Performance Pay, Wage Flexibility, and Hours of Work *

Thomas Lemieux
Department of Economics
University of British Columbia

W. Bentley Macleod
Department of Economics
Columbia University

Daniel Parent
Department of Economics
McGill University

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Abstract

Using data from the Panel Study of Income Dynamics, we study the impact of local labor market shocks on wages, hours of work and employment under different contractual arrangements. We divide jobs on the basis of whether they pay for performance, and whether they are covered by collective bargaining agreements. Using the county unemployment rate as a proxy for local labor market shocks, we find that wages and hours of work respond very differently to shocks depending on contractual arrangements. Wages are most flexible under non-union performance-pay contracts, and least flexible under non-performance-pay union contracts. Precisely the opposite happens in the case of hours of work that are the least sensitive to shocks under non-union performance-pay contracts, and the most sensitive under union non-performance-pay contracts. We discuss the implications of these findings for labor market inequality and the role of the labor market in the transmission of shocks in the macroeconomy.

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1 Introduction

Unemployment and the role of the labor market in transmitting real and monetary shocks has long played a central role in macro economics. Beginning with Keynes, it has been speculated that the labor market is not perfectly competitive. A great deal of research work has explored the extent to which search frictions and optimal inter-temporal risk sharing contracts can explain the evidence.

It has been found that these models cannot explain all aspects of the data, and as a consequence recent work has returned to exploring the implications of models with sticky nominal wages. These models are typically at the aggregate level, and suppose that different sectors of the economy experience the same degree of stickiness. One reason for this is analytical convenience. A second reason is that lack of evidence on the extent to which contract form is heterogeneous in the economy in a way that is meaningful.

This is a major shortcoming since a number of studies have shown that contractual arrangements in the labor market have undergone major changes over the last few decades. As is well known, the rate of unionization in the U.S. and several other countries has declined dramatically since the 1970s (Farber and Western (2001)). Most unionized workers are now working for the public sector, while the unionization rate among private-sector workers is now below 10 percent. This is a major development as union contracts typical fix wages over the duration of the contract (typically 2-3 years), which results in a staggered wage structure "a la" Fischer (1977). No such explicit medium terms contracts typically prevail in non-unionized firms.

Furthermore, Lemieux, MacLeod, and Parent (2009) show the fraction of workers who receive part of their compensation in the form of bonuses or commissions has grown substantially over the same time period. Since wages under these performance-pay contracts explicitly depend on the worker's performance, they are likely more flexible than under more traditional pay systems. Other developments such as the growth of contingent employment and temporary work agencies (Segal and Sullivan (1997)) has also contributed to the movement away from more traditional, and union-based, pay systems.

In this paper we present direct evidence that wages, employment, and hours of work respond very differently to labor market shocks under different contractual arrangements. We divide jobs into four categories based on whether the workers are unionized and are covered by performance-pay schemes. Using the Panel Study of Income Dynamics (PSID), our main finding is that wages are most responsive to shocks for non-union workers covered by performance-pay schemes, and least responsive for union workers who are not paid for performance. Interestingly, precisely the opposite happens in case of hours of work. This confirms our expectation that shocks have a larger impact on employment under traditional contractual arrangements where rigid wages results in more employment (and output) response to shocks.

Our findings have two important implications. First, as contractual arrangements have moved away from the traditional or union-based model over time, our results suggest that this "modernization" of the U.S. labor market has reduced its role in the transmission of real or monetary shocks to the macroeconomy. Second, while we show in our earlier work (Lemieux, MacLeod, and Parent (2009)) that performance-pay results in more (hourly) wage inequality, it also reduces variability in hours of work. This mitigates substantially the overall impact of performance pay on total earnings inequality in both a static and dynamic sense.

The paper proceeds as follows. In Section 2, we present our theoretical model and derive some predictions regarding the impact of productivity shocks under different contractual arrangements. We present the PSID data and discuss how we empirically classify workers into the different types of contracts in Section 3. The main empirical results are presented in Section 4. We discuss the implication of our findings for inequality and the transmission of shocks in the macroeconomy in Section 5, and conclude in Section 6.

2 Wages, Hours, and Contractual Arrangements

In this section we consider different contractual settings and compare their implications for the impact of productivity shocks on wages, hours of work, and employment probability. We focus our discussion on the distinction between performance-pay and fixed-wage contracts. This distinction follows Lemieux, MacLeod, and Parent (2009) who consider a situation where employers don't observe the level of effort of workers. We then extend the discussion to the case of union and non-union wage setting.

2.1 Performance Pay

In the standard competitive model firms and the rest of the labor market observe the marginal product of workers, while competition ensures that the wage is equal to a worker's marginal product. In this setting, modes of payment (fixed wages, performance pay, etc.) have no empirical content since no matter how workers are paid, they are paid for their marginal product. In practice, firms appear to find the problem of setting wages equal to marginal products difficult if not daunting.[1]

There are a number of reasons why it may be in the interest of firms to introduce performance-pay schemes, even if this entails substantial monitoring and administrative costs. As always, firms will be willing to incur these additional costs provided that they obtain sufficient benefits in return. A commonly mentioned benefit of performance pay is that it provides incentives for workers to exert more effort. But even if performance pay has no effect on workers' effort, when workers are heterogeneous in terms of their innate productive abilities it can be profitable for firms to pay the monitoring cost and then attract more able workers by paying them a wage that better reflects their productivity. In such a setting, performance pay plays an important role in sorting workers across different jobs and/or employers.[2]

Since the cost of obtaining a good measure of the performance of workers is likely to be related to job characteristics, the incidence of performance-pay schemes should also vary according to these characteristics. This prediction holds regardless of whether performance pay is used for incentive or sorting reasons. Using data from the BLS industry wage survey, Brown (1990) explores how the choice between a fixed salary, merit pay and piece-rate compensation depends on monitoring costs. He finds that firms choose standard rates when monitoring costs are high, as is the case with complex jobs. Merit pay systems are more likely to be used when workers feel that their evaluations are fair.

MacLeod and Parent (1999) consider a similar question using a number of panel data sets to control for unobserved worker-specific characteristics. They also extend Brown's analysis to a broader class of compensation systems, and differentiate between bonus pay, commission contracts, and piece-rate contracts. They find that commission contracts are widely used in sales jobs, where the level of sales provides a clean measure of performance.

[1] Stephen Kerr (1975), in a paper that has earned a place in the canonical MBA course on human resource management, provides a number of examples of firms that, in his opinion, completely fail in their attempt to encourage and pay people according to their marginal product. See also Gibbons (1997), page 9.

[2] See Lazear (2000) for some evidence on worker sorting.

When performance measures are more subjective, then firms either use bonus pay or pay as a function of hours or days worked, with little explicit pay-for-performance.

In addition to monitoring costs, there are a number of reasons why performance pay may be chosen over other methods of payment in different jobs. Firms that employ high-turnover workers may be more likely to introduce performance-pay schemes than firms with a more stable workforce that can rely upon deferred payments (promotions, pension plans, etc.) to tailor compensation to the characteristics of workers. Indeed, Goldin (1986) shows that around the turn of the 20th century, piece-rates were more widely used in female- than male-dominated occupations, a phenomenon she attributes to the fact that female workers had a higher rate of turnover. Interestingly, piece-rates were more widely used back then than they are today. As modern management practices were introduced and the fraction of clerical and managerial workers grew steadily over time, long-term employment relationships became more prevalent and firms started relying on promotions and other schemes instead of performance pay to provide incentives to their workers.

2.2 Performance Pay vs. Fixed Wages: A Simple Model

We now explore these issues more formally using a simple model. The model builds upon Lazear (1986)'s observation that the reason performance pay is used is because at the time a worker is hired the employer cannot observe her ability. This may result in a mis-match between what the worker is capable of doing and what the employer expects. Linking compensation to performance can reduce this mis-match, and thereby increase overall productivity. However, the introduction of an effective performance pay system is expensive, and thus one faces a trade-off between the cost of introducing such a system, and the benefits in terms of improved match quality.

Suppose a worker i paid a wage w_{it} at time t obtains utility $U_{it} = w_{it} - exp\left(e_{it} - \alpha_i\right)$, where e_{it} is effort and where ability is given by the latent variable, $\alpha_i \sim N\left(\hat{\alpha}_i, \sigma_i^2\right)$. What we call "effort" here can be more broadly interpreted as the effective skills supplied by the worker to complete some specific tasks or duties. For example, workers with lower levels of education (lower α) can supply the same effective skill and perform the same tasks as more educated workers, but doing so is more expensive in utility terms. It is assumed that conditional upon worker characteristics x_i, the mean and variance are known and given by: $\hat{\alpha}_i = E\left\{\alpha|x_i\right\}$ and $2\sigma_i^2 = var\left\{\alpha|x_i\right\}$. Following a long standing tradition in labor economics (Jovanovic (1979) and Harris and Holmström (1982)) it is assumed that information is symmetric; both the worker and firm learn α_i at the same time.

Output y_{it} is assumed to be a linear function of effort:

$$y_{it} = k + \gamma_t e_{it},$$

where k is the output produced on the job regardless of effort and γ_t is the marginal product of effort. The parameter represents a market return to effort linked, for instance, to product demand or production technology. Under performance-pay contracts, net output is obtained by subtracting the cost of monitoring effort, M.

Under fixed-wage contracts, workers agree to supply a fixed level of effort $\bar{e}_{it}$ in exchange for a wage w_{it}^{FW}. Under performance-pay contracts, the firm and the worker agree to a contract linking the wage w_{it}^{PP} to effort, and the worker sets her effort e_{it} optimally once her ability α_i is revealed. As mentioned above, we can think of effort as the tasks or duties performed by a worker on a job. For fixed-wage jobs, the worker and the firm agree on specific duties to be performed in exchange for a fixed wage. For performance-pay jobs, a worker is free to pick the tasks or duties that maximize utility. Firms simply design a contract to make sure the interests of the worker are aligned with those of the firm. Once this is done, there is no need to specify strict duties to be performed, and productivity is improved by letting workers tailor their duties to their own skills and abilities.

We show in Appendix 1 that under a fixed-wage contract, the wage is:

$$w_{it}^{FW} = m_t + \widehat{\gamma}_t \left(\hat{\alpha}_i - \sigma_i^2\right), \tag{1}$$

where $m_t^{FW} = k + \widehat{\gamma}_t log(\widehat{\gamma}_t)$, and $\widehat{\gamma}_t = E\left\{\gamma_t\right\}$ is the expected value of productivity at the time the contract is signed. Under a performance-pay contract, the observed wage is given by:

$$w_{it}^{PP} = m_t + \gamma_t \alpha_i - M, \tag{2}$$

The key difference between these two wage equations is that the wage on performance-pay jobs depends on the actual value of productivity (γ_t) and ability (α_i), while the wage on fixed-wage jobs only depends on their expected values $\hat{\alpha}_i$ and $\widehat{\gamma}_t$. The important consequence is that wages on performance-pay jobs directly respond to changes in productivity, while wages on fixed-wage jobs do not.

Note that proposition 1 in Appendix 1 shows that a performance-pay contract is used whenever the selection rule

$$\sigma_\gamma^2/\widehat{\gamma}_t + \widehat{\gamma}_t\sigma_i^2 \geq M \tag{3}$$

is satisfied, where $2\sigma_\gamma^2 = var(\gamma)$. Thus, performance-pay contracts are chosen whenever the efficiency gain of performance pay, $\sigma_\gamma^2/\widehat{\gamma}_t + \widehat{\gamma}_t\sigma_i^2$, exceeds its cost, M. The efficiency gain grows with the conditional variance of ability, σ_i^2, and productivity shock, σ_γ^2, because performance-pay jobs more closely tailor workers' abilities and productivity to their work efforts. In contrast, mis-match in fixed-wage jobs rises with σ_i^2 and σ_γ^2. This effect also depends on the extent of the (expected) return to effort $\widehat{\gamma}_t$.

This simple selection rule provides a number of interesting predictions about the conditions under which performance pay is chosen over fixed wage contracts. Obviously, reducing the monitoring costs M increases the likelihood of selecting performance pay. Jobs, like executive positions, where output is more sensitive to effort (high γ) are also more likely to offer performance pay. Furthermore, performance-pay contracts are more likely to be selected for workers with a higher conditional variance of ability, σ_i^2. Since it is well known that the within-group variance of wages grows with education (see, e.g., Lemieux (2006)), it is reasonable to assume that σ_i^2 is a growing function of expected ability, $\hat{\alpha}_i$.

2.3 Wages and the Impact of Productivity Shocks

We now derive the empirical specification we use for the wage equations for performance-pay and fixed-wage jobs. The wage equation in performance-pay jobs (equation (2)) can be rewritten as

$$w_{it}^{PP} = m_t + (\gamma_t - \widehat{\gamma}_t)\hat{\alpha}_i + \gamma_t(\alpha_i - \hat{\alpha}_i) + \widehat{\gamma}_t\hat{\alpha}_i - M + \mu_{it}, \tag{4}$$

where $\mu_{it} = (\gamma_t - \widehat{\gamma}_t)(\alpha_i - \hat{\alpha}_i)$ is an interaction term between innovations to productivity $(\gamma_t - \widehat{\gamma}_t)$ and to ability $(\alpha_i - \hat{\alpha}_i)$. Since both $\hat{\alpha}_i$ and $\widehat{\gamma}_t$ generally depend on observable characteristics, x_{it}, as well as unobservable idiosyncratic error terms, we get the following empirical specifications for the wage equations. The wage equation for worker i at time t under performance pay is

$$w_{it}^p = a_t^p + x_{it}b_t^p + c_t^p u_t + d_t^p\theta_i + \varepsilon_{it}^p,$$

while the wage for non-performance-pay jobs is

$$w_{it}^n = a_t^n + x_{it} b_t^n + c_t^n u_t + d_t^n \theta_i + \varepsilon_{it}^n,$$

where x_{it} represents standard observable characteristics such as potential experience, education, occupation, etc.; $\theta_i = \alpha_i - \hat{\alpha}_i$ is the unobservable ability component; $u_t = \gamma_t - \widehat{\gamma}_t$ is a productivity shock; and ε_{ijt}^p and ε_{ijt}^n are idiosyncratic error terms. Note that, as a matter of notational convention, we use the superscript p for performance-pay jobs, and n for "non-performance-pay jobs" (i.e. fixed-wage jobs).

