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# Job Characteristics, Wages, and the Employment Contract

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This paper explores some of the determinants of compensation in the United States. We suggest that compensation systems should be viewed as an integral part of the production process. We also wish to highlight the diversity in observed systems of pay that is often overlooked when examining wage trends from a macroeconomic perspective.[1] A goal of the work reviewed here is to introduce compensation models that make predictions based upon *observed* job characteristics, and illustrate how compensation form may respond to changes in both the nature of work and labor-market conditions.

The extent to which we are able to relate compensation to job characteristics is very much limited by the data. Fortunately, available data sets do have some information that we can use. In this essay we use both the National Longitudinal Survey of Youth (NLSY) and the Panel Study on Income Dynamics (PSID) to explore these issues. These data are not perfect, but they do provide information on some quite distinctive compensation practices. Table 1 reports the incidence of pay method by occupation for the NLSY. Workers were asked if during the current year they received any of the following types of compensation:

1. Hourly: Pay that depends upon the number of hours worked.
2. Salary: Pay by fixed period, such as weekly, monthly or yearly. Hours of work may vary from pay period to pay period, with no corresponding change in salary.
3. Piece Rate: Payment based upon the number of pieces produced by the worker, typically a supplement to hourly pay. For the PSID, workers are also asked if they are paid a combination consisting of an hourly rate and a piece rate.
4. Commission: Pay based upon some dollar measure of output, such as sales in the last period, typically commissions supplement salary pay. For the PSID, workers are also asked if they are paid a combination consisting of a salary and commission.
5. Bonus: Pay above one's salary or hourly pay that is *not* contractually linked to a measure of performance, and hence its level is at the discretion of the employer.
6. Promotion: Movement to a higher rank, usually, though not always, associated with greater pay.[2]

This list does not exhaust the types of pay that we observe in practice, though it does move beyond the types of pay that would be considered in most macroeconomic models. In the next section, we briefly review the standard agency model. This model, the starting point for the economic theory of contracts, helps us understand the conditions under which a firm should link measures of performance to pay. As Table 1 illustrates, however, explicit pay-for-performance contracts are by no means ubiquitous. In a later section entitled "Opportunism and Contract Complexity," we will explore the limitations of the agency model in the context of Williamson's (1975) concept of opportunism.

When the employment relation is complex, then pay-for-performance contracts are incomplete, and hence workers may engage in inefficient opportunistic behavior. A solution to this problem, discussed in a section entitled "Relational Contracts," is to use a relational contract that delays specifying rewards and exact performance

[1] However, there are a large number of possible models of compensation, as nicely outlined in the review of Ritter and Taylor (1997).

[2] See the Data Appendix for the exact question pertaining to pay-for-performance in the NLSY.

Table 1

## Pay Method by Occupation

National Longitudinal Survey of Youth (NLSY) 1988-90

| Occupation | Hourly | Salary | Piece Rate | Commission | Bonus | Promotion |
|---|---|---|---|---|---|---|
| Managers and admin.except farm | 19.98% | 80.02% | 0.68% | 9.84% | 28.46% | 18.91% |
| Writers, artists, etc. | 21.84% | 78.16% | 2.30% | 9.20% | 17.24% | 14.94% |
| Sales workers | 25.07% | 74.94% | 0.78% | 37.98% | 25.58% | 11.37% |
| Prof., tech, except eng. techn. | 27.94% | 72.06% | 0.43% | 1.99% | 15.46% | 13.76% |
| Personal service workers | 36.81% | 63.19% | 1.84% | 20.25% | 9.20% | 9.82% |
| Secretaries | 37.20% | 62.80% | 1.02% | 1.37% | 11.60% | 13.99% |
| Engineering and science techn. | 42.37% | 57.63% | 0.00% | 5.09% | 9.32% | 18.64% |
| Clerical and unskilled 1* | 43.18% | 56.83% | 1.34% | 3.12% | 13.21% | 16.32% |
| Office machine operators | 43.88% | 56.12% | 0.84% | 1.27% | 13.50% | 14.77% |
| Clerical and unskilled 2** | 48.76% | 51.24% | 1.99% | 1.74% | 10.20% | 14.93% |
| Transport equip. operatives | 50.48% | 49.52% | 3.38% | 8.21% | 13.53% | 10.14% |
| Food service workers | 52.46% | 47.55% | 0.52% | 1.29% | 7.49% | 11.37% |
| Mechanics and repairmen | 53.16% | 46.84% | 4.54% | 9.56% | 9.89% | 12.16% |
| Cleaning service workers | 54.46% | 45.55% | 1.49% | 0.50% | 7.43% | 9.90% |
| Craftsmen and kindred 1*** | 60.32% | 39.68% | 2.67% | 1.60% | 10.68% | 17.97% |
| Precision machine operatives | 60.44% | 39.56% | 36.81% | 1.10% | 9.34% | 10.44% |
| Laborers, except farm | 60.71% | 39.29% | 6.02% | 1.88% | 10.34% | 13.16% |
| Health service workers | 65.99% | 34.01% | 2.03% | 0.51% | 8.63% | 9.65% |
| Textile operators | 66.67% | 33.33% | 9.76% | 0.71% | 11.43% | 10.00% |
| Operatives exc. precis. machines and textile | 68.93% | 31.07% | 8.75% | 1.79% | 10.54% | 7.32% |

* From bank tellers to meter readers for utilities (Census 301 to 334)
**From shipping clerks to ticket agents and other miscellaneous clerks (Census 374 to 395)
***From auto accessory installers to machinist apprentices (Census 401 to 462)

expectations until after the worker has selected effort. Under the appropriate conditions, this provides a solution to the problem of opportunistic behavior. Moreover, it has the empirical prediction that firms are more likely to use bonus pay rather than efficiency wages when labor markets are tight. We test and find some support for this hypothesis. The final section of the paper contains concluding remarks.

## AGENCY THEORY

The agency model begins with a principal who wishes to hire an agent to carry out a task, usually involving the assets owned by the principal.[3] There are three basic ingredients in such a model:

1. The agent is risk averse.
2. The output of the agent is a stochastic function of effort.
3. The agent's effort is imperfectly observable.

