherwise. His choice for period zero is either to work at zero effort or at effort equal to u^* because no intermediate value affects his income. He chooses to work at $u = u^*$ iff

$$W_1 - C(u^*) + W_0 > (1 - p)W_1 + W_0 \; .$$

This condition and zero profits imply equation (5).

What are the implications of such a scheme for wage rigidity? First, this scheme causes the age-earnings profile to deviate from the age-productivity profile. Output in period zero is Vu^*, but W_0 falls short of that. Output in period 1 is zero, and W_1 is necessarily positive. This does not imply, however, that wages vary more over the life cycle as a result of such a scheme. For example, if $Vu^* > 2C(u^*)/p$, then it is possible to find an $x > 0$ such that $W_0 = W_1$. If workers were paid their exact output in each period, the wage in period one would fall short of that in period zero. The incentive

scheme would actually smooth earnings over the life cycle in an absolute sense.

How do the wages respond to business cycle fluctuations? The wage received over the entire life cycle is Vu^* so any permanent change in V is reflected one-to-one in the lifetime wage. But this does not imply the same correspondence in each of the two periods.

First, differentiation of W_0 with respect to V yields

$$\partial W_0/\partial V = u^* + V \, \partial u^*/\partial V - (C'(u^*)/p)(\partial u^*/\partial V)$$
$$= u^* + V \, \partial u^*/\partial V - (V/p)(\partial u^*/\partial V)$$

which is smaller than the right-hand side of (3a) because $\partial u^*/\partial V > 0$. The conclusion is that the wage in period zero does not move with the business cycle by as much as it would if output were geared directly to productivity.

For period 1, there is no change in productivity, but there is a change in the wage W_1. Differentiation with respect to V yields

$$\partial W_1/\partial V = (C'(u^*)/p)(\partial u^*/\partial V)$$
$$= (V/p)(\partial u^*/\partial V) > 0 .$$

Although W_1 is more sensitive to changes in value of output than would be warranted by productivity considerations, it is still true that in neither period does the wage move as rapidly as the product price. This might give the appearance of wage rigidity since no one worker's wage at any point in the life cycle moves as rapidly as product price.

V. Relative Comparisons

More recent literature has discussed the role of relative comparisons in providing incentives. Tournament-type labor contracts, where one worker competes with another for a particular job that has a high wage, can induce workers to behave appropriately and to select first best levels of effort.[7]

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[7] See Lazear and Rosen (1981), Holmstrom (1982), Carmichael (1983), Green and Stokey (1983), and Nalebuff and Stiglitz (1983) for analyses of relative compensation schemes.

At this point, the variance of e in equation (1) can no longer be assumed to be zero. The essence of contest-like labor contracts requires that there be some random noise in the world. Without going into the details of the tournament labor contract, the basic idea is this: Workers compete against one another for a particular job that carries a specified wage. The individual who has the highest level of output is given the job and is entitled to the wage that goes along with it, irrespective of the output level. It turns out that in competition, the equilibrium wage structure generates a first best solution, with each worker putting out the efficient amount of effort. The spread between the winner's wage and the loser's wage is the motivating factor.

If each individual draws an e in equation 1, then $e_i - e_j$ defined as z is distributed with density function $g(z)$. If W_1 is the wage that goes to the winner and W_2 is the wage that goes to the loser, then the equilibrium is[8]

(7)
$$\text{a.} \quad W_1 = (V)(u^* + 1/g(0))$$
$$\text{b.} \quad W_2 = (V)(u^* - 1/g(0)) \ .$$

First consider the wage variation relative to output variation. The expected wage across the two individuals is Vu^* and expected output from (1) is also Vu^*. However, no individual is paid the expected output. Individuals are ex ante identical, yet with certainty they receive different wages. In an ex post sense, output may have more or less variance across individuals than the wages. Since q is a random variable, whereas W_1 and W_2 are fixed in advance, whether actual q is more or less disperse than wages depends upon the realization of the random variable z. Even the expectation of Vq_j, given that j is the winner, may be closer or further from Vu^* than is the winner's wage.[9] The conclusion is that the contest-type incentive structure adds variance

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[8] See Lazear and Rosen (1981).

[9] A simple example makes this clear. Suppose that e can take the values a and -a only. Then $z = a_i - a_j$ has $g(0) = 1/2$ independent of

in wages relative to the ex ante expected output, but may add or reduce variance relative to ex post output.

Additionally, the winner's wage is more sensitive, while the loser's wage is less sensitive, to changes in V than indicated by (3a). Differentiation of (7) yields

and

$$\partial W_1/\partial V = u^* + V\, \partial u^*/\partial V + 1/g(0)$$

$$\partial W_2/\partial V = u^* + V\, \partial u^*/\partial V - 1/g(0) \ .$$

The last term on the right-hand side distinguishes these expressions from (3a), adding and subtracting wage flexibility, respectively. The reason is that when V increases, a higher u^* is appropriate. That can only be motivated by increasing the spread between W_1 and W_2. The first two terms on the right-hand side reflect the value of increased average productivity. The last term is the effect of increasing the spread.

"Winners" are the individuals who have advanced further up the hierarchy. This implies that salaries should be more volatile with output at higher job levels than at lower job levels. It is surely true that executives' compensation is more likely to be contingent on the performance of the firm than middle management's. Whether this relationship holds over the business cycle as well can be discovered.

VI. Conclusion

There exists no obvious link between wage rigidity and the provision of incentives. Some incentive devices introduce additional wage variation into an economy, but others, such as relative compensation schemes, can actually reduce it, even when risk aversion is not an issue. The more specific conclusions are:

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the value of a so $W_1 = Vu^* + 2V$ and $W_2 = Vu^* - 2V$. What is the expected level of output, given that j has drawn $e_i > e_j$? It is $Vu^* + Va/2$ which can exceed or fall short of W_1, depending on the value of a.

1. Piece rates increase cross sectional wage variation relative to a straight salary, but piece rate compensation is not necessarily more flexible over a business cycle than is a salary.

2. If output is not perfectly observed at zero cost, then some type of sampling scheme may be used. One reasonable scheme adds cross-sectional variation in wages. That same scheme makes some worker's wage rigid with respect to the business cycle, and others overly sensitive to the business cycle. But this is not a necessary consequence of imperfect observability. Another efficient scheme adds no variation that would not be present were piece rates and perfectly observed output to prevail.

3. Life cycle incentive devices steepen the age-earnings profile relative to the age-productivity profile. However, this does not imply that wages are more variable than productivity over the life cycle because the relative steepening could actually flatten the wage path. What is true, however, is that the annual wage is never as flexible with respect to the business cycle as are product prices.

4. Incentive schemes that involve relative comparisons, and in particular, tournament-style labor contracts, add wage variation relative to expected output. Such schemes do not unambiguously increase wage variation relative to realized output. An implication of this incentive scheme is that wages at the top of the hierarchy are more sensitive to changes in the value of output than wages at the bottom of the hierarchy.

Researchers who have conjectured that the provision of incentives can change the amount of wage flexibility in an economy are quite correct. Unfortunately, the direction of the change is not unambiguous. Those seeking to explain international or intertemporal differences in wage rigidity are not likely to find the answer in the incentive structure.

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