In the case of wages, the main focus of our empirical analysis will be to compare the effect of productivity shocks under performance-pay (c_t^p) and non-performance-pay contracts (c_t^n), respectively. Strictly speaking, we should have $c_t^p > 0$ and $c_t^n = 0$ since productivity shocks should not affect wages when they are set in advance. As we will see below, however, the prediction that $c_t^n = 0$ may be too strong since we do not have a perfect measure of whether or not a worker is paid for performance. We nonetheless expect to find that $c_t^p > c_t^n$. The key empirical implication of the model is, thus, that productivity shocks should have a larger impact on wages in performance-pay than in non-performance-pay jobs.

We also present the results of a variance decomposition exercise toward the end of the paper. In the pure version of the model above, we expect that $d_t^p > 0$ and $d_t^n = 0$, which means that the worker specific component θ_i should only matter in performance-pay jobs. Once again, this strict prediction would not hold when performance-pay status is mismeasured. Furthermore, if workers and firms have more information than the econometrician, part of the expected ability $\hat{\alpha}_i$ will end up in the error term, suggesting the presence of a worker-specific error component in the estimating equation. For these reasons, we simply expect to find that $c_t^p > c_t^n$, i.e. that the variance of the worker-specific error component is larger in performance-pay than in non-performance-pay jobs.

2.4 Hours of Work and Employment

The two contracts discussed above also have pretty stark implications in terms of employment probabilities and hours of work. For simplicity, we have assumed up to know that, under performance pay, firms were making zero profits and that workers were getting all the surplus through the performance-pay arrangement. In these circumstances, the firm is indifferent between employing and not employing the worker. Employment will thus be determined by the worker, depending on whether the utility of employment exceeds the reservation utility.

This is similar to the situation considered by Fehr and Lorenz (2007) who look at how bike messengers adjust both the daily effort and the number of days worked in response to an increase in the marginal product of overall effort. In general, we would expect both hours of work (h) and the hourly wage (w) to increase in response to an increase in the marginal product of effort, γ. Changes in γ just traces changes in wages and hours along the labor supply curve. If labor supply is relatively inelastic, we expect hours to respond much less than wages to changes in γ.

Consider the following equation for hours of work among performance-pay workers:

$$h_{it}^p = a_{ht}^p + x_{it}b_{ht}^p + c_{ht}^p u_t + d_{ht}^p \theta_i + \nu_{it}^p.$$

With both hours and wages expressed in logs, the ratio c_{ht}^p / c_t^p represents the labor supply elasticity. Since our analysis is restricted to a sample of men (more below), we expect c_{ht}^p / c_t^p to be fairly small, i.e. the impact of shocks on hours of work (c_{ht}^p) to be much smaller than the impact of shocks on wages (c_t^p).

The situation is very different in the case of workers not paid for performance. In the case considered above, wages are set in advance and do not adjust at all to productivity shocks. When productivity is higher than expected, the firm will make positive profits and will be very likely to employ the worker. Under a negative productivity shocks, however, the firm will lose money and will likely layoff the worker.

One useful benchmark here it the "right-to-manage" model where a firm and a union bargain on a (fixed) wage, and the firm later sets employment at the level such that the marginal product of labor is equal to the wage. In this setting, employment moves along the labor demand curve in response to productivity shocks. The coefficient c_{ht}^n in the hours equation for non-performance-pay jobs

$$h_{it}^n = a_{ht}^n + x_{it}b_{ht}^n + c_{ht}^n u_t + d_{ht}^n \theta_i + \nu_{it}^n,$$

should be larger than c_{ht}^p if labor demand is more elastic than labor supply.

In summary, the basic prediction is that, under performance-pay contracts, wages and, to a more modest extent, hours increase in response to a positive shock. By contrast, the hourly wage remains fixed while hours bear the brunt of the adjustment under non-performance-pay contracts. We will test these predictions below by using the local unemployment rate as a proxy for productivity shocks.

2.5 Unions

At this stage, we simply view unionization as an additional indicator of the type of contract involved. While the above model draws a sharp contrast between performance-pay and fixed-wage contracts, we will see below that there is difficulties in measuring these two concepts empirically. For simplicity, we expect that unionization gets us even closer to a fix wage setting, since collective bargaining agreements indeed tend to pre-specify wages over the duration of the contract (2-3 years, often more in recent years). Interestingly, however, some union contracts allow for a limited amount of pay-for-performance, which generates more flexibility in response to labor market shocks.

In practice, we divide contracts into four categories based both on the union status and performance-pay status. We expect union contracts without performance-pay to exhibit the least wage flexibility and the largest hours response to a change in γ. At the other extreme, wages should be most flexible for performance-pay contracts in non-union settings and hours should, accordingly, respond less to changes in γ.

3 Data

The bulk of our analysis is conducted using data from the PSID. The main advantage of the PSID is that it provides a representative sample of the workforce for a relatively long time period. One disadvantage of the PSID is that our constructed measures of performance pay are relatively crude for reasons discussed below.

3.1 The Panel Study of Income Dynamics (1976-1998)

The PSID sample we use consists of male heads of households aged 18 to 65 with average hourly earnings between \$1.50 and \$100.00 (in 1979 dollars) for the years 1976-1998, where the hourly wage rate is obtained by dividing total labor earnings from all jobs by total hours of work, both reported retrospectively for the previous calendar year.[3,4] Given our

[3] 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 in interview year t+1. Thus we actually use data covering interview years 1976-1999. Annual earnings were top coded at \$99,999 until 1982 (and not top coded since then), but only a handful of individuals were at the top code. We trim very high values of wages (above \$100.00 in 1979 dollars) but do not otherwise adjust for top coding.

[4] Our focus on male heads of households stems from the fact that only heads are asked about their income derived from bonuses, commissions, or overtime. In the PSID, males are designated as the head in

focus on performance pay, this wage measure based on total yearly earnings, inclusive of performance pay, is preferable to "point-in-time" wage measures that would likely miss infrequent payments (e.g. bonuses) of performance pay.

Individuals who are self-employed are excluded from the analysis since our measure of performance pay based on receiving bonuses, commissions, or piece-rates is defined for employed workers only.[5] We also exclude workers from the public sector since it is not clear what it means to pay workers for their productivity in a sector where employment and wage setting decisions are not based on profit maximization. This leaves us with a total sample of 26,146 observations for 3,053 workers. All of the estimates reported in the paper are weighted using the PSID sample weights.

Identifying Performance Pay In the PSID, we construct a performance-pay indicator variable by looking at whether part of a worker's total compensation includes a variable pay component (bonus, commission, or piece-rate). For interview years 1976-1992, we are able to determine whether a worker received a bonus or a commission over the previous calendar year through the use of multiple questions. First, workers are asked the amount of money they received from working overtime, from commissions, or from bonuses paid by the employer.[6] Second, we sometimes know only whether or not workers worked overtime, and if they are working overtime in a given year, not the amount of pay they received for overtime. Thus, we classify workers as not having had a variable pay component if they worked overtime. Third, workers not paid exclusively by the hour, or not exclusively by a salary, are asked how they are paid: they can report being paid commissions, piece-rates, etc., as well as a combination of salaried/hourly pay along with piece-rates or commissions.[7]

all husband-wife pairs. The same is true if the female has a boyfriend with whom she has been living for at least a year, even if the female is the person with the most financial responsibility in the family unit. Consequently, the sample of female heads is relatively small. Using the same sample selection criteria as the ones we use for males would leave us with 1,367 females for a total of 8,185 observations. Perhaps more importantly, issues of representativeness would arise as those female heads are disproportionately nonwhite (24.4 percent) and are much less likely to be married (9.2 percent).

[5] Self-employed workers can be viewed as being, by definition, paid for performance regardless of the mode of payment (earnings, dividends, etc.) they use to remunerate themselves.

[6] Note that the question refers specifically to any amounts earned from bonuses, overtime, or commissions in addition to wages and salaries earned.

[7] In many survey years workers are not asked if their compensation package involves a mixture of salary/hourly pay and a variable component. All they are asked is how they are paid if not by the hour or with a salary. Although there is no way to directly verify it, this likely results in understating the incidence of any form of variable pay because workers are not allowed to answer that they are paid, say, a salary,

Through this combination of questions, we are thus able to identify *all* non-overtime workers who received performance pay in bonus, commission, or piece-rate form.

Starting with interview year 1993, there are separate questions about the amounts earned in bonuses, commissions, tips, and overtime for the previous calendar year. Thus, there is no need to back out an estimate of bonuses from an aggregate amount since the question is asked directly. For the sake of comparability with the pre-1993 years, we nevertheless classify as receiving no performance pay all workers who report any overtime work. In this way we are able to determine whether a worker's total compensation included a performance-pay component for each year of the survey. One obvious drawback is that it is likely that the performance-pay component we construct will be noisy for hourly workers, though not for salaried workers who are not eligible for overtime payments. However, due to our treatment of overtime workers, we conservatively lean on the side of misclassifying workers as receiving no performance pay even when they do.[8]

Defining Performance-pay Jobs We define performance-pay jobs as employment relationships in which part of the worker's total compensation includes a variable pay component (bonus, a commission, piece-rate) at least once during the course of the relationship.[9] Since we use actual payments of bonuses, commissions or piece rates to identify performance-pay jobs, we are likely to misclassify performance-pay jobs as non-performance-pay jobs if some employment relationships are either terminated before performance pay is received, or partly unobserved for being out of our sample range. This source of measurement error is problematic because of an "end-point" problem in the PSID data. Given our definition of performance-pay jobs, we may mechanically understate the fraction of workers in such jobs at the beginning of our sample period because most employment relationships observed

and then report a commission: they have to choose. Our assertion that this response likely understates the extent of variable pay is motivated in part by the fact that workers in the NLSY, to be described below, are not restricted in describing the way they are paid. We find that workers in the NLSY are more likely to report having part of their compensation package contain a performance-pay component.

[8]In an earlier version of the paper, we re-did the analysis for 1992 to 1998 using the finer measure of performance pay that allows us to identify the performance-pay status of overtime workers. Doing so had little impact on the results. It only increased the fraction of workers on performance-pay jobs (for 1992-98) by one percentage point, and regression coefficients were essentially unchanged.

[9]We use "jobs", "employment relationship", and "job match" interchangeably. Although the PSID does have information on tenure in the position in most of the survey years spanning the sample period, we do not use it. As is well known, simply determining employer tenure in the PSID can be problematic (see Brown and Light (1992)). As a result, what we call a "job match" could be called an "employer match" instead. We generally use the word "job" for the sake of simplicity.

in 1976 started before 1976, and we do not observe whether or not performance pay was received prior to 1976. Similarly, jobs that started toward the end of the sample period may be performance-pay jobs but are classified otherwise because they have not lasted long enough for performance pay to be observed.

The problem is that, conditional on job duration, we tend to observe a given job match fewer times at the two ends of our sample period than in the middle of the sample. Consider, for example, the case of a job that lasts for five years. For jobs that last from 1985 to 1989, all five observations on this job match are captured in our PSID sample. For jobs that last from 1973 to 1977, however, only two of the five years of the job match are observed, which mechanically reduces the probability of classifying the job as one with performance pay.

Because of this end-point problem, we get an unbalanced distribution of the number of times job matches are observed at different points of the sample period. One simple solution to the problem is to "rebalance" the sample using regression or other methods. In practice, we adjust measures of the incidence of performance pay over time by estimating a linear probability model in which dummies for calendar years and for the number of times the job-match is observed are included as regressors (estimating a logit gave almost identical results). We then compute an adjusted measure of the incidence of performance pay by holding the distribution of the number of times the job-match is observed to its average value for the years 1982 to 1990, which are relatively unaffected by the end-point problem.

The end-point problem could also affect the estimates of the effect of performance pay on both wage, hours, and earnings because the sample of non-performance-pay jobs is being contaminated by observations from performance-pay jobs for which performance-based payments are never observed. Lemieux, MacLeod, and Parent (2009) have investigated this issue in detail and concluded that, if anything, this measurement problem biases downward the estimated effect of performance pay. For the sake of clarity and simplicity, the wage we report in the next sections are unadjusted for these measurement issues.

3.2 Descriptive Statistics from the PSID

Table 1 compares the mean characteristics of workers on performance-pay and non-performance-pay jobs, respectively. First, notice that 36 percent of the 27,899 observations are in performance-pay jobs. Workers on performance-pay jobs tend to earn more and have higher levels of education than workers on non-performance-pay jobs. Note that the hourly wage rate includes both regular wage and salary earnings and performance pay in the case of workers on performance-pay jobs. Annual hours worked and employer tenure also tend to be higher for workers on performance-pay than non-performance-pay jobs.

The unionization rate (percent covered by a collective bargaining agreement) is much lower among performance-pay workers. This suggests that, as expected, the pay structure in union firms corresponds more closely to the fixed-wage contracts discussed in Section 2. Another important difference is that there is a much higher fraction of workers paid by the hour in non-performance-pay than performance-pay jobs. Conversely, workers on performance-pay jobs are more likely to be salaried workers than those on non-performance-pay jobs.

An important point illustrated at the bottom of the table is that, of the 3131 workers, 1318 are observed on a performance-pay job, and 2715 are observed on a non-performance-pay job. So 902 workers (1318+2715-3131) are "switchers" observed on both types of jobs, which is useful for identifying models with fixed effects presented in Section 4.

Figure 1 shows the incidence of performance pay over the 1976-98 sample period. Note that we correct for the end-point problem using the procedure described above. Figure 1 shows that the overall incidence of performance-pay jobs has increased from about 35 percent in the late 1970s to around 45 percent in the 1990s. The figure also shows the simpler measure based on the fraction of workers actually reporting performance pay in a given year. This alternative measure clearly understates the incidence of performance-pay jobs since workers on performance-pay jobs will not necessarily receive a performance payment (like a bonus) in each year on the job. One advantage of this simple measure, however, is that it is not affected by the end-point problem and provides additional evidence of the robustness of the underlying trends in performance pay. Indeed, even this crude measure of performance pay clearly increases over time, especially in the 1980s.