For simplicity, assume that the principal is risk neutral, given that the agent is risk averse, this implies that the individual would prefer to receive a fixed income stream that is independent of the project's fortunes. Given that effort is not easily observable, however, this may give rise to *moral hazard*: The agent may choose less than the efficient level of effort. The prin-

[3] See Hart and Holmstrom (1987) for a good overview of the agency model. See also Gibbons (1995) for a more up-to-date review of this literature.

cipal can provide incentives for performance by making the agent's pay conditional upon the available performance measures.

More formally, suppose that the agent's preferences are given by:

$$(1) \qquad U(\omega, e) = u(\omega) - v_e,$$

where $\omega$ is income and $e \in \{L,H\}$ is low or high effort. The utility for income is assumed to be twice differentiable, and satisfy $u'(\omega) > 0, u''(\omega) < 0$ for every $\omega > 0$. The disutility for effort satisfies $v_H > v_L > 0$. The effort of the agent results in a stochastic output denominated in dollars, $y \in Y \subseteq \Re$, as well as a vector of performance measures, $\mathbf{m} = \{m1,...,mn\} \in \mathbf{M}$. Let $f_e(y,\mathbf{m})$ denote the joint distribution of $y$ and $\mathbf{m}$ as a function of effort, where it is assumed that $f_e(y,\mathbf{m}) > 0$ for all $(y,\mathbf{m}) \in Y \times \mathbf{M}$.[4] Let us further suppose that it is efficient for the agent to produce a high level of effort (otherwise the problem is trivial), and that the principal offers a wage contract that is a function of the observable signals $(y,\mathbf{m})$, given by $w + c(y,\mathbf{m})$.

In this case the principal agent problem is given by:

$$(2) \qquad \max_{c(\cdot,\cdot)} \int \left(y - c(y,\mathbf{m})\right) f_H(y,\mathbf{m})\, dy\, d\mathbf{m},$$

subject to:

$$(3) \qquad E\left\{U\left(c(y,\mathbf{m}),H\right)\right\} \geq \overline{U}, \text{ and}$$

$$(4) \qquad E\left\{U\left(c(y,\mathbf{m}),H\right)\right\} \geq E\left\{U\left(c(y,\mathbf{m}),L\right)\right\}$$

where

$$E\left\{U\left(c(y,\mathbf{m}),e\right)\right\} =$$

$$\int v\left(c(y,\mathbf{m})\right) f_H(y,\mathbf{m})\, dy\, d\mathbf{m} - v_e .$$

Constraint 3 is the individual rationality constraint that ensures the agent receives as much as his or her next best alternative, denoted $\overline{U}$. The next constraint, 4, is the incentive constraint that ensures that the agent prefers to work hard rather than to shirk.

Notice that even though the principal cannot directly observe the actions of the agent, the contract is designed so that in equilibrium the agent chooses to work hard. Assuming that the solution can be characterized by the first order conditions for the optimum, then the optimal contract solves the following equation:

$$(5) \qquad \frac{1}{u'\left(c^*(y,\mathbf{m})\right)} = \mu + \lambda\left(1 - \frac{f_L(y,\mathbf{m})}{f_H(y,\mathbf{m})}\right),$$

where $\mu, \lambda \geq 0$ are the LaGrange multipliers associated with constraints 3 and 4, respectively. If there were no moral hazard problem, then constraint 4 would not be binding, and $\lambda = 0$ with the optimal contract given by a constant wage $\hat{\omega}$ satisfying $v'(\hat{\omega}) = 1/v'(\hat{\omega}) = 1/\mu$

The interesting case is when moral hazard *is* a problem, and $\lambda > 0$. In that case, the sensitivity of the contract to $y$ and $\mathbf{m}$ depends upon the behavior of the likelihood ratio $r(y,\mathbf{m}) =_{def} \frac{f_{L(y,\mathbf{m})}}{f_{H(y,\mathbf{m})}}$. When the likelihood ratio is a decreasing function of $y$, called the *monotone likelihood ratio condition*, then the optimal contract will be increasing in $y$. This condition implies that $F_H$ first-order stochastically dominates $F_L$ (though the converse is not true). As discussed in detail by Hart and Holmstrom (1987), the intuition is that a high $y$ signals high effort, and the agent should receive a greater reward. In equilibrium the principal has correct expectations concerning worker effort, and the signaling effect is to provide *ex ante* incentives, and does not provide information to the principal *per se*. The signaling perspective does provide guidance about when additional measures of performance should be incorporated into the optimal contract, as shown in the following proposition.[5]

*Proposition 1. Suppose that the solution to the principal agent problem satisfies the first-order condition 5, then the optimal contract $c^*(y,\mathbf{m})$ depends upon the signal $m_i$ if and only $\partial r(y,\mathbf{m}) / \partial \mathbf{m}_i \neq 0$ for some value $(y,\mathbf{m})$.*

[4] This is the so-called full-support assumption that is a necessary (though not sufficient) condition to use the first-order approach to characterize the optimum. Harris and Raviv (1979) show that if the support moves with effort then one can implement the first best. We also assume that the density is a differentiable function of $y$ and $\mathbf{m}$.

[5] See Holmstrom (1982) for more details.

For example, if $m_i$ represents the clothes of the agent or their hairstyle, and these provide no information concerning their effort, then they should not enter into the optimal contract. Any other measures, however, such as customer complaints, supervisor reports, etc., that provide additional information concerning performance above and beyond $y$ should be included in the optimal contract, even if the contract already depends upon $y$.

Consider for example a sales person who is paid on commission. Sales is a discrete variable that depends upon a number of factors, including price, buyer preferences, store location, etc. Hence a sale may be made even if a salesperson is rude (for example, the buyers had to purchase the good immediately and could not search further). Rudeness, however, is likely to affect the probability of a sale in many cases. Even if the sale is consummated, the optimal contract would entail a penalty if the customers report to the manager that the salesperson is rude. The model predicts that even a single report of rudeness should generate a negative financial consequence, and more generally, as Gibbons (1995) observes, agency theory generically predicts a sensitivity to available performance measures that we rarely observe in practice.