Figure 1 also shows the fraction of workers covered by a collective bargaining agreement. Interestingly, the decline in unionization and the growth in performance pay are both concentrated in the same period (the 1980s). Figure 2 presents kernel density estimates of the distribution of annual hours for performance-pay and non-performance-pay jobs. The figure shows that annual hours have a higher mean and median, and are less evenly distributed among performance-pay than non-performance-pay jobs.

Note that performance pay represents a relatively modest share of total earnings (Figure 3). However, this does not mean that performance pay has a limited impact on total compensation since we expect the straight wage component to be more sensitive to workers' characteristics on performance-pay than non-performance-pay jobs. In order to pay for performance, the employer must evaluate the worker, which then affects the straight wage through promotions and job assignment. Hence, even though performance pay is a relatively small fraction of compensation for most workers, the fact that it exists is a signal of more careful monitoring.

4 Estimation Results

The model of Section 2 provides a number of testable implications about the effect of local shocks in performance-pay and non-performance-pay jobs. We now present the estimation results and show that they are consistent with the predictions of the model outlined in Section 2.

We first report in Table 2 some descriptive regression models to illustrate the link between performance-pay and the level of (hourly) wages, annual hours of work, and annual earnings. All models include a large set of covariates that are not reported in the table: polynomials (cubic) in potential experience and tenure, years of completed schooling, and dummies for occupation, industry, race, marital status, collective bargaining, and calendar year. Standard errors are clustered at the job-match level.

In all regression models reported hereinafter, we show three sets of models for two different sample of workers. We start with simple OLS estimates, then move to models with worker-specific fixed effects that capture unobserved ability θ_i, and then report models with a full set of job match effects. Note that the direct effect of performance-pay can be identified in the models with worker-specific fixed effects because of workers who are observed to switch between performance-pay and non-performance pay jobs (and vice versa). The direct effect of performance-pay cannot be identified, however, when job-match fixed effects are included since performance-pay status is determined at the job level. It is still possible to identify, however, the differential effect of the local unemployment rate (or other variables) in performance-pay and non-performance-pay jobs even with job-match fixed effects included. Estimates from these models are particularly credible as they solely rely on differential variation in the local unemployment rate, after controlling for year effects and job-match effects to identify the differential responsiveness to unemployment shocks in the different types of jobs.

The two sample of workers used are based on whether or not the worker is unemployed at the time of the interview. In our PSID sample, we only keep workers with at least some positive earnings and hours of work in the previous calendar year. These workers may or may not be working at the time of the interview. We first report results for the more "stable" sample of workers employed at the time of the interview, and then for the broader sample that also includes workers unemployed at the time of the interview.

Panel A of Table 2 shows that most of the difference in wages between performance-pay and non-performance-pay workers documented in Table 1 vanishes when standard covariates are controlled for in the wage equation (columns 1 and 4). After controlling for worker-specific fixed effects (column 2 and 5), there is not longer a significant different between the two types of jobs. Not surprisingly, workers earn more in years when they actually receive a performance-based payment. The estimated effects in the 4-5 percent range more or less corresponds to the size of performance-based payments documented in Figure 3.

Panel B of Table 3 shows that, unlike wages, annual hours of work on performance-pay jobs remain higher than on non-performance-pay jobs even after controlling of standard covariates and worker-specific fixed effects. Interestingly, after controlling for these factors there is no significant effect of receiving a performance-based payment in a given year on hours of work in that year. Not surprisingly, the results in columns 4-6 indicate that workers observed to be unemployment at the time of the interview tend to have worked less hours in the previous year.

Panel C puts the hourly wage and hours together by showing the overall impact of performance-pay status on total earnings (wage times hours). Consistent with the hours results, earnings are higher on performance-pay jobs even after controlling for covariates and worker-specific fixed effects. Consistent with the wage results, earnings are 4-5 percent higher in years when an actual performance-based payment is actually observed.

The main results of the paper are reported in Tables 3 and 4. As mentioned in Section 2, at this stage we simply use the local (county) unemployment rate as a proxy for the productivity shock u_t in the regression models. Since the results across specifications and samples tend to be quite similar, we focus the discussion on the models reported in column 3 of the tables where only workers employed at the time of the interview are used, and job-match fixed effects are included. Table 3 shows the estimated effect of the local unemployment rate for performance-pay and non-performance-pay jobs, respectively. Table 4 goes further by dividing jobs on the basis of both the performance-pay and union status on the job. In both cases, we cluster the standard errors at the county times year level.

Panel A of Table 3 shows that, as expected, the unemployment rate has a negative and significant effect of wages in performance-pay jobs, but no significant effect on non-performance-pay jobs. The estimated coefficient for performance-pay jobs varies across specification but is generally close to -0.01, suggesting that a one percentage point increase in the unemployment rate is associated with a one percent decline in the hourly wage.

Panel B of Table 4 shows that precisely the opposite happens in the case of hours of work. The unemployment rate has a negative and significant impact on hours of work for workers not paid for performance, but an insignificant impact for performance-pay workers. The latter effect is consistent with a fairly inelastic labor supply elasticity for performance-pay workers. By contrast, since wages fail to adjust for non-performance-pay jobs, employers have little choice but to cut back on hours and employment in the presence of adverse productivity shocks.

The results for hours are in levels. They are not directly comparable to those for wages (in logs). Since average yearly hours is about 2000, the -10 estimate reported in Panel B corresponds to a 0.5 percent decline in hours. This is fairly similar in terms of magnitude to the estimated effect on the wages of performance-pay workers (Panel A of Table 3). It suggests that the total effect of the unemployment rate on earnings (wages time hours) should be roughly comparable for performance-pay and non-performance-pay jobs. The only difference is that the adjustment happens along the wage margin for performance-pay workers, but along the hours margins for non-performance workers.

This conjecture is confirmed in Panel C of Table 3, which shows the estimated effect of the local unemployment rate on the log of annual earnings. In our preferred specification with job-match fixed effects, the effect of the unemployment rate on annual earnings is equal to about -.008 for both performance-pay and non-performance pay jobs. This means that a one percentage point increase in the local unemployment rate reduces earnings by close to one percent in both sectors. The difference is that hourly wages account for essentially all the earnings adjustment in performance-pay jobs, while hours account for the bulk of the adjustment in non-performance-pay jobs. While the implications are the same in terms of workers' earnings, the fact that there is little impact on hours of work for performance-pay jobs suggests that shocks have a smaller impact on firms' output under these more "flexible" pay arrangements, which has important implications for the role of labor market in the transmission of shocks in the macroeconomy. We plan to explore these issues in more detail in the next version of this paper.

Table 4 presents similar estimates except that we now divide jobs both in terms of performance-pay and union status. As discussed in Section 2, we expect wages to be most responsive to shocks in performance-pay jobs that are not unionized, and least responsive to shocks in unionized non-performance-pay jobs. We also expect the exact opposite to happen for hours of work. The two other types of contractual arrangements (union/performance-pay and non-union/non-performance pay) should fall somewhere in between these two extreme cases.

Looking once again at our preferred specification (column 3), we see that the results are consistent with these expectations. Panel A of Table 3 shows that the unemployment rate has the largest impact on non-union performance-pay jobs (-0.0076) and the smallest (and not statistically significant) impact on union non-performance-pay workers (-0.0001). By contrast, exactly the opposite happens in the case of hours of work (Panel B). As a result, the overall impact on annual earnings is more or less similar for all four types of contractual arrangements (Panel C).

One potential concern with these results is that some of the differential responsiveness to shocks under differential contractual arrangements is due to composition effects. For example, performance-pay workers tend to be more concentrated in occupations such as managers and professionals (see Lemieux, MacLeod, and Parent (2009)) that may be less sensitive to the business cycle than blue collar occupations. One simple way of checking for this is to rebalance the performance-pay and non-performance pay samples so that they have the same distribution of observed characteristics. We did so using a reweighting method and this did not substantially changed the results.

5 Implications

In this section we first discuss implications of our finding for inequality. We then briefly mention how our results have important implications for understanding the role of contractual arrangements in the labor market in the transmission of shocks in the macroeconomy.

5.1 Inequality

In Lemieux, MacLeod, and Parent (2009), we show that performance pay tend to increase cross-sectional inequality in hourly wages. The main reason for this finding is that both observed and unobserved dimensions of skills tend to be more rewarded in performance-pay than in non-performance-pay jobs. In the case of unobserved skills, this result follows directly from the prediction of the model. While the return to the unobserved worker-specific component $\theta_i = \alpha_i - \hat{\alpha}_i$ is positive in performance-pay jobs, it is equal to zero in non-performance-pay jobs.

This finding leaves two important questions open. First, while the hourly wage is an important component of overall inequality, it is also useful to look at broader measures such as inequality in annual earnings. Second, it matters from a welfare point of view how much cross-sectional inequality is due to a transitory as opposed to a permanent inequality component (Moffitt and Gottschalk (1994)).

Our results suggest that when going from hourly wages to annual earnings, inequality likely increases more in non-performance-pay than non-performance-pay jobs because hours vary more in the latter sector in response to shocks. If that variation in hours is more volatile than the variation in wages it is not clear, however, that this results in more permanent inequality in annual earnings.

To explore these issues, we first "residualize" wages and earnings by running regressions on the rich set of covariates used in Tables 3 and 4. We focus on this "residual" or "within-group" component of inequality, as opposed to the more systematic "between-group" component, which is not presumably affected very much by transitory labor market shocks.

Appendix Table 1 shows the raw autocovariance matrices for wages and earnings in performance-pay and non-performance-pay jobs. A number of interesting patterns can be observed in the raw data. First, cross-sectional inequality as measured by the variances (zero order covariances on the diagonal) tends to increase over time. Second, while the variance of wages is generally larger in performance-pay then in non-performance-pay jobs, the variance increases much more in non-performance-pay jobs when we move to the broader measure of inequality based on annual earnings. Third, the autocovariances decline slower when we move off the diagonal for performance-pay than non-performance-pay jobs. This is particularly striking in the case of earnings and suggests that the larger variance in non-performance-pay jobs is due to transitory variability in hours.

These main findings are easier to see in Figures 4-6 that plot the evolution of the different variances over time, and in Appendix Table 2 that shows the average values of the autocovariances (for workers employed at the time of the survey). Comparing columns 1 and 2 of Appendix Table 2, it is clear that going from wages to annual earnings has little impact on the autocovariances in performance-pay jobs. By contrast, there is a large difference between the autocovariances of wages and earnings in non-performance-pay jobs (columns 3 and 4). This is consistent with our finding in Table 3 that there is much more variation in hours in response to shocks in non-performance-pay jobs. The difference also diminishes quickly as we increase the order of the autocovariances, suggesting that most of the variation in hours is transitory. As a result, the autocovariance in earnings in performance-pay jobs is larger than in non-performance-pay jobs for all autocovariances except the zero order autocovariance (the variance).

We now explore these issues more formally using some parametric models for the autocovariance of wages and earnings. Following Lemieux, MacLeod, and Parent (2009), we look at a transitory (ε) and permanent (θ) component of wages and earnings, plus a job-match specific component (ν). Lemieux, MacLeod, and Parent (2009) argue that the latter component is more important in non-performance-pay jobs since the "job" one has in that sector plays a more important role than under performance-pay where all that should matter is the skills and ability of the worker, and not the job *per se*. For simplicity, we only present this model for performance-pay and non-performance-pay workers, but also divide workers according to union status in the empirical application.

Consider the residual for performance-pay jobs, e^p_{ijt},

$$e^p_{ijt} = d^p_t \theta_i + \nu^p_{ij} + \varepsilon^p_{ijt}, \tag{5}$$

while the residual for non-performance-pay jobs, e^n_{ijt}, is

$$e^n_{ijt} = d^n_t \theta_i + \nu^n_{ij} + \varepsilon^n_{ijt}, \tag{6}$$

where the subscript j refers to the job (i.e the employer-employee or job-match). The parameters of interest to be estimated are the variances of each of the six error components in equations (5) and (6). We estimate the model under the simplifying assumption that the idiosyncratic error terms ε^p_{ijt} and ε^n_{ijt} are uncorrelated over time. Following Parent (2002), we estimate the variance components by fitting regression models to all the cross-products of residuals for the same individual.[10] This procedure is similar to the equally-weighted minimum distance approach of Abowd and Card (1989), but provides an easy way of dealing with an unbalanced sample like ours.

The results are reported in Tables 5-8 for various samples and specifications. In all cases, we first report estimates from a simple model where the factor loadings d^p_t and d^n_t are assumed to be fixed over time, and the job-match component is set to zero. We then add the job-match component in a second specification, and free up the factor loadings (return to unobserved ability) and the variance of ε^p_{ijt} and ε^n_{ijt} to reflect the well-known growth in inequality over time.

In all four tables, we first report (Panel A) results estimated over the whole sample. One potential pitfall of using the whole sample is that some individuals are only observed on performance-pay jobs, while others are only observed on non-performance-pay jobs. As a result, the variance of the worker-specific effect θ_i may not be the same in the two subsamples, and differences between the estimated variance components $var(d^p_t\theta_i)$ and $var(d^n_t\theta_i)$ may reflect composition effects related to θ_i, as opposed to true differences in the return to unobservables d^n_t and d^p_t. To control for this potential problem, we report in Panel B the results for the subsample of "switchers" who are observed on both performance-pay and non-performance-pay jobs.

As a benchmark, we report in Appendix Table 3 the results of the wage decomposition in Lemieux, MacLeod, and Parent (2009). Consistent with the pattern observed in the empirical autocovariances (Appendix Tables 1 and 2), the results confirm that the permanent component of wages (variance of θ_i) is substantially larger in performance-pay than non-performance pay jobs. The rest of the tables (Table 5-8) report the results for the broader measure of inequality based on annual earnings.