## Some Evidence

To understand why performance-pay contracts are not ubiquitous, we begin by looking at some of the determinants of performance pay. Even if agency theory is not a complete model, it still provides important insights into the necessary conditions for the use of a performance measure. In particular, jobs for which the cost of obtaining good measures are low should have a higher incidence of performance pay. As we can see from Table 1, we have data from the NLSY that describes certain types of performance pay during the 1988-90 period. Unfortunately, no questions pertaining to the characteristics of the jobs were asked in the NLSY during the 1988-90 period. But such questions were asked in 1979 and 1982, which we can use to carry out a preliminary investigation of the relationship between performance pay and job characteristics. The relevant question in those years was: "We would like to know what kind of opportunities this job offers you. How much opportunity does this job give you? A minimum amount, not too much, a moderate amount, quite a lot, or a maximum amount?

1. To do a number of things (variety).
2. Deal with people.
3. For independent thought or action (autonomy).
4. Friendships.
5. To do a job from beginning to end (probe if necessary: that is, the chance to do the whole job) (complete TASK)."

Answers are re-coded to zero if respondents answer either "a minimum amount, not too much, or a moderate amount," while they are re-coded to one if respondents answered either one of the last two possibilities. For each one of 20 occupation cells, we compute the average of the answers in both the 1979 and the 1982 surveys. We then merge these averages to each corresponding occupation category for the 1988-90 period. This, of course, is a crude way to proxy the different dimensions of the jobs, but we think that it is not too unreasonable to assume that jobs that are in the same occupation cell may share some common characteristics.

In Table 2 we report the results from a linear probability model of different types of performance pay.[6] Given that piece rate workers also are categorized as wage earners (notice that all workers are categorized as either wage or salary workers), then we can ask what job characteristics are associated with the use of piece rates. These results are reported in the first two columns, with the second column correcting for biases that may be introduced due to misclassification of worker occupation.[7]

Notice that requiring workers to perform complete tasks is negatively related to the use of piece rates. This may suggest that individuals on straight wages are more

[6] We use a linear probability model rather than a logit or probit because we can better control for selection effects and misclassification error. The main drawback of a linear probability model is that it is less efficient, but in general it is more robust to specification errors than a nonlinear model would be. Note also that the standard errors are adjusted for group effects (see e.g., Moulton, 1986) and that we take into account possible selection (into occupation) effects. See MacLeod and Parent (1997) for complete details.

[7] To correct for misclassification error, we borrow from Krueger and Summers (1988).

Table 2

The Effect of Job Attribute on the Likelihood of a Compensation Characteristic Based upon the National Longitudinal Survey of Youth (NLSY) (1988-90)

| Is the following attribute important in your job? | Piece Rate(1) vs. Hourly Wage (0) | | Commission (1) vs. Salary and/or Bonus Pay (0) | | Bonus + Salary (1) vs. Salary + Termin. Contract (0) | |
|---|---|---|---|---|---|---|
| **Autonomy** | -0.1331 | -0.1835 | 1.5634 | 2.2259 | 0.982 | 1.1825 |
| | (0.5382) | (0.3536) | (0.4433) | (0.5464) | -0.9165 | -0.5275 |
| **Complete Task** | -1.4971 | -1.4102 | -0.7975 | -1.2647 | 0.3077 | -0.4598 |
| | (0.6352) | (0.4173) | (0.5231) | (0.5960) | (0.9044) | (0.6226) |
| **Variety** | 0.9406 | 0.6816 | -1.1221 | -1.156 | -1.1146 | -0.5263 |
| | (0.4795) | (0.3451) | (0.3949) | (0.4429) | (0.7175) | (0.4700) |
| **Friendships** | -0.5213 | -0.0419 | -0.3344 | -0.5861 | -0.3302 | -0.6134 |
| | (0.6105) | (0.4029) | (0.5052) | (0.6794) | (1.2908) | (0.6012) |
| **Deal with People** | -0.0435 | 0.0611 | 0.2367 | 0.1735 | 0.1426 | 0.4136 |
| | (0.1921) | (0.1262) | (0.1582) | (0.3429) | (0.2593) | (0.1883) |
| **Correction for Misclassification?** | No | Yes | No | Yes | No | Yes |
| **F-Test of No Selection (P-Value)** | 0.0878 | | 0.2599 | | 0.7084 | |
| **Sample Size** | 3927 | 3927 | 4238 | 4238 | 3832 | 3832 |

Notes: Standard errors are in parentheses, with 5 percent significance given in white, and 1 percent significance in grey. These are adjusted for structural group effects where applicable. Other covariates include tenure, labor market experience, and dummies for region, industry, year, residence in Standard Metropolitan Statistical Area (SMSA), unemployment rate, schooling, union status, and increase in responsibility.

likely to be assigned specific tasks, with target completion dates, this is consistent with our view that a worker is paid a fixed hourly wage but does not imply a lack of incentive pay. Rather, the worker is paid for the time spent on the job, where he or she is required to achieve a satisfactory level of performance. Relative to piece-rate contracts, tasks with less variety would be easier to monitor on a day-to-day basis, hence performance can be measured in terms of acceptable/unacceptable, with termination being the consequence if there is unacceptable performance.

The Autonomy variable has positive sign in the Commission vs. Fixed-Salary regression, while the complete task variable is negative. Given that commission workers are rewarded based upon a measure of output, direct monitoring is less necessary and hence they have more autonomy. This also implies that those workers who are not paid commissions would be more closely monitored, an observation that is consistent with the negative coefficient for the Complete Task variable.

Consistent with earlier results by Brown (1990), we find that Variety has a negative effect on the likelihood that commission contracts are used. This result does not follow directly from the agency theory that would predict the use of more, not less, performance pay. In the next section we outline a model based upon

Williamson's (1975) notion of opportunism, which may help explain this effect. It is also interesting to observe that job characteristics have little impact upon the choice of whether to use bonus pay.