For performance-pay jobs, the variance decomposition of earnings reported in Table 5 is fairly similar to the decomposition for wages in Appendix Table 3. The only noticeable difference is that the transitory variance (variance of ε^p_{ijt}) is slightly larger than in the wage

[10] See Parent (1999) for a related analysis with the NLSY comparing piece-rate/commission workers and those receiving bonuses to salaried and hourly paid workers. More details on the identification and estimation of the variance components models are provided in Appendix 2.

models. By contrast, the transitory variance is almost twice as large for earnings than wages in non-performance-pay jobs, while the permanent variance is only slightly larger. This is consistent with the pattern of results documented in the raw data reported in Appendix Tables 1 and 2. The transitory variance becomes even larger when workers unemployed at the time of the interview are also included in the sample in Table 6. Even in that case, however, the variance linked to the permanent wage component θ_i remains larger in performance-pay than non-performance-pay jobs.

Finally, we report in Table 7 and 8 separate results for the four types of contractual arrangements based on union and performance-pay status. For the sake of simplicity, we focus our discussion on the simplest models reports in columns 1 and 4. Consistent with the large literature on unions and wage inequality, both the transitory and permanent components of inequality tend to be lower in union than non-union jobs (see, e.g., Lemieux (1998)). Other than this, the results are fairly consistent with those reported in Table 5 and 6. The permanent component is larger in performance-pay jobs, while the transitory component is larger in non-performance-pay jobs. This confirms that the results in Tables 5 and 6 truly reflect the role of performance-pay jobs, and not the fact that performance-pay jobs are less likely to be unionized, and vice versa.

In summary, looking at earnings instead of just hourly wages first suggests that inequality is actually smaller in performance-pay than non-performance-pay jobs, contrary to what Lemieux, MacLeod, and Parent (2009) found for hourly wages only. This result only holds, however, for purely cross-sectional measures of inequality. Since the variation in hours is mostly transitory, from a welfare point of view inequality likely remains larger in performance-pay than non-performance-pay jobs. The fact that hours of work are quite volatile and respond more to shocks in non-performance-pay jobs has a substantial impact on earnings in the short run, but little impact on long-run measures of both the level and the inequality of earnings.

5.2 Transmission of shocks

The finding that local unemployment shocks have very different impacts on wages and employment have potentially important macroeconomic implications. Roughly speaking, the U.S. labor market has been moving towards contractual arrangements (performance-pay and lack of union representation) where workers absorb a larger share of the shock through their wages. As a result, employer don't need to adjust the level as employment as much as they used to. This suggests that the U.S. labor market is more flexible than it used to be, and that monetary and real shocks may have less impact than they used to have.

Probing in more details this hypothesis requires estimating a more complete dynamic model to see how wages and employment adjust in the few years after a shock happens. For instance, even if wages in non-performance-pay jobs are rigid in the short run, they may eventually adjust so that the medium run impact of shocks is not so different in the two different types of contractual arrangements. Some preliminary investigation of this hypothesis suggest this is not the case, however. We plan to evaluate this issue in much more detail in the next version of the paper.

6 Conclusion

In this paper, we use data from the Panel Study of Income Dynamics to study the impact of local labor market shocks on wages, hours of work and employment under different contractual arrangements. We divide jobs on the basis of whether they pay for performance, and whether they are covered by collective bargaining agreements. Using the county unemployment rate as a proxy for local labor market shocks, we find that wages and hours of work respond very differently to shocks depending on contractual arrangements. Wages are most flexible under non-union performance-pay contracts, and least flexible under non-performance-pay union contracts. Precisely the opposite happens in the case of hours of work that are the least sensitive to shocks under non-union performance-pay contracts, and the most sensitive under union non-performance-pay contracts.

We also consider the implication of these findings for inequality. Looking at earnings instead of just hourly wages suggests that inequality is actually smaller in performance-pay than non-performance-pay jobs. This result only holds, however, for purely cross-sectional measures of inequality. Since the variation in hours is mostly transitory, from a welfare point of view inequality likely remains larger in performance-pay than non-performance-pay jobs. The fact that hours of work are quite volatile and respond more to shocks in non-performance-pay jobs has a substantial impact on earnings in the short run, but little impact on long-run measures of both the level and the inequality of earnings.

Appendix 1: Performance Pay, Monitoring Costs and Productivity Shocks

This appendix presents a simple model of compensation choice that builds upon Lazear (1986)'s observation that the reason performance pay is used is because at the time a worker is employed neither the worker nor the firm can perfectly observe ability. This can result in a mis-match between what the worker is capable of doing and what the employer expects. Linking compensation to performance can reduce this mis-match, and increase overall productivity. However, the introduction of an effective performance-pay system is expensive and difficult (see Kerr (1975)).[11] Hence, one faces a trade-off between the cost of introducing such a system, and the benefits in terms of improved match quality.

More formally, consider a competitive labor market in which the workers obtain all the rents from any match. Hence, in contrast to union settings, in this case there will be no tension between the worker's and the employer's preferences over contract form. We will suppose that there is symmetric information, namely the worker and employer have the same information regarding the employee's characteristics. For simplicity, suppose that the observed characteristics of the individual, x_i, are a sufficient statistic describing the individual's expected ability.

When worker i approaches a firm, they engage in the following sequence of moves:

1. The firm makes a take it or leave if offer of a fixed-wage or a performance-pay contract:
    (a) A fixed wage contract is of the form $c_{it} = \{w_{it}, \bar{e}_{it}\}$, where the worker agrees to supply effort $\bar{e}_{it}$ in exchange for a wage w_{it}. It is assumed that this contract is enforceable, and performed as promised.
    (b) A performance wage contract $w_{it}(y_{it}) = y_{it} - M$, where y_{it} is output and M is monitoring costs.
2. After accepting the contract the worker observes his individual ability (α_i) and productivity (γ_t) and chooses "effort" e_{it}.
3. Output $y_{it} = k + \gamma_t \bar{e}_{it}$ under the fixed wage contract is produced, while $y_{it} = k + \gamma_t e_{it} - M$ is produced under the performance pay contract, where:

[11] See also Baker (1992) and Holmström and Milgrom (1987).

(a) k is output that is independent of effort.

(b) $\gamma_t > 1$ is the marginal product of effort.

(c) M is the fixed cost of putting in a system to monitor effort.

The worker is paid a wage w_{it} according to the contract terms and gets utility:

$$U_{it} = w_{it} - exp\left(e_{it} - \alpha_i\right),$$

where ability is given by the latent variable, $\alpha_i \sim N\left(\hat{\alpha}_i, 2\sigma_i^2\right)$. It is assumed that the mean and variance are known conditional upon worker characteristics x_i: $\hat{\alpha}_i = E\left\{\alpha_i | x_i\right\}$and $2\sigma_i^2 = var\left\{\alpha_i | x_i\right\}$.

We now solve for the explicit value of the wage under the two contracts, and discuss what contract form will a particular worker choose.

Optimal Contract Choice

Consider a particular worker. Under the assumption that the worker receives all the rent from a relationship, we can derive the optimal contract as follows. Under a fixed wage contact, $c_{it} = \{w_{it}, \bar{e}_{it}\}$, the worker obtains:

$$\begin{aligned} U_{it}\left(c_{it}\right) &= E\left\{k + \gamma_t \bar{e}_{it} - exp\left\{\bar{e}_{it} - \alpha_i\right\}\right\} \\ &= k + \widehat{\gamma}_t \bar{e}_{it} - exp\left\{\bar{e}_{it} - \hat{\alpha}_i + \sigma_i^2\right\}. \end{aligned}$$

where $\widehat{\gamma}_t = E\{\gamma_t\}$. From this the optimal effort is $\bar{e}_{it}^* = log\left(\widehat{\gamma}_t\right) + \hat{\alpha}_i - \sigma_i^2$, from which we obtain the optimal utility for a fixed-wage job:

$$\begin{aligned} U_{it}^{FW} &= k + \widehat{\gamma}_t log\left(\widehat{\gamma}_t\right) + \widehat{\gamma}_t\left(\hat{\alpha}_i - \sigma_i^2\right) - \widehat{\gamma}_t, \\ &= m_t + \widehat{\gamma}_t\left(\hat{\alpha}_i - \sigma_i^2\right) - \widehat{\gamma}_t, \end{aligned}$$

where without loss of generality we let $m_t = k + \widehat{\gamma}_t log(\widehat{\gamma}_t)$, and hence the observed wage is given by:

$$w_{it}^{FW} = m_t + \widehat{\gamma}_t\left(\hat{\alpha}_i - \sigma_i^2\right).$$

Now consider the performance pay situation, where $w_{it}(e) = k + \gamma_t e - M$, and the individual is able to choose effort after observing ability α_i and productivity γ_t. In this case the payoff is:

$$U_{it}\left(c_{ij}\right) = k + \gamma_t e(\alpha_i, \gamma_t) - M - \exp\left\{e(\alpha_i, \gamma_t) - \alpha_i\right\},$$

and optimal effort satisfies $e^*_{it}(\alpha_i, \gamma_t) = log\left(\gamma_t\right) + \alpha_i$, and expected utility from a performance pay contract satisfies:

$$\begin{aligned} U_{it}^{PP} &= E\left\{k + \gamma_t\left(log\left(\gamma_t\right) + \alpha_i\right) - exp\left\{log(\gamma_j)\right\} - M\right\} \\ &= k + \widehat{\gamma}_t log(\widehat{\gamma}_t) + \sigma_\gamma^2/\widehat{\gamma}_t + \widehat{\gamma}_t\hat{\alpha}_i - \widehat{\gamma}_t - M \\ &= m_t + \widehat{\gamma}_t\hat{\alpha}_i - M - \widehat{\gamma}_t + \sigma_\gamma^2/\widehat{\gamma}_t. \end{aligned}$$

where $2\sigma_\gamma^2 = var(\gamma_t)$. This is the expected utility before accepting the job. Under a performance-pay job the *observed wage* is given by:

$$w_{it}^{PP} = m_t + \gamma_t\alpha_i - M,$$

while the *ex ante* expected wage is:

$$\hat{w}_{it}^{PP} = m_t + \widehat{\gamma}_t\hat{\alpha}_i - M.$$

Given these we now have:

Proposition 1 A performance pay contract is used if and only if:

$$U_{it}^{PP} \geq U_{it}^{FW}, \tag{7}$$

and hence if and only if:

$$\sigma_\gamma^2/\widehat{\gamma}_t + \widehat{\gamma}_t\sigma_i^2 \geq M. \tag{8}$$

This inequality (equation (8)) shows how workers of different ability levels self-select themselves into performance-pay jobs. This highlights the point made in Lazear (1986) that the benefit of performance pay lies in its ability to tailor the demands of the job to the individual. It is common for people to think of performance pay as a way to "extract more effort," and hence that it is likely to be preferred by more skilled individuals. Such reasoning does not explain the wide use of performance pay in some low skilled jobs, such as agricultural work or sales. In these occupations the cost of monitoring, M, is low while there is a great deal of variance in ability (in agricultural work often the whole family, including children, are involved). In these cases it is more efficient to use performance pay because it allows more efficient matching of skills to the job for both high and *low* ability individuals.

Appendix 2: Estimation of the Variance Components Model

To see how the variance components model of Section V.3 is identified, consider the expected value of the different cross-products of residuals in the case where the factor loadings (the d's) do not change over time. For individuals on performance-pay jobs, the expected value of the squared residuals is $E(e^p_{ijt} \cdot e^p_{ijt}) = (d^p)^2 \cdot var(\theta_i) + var(\nu^p_{ij}) + var(\varepsilon^p_{ijt})$, the expected value of cross-products for two observations (at time t and time s) on the same job j is $E(e^p_{ijt} \cdot e^p_{ijs}) = (d^p)^2 \cdot var(\theta_i) + var(\nu^p_{ij})$, and the expected value of cross-products for two observations on different jobs j and k is $E(e^p_{ijt} \cdot e^p_{iks}) = (d^p)^2 \cdot var(\theta_i)$. In this simple example, we can estimate the three error components $(d^p)^2 \cdot var(\theta_i)$, $var(\nu^p_{ij})$ and $var(\varepsilon^p_{ijt})$ by taking simple differences of the sample analogs of $E(e^p_{ijt} \cdot e^p_{ijt})$, $E(e^p_{ijt} \cdot e^p_{ijs})$, and $E(e^p_{ijt} \cdot e^p_{iks})$. The same procedure can then be used to estimate the three components $(d^n)^2 \cdot var(\theta_i)$, $var(\nu^n_{ij})$ and $var(\varepsilon^n_{ijt})$ for non-performance-pay jobs. The ratio of the (square) return to unobserved worker characteristics in the two sectors, $(d^p/d^n)^2$, can then be computed as the ratio of the estimated components $(d^p)^2 \cdot var(\theta_i)$ and $(d^n)^2 \cdot var(\theta_i)$.

In the case where factor loading change over time, the expected value of the own-product becomes $E(e^p_{ijt} \cdot e^p_{ijt}) = (d^p_t)^2 \cdot var(\theta_i) + var(\nu^p_{ij}) + \sigma^2_{\varepsilon,t}$, where the factor loading d^p_t and the idiosyncratic variance $\sigma^2_{\varepsilon,t} = var(\varepsilon^p_{ijt})$ are allowed to change over time. The expected value of cross-products for two observations (at time t and time s) on the same job j is $E(e^p_{ijt} \cdot e^p_{ijs}) = d^p_t \cdot d^p_s \cdot var(\theta_i) + var(\nu^p_{ij})$. Since these equations are now non-linear in the parameters (factor loadings), we estimate the models by jointly fitting equations for all the cross-products using non-linear least-squares.