If bonus pay is not directly related to job characteristics, then what is its role? The use of bonus pay is not a prediction of the agency model because it is not an explicit function of a performance measure, rather it is the consequence of some subjective performance-evaluation system. More generally, the data also suggests that for many workers, contracted-performance pay (piece rate or commission) is not always an important ingredient of compensation, especially when Variety is important—even though agency theory predicts that even imperfect measures of performance should be incorporated into pay. In the next section we discuss how a model of contract incompleteness based upon a simple complexity argument can explain both the use of noncontingent pay and why the incidence of bonus pay may not depend upon job characteristics.

## OPPORTUNISM AND CONTRACT COMPLEXITY

What we learn from the agency model is that generically optimal contracts should incorporate all available performance measures. This implies that pay-for-performance should be the norm rather than the exception. There is a large body of evidence in the management literature that emphasizes the dysfunctional attributes of performance pay. For example, if we were to reward computer programmers based upon the number of lines of code that they produce, then the likely consequence is not necessarily high output, but many lines of inefficient and error-ridden code.

An immediate response is that lines of code is not an appropriate measure of output. As the famous study by Kerr (1975) eloquently illustrates, many organizations and firms have implemented pay-for-performance systems, only later to discover that they result in dysfunctional behavior from the organization's point of view. Recall that in an agency model the optimal contract incorporates the incentives for shirking via the Incentive-Compatibility constraint, and thus, firms would never be surprised by worker behavior *ex ante*. Kerr's observation of unexpected, dysfunctional behavior *ex post* is consistent with Williamson's (1975) notion of opportunism: self-interest seeking with guile.

In the context of an agency relationship, we define guile as behavior that takes advantage of the incentive system by increasing the agent's payoff at the expense of the principals that is *not* anticipated via the Incentive Constraint. For example, consider a firm that rewards typists based upon the measured number of keystrokes per day. This is a clear pay-for-performance contract committing the firm to a pay method that is a simple function of "output." The difficulty with this system, as was discovered when the system was implemented at one firm, is that one typist discovered that she could increase her income by pressing the same key repeatedly.

Had the firm anticipated this behavior, it would have implemented additional monitoring to ensure the quality of output. The agency model explicitly assumes that all possible types of dysfunctional behavior are anticipated and controlled with the appropriate contract terms and conditions. Hence, the introduction of a negative behavior such as guile necessarily requires the relaxation of the complete-contracts assumption, which in turn requires a fundamental modification of the standard economic model of decision-making.[8]

The conceptual starting point is to view contract incompleteness as arising from the problem of exchanging *complex goods*, such as labor services. A distinguishing feature of a complex good, relative to an exchange of a simple good or commodity, is that quality is difficult to define, and therefore difficult to enforce using a contingent contract enforced by the threat of a court action. Secondly, both the creation of complex goods and the formation of contracts to govern their exchange are *innovative activities* that do not fit easily into the standard agency model.

[8] See MacLeod (1997) for a complete discussion of this point.

The problem can be illustrated formally with a simple model of employment based upon the multitasking model of Holmstrom and Milgrom (1991):

1. The principal and agent agree on compensation and expectations for performance (which may include the continuation of a previous agreement).
2. The state of the world $\omega_t \in \Omega$ is revealed.
3. The agent divides a time endowment of $Y$ among $k$ different tasks: $y_t \in \Re^K$.
4. The principle pays the agent $W_t$.
5. Both principle and agent decide whether to continue the relationship or not.

The date is denoted by the subscript $t$, and $K$ is the number of possible tasks. The twist upon the previous literature concerns the interpretation of the state of nature. Suppose that both the costs and benefits of different actions are unknown *ex ante*; for example, a fireman may not know which house will catch fire; how difficult it will be to put out the fire; nor is he able to anticipate the set of actions that will need to be carried out upon entering the burning house. A state space that incorporates uncertain costs and benefits for each of the possible tasks can be defined as follows:

$$(6) \qquad \Omega = \left\{\left\{\alpha^1,...,\alpha^n\right\} \times \left\{\beta^1,...,\beta^m\right\}\right\}^k,$$

where $\alpha_k \in \left\{\alpha^1,...,\alpha^n\right\}$

denotes one of $n$ levels of productivity for task $k$, while

$$\beta_k \in \left\{\beta^1,...,\beta^m\right\}$$

represents one of the $m$ cost levels for task $k$. The total benefit from an effort choice $\mathbf{y}_t$ is defined by $\alpha^T \mathbf{y}_t$ (boldface represents a vector), while the total cost to the worker of producing this effort is

$$(7) \qquad C(\mathbf{y}_t, \beta) \equiv \sum_{i=1}^{K} \left(\beta_i y_{it}^2 - \delta(y_{it}) f\right).$$

The quadratic term implies that the marginal cost of effort in a single task is increasing with effort, ensuring an interior optimum. The function $\delta(y_{it})$ is 1 if $y_{it}$ is positive and zero otherwise, which implies that there is a fixed cost $f$ of supplying a positive level of effort to a particular task. When there are a large number of tasks this implies that the individual will supply effort to only a subset of possible tasks.

The benefits and costs have been modeled as functions, however it is explicitly assumed that a measurement system does not exist. Consider a secretary who carries out a variety of tasks including typing, answering the phone, filing, making travel reservations, etc. The costs and benefits for these different activities vary with the day-to-day demands of the office. For example, several people in the office may need to go to the same conference, raising the productivity of allocating time to travel plans, and resulting in a cutback in typing throughput. On the cost side, if the conference occurs during a busy period (for example college convocation), then one may have to call several hotels to find accommodations. Not only do these costs and benefits vary in an independent way from day-to-day, it is not clear (at least to me) how one would construct a measurement system to directly compare the costs and benefits of the different actions.

Notice that in the principal agent model it assumed that all signals, $m$, are verifiable and can be used to construct an explicit contract; however the $y_{it}$ are assumed to not be measurable. Here, we suppose that the $y_{it}$ can be observed, but there exists no contractible m. For example, if one had a measure of individual contribution, $m_t = \alpha^T y_t$, this could be used to construct an efficient, explicit contract. For many, if not most jobs, it is very difficult to construct such a measure.

The lack of a measurement system aggregating performance implies that the contract must explicitly describe each state and specify the appropriate associated action.[9] This is common in many contracts. For example, the contract for a singer at a concert may explicitly list acceptable reasons, such as laryngitis, that excuse the

[9] This assumption can be contrasted with the agency approach to compensation as outlined in Baker (1992) and Holmstrom and Milgrom (1991). This work examines the optimal way to incorporate imperfect signals of worker performance into the pay package.

Table 3

Cost of a Complete-State Contingent Contract

| Number of Cost and Performance Levels | Number of Tasks: 2 | 5 | 10 | 15 |
|---|---|---|---|---|
| 2 | $0.16 | $10 | $10,000 | $10 million |
| 3 | $0.81 | $600 | $35 million | $2 trillion |
| 4 | $2.56 | $10,000 | $11 billion | $11,000 trillion |
| 5 | $6.25 | $100,000 | $1,000 billion | $10 million trillion |
| **Cost of a contract clause:** | **1 cent** | | | |

individual from providing the contracted upon services. Formally the contract is a function

$$c:\Omega \to X = \Re \times \Re^k,$$

where for each state w ∈ Ωthe

$$c(\omega) = (\omega(\omega), y(\omega)) \in X$$

defines the wage payment and the output expected from the agent. This assumption differs from the incomplete contracts literature where it is assumed that such a contract is impossible, while maintaining the hypothesis that individuals understand all the possible outcomes and can recontract based on the *ex post* realization of the state.

For this model an efficient complete contract,

$$c^*(\omega) = (\omega(\omega), y(\omega)),$$

is the solution to the following program:

$$(8)\quad \mathrm{y}(\omega) \in \arg\max_{\mathrm{y}'} \ \mathrm{a}\,\mathrm{y}' - C(\mathrm{y}', \beta),$$

subject to:

$$(9)\quad |\mathrm{y}| \equiv \sum_{i=1}^{k} y_i' = Y,$$

and

$$(10)\quad w(\omega) = \overline{U} + C(\mathrm{y}(\omega), \beta),$$

where $\overline{U}$ is the one-period alternative utility for the worker. Following Townsend (1979) and Dye (1985), let us suppose that there is a cost for including additional contract contingencies, given by γper contingency. For this multitasking model one has the following result.

*Proposition 2.* The cost of implementing the complete contract procedure when all states occur with positive probability is $n^k m^k \gamma$.

What is important to observe is that the cost of the contract is an exponential function of the number of tasks. The literature on computational complexity emphasizes the impossibility of implementing algorithms whose costs are exponential in the size of the problem (see Garey and Johnson, 1979). To see why this is the case, suppose that $\gamma = 1$ cent, and that the number of cost and performance levels are the same ($n = m$). Table 3 presents the costs of the complete contract as a function of the number of tasks and effort levels.

As one can see, the use of a complete contract when there are more than say 10 tasks is impossible. Furthermore, given that these costs reflect the number of underlying states, dynamic programming is impossible because one could not compute the expected value of the relationship. Observe that the piece rate contracts correspond to basing compensation on one dimension of output. In this simple

setup complete contracts are very inexpensive; therefore, they should be observed when there is a small number of tasks to be measured.

A solution to the problem of complexity is to use an *ex post* evaluation of the employee using supervisor reports. The subjective nature of these reports make third-party enforcement impossible. Hence, performance depends upon what MacNeil (1974) calls a *relational contract*, which is discussed in more detail in the next section. Given that direct supervision of the employee is an essential ingredient of the relational contract, then not only should workers in such contracts have less autonomy, but they also should have well-defined goals that are determined by their supervisors.

## RELATIONAL CONTRACTS

When an explicit contract is not possible, the firm must rely upon some form of *ex post* incentive to ensure performance. There are essentially three types of noncontracted *ex post* rewards that we observe in the NLSY:

1. Termination contracts—pay the worker a fixed salary, and fire the worker at the end of the period if performance is not satisfactory.
2. Bonus contract—pay the worker a discretionary bonus at the end of the period that depends on performance.
3. Deferred compensation—reward the worker with a promotion or permanent wage increase.

Bonus pay and deferred compensation are not perfect substitutes since a promotion entails a permanent increase in income. Given that we are using only indicators rather than levels, however, we have coded bonuses and deferred compensation into the same category. This reduces the error associated with imputing the true value of the promotion. Between 10 percent to 14 percent of the individuals in our data set receive some form of bonus pay (as opposed to piece rates or commissions, which are forms of complete contingent contract with no *ex post* evaluation).[10] The theory developed in MacLeod and Malcomson (1989) makes some predictions concerning the effect of market alternatives for workers upon the incidence of bonus pay that we briefly outline here.

Suppose the employment contract is given by $c=\{w,b\}$, where $w$ is a fixed wage that is paid at the end of the period regardless of performance, and $b \geq 0$ is a discretionary bonus payment that depends on the firm's subjective *ex post* evaluation of performance. Given this contract, individual utility and firm profits are given by:

$$U(c) = \omega + b - \upsilon e + \delta U^c, \tag{11}$$

$$\Pi(c) = \theta e - w - b + \delta \Pi^c, \tag{12}$$

where $e \in \{0,1\}$ is a noncontractible effort choice taken by the worker, $U^c$ and $\Pi$ are the utility and profit, respectively, from continuing the relationship, assumed to be discounted at the rate $\delta$. The parameters $\upsilon$ and $\theta$ are respectively the cost and benefit of one unit of effort.

The implicit agreement between the firm and worker requires the firm to pay the bonus if and only if the worker selects the high level of effort.[11] Should either party shirk, then the relationship is terminated immediately. Letting $\overline{U}$ and $\overline{\Pi}$ denote the market alternatives for the worker and the firm, then a contract is self-enforcing if and only if the following incentive conditions are satisfied:

$$\delta\left(U^c - \overline{U}\right) \geq \upsilon - b, \tag{13}$$

$$\delta\left(\Pi^c - \overline{\Pi}\right) \geq b. \tag{14}$$

Notice that it is necessary to pay a bonus only if $\delta(U^c - \overline{U}) < v$. For example. if unemployment rates for the worker were to increase, this would lower $\overline{U}$ and increase the likelihood that $\delta(U^c - \overline{U}) \geq v$. In this case, the threat of termination alone provides sufficient incentives for the worker not to shirk. Conversely, with a tight local labor

[10] Some individuals in the NLSY data receive both piece rates and bonuses. They are a small fraction of our sample, however, and so we do not explicitly consider this case.