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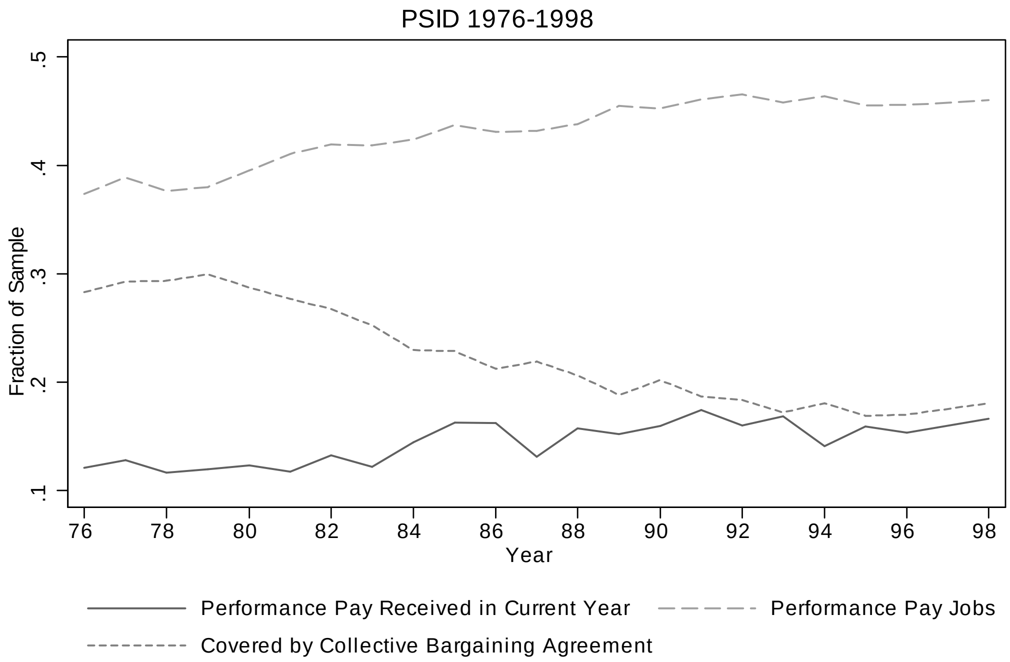
Figure 1. Performance Pay Job Incidence



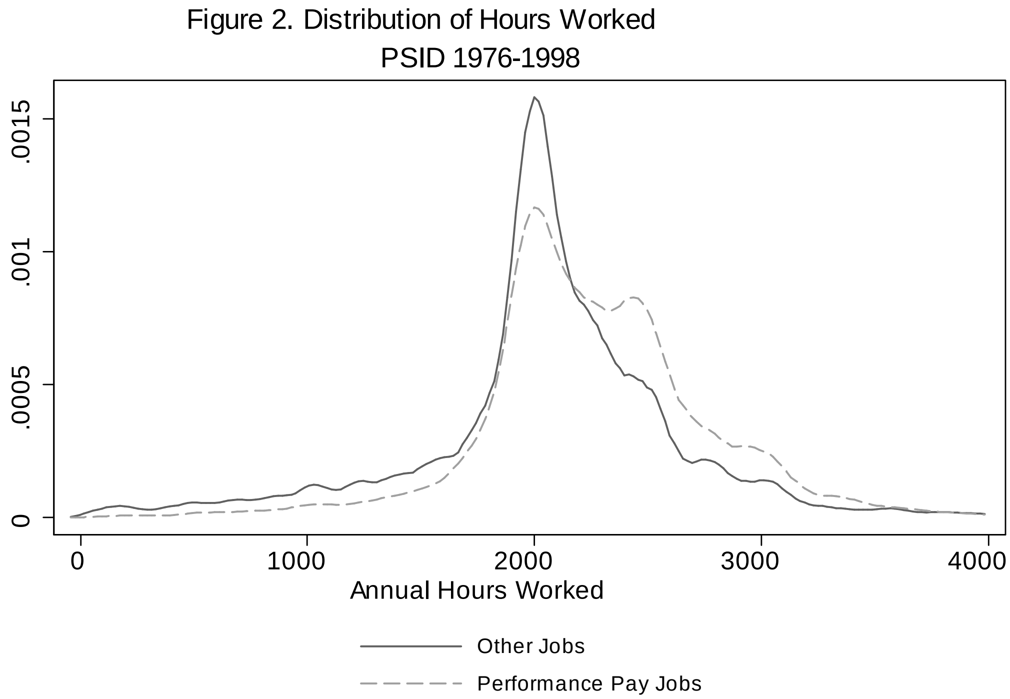


Figure 2. Distribution of Hours Worked
PSID 1976-1998
.0015
.001
.0005
0
0
1000
2000
3000
4000
Annual Hours Worked
Other Jobs
Performance Pay Jobs

Figure 3. Share of Performance Pay in Total Earnings

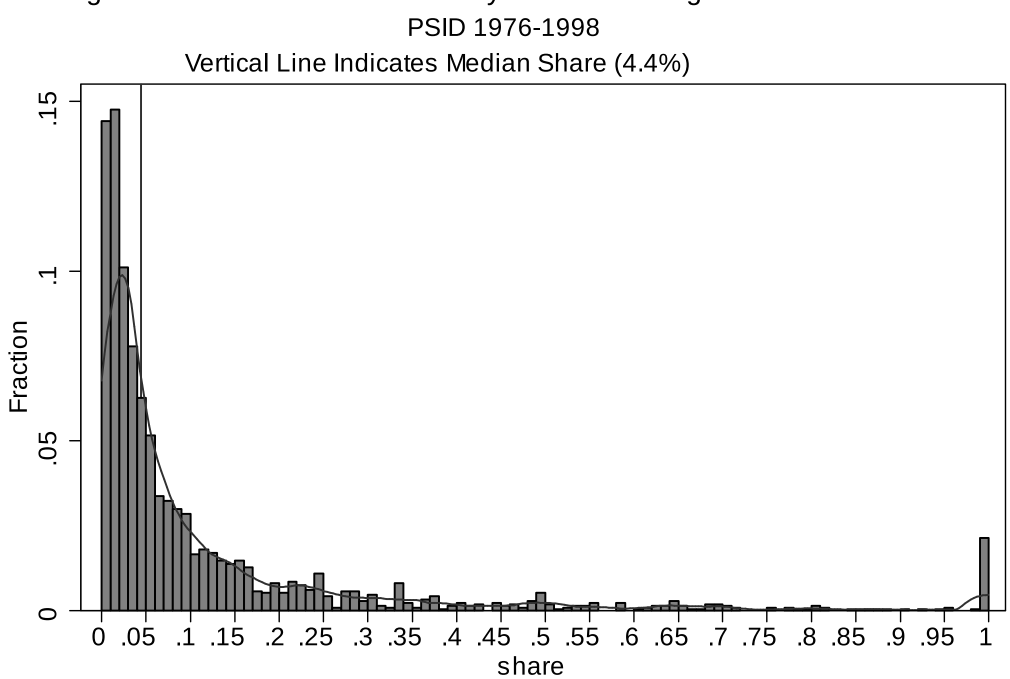
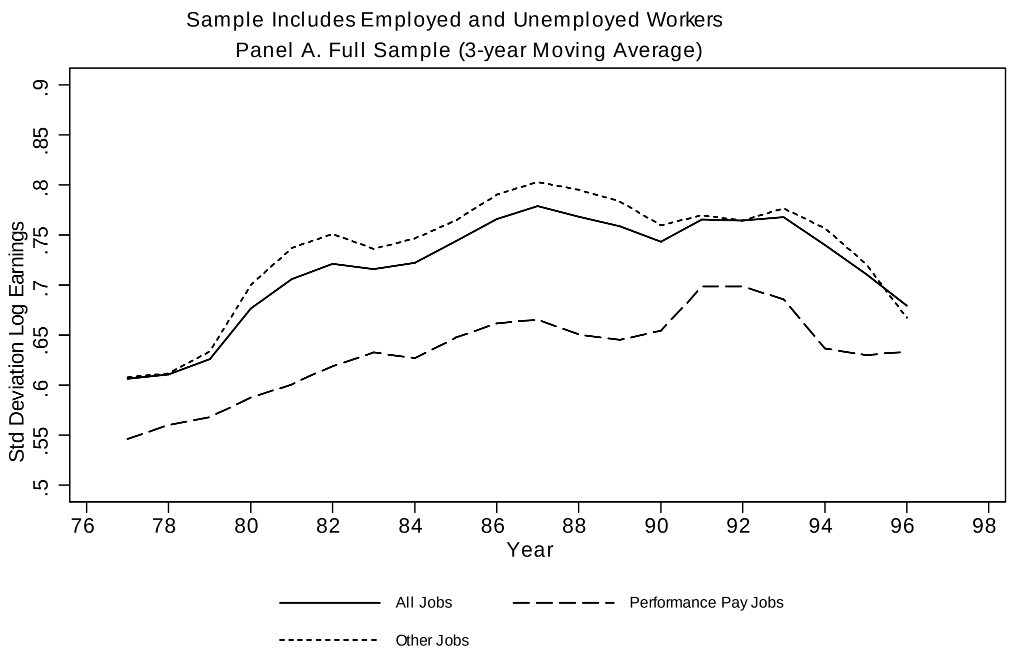


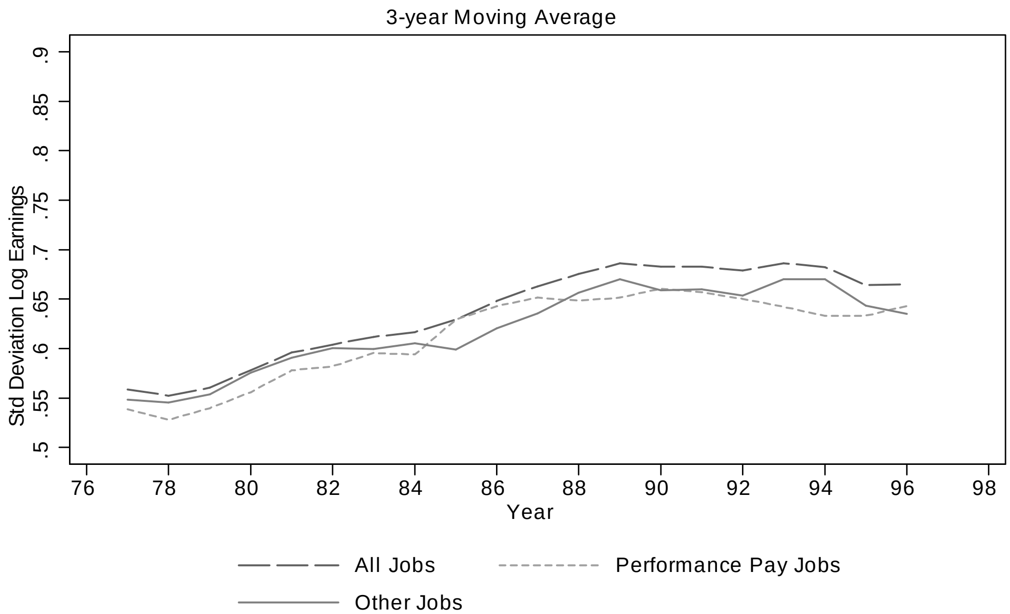
Figure 4. Total Log Earnings Inequality




Sample Includes Only Employed Workers
Panel B. Full Sample (3-year Moving Average)
Std Deviation Log Earnings
.5
.55
.6
.65
.7
.75
.8
.85
.9
76
78
80
82
84
86
88
90
92
94
96
98
Year
All Jobs
Performance Pay Jobs
Other Jobs

Figure 5. Total Log Earnings Inequality

Panel A: Sample Includes Only Employed Workers



Panel B: Sample Includes Employed and Unemployed Workers

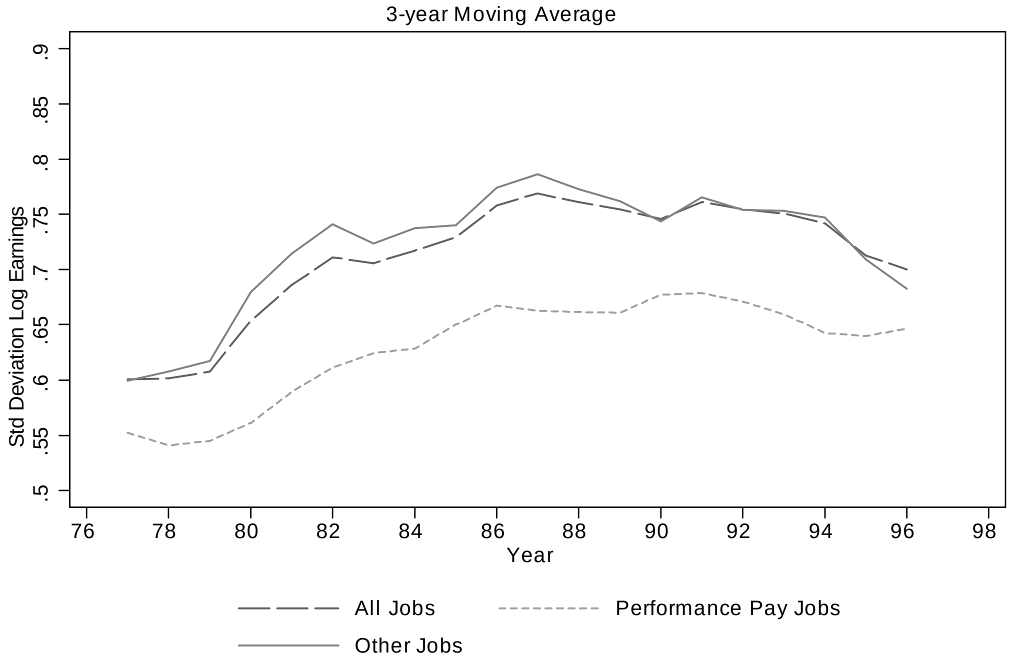
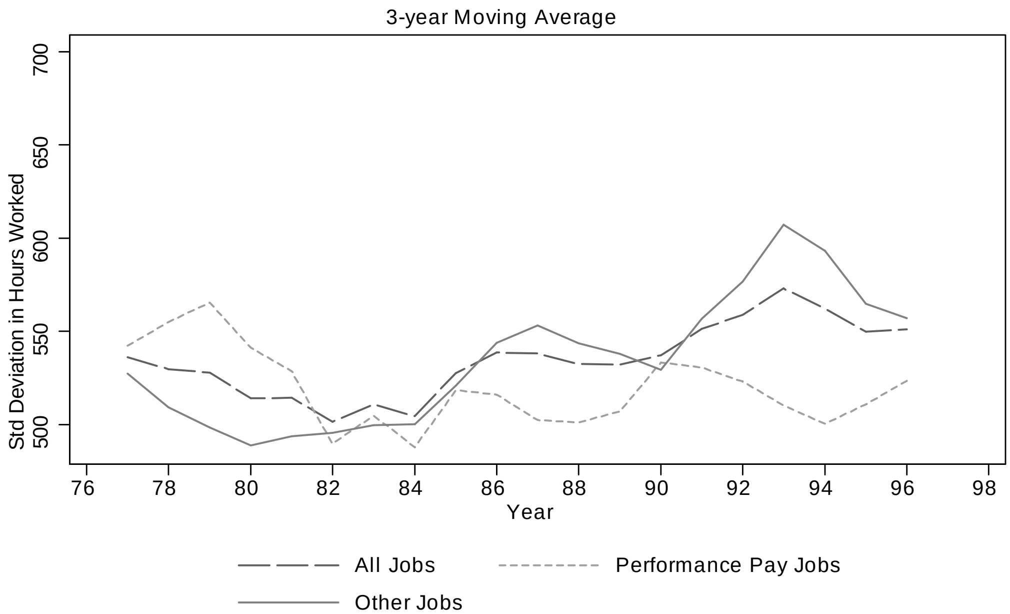