[11] MacLeod and Malcomson (1989) prove that there is no loss of generality when contracts are restricted to take this form.

Table 4

Tobit Analysis of Determinants of Bonus Pay
Panel Study of Income Dynamics (1984-91) $1979
(Standard Errors in Parenthesis)

| Variable | All Observations | | | SMSA Workers Only | | |
|---|---|---|---|---|---|---|
| Local Unemployment Rate | -360.47 | -357.2 | -525.37 | -570.49 | -542.78 | -893.73 |
| | (76.97) | (76.83) | (75.41) | (158.22) | (157.94) | (152.61) |
| Industry Unemployment Rate (one-digit) | -91.36 | -125.58 | | -396.76 | -36.86 | |
| | (328.33) | (77.96) | | (598.02) | (133.36) | |
| Schooling | 186.98 | 200.69 | -47.69 | 242.25 | 277.29 | -6.64 |
| | (66.65) | (66.63) | (56.34) | (107.46) | (107.66) | (92.18) |
| Union | -1920.59 | -2059.63 | -1869.24 | -2165.24 | -2408.64 | -2258.56 |
| | (554.94) | (548.56) | (559.72) | (982.56) | (970.28) | (995.49) |
| Potential Experience | -10.73 | -11.6 | -52.79 | 38.8 | 39.57 | -9.38 |
| | (20.80) | (20.52) | (20.21) | (35.39) | (35.46) | (34.29) |
| Tenure | 14.63 | 15.63 | 30.94 | 26.38 | 30.67 | 40.91 |
| | (26.12) | (25.69) | (26.20) | (44.00) | (43.00) | (44.16) |
| Live in a SMSA | 571.09 | 657.22 | 347.53 | | | |
| | (345.38) | (344.84) | (103.79) | | | |
| Industry Dummies | Yes | No | Yes* | Yes | No | Yes* |
| Log Likelihood | -14116 | -14124.2 | -14113.6 | -7724 | -7733.5 | -7721.6 |
| N | 10217 | 10217 | 10217 | 5119 | 5119 | 5119 |

Note: Workers paid commissions are excluded from the analysis. Additional regressors include time and occupation dummies, as well as a dummy for being married.

*A full set of Year X Industry (one-digit) dummies.

market, when the worker can always find alternative work easily, the incentive constraints imply that some form of end-of-the-period bonus must be paid. Therefore, we expect the incidence of bonus pay to be a decreasing function of the local unemployment rate.

In Table 4 we present some evidence of this effect using the Panel Study on Income Dynamics. We also explore the effect of both the local and industry unemployment rates upon the amount of bonus pay. Table 5 shows the same relationship regarding the incidence of bonuses/promotions in the NLSY. One explanation for the incidence/amount-of-bonus pay is as a form of profit sharing between the firm and the worker. Most firm's profits are correlated with industry rather than local unemployment rates. When this is the case, it implies that bonus pay incidence will increase with a decrease in the industry unemployment rate, while the local rate would be unimportant. The self-enforcing contract model makes the opposite prediction.

As we can see from the regression results, the industry rate is not significant, while the local unemployment rate has a negative impact upon the amount and the incidence of bonus pay. Also, as we would expect, this effect is stronger when we restrict analysis to urban areas where workers would have better market alterna-

tives. More surprising for us, is the fact that the local labor market effect increases in the PSID data set when we add controls for time-varying industry effects. If bonus pay were the result of profit sharing, then the addition of such controls would make the effect of local unemployment either small or less precise, whereas we observe exactly the opposite.

In this model we have assumed that the supervisor can perfectly observe performance *ex post*. We could add imperfect observability, as in Shapiro and Stiglitz (1984), and obtain the same result. It is sometimes believed that it is imperfect observability that generates an efficiency wage. As the results of Holmstrom (1982) demonstrate, however, an imperfect but *contractible* measure of output would completely eliminate the equilibrium unemployment result for a standard efficiency wage model. Hence, the use of bonus pay and/or efficiency wages are a consequence of increases in job complexity that make it impossible to fully specify *ex ante* an employer's performance expectations.

Therefore, our results provide more support for efficiency-wage type models. In the absence of bonus pay, an efficiency-wage model implies that the wage must be above market clearing, and if unemployment falls this may lead to an increase in inflation. Recently, the economy has appeared to have both low inflation and low unemployment. This could occur if firms move towards a system of bonus pay, rather than raise wages. In Figure 1 we illustrate the trend in the incidence of bonus pay, inflation, and unemployment from 1976 until 1991. While this is not a test, it does show a definite upward trend in the use of bonus pay during this period.

Table 5

Fixed-Effect Results—NLSY 1988-90

| Variable | Bonus / Promotion vs. Termination Contract (Bonus=1) (Salaried Workers Only) | Bonus / Promotion vs. Termination Contract (Bonus=1) (All Noncommission Workers) |
|---|---|---|
| Autonomy | 0.982 | 0.5743 |
| | (0.9165) | (0.8136) |
| Complete Task | 0.3077 | 0.0397 |
| | (0.9044) | (0.8621) |
| Variety | -1.1146 | -0.793 |
| | (0.7175) | (0.6839) |
| Friendships | -0.3302 | 0.4767 |
| | (1.2908) | (1.2377) |
| Deal with People | 0.1426 | 0.4306 |
| | (0.2593) | (0.2472) |
| Unemployment Rate in Local Labor Market | -0.0774 | -0.0321 |
| | (0.0161) | (0.0159) |
| Unemployment Rate in Industry | -0.0299 | 0.0123 |
| | (0.0225) | (0.0213) |
| Schooling | -0.0104 | 0.0134 |
| | (0.0316) | (0.0206) |
| Union | -0.0807 | 0.0092 |
| | (0.0336) | (0.0264) |
| Sample Size | 3832 | 7682 |

Note: Standard errors are in parentheses, with 5 percent significance given in white, and 1 percent significance in grey. These are adjusted for structural group effects where applicable. Other covariates include tenure, labor market experience, and dummies for region, industry, year, residence in Standard Metropolitan Statistical Area, and increase in responsibility.

## CONCLUSIONS

In this essay we have reviewed some preliminary evidence relating job characteristics to the form of compensation. Our main message is that we observe a variety of compensation systems used in practice, the form of which depends upon job characteristics. There is no single economic model of contract formation that can explain the data. Rather, the data suggests that compensation systems depend on explicit performance measures when these accurately measure the contribution of work. In complex environments, firms must depend upon subjective measures of performance associated with *ex post* rewards to the worker.

We have also presented evidence showing that the amount of bonus pay is dependent upon the state of the local labor market. One benefit of bonus pay is that its level can be adjusted easily from year-to-year in response to business cycle fluctuations,

which as Weitzman (1985) has argued, can result in both low unemployment and low inflation. The recent trend increase in the use of bonus pay may be one reason why inflation has not increased, even though the United States also is experiencing low unemployment.

Currently, we do not know if this trend is the consequence of secular changes in the nature of work, or the result of innovative activity on the part of the firm. Given that the form of compensation is likely to affect the responsiveness of incomes to inflation and business cycle fluctuations, it is important to better understand the reasons for these changes. We can conclude that it is an oversimplification to view wage formation as the simple consequence of supply and demand forces, and that better understanding the source of variation in pay systems may have important implications for the nature of monetary policy, a question we hope to explore in future work.

## REFERENCES

Baker, George. "Incentive Contracts and Performance Measurement," *Journal of Political Economy* (June 1992), pp. 598-614.

Brown, Charles. "Firm's Choice of Method of Pay," *Industrial and Labour Relations Review* (Special Issue 1990), pp. 165S-82S.

Dye, Ronald A. "Costly Contract Contingencies," *International Economic Review* (February 1985), pp. 233-50.

Garey, Michael R. and David S. Johnson. *Computers and Intractability,* W. H. Freeman and Co., 1979.

Gibbons, Robert. "The Employment Relationship," mimeo, survey paper prepared for the Seventh World Congress of the Econometric Society, Tokyo, August 1995.

Hart, Oliver D., and Bengt Holmström. "The Theory of Contracts," *Advances in Economic Theory, Fifth World Congress.*, Truman Bewley, ed., Cambridge University Press, 1987, pp. 71-155.

Holmstrom, Bengt. "Moral Hazard in Teams," *Bell Journal of Economics* (Autumn 1982), pp. 324-40.

_____, and Paul Milgrom. "Multi-Task Principal-Agent Analyses: Incentive Contracts, Asset Ownership, and Job Design," *Journal of Law, Economics, and Organization* (1991), pp. 24-52.

Kerr, Steven. "On the Folly of Rewarding A, While Hoping for B," *Academy of Management Journal* (December 1975), pp. 769-83.

Krueger, Alan B., and Lawrence H. Summers. "Efficiency Wages and the Inter-Industry Wage Structure," *Econometrica* (March 1988), pp. 259-94.

MacLeod, W. Bentley. "Complexity, Bounded Rationality and Heuristic Search," mimeo, University of Southern California, (August 1997).

_____, and James M. Malcomson. "Implicit Contracts, Incentive Compatibility, and Involuntary Unemployment," *Econometrica* (March 1989), pp. 447-80.

_____, and Daniel Parent. "Jobs Characteristics and the Form of Compensation," mimeo, University of Southern California (1997).

MacNeil, Ian R. "The Many Futures of Contracts," *Southern California Law Review* (1974), pp. 691-816.

Moulton, Brent R. "Random Group Effects and the Precision of Regression Estimates," *Journal of Econometrics* (August 1986), pp. 385-97.

Ritter, Joseph A. and Lowell J. Taylor. "Economic Models of Employee Motivation," this *Review* 79 (September/October, 1997), pp. 3-21.

Shapiro, Carl, and Joseph E. Stiglitz. "Equilibrium Unemployment as a Worker Discipline Device," *American Economic Review* (June 1984), pp. 433-44.

Townsend, Robert. "Optimal Contracts and Competitive Markets with Costly State Verification," *Journal of Economic Theory* (October 1979), pp. 265-2.

Weitzman, Martin L. "Profit Sharing as Macroeconomic Policy," *American Economic Review* (May 1985), pp. 41-45.

Williamson, Oliver. *Markets and Hierarchies: Analysis and Antitrust Implications*, The Free Press (1975).

## DATA APPENDIX

### *National Longitudinal Survey of Youth (1988-90)*

The National Longitudinal Survey of Youth (NLSY) data set surveyed 12,686 young males and females who were between the ages of 14 and 21 in 1979. In 1988, 1989, and 1990, respondents were asked whether all or part of their earnings were based on job performance. They were also asked a few questions on their work environment. For instance, we know if the respondents were supervising other employees and whether they had received a promotion since their last interview. Unfortunately, we do not know the precise dollar amounts of incentive pay received by workers nor do we know the proportion of their earnings which is due to pay-for-performance.

We asked the following question pertaining to pay-for-performance: "The earnings on some jobs are based all or in part on how a person performs the job (hand card D). On this card are some examples of earnings that are based on job performance. Please tell me if any of the earnings on your job (are/were) based on any of these types of compensation. Please do not include profit sharing or employee stock purchase plans.