Figure 6. Inequality in Annual Hours Worked

Panel A: Sample Includes Only Employed Workers



Panel B: Sample Includes Employed and Unemployed Workers

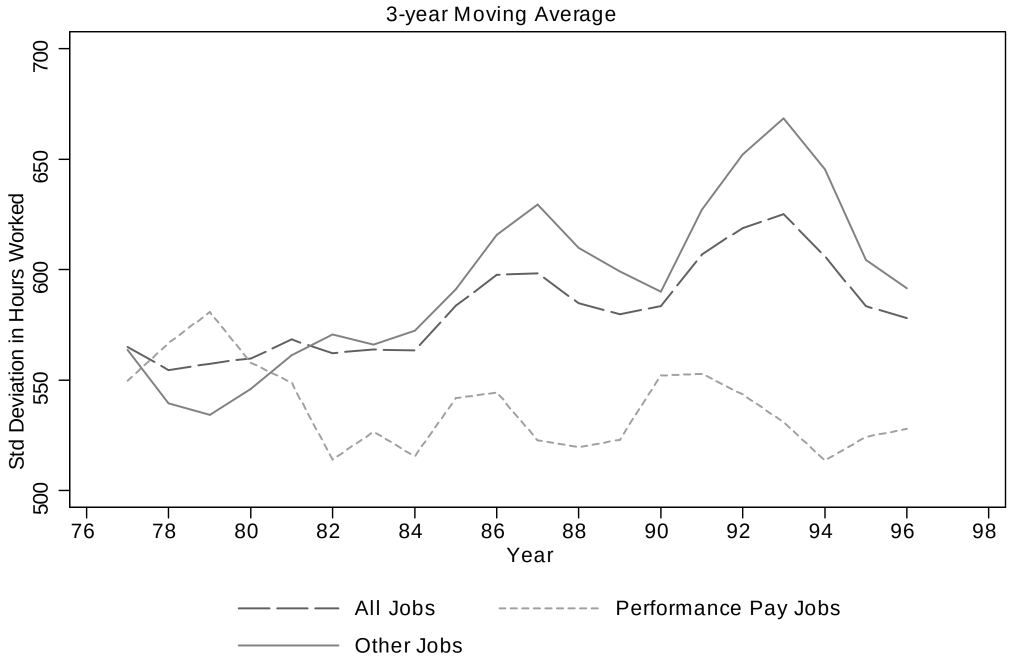


Table 1. Summary Statistics: Panel Study of Income Dynamics 1976-1998

	Non Performance Pay Jobs	Performance Pay Jobs
Average Hourly Earnings ($79)	8.24	10.81
Education	12.49	13.37
Potential Experience	19.57	19.54
Employer Tenure	7.22	9.20
Married	0.71	0.77
Unionized	0.27	0.15
Non White	0.14	0.09
Paid by the Hour	0.63	0.31
Paid a Salary	0.30	0.50
Fraction Unemployed at Interview	0.073	0.018
Annual Hours Worked	2061.6	2272.1
# workers (Tot:3131)	2715	1318
# Job Matches (Tot: 8689)	6819	1870
# Observations (Tot: 27899)	17934	9965

Notes: The sample consists of male household heads aged 18-65 working in private sector, wage and salary jobs. All figures in the table represent sample means. Education, potential experience, and employer tenure are measured in years. Potential experience is defined as age minus education minus 6. Performance-pay jobs are employment relationships in which part of the worker's total compensation includes a variable pay component (bonus, commission, piece rate). Any worker who reports overtime pay is considered to be in a non-performance-pay job. Workers are considered unionized if they are covered by a collective bargaining agreement. Temporarily laid off workers are included among the unemployed. For unemployed workers at the time of the interview, the type of job they have refers to the last job they had.

Table 2. The Effect of Pay-for-Performance on Earnings and Hours Worked: PSID, 1976-1998

Sample:	Employed Individuals			All Employed and Unemployed Individuals		
	[1]	[2]	[3]	[4]	[5]	[6]
Variable	OLS	Fixed-Effects Within Worker	Fixed-Effects Within Employer	OLS	Fixed-Effects Within Worker	Fixed-Effects Within Employer
Panel A: Log Hourly Earnings						
Performance Pay Job Dummy	0.0572	0.0175	-	0.0608	0.0183	-
	(0.0156)	(0.0134)		(0.0155)	(0.0133)	
Current Year's Earnings Based Partly on Performance Pay Component	0.0817	0.0401	0.0466	0.0813	0.0434	0.0492
	(0.0178)	(0.0090)	(0.0083)	(0.0183)	(0.0095)	(0.0084)
Unemployed at Interview	-	-	-	-0.0981	-0.0344	-0.0190
				(0.0210)	(0.0175)	(0.0301)
Panel B: Annual Hours Worked						
Performance Pay Job Dummy	81.21	75.01	-	83.92	73.32	-
	(16.23)	(19.83)		(16.53)	(19.20)	
Current Year's Earnings Based Partly on Performance Pay Component	61.50	15.74	12.54	64.03	17.46	15.58
	(17.44)	(11.72)	(11.38)	(17.14)	(11.64)	(11.17)
Unemployed at Interview	-	-	-	-777.96	-657.03	-598.56
				(26.04)	(26.55)	(46.69)
Number of Observations	26146	26146	26146	27899	27899	27899

Table 2. The Effect of Pay-for-Performance on Earnings and Hours Worked: PSID, 1976-1998 (continuation)

Panel C: Log Annual Earnings

Sample:	Employed Individuals			All Employed and Unemployed Individuals		
	[1]	[2]	[3]	[4]	[5]	[6]
Variable	OLS	Fixed-Effects Within Worker	Fixed-Effects Within Employer	OLS	Fixed-Effects Within Worker	Fixed-Effects Within Employer
Performance Pay Job Dummy	0.1017	0.0615	-	0.1089	0.0583	-
	(0.0153)	(0.0136)		(0.0151)	(0.0139)	
Current Year's Earnings Based Partly on Performance Pay Component	0.1054	0.0457	0.0525	0.1060	0.0497	0.0562
	(0.0185)	(0.0087)	(0.0077)	(0.0184)	(0.0087)	(0.0080)
Unemployed at Interview	-	-	-	-0.7410	-0.5782	-0.5137
				(0.0312)	(0.0280)	(0.0407)
Number of Observations	26146	26146	26146	27899	27899	27899

Notes. Performance pay dummy is equal to 1 if the worker's total annual earnings are based partly on performance pay at least once over the course of the employment relationship. Other covariates include polynomials (cubic) in potential experience and tenure, years of completed schooling, and dummies for occupation, industry, race, marital status, collective bargaining, calendar year, and having part of current year's earnings based on performance pay. Standard errors are clustered at the job-match level.

Table 3. The Effect of Local Labor Market Conditions: PSID, 1976-1998

Sample:	Employed Individuals			All Employed and Unemployed Individuals		
	[1]	[2]	[3]	[4]	[5]	[6]
Variable	OLS	Fixed-Effects Within Worker	Fixed-Effects Within Employer	OLS	Fixed-Effects Within Worker	Fixed-Effects Within Employer
Panel A: Log Hourly Earnings						
Unemployment Rate in County X Non Performance Pay Job	-0.0030	-0.0066	-0.0021	-0.0027	-0.0075	-0.0023
	(0.0016)	(0.0016)	(0.0016)	(0.0016)	(0.0016)	(0.0016)
Unemp. Rate in County X Performance Pay Job	-0.0113	-0.0148	-0.0072	-0.0097	-0.0153	-0.0082
	(0.0022)	(0.0020)	(0.0021)	(0.0022)	(0.0020)	(0.0021)
P-Value of Test of Equality	0.0009	0.0010	0.0490	0.0050	0.0022	0.0246
Unemployed at Interview	-	-	-	-0.1110	-0.0400	-0.0447
				(0.0194)	(0.0165)	(0.0255)
Panel B: Annual Hours Worked						
Unemployment Rate in County X Non Performance Pay Job	-6.04	-10.76	-10.73	-6.79	-11.59	-9.80
	(2.02)	(2.48)	(2.62)	(1.99)	(2.48)	(3.13)
Unemp. Rate in County X Performance Pay Job	-0.11	1.68	1.22	0.47	1.43	1.41
	(2.30)	(2.77)	(3.15)	(2.27)	(2.79)	(2.58)
P-Value of Test of Equality	0.0511	0.0005	0.0031	0.0160	0.0002	0.0048
Unemployed at Interview	-	-	-	-773.72	-654.51	-617.25
				(25.13)	(24.21)	(40.05)
Number of Observations	26146	26146	26146	27899	27899	27899

Table 3. The Effect of Local Labor Market Conditions: PSID, 1976-1998 (continuation)

Panel C: Log Annual Earnings

Sample:	Employed Individuals			All Employed and Unemployed Individuals		
Variable	[1] OLS	[2] Fixed-Effects Within Worker	[3] Fixed-Effects Within Employer	[4] OLS	[5] Fixed-Effects Within Worker	[6] Fixed-Effects Within Employer
Unemployment Rate in County X Non Performance Pay Job	-0.0070	-0.0165	-0.0076	-0.0072	-0.0110	-0.0064
	(0.0018)	(0.0020)	(0.0019)	(0.0020)	(0.0021)	(0.0018)
Unemp. Rate in County X Performance Pay Job	-0.0116	-0.0125	-0.0078	-0.0096	-0.0163	-0.0085
	(0.0023)	(0.0018)	(0.0017)	(0.0023)	(0.0021)	(0.0021)
P-Value of Test of Equality	0.0849	0.1132	0.9376	0.4013	0.2564	0.4478
Unemployed at Interview	-	-	-	-0.7627	-0.5904	-0.5514
				(0.0316)	(0.0266)	(0.0411)
Number of Observations	26146	26146	26146	27899	27899	27899

Notes. Estimates come from unrestricted regressions in which all covariates are interacted with the performance pay job dummy. Other covariates include polynomials (cubic) in potential experience and tenure, years of completed schooling, and dummies for occupation, industry, race, marital status, collective bargaining, calendar year, and having part of current year's earnings based on performance pay. Standard errors are clustered at the county X year level.

Table 4. The Effect of Local Labor Market Conditions: PSID, 1976-1998; All Sectors

Panel A: Log Hourly Earnings

Sample:	Employed Individuals			All Employed and Unemployed Individuals		
Variable	[1] OLS	[2] Fixed-Effects Within Worker	[3] Fixed-Effects Within Employer	[4] OLS	[5] Fixed-Effects Within Worker	[6] Fixed-Effects Within Employer
U. Rate X Unionized Workers	0.0162	0.0052	-0.0001	0.0175	0.0047	-0.0001
X Non Performance Pay Job	(0.0017)	(0.0018)	(0.0019)	(0.0017)	(0.0019)	(0.0019)
U. Rate X Non-Unionized Workers	-0.0124	-0.0122	-0.0036	-0.0117	-0.0128	-0.0036
X Non Performance Pay Job	(0.0018)	(0.0017)	(0.0017)	(0.0018)	(0.0017)	(0.0017)
U. Rate X Unionized Workers	0.0095	-0.0101	-0.0040	0.0100	-0.0115	-0.0060
X Performance Pay Job	(0.0033)	(0.0033)	(0.0033)	(0.0031)	(0.0035)	(0.0035)
U. Rate X Non-Unionized Workers	-0.0145	-0.0154	-0.0076	-0.0138	-0.0160	-0.0084
X Performance Pay Job	(0.0026)	(0.0022)	(0.0024)	(0.0025)	(0.0022)	(0.0023)
Panel B: Annual Hours Worked						
U. Rate X Unionized Workers	-13.32	-14.63	-13.90	-14.71	-15.48	-13.31
X Non Performance Pay Job	(2.13)	(2.77)	(6.96)	(2.12)	(2.73)	(3.05)
U. Rate X Non-Unionized Workers	-2.43	-8.62	-7.84	-3.36	-10.09	-6.91
X Non Performance Pay Job	(2.18)	(2.62)	(2.83)	(2.15)	(2.61)	(2.79)
U. Rate X Unionized Workers	3.19	-2.64	2.77	5.65	0.19	1.64
X Performance Pay Job	(5.47)	(6.79)	(6.96)	(4.97)	(6.11)	(6.31)
U. Rate X Non-Unionized Workers	-0.14	1.96	1.27	0.05	1.97	0.78
X Performance Pay Job	(2.51)	(2.91)	(3.26)	(2.54)	(2.98)	(3.28)
Number of Observations	26146	26146	26146	27899	27899	27899

Table 4. The Effect of Local Labor Market Conditions: PSID, 1976-1998; All Sectors (continuation)

Panel C: Log Annual Earnings

Sample:	Employed Individuals			All Employed and Unemployed Individuals		
	[1]	[2]	[3]	[4]	[5]	[6]
Variable	OLS	Fixed-Effects Within Worker	Fixed-Effects Within Employer	OLS	Fixed-Effects Within Worker	Fixed-Effects Within Employer
U. Rate X Unionized Workers	0.0094	-0.0021	-0.0070	0.0104	-0.0016	-0.0055
X Non Performance Pay Job	(0.0038)	(0.0020)	(0.0019)	(0.0020)	(0.0024)	(0.0022)
U. Rate X Non-Unionized Workers	-0.0150	-0.0172	-0.0079	-0.0151	-0.0180	-0.0067
X Non Performance Pay Job	(0.0020)	(0.0019)	(0.0019)	(0.0021)	(0.0022)	(0.0019)
U. Rate X Unionized Workers	0.0106	-0.0124	-0.0065	0.0125	-0.0131	-0.0060
X Performance Pay Job	(0.0038)	(0.0038)	(0.0031)	(0.0036)	(0.0040)	(0.0034)
U. Rate X Non-Unionized Workers	-0.0149	-0.0171	-0.0077	-0.0138	-0.0170	-0.0090
X Performance Pay Job	(0.0020)	(0.0023)	(0.0021)	(0.0027)	(0.0024)	(0.0022)
Number of Observations	26146	26146	26146	27899	27899	27899

Notes. Estimates come from unrestricted regressions in which all covariates are interacted with the performance pay job dummy. Other covariates include polynomials (cubic) in potential experience and tenure, years of completed schooling, and dummies for occupation, industry, race, marital status, collective bargaining, calendar year, and having part of current year's earnings based on performance pay. Standard errors are clustered at the county X year level.

Table 5
Error Component Models of Annual Earnings by Type of Job: Employed Workers at Time of Interview

Panel A: full sample

	Performance-pay jobs			Non-performance-pay jobs		
Parameter	[1]	[2]	[3]	[4]	[5]	[6]
Variance of	0.114	0.108	0.084	0.087	0.080	0.067
worker component	(0.001)	(0.003)	(0.005)	(0.001)	(0.002)	(0.004)
Factor loading: 1990-93	-	-	1.233	-	-	1.156
relative to 1976-79			(0.036)			(0.046)
Variance of job-	-	0.007	0.004	-	0.012	0.009
match component		(0.003)	(0.003)		(0.003)	(0.003)
Variance of	0.096	0.095	0.092	0.160	0.155	0.123
idiosyncratic error	(0.003)	(0.003)	(0.009)	(0.003)	(0.004)	(0.008)
Change in variance,	-	-	-0.009	-	-	0.078
1976-79 to 1990-93			(0.012)			(0.012)
Number of workers	1,271	1,271	1,271	2,616	2,616	2,616
Number of cross-products	64,486	64,486	64,486	99,554	99,554	99,554

Panel B: workers who worked in both types of jobs

	Performance pay jobs			Non performance pay jobs		
Parameter	[1]	[2]	[3]	[4]	[5]	[6]
Variance of	0.113	0.106	0.080	0.085	0.081	0.061
worker component	(0.002)	(0.004)	(0.007)	(0.003)	(0.004)	(0.008)
Factor loading: 1990-93	-	-	1.239	-	-	1.152
relative to 1976-79			(0.061)			(0.099)
Variance of job-	-	0.008	0.005	-	0.009	0.006
match component		(0.005)	(0.005)		(0.006)	(0.006)
Variance of	0.101	0.099	0.108	0.160	0.155	0.104
idiosyncratic error	(0.005)	(0.005)	(0.014)	(0.006)	(0.007)	(0.015)
Change in variance,	-	-	-0.023	-	-	0.055
1976-79 to 1990-93			(0.018)			(0.022)
Number of workers	834	834	834	834	834	834
Number of cross-products	32,476	32,476	32,476	19,597	19,597	19,597

Note: Standard errors in parentheses. Models in columns 3 and 6 allow the variance of the idiosyncratic errors and the factor loadings on the worker component to vary across the 1976-1979, 1980-1984, 1985-1989, 1990-1993, and 1994-1998 periods, while models in columns 1, 2, 4, and 5 do not. These equally weighted covariance structure models are fit to the cross-products of the residuals of an OLS regression of log wages on the same set of covariates described in Table 3. Note that the factor loadings in columns 3 and 6 are normalized to 1 in the base period (1976-1979), so that the changes in factor loadings can be interpreted as the percentage changes in the return to the worker component.

Table 6
Error Component Models of Annual Earnings by Type of Job: Employed and Unemployed Workers at Time of Interview

Panel A: full sample

	Performance-pay jobs			Non-performance-pay jobs		
Parameter	[1]	[2]	[3]	[4]	[5]	[6]
Variance of worker component	0.114	0.108	0.084	0.093	0.091	0.069
	(0.001)	(0.003)	(0.005)	(0.002)	(0.003)	(0.005)
Factor loading: 1990-93 relative to 1976-79	-	-	1.233	-	-	1.210
			(0.037)			(0.054)
Variance of job-match component	-	0.007	0.004	-	0.003	0.000
		(0.003)	(0.003)		(0.003)	(0.004)
Variance of idiosyncratic error	0.107	0.106	0.102	0.227	0.225	0.172
	(0.003)	(0.003)	(0.009)	(0.004)	(0.005)	(0.010)
Change in variance, 1976-79 to 1990-93	-	-	-0.007	-	-	0.119
			(0.012)			(0.015)
Number of workers	1,318	1,318	1,318	2,715	2,715	2,715
Number of cross-products	66,629	66,629	66,629	110,791	110,791	110,791

Panel B: workers who worked in both types of jobs

	Performance pay jobs			Non performance pay jobs		
Parameter	[1]	[2]	[3]	[4]	[5]	[6]
Variance of worker component	0.111	0.105	0.081	0.098	0.100	0.049
	(0.002)	(0.004)	(0.007)	(0.004)	(0.005)	(0.010)
Factor loading: 1990-93 relative to 1976-79	-	-	1.225	-	-	1.409
			(0.060)			(0.164)
Variance of job-match component	-	0.007	0.004	-	-0.005	-0.009
		(0.005)	(0.005)		(0.009)	(0.009)
Variance of idiosyncratic error	0.114	0.113	0.114	0.239	0.242	0.185
	(0.005)	(0.005)	(0.014)	(0.009)	(0.011)	(0.022)
Change in variance, 1976-79 to 1990-93	-	-	-0.013	-	-	0.083
			(0.018)			(0.032)
Number of workers	903	903	903	903	903	903
Number of cross-products	34,484	34,484	34,484	24,606	24,606	24,606

Note: Standard errors in parentheses. Models in columns 3 and 6 allow the variance of the idiosyncratic errors and the factor loadings on the worker component to vary across the 1976-1979, 1980-1984, 1985-1989, 1990-1993, and 1994-1998 periods, while models in columns 1, 2, 4, and 5 do not. These equally weighted covariance structure models are fit to the cross-products of the residuals of an OLS regression of log wages on the same set of covariates described in Table 3. Note that the factor loadings in columns 3 and 6 are normalized to 1 in the base period (1976-1979), so that the changes in factor loadings can be interpreted as the percentage changes in the return to the worker component.

Table 7
Error Component Models of Annual Earnings by Type of Job: Employed Workers at Time of Interview

Panel A: Unionized Workers

	Performance-pay jobs			Non-performance-pay jobs		
Parameter	[1]	[2]	[3]	[4]	[5]	[6]
Variance of worker component	0.073 (0.002)	0.033 (0.012)	0.027 (0.012)	0.059 (0.002)	0.040 (0.004)	0.043 (0.006)
Factor loading: 1990-93 relative to 1976-79	-	-	1.221 (0.191)	-	-	0.968 (0.095)
Variance of job-match component	-	0.041 (0.012)	0.042 (0.012)	-	0.024 (0.004)	0.024 (0.004)
Variance of idiosyncratic error	0.078 (0.005)	0.077 (0.005)	0.097 (0.014)	0.119 (0.004)	0.114 (0.004)	0.097 (0.010)
Change in variance, 1976-79 to 1990-93	-	-	-0.004 (0.019)	-	-	0.042 (0.016)
Number of workers	197	197	197	772	772	772
Number of cross-products	11,061	11,061	11,061	29,081	29,081	29,081

Panel B: Non Unionized Workers

	Performance pay jobs			Non performance pay jobs		
Parameter	[1]	[2]	[3]	[4]	[5]	[6]
Variance of worker component	0.120 (0.001)	0.119 (0.003)	0.086 (0.005)	0.096 (0.002)	0.087 (0.003)	0.076 (0.006)
Factor loading: 1990-93 relative to 1976-79	-	-	1.288 (0.042)	-	-	1.138 (0.058)
Variance of job-match component	-	0.002 (0.004)	-0.003 (0.004)	-	0.014 (0.004)	0.012 (0.004)
Variance of idiosyncratic error	0.099 (0.004)	0.099 (0.004)	0.102 (0.011)	0.171 (0.005)	0.165 (0.005)	0.119 (0.011)
Change in variance, 1976-79 to 1990-93	-	-	-0.021 (0.014)	-	-	0.097 (0.016)
Number of workers	1,116	1,116	1,116	2,213	2,213	2,213
Number of cross-products	52,654	52,654	52,654	64,321	64,321	64,321

Note: Standard errors in parentheses. Models in columns 3 and 6 allow the variance of the idiosyncratic errors and the factor loadings on the worker component to vary across the 1976-1979, 1980-1984, 1985-1989, 1990-1993, and 1994-1998 periods, while models in columns 1, 2, 4, and 5 do not. These equally weighted covariance structure models are fit to the cross-products of the residuals of an OLS regression of log wages on the same set of covariates described in Table 3. Note that the factor loadings in columns 3 and 6 are normalized to 1 in the base period (1976-1979), so that the changes in factor loadings can be interpreted as the percentage changes in the return to the worker component.

Table 8

Error Component Models of Annual Earnings by Type of Job: Employed and Unemployed Workers at Time of Interview

Panel A: Unionized Workers

	Performance-pay jobs			Non-performance-pay jobs		
Parameter	[1]	[2]	[3]	[4]	[5]	[6]
Variance of worker component	0.076	0.032	0.019	0.062	0.046	0.051
	(0.002)	(0.013)	(0.011)	(0.002)	(0.004)	(0.007)
Factor loading: 1990-93 relative to 1976-79	-	-	1.345	-	-	0.902
			(0.271)			(0.093)
Variance of job-match component	-	0.045	0.045	-	0.020	0.021
		(0.013)	(0.011)		(0.005)	(0.005)
Variance of idiosyncratic error	0.092	0.091	0.110	0.142	0.138	0.121
	(0.006)	(0.006)	(0.014)	(0.005)	(0.005)	(0.012)
Change in variance, 1976-79 to 1990-93	-	-	-0.011	-	-	0.043
			(0.020)			(0.018)
Number of workers	206	206	206	787	787	787
Number of cross-products	12,043	12,043	12,043	30,277	30,277	30,277

Panel B: Non Unionized Workers

	Performance pay jobs			Non performance pay jobs		
Parameter	[1]	[2]	[3]	[4]	[5]	[6]
Variance of worker component	0.119	0.118	0.084	0.103	0.102	0.076
	(0.002)	(0.004)	(0.005)	(0.002)	(0.004)	(0.007)
Factor loading: 1990-93 relative to 1976-79	-	-	1.304	-	-	1.219
			(0.043)			(0.070)
Variance of job-match component	-	0.001	-0.003	-	0.002	-0.001
		(0.004)	(0.004)		(0.005)	(0.005)
Variance of idiosyncratic error	0.109	0.109	0.111	0.251	0.251	0.180
	(0.004)	(0.004)	(0.011)	(0.006)	(0.006)	(0.014)
Change in variance, 1976-79 to 1990-93	-	-	-0.017	-	-	0.140
			(0.014)			(0.020)
Number of workers	1,271	1,271	1,271	2,365	2,365	2,365
Number of cross-products	53,744	53,744	53,744	72,330	72,330	72,330

Note: Standard errors in parentheses. Models in columns 3 and 6 allow the variance of the idiosyncratic errors and the factor loadings on the worker component to vary across the 1976-1979, 1980-1984, 1985-1989, 1990-1993, and 1994-1998 periods, while models in columns 1, 2, 4, and 5 do not. These equally weighted covariance structure models are fit to the cross-products of the residuals of an OLS regression of log wages on the same set of covariates described in Table 3. Note that the factor loadings in columns 3 and 6 are normalized to 1 in the base period (1976-1979), so that the changes in factor loadings can be interpreted as the percentage changes in the return to the worker component.