1. Piece rates.
2. Commissions.
3. Bonuses (based on job performance).
4. Stock options.
5. Tips.
6. Other."

They also were asked whether they had received a promotion on their current/most recent job since the last interview. We restricted the sample to individuals who were in the labor market on a full-time basis. The people who were considered as meeting that criterion were those:

1. Whose primary activity was either working full-time, on a temporary lay-off or looking actively for a job,

2. Who had worked at least half the year since the last interview and who were working at least 20 hours per week.

Table 6

Average Real Wage Change, NLSY 1988-90

| | No Promotion No Bonus | Bonus Only | Promotion Only | Bonus and Promotion |
|---|---|---|---|---|
| **All Jobs** | 6.7% | 7.6% | 12.0% | 11.6% |
| **Within Existing Employment Relationships Only** | 6.2% | 7.2% | 11.7% | 3.8% |

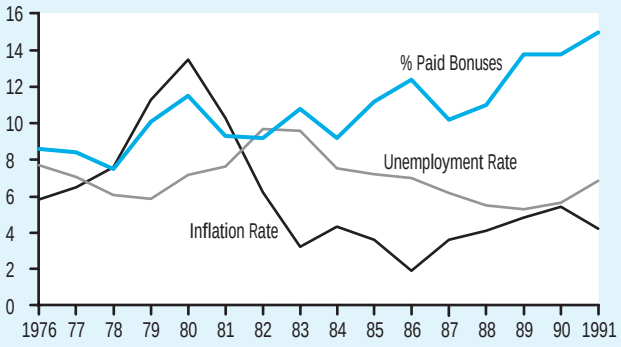
Incidence of Different Combinations, NLSY 1988-90

| | No Promotion No Bonus | Bonus Only | Promotion Only | Bonus and Promotion |
|---|---|---|---|---|
| **All Jobs** | 72.3% | 10.5% | 13.5% | 3.7% |
| **First Time Observed With Employer** | 72.7% | 9.8% | 13.7% | 3.8% |

Figure 1

Evolution of Bonus Incidence in the United States.

**PSID 1976-91**




Individuals excluded from the sample were those who have been in the military at any time, the self-employed, and all public-sector employees. These restrictions left us with an unbalanced sample of 8,165 observations (3,847 workers), of which 3,832 were paid either a salary or a salary and a bonus.

## The Panel Study of Income Dynamics (PSID), (1976-91)

The sample consisted of white male heads of households aged 18 to 64 with positive earnings for the period spanning the years 1976-91.[12] Individuals in the public sector and those who worked less than 500 hours were excluded from the analysis. We know whether each worker was paid a piece rate, a commission, an hourly rate, or a salary. One interesting feature of the PSID for the 1976-91 period is the fact that we were able to determine whether a worker received a bonus during the last year. In the PSID questionnaire, workers were asked the amount of money they received from either working overtime, or from commissions, or from bonuses paid by the employer. Given that workers reported either their number of overtime hours worked (or simply that they worked overtime) as well as the hourly rate for overtime, we were able to compute an estimate of the amounts paid in bonuses.[13]

[12]In the PSID, data on hours worked during year *t*, as well as on total labor earnings, bonuses/commissions/overtime income, and overtime hours, are asked at the year *t+1* interview. Thus, we actually use data covering interview years 1976-92.

[13]Since we cannot separately identify the amount of income derived exclusively par from commissions, we have to remove these workers from the calculations. Note that removing all negative estimates of the bonuses probably biases the par mean bonus paid upward.

## Computation of Bonuses from PSID Data

Variables V5285, V5784, V6393, V6983, V7575, V8267, V8875, V10258, V11399, V12798, V13900, V14915, V16415, V17831, V19131, and V20431: "Head's income from bonuses, overtime, and/or commissions."

Note that starting with interview year 1986, the codebook specifies that the values for this variable represented any extra bonus, overtime and commissions income not included in heads of household's income from wages and salaries during the preceding calendar year. Therefore, it is possible that some workers who actually received a bonus from their employer did not report it separately from their usual. income.

Variables V5419, V5906, V6517, V7120, V7743, V8405, V9036, and V10563: "Did you work any overtime which isn't reported in [average hours per week worked last year]?"

Variables V11142, V12541, V13741, V14831, V16331, V17740, V19044, and V20340: "The values for this variable [...] represent the annual overtime hours worked on all main jobs, if reported separately from regular work hours."

Variables V4515, V5426, V5913, V6524, V7127, V7720, V8388, V9019, V10468, V11659, V13062, V14162, V15170, V16671, V18109, V19409: "How is that? Neither salaried nor paid hourly."

This question refers to the method of pay where the respondent was paid neither a straight salary nor an hourly rate. From this question, we were able to identify those workers paid commissions or a base salary plus commissions.

Variables V10465, V11656, V13059, V14159, V15167, V16668, V18106, V19406: This is the overtime hourly rate for salaried workers.

Variables V10467, V11658, V13061, V14161, V15169, V16670, V18108, V19408: This is the overtime hourly rate for hourly paid workers.

Variables V10469, V11660, V13063, V14163, V15171, V16672, V18110,

V19410: This is the overtime hourly rate for workers not paid either a salary or an hourly rate.

Since no information on overtime hours is available before 1984, we could not compute an estimate of overtime income for the years 1976-83. Thus, we simply deleted from the sample all workers who report working overtime between 1976 and 1983 and those who report positive hours of overtime work between 1984 and 1991.[14] We also deleted commission workers.

It is worth repeating that we may have a noisy measure of bonuses paid. The reason is that the questions on overtime are not clear cut because workers were NOT asked to report any overtime activity during the previous calendar year. Instead, they were asked to report all overtime work *not already included* in the usual hours per-week worked.

Measures of Local Labor Market Conditions. From the beginning of the PSID to interview year 1989, questionnaires were sent to state employment offices asking about current labor market conditions in these counties. Specifically, the unemployment rate measure refers to a specific period during the corresponding interview year. For interview year 1976, the reference month is August; for interview years 1977-79, it is November; for interview years 1981 and 1983, it is December, while for interview years, 1982, 1984-88, it is September.

Starting with interview year 1990, they replaced the variables about the availability of unskilled jobs and unemployment rates with the average annual unemployment rates for the respondents' counties for the calendar year prior to the interview. These figures come from the U.S. Bureau of Labor Statistics (BLS) Local Area Unemployment Statistics Program. The industry (1 digit) level unemployment rate series also comes from the BLS.

[14]Restricting the sample to 1984-91 and using the amount earned in overtime to compute bonuses does not change the results, apart from the standard errors.