Appendix Table 1

Empirical Covariance Matrix Residuals: Workers Employed at Interview Only

Panel A: Performance Pay Jobs

Log Hourly Earnings

Year	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1998
1976	0.198																					
1977	0.144	0.177																				
1978	0.132	0.119	0.179																			
1979	0.113	0.096	0.101	0.176																		
1980	0.103	0.097	0.096	0.116	0.163																	
1981	0.094	0.087	0.104	0.099	0.116	0.171																
1982	0.076	0.090	0.089	0.093	0.099	0.102	0.173															
1983	0.109	0.097	0.111	0.097	0.100	0.109	0.110	0.163														
1984	0.100	0.099	0.094	0.089	0.092	0.107	0.109	0.116	0.184													
1985	0.092	0.087	0.074	0.078	0.092	0.098	0.088	0.103	0.117	0.181												
1986	0.097	0.089	0.101	0.086	0.098	0.109	0.091	0.124	0.121	0.138	0.211											
1987	0.095	0.092	0.083	0.074	0.089	0.100	0.091	0.106	0.104	0.122	0.142	0.183										
1988	0.086	0.076	0.089	0.074	0.091	0.111	0.076	0.117	0.101	0.124	0.148	0.137	0.190									
1989	0.078	0.078	0.085	0.073	0.086	0.105	0.080	0.110	0.094	0.114	0.136	0.127	0.143	0.177								
1990	0.093	0.087	0.089	0.081	0.085	0.105	0.082	0.113	0.098	0.115	0.129	0.130	0.131	0.125	0.176							
1991	0.095	0.099	0.107	0.082	0.090	0.116	0.087	0.122	0.105	0.116	0.136	0.131	0.142	0.135	0.142	0.211						
1992	0.112	0.075	0.113	0.075	0.086	0.099	0.079	0.095	0.089	0.105	0.128	0.123	0.134	0.128	0.118	0.124	0.251					
1993	0.102	0.072	0.086	0.093	0.099	0.100	0.077	0.104	0.107	0.101	0.125	0.115	0.130	0.119	0.120	0.133	0.129	0.193				
1994	0.093	0.088	0.083	0.084	0.099	0.099	0.092	0.095	0.094	0.100	0.118	0.105	0.111	0.097	0.110	0.112	0.111	0.116	0.188			
1995	0.089	0.086	0.075	0.070	0.075	0.070	0.084	0.072	0.089	0.089	0.119	0.104	0.111	0.104	0.107	0.110	0.107	0.129	0.118	0.196		
1996	0.087	0.072	0.072	0.059	0.085	0.099	0.086	0.082	0.100	0.104	0.128	0.123	0.126	0.124	0.123	0.123	0.106	0.128	0.128	0.133	0.227	
1998	0.051	0.061	0.065	0.081	0.089	0.081	0.057	0.068	0.084	0.087	0.102	0.097	0.130	0.109	0.125	0.111	0.100	0.132	0.132	0.123	0.132	0.238

Log Annual Earnings

Year	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1998
1976	0.212																					
1977	0.133	0.161																				
1978	0.116	0.117	0.160																			
1979	0.116	0.104	0.110	0.193																		
1980	0.097	0.095	0.091	0.133	0.197																	
1981	0.094	0.089	0.100	0.107	0.129	0.192																
1982	0.091	0.099	0.087	0.102	0.114	0.128	0.218															
1983	0.109	0.108	0.109	0.104	0.107	0.108	0.120	0.203														
1984	0.109	0.110	0.099	0.105	0.106	0.117	0.128	0.136	0.212													
1985	0.090	0.101	0.080	0.094	0.105	0.104	0.104	0.117	0.136	0.188												
1986	0.092	0.110	0.095	0.096	0.113	0.119	0.103	0.138	0.142	0.161	0.268											
1987	0.090	0.108	0.084	0.086	0.092	0.108	0.099	0.111	0.115	0.129	0.156	0.211										
1988	0.093	0.092	0.096	0.089	0.098	0.118	0.097	0.116	0.112	0.133	0.156	0.144	0.207									
1989	0.092	0.090	0.086	0.105	0.108	0.118	0.091	0.113	0.103	0.126	0.150	0.135	0.147	0.232								
1990	0.091	0.092	0.090	0.097	0.093	0.107	0.087	0.113	0.105	0.115	0.129	0.136	0.143	0.146	0.201							
1991	0.099	0.106	0.103	0.102	0.091	0.115	0.089	0.118	0.112	0.120	0.139	0.140	0.146	0.149	0.162	0.236						
1992	0.105	0.083	0.089	0.089	0.094	0.105	0.080	0.100	0.095	0.106	0.138	0.130	0.153	0.134	0.131	0.149	0.215					
1993	0.112	0.093	0.073	0.087	0.085	0.094	0.072	0.094	0.101	0.101	0.122	0.119	0.139	0.131	0.136	0.135	0.145	0.204				
1994	0.097	0.086	0.082	0.088	0.103	0.105	0.099	0.099	0.100	0.106	0.117	0.109	0.130	0.101	0.121	0.118	0.124	0.137	0.213			
1995	0.082	0.069	0.063	0.067	0.061	0.072	0.083	0.084	0.082	0.081	0.105	0.087	0.110	0.106	0.110	0.119	0.105	0.133	0.130	0.213		
1996	0.088	0.083	0.075	0.056	0.083	0.111	0.102	0.107	0.099	0.107	0.127	0.124	0.145	0.154	0.132	0.129	0.117	0.137	0.131	0.143	0.231	
1998	0.053	0.058	0.063	0.067	0.075	0.079	0.055	0.072	0.058	0.084	0.098	0.088	0.120	0.110	0.120	0.106	0.101	0.139	0.137	0.127	0.150	0.234

Panel B: Non Performance Pay Jobs

Log Hourly Earnings

Year	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1998
1976	0.154																					
1977	0.093	0.125																				
1978	0.080	0.083	0.166																			
1979	0.071	0.074	0.096	0.162																		
1980	0.073	0.074	0.092	0.094	0.146																	
1981	0.072	0.068	0.084	0.083	0.095	0.156																
1982	0.060	0.069	0.076	0.076	0.088	0.097	0.164															
1983	0.055	0.058	0.065	0.062	0.076	0.078	0.089	0.137														
1984	0.058	0.056	0.061	0.060	0.071	0.077	0.080	0.076	0.156													
1985	0.047	0.047	0.058	0.063	0.080	0.082	0.085	0.071	0.083	0.161												
1986	0.050	0.050	0.047	0.054	0.061	0.072	0.073	0.074	0.078	0.097	0.146											
1987	0.053	0.047	0.049	0.052	0.068	0.065	0.069	0.060	0.064	0.092	0.080	0.153										
1988	0.045	0.051	0.044	0.035	0.060	0.059	0.070	0.068	0.072	0.088	0.087	0.088	0.167									
1989	0.042	0.038	0.043	0.034	0.051	0.053	0.054	0.056	0.061	0.080	0.069	0.079	0.099	0.143								
1990	0.050	0.046	0.047	0.046	0.048	0.056	0.063	0.070	0.073	0.079	0.078	0.081	0.100	0.108	0.162							
1991	0.046	0.037	0.035	0.037	0.045	0.053	0.062	0.065	0.064	0.073	0.072	0.067	0.090	0.090	0.100	0.154						
1992	0.041	0.027	0.023	0.021	0.037	0.053	0.048	0.068	0.049	0.059	0.065	0.061	0.077	0.082	0.086	0.082	0.221					
1993	0.041	0.042	0.035	0.040	0.041	0.055	0.059	0.087	0.059	0.071	0.072	0.067	0.083	0.075	0.091	0.097	0.074	0.241				
1994	0.030	0.033	0.027	0.026	0.037	0.049	0.044	0.068	0.041	0.068	0.062	0.060	0.069	0.070	0.069	0.074	0.075	0.090	0.199			
1995	0.043	0.028	0.024	0.024	0.045	0.039	0.028	0.049	0.043	0.051	0.052	0.052	0.059	0.067	0.069	0.074	0.064	0.081	0.091	0.173		
1996	0.031	0.025	0.014	0.025	0.041	0.049	0.046	0.061	0.045	0.056	0.066	0.059	0.057	0.051	0.058	0.078	0.078	0.078	0.078	0.095	0.192	
1998	0.054	0.026	0.023	0.018	0.033	0.045	0.019	0.055	0.049	0.055	0.060	0.063	0.072	0.065	0.064	0.094	0.076	0.098	0.092	0.090	0.102	0.205

Log Annual Earnings

Year	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1998
1976	0.198																					
1977	0.114	0.193																				
1978	0.085	0.109	0.195																			
1979	0.093	0.115	0.120	0.215																		
1980	0.089	0.110	0.122	0.127	0.228																	
1981	0.084	0.103	0.103	0.113	0.131	0.228																
1982	0.071	0.084	0.085	0.094	0.117	0.124	0.242															
1983	0.070	0.083	0.079	0.089	0.100	0.104	0.112	0.243														
1984	0.063	0.074	0.069	0.081	0.093	0.092	0.097	0.108	0.228													
1985	0.066	0.067	0.064	0.082	0.095	0.096	0.097	0.098	0.107	0.257												
1986	0.071	0.066	0.055	0.076	0.079	0.082	0.096	0.100	0.102	0.127	0.236											
1987	0.086	0.086	0.070	0.080	0.088	0.093	0.093	0.091	0.107	0.122	0.120	0.264										
1988	0.062	0.069	0.048	0.066	0.067	0.070	0.076	0.097	0.089	0.094	0.103	0.122	0.247									
1989	0.054	0.066	0.066	0.051	0.063	0.057	0.073	0.067	0.076	0.094	0.108	0.131	0.114	0.266								
1990	0.046	0.064	0.062	0.053	0.066	0.069	0.084	0.100	0.093	0.098	0.109	0.117	0.126	0.183	0.384							
1991	0.047	0.058	0.040	0.049	0.061	0.059	0.088	0.083	0.071	0.088	0.093	0.096	0.106	0.101	0.128	0.227						
1992	0.028	0.041	0.024	0.044	0.066	0.063	0.064	0.078	0.062	0.075	0.089	0.095	0.097	0.093	0.116	0.119	0.276					
1993	0.046	0.060	0.045	0.055	0.074	0.067	0.063	0.084	0.069	0.077	0.084	0.094	0.079	0.088	0.113	0.108	0.117	0.310				
1994	0.028	0.026	0.012	0.034	0.057	0.056	0.054	0.071	0.051	0.093	0.082	0.093	0.075	0.079	0.088	0.092	0.115	0.130	0.304			
1995	0.038	0.043	0.040	0.040	0.065	0.050	0.064	0.054	0.063	0.072	0.062	0.071	0.067	0.064	0.090	0.086	0.072	0.098	0.122	0.243		
1996	0.032	0.036	0.041	0.046	0.045	0.063	0.073	0.059	0.049	0.067	0.081	0.073	0.063	0.056	0.070	0.085	0.086	0.086	0.096	0.113	0.234	
1998	0.055	0.033	0.024	0.034	0.027	0.043	0.048	0.079	0.087	0.058	0.062	0.057	0.065	0.060	0.077	0.087	0.098	0.099	0.082	0.086	0.103	0.232

Appendix Table 2: Autocovariances in Wages and Earnings
(workers employed at the time of the interview)

	Performance-pay		Non-Performance-Pay	
Order of autocov:	[1] Wage	[2] Earnings	[3] Wage	[4] Earnings
0	0.193	0.219	0.179	0.318
1	0.123	0.138	0.090	0.136
2	0.118	0.128	0.083	0.116
3	0.114	0.122	0.076	0.102
4	0.108	0.117	0.072	0.091
5	0.108	0.115	0.071	0.091
6	0.102	0.112	0.065	0.089
7	0.102	0.107	0.062	0.082
8	0.099	0.103	0.057	0.082
9	0.096	0.100	0.056	0.077
10	0.094	0.098	0.053	0.074
11	0.088	0.091	0.052	0.066
12	0.087	0.093	0.046	0.059
13	0.086	0.092	0.043	0.059
14	0.089	0.086	0.037	0.050
15	0.080	0.082	0.039	0.057
16	0.077	0.078	0.032	0.037
17	0.078	0.077	0.033	0.048
18	0.080	0.076	0.027	0.038
19	0.078	0.074	0.027	0.044
20	0.075	0.073	0.022	0.024
22	0.050	0.050	0.052	0.028

Appendix Table 3
Error Component Models of Hourly Wages by Type of Job: Employed Workers at Time of Interview

Panel A: full sample

	Performance-pay jobs			Non-performance-pay jobs		
Parameter	[1]	[2]	[3]	[4]	[5]	[6]
Variance of	0.102	0.102	0.082	0.068	0.057	0.047
worker component	(0.003)	(0.003)	(0.004)	(0.001)	(0.001)	(0.002)
Factor loading: 1990-93	-	-	1.202	-	-	1.173
relative to 1976-79			(0.033)			(0.034)
Variance of job-	-	0.004	0.004	-	0.018	0.017
match component		(0.003)	(0.003)		(0.002)	(0.002)
Variance of	0.083	0.082	0.096	0.098	0.091	0.093
idiosyncratic error	(0.003)	(0.003)	(0.008)	(0.002)	(0.002)	(0.004)
Change in variance,	-	-	-0.011	-	-	0.024
1976-79 to 1990-93			(0.011)			(0.006)
Number of workers	1,271	1,271	1,271	2,616	2,616	2,616
Number of cross-products	64,486	64,486	64,486	99,554	99,554	99,554

Panel B: workers who worked in both types of jobs

	Performance pay jobs			Non performance pay jobs		
Parameter	[1]	[2]	[3]	[4]	[5]	[6]
Variance of	0.104	0.102	0.067	0.065	0.053	0.036
worker component	(0.002)	(0.004)	(0.006)	(0.002)	(0.002)	(0.004)
Factor loading: 1990-93	-	-	1.312	-	-	1.309
relative to 1976-79			(0.061)			(0.105)
Variance of job-	-	0.002	0.000	-	0.026	0.023
match component		(0.004)	0.004		(0.004)	(0.004)
Variance of	0.085	0.085	0.114	0.108	0.094	0.082
idiosyncratic error	(0.004)	(0.004)	(0.012)	(0.004)	(0.004)	(0.009)
Change in variance,	-	-	-0.027	-	-	0.035
1976-79 to 1990-93			(0.015)			(0.013)
Number of workers	834	834	834	834	834	834
Number of cross-products	32,476	32,476	32,476	52,073	52,073	52,073

Note: Standard errors in parentheses. Models in columns 3 and 6 allow the variance of the idiosyncratic errors and the factor loadings on the worker component to vary across the 1976-1979, 1980-1984, 1985-1989, 1990-1993, and 1994-1998 periods, while models in columns 1, 2, 4, and 5 do not. These equally weighted covariance structure models are fit to the cross-products of the residuals of an OLS regression of log wages on the same set of covariates described in Table 3. Note that the factor loadings in columns 3 and 6 are normalized to 1 in the base period (1976-1979), so that the changes in factor loadings can be interpreted as the percentage changes in the return to the worker component.