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ABSTRACT

Performance Pay and Wage Inequality*

We document that an increasing fraction of jobs in the U.S. labor market explicitly pay workers for their performance using bonuses, commissions, or piece-rates. We find that compensation in performance-pay jobs is more closely tied to both observed (by the econometrician) and unobserved productive characteristics of workers. Moreover, the growing incidence of performance-pay can explain 24 percent of the growth in the variance of male wages between the late 1970s and the early 1990s, and accounts for nearly all of the top-end growth in wage dispersion (above the 80th percentile).

JEL Classification: J31, J33

Keywords: performance pay, compensation, bonus pay, incentive pay, wage inequality

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1 Introduction

The standard competitive model of the labor market supposes that wages are equal to marginal products and the wage structure is determined by the equilibrium of supply and demand. That simple model forms the backbone of most studies of the evolution of wage inequality. For example, Katz and Murphy (1992) argue that the return to education increased in the 1980s because the rate of increase in the relative supply of more-educated labor decelerated, while relative demand steadily increased. Similarly, Juhn, Murphy, and Pierce (1993) argue that the growth in within-group wage inequality throughout the 1970s and 1980s was driven by an increase in the demand for unobserved skills. A main virtue of such studies that deploy a standard competitive model of the labor market is that they generally provide a straightforward interpretation of the evolution of the wage structure in familiar terms of the supply and demand for different types of labor.

Despite the appeal of the standard competitive model, however, in reality firms appear to find the problem of setting wages equal to marginal products difficult if not daunting. Stephen Kerr (1975), in a paper that has earned a place in the canonical MBA course on organization, 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 production.[1] The U.S. federal government, in an effort to improve the operation and wage structure of the federal civil service, commissioned the National Research Council to produce the study *Pay for Performance* in 1991.[2] The study found that in 1978 the federal government had 6000 pages of civil service law, procedure, and regulation in place, governing more than 30 pay systems, and a key recommendation of the study was the need to simplify and improve such complex operations. Returning to the private sector, Baker, Jensen, and Murphy (1988) lament the fact that firms seem to be using pay systems that are difficult to explain using standard economic models. They conclude that practitioners in the field of compensation may be sacrificing organizational efficiency in favor of pay equity.

Such evidence suggests that measuring and rewarding individual performance is difficult and costly. If so, efforts to bolster the effectiveness of payment systems, as with any other technology, should improve over time. The contribution of this paper is threefold. We first show, using data from the Panel Study of Income Dynamics (PSID), that the incidence of

[1] See Robert Gibbons (1997) page 9.
[2] See Milkovich and Wigdor (1991).

performance-pay has increased substantially since the late 1970s. This increase is consistent with the view that the cost of collecting and processing information has declined over time with advances in information and communication technologies. Second, we show that wages are less equally distributed in performance-pay jobs than in other jobs because the return to productive characteristics like education is larger in performance-pay jobs. Combining these two sets of findings, we demonstrate that the growth in performance-pay jobs has contributed substantially to the rise in wage inequality in the United States between the late 1970s and the early 1990s. We also find that evidence from a brief analysis of the National Longitudinal Survey of Youth (NLSY) supports our results using the PSID.

The paper also is an interesting complement to studies on labor market institutions that tend to focus on a very different segment of the work force–unionized labor. We show that workers paid for performance are relatively unlikely to belong to unions or to be paid around the minimum wage. Just as a fall in unionization and the real value of the minimum wage may have made wages in the middle and low end of the wage distribution closer to marginal products, it appears that the growing incidence of performance-pay produces a similar outcome for workers on the high end of the wage distribution. This is particularly important because changes in inequality are increasingly concentrated at the top levels of the wage distribution (see, for example, Piketty and Saez (2003), Autor, Katz, and Kearney (2006) and Lemieux (2006)).

Our empirical strategy builds upon two of the most prevalent solutions to how best to set employee pay. The first of these, epitomized by the system recommended by Hay Associates, begins with an evaluation of the needs of a job, and then fixes compensation equal to "job value".[3] Under such a system, compensation is effectively fixed *before* the worker is hired. This implies that compensation is mainly determined by characteristics of the job, with the relationship between worker ability and compensation driven by selection–firms hire the most able person that applies for the job. A common alternative compensation system, recommended by compensation consultants such as Ed Lawler, is "pay for the person". That system entails rewarding a person's productivity rather than the job. Under such a regime, the base pay reflects job value, with additional compensation paid after employment to reward the worker for realized performance.[4]

Although we cannot observe all the details of the type of compensation system used

[3]See chapter 4 of Milkovich and Newman (1996) for a detailed description of this approach.
[4]See Section III of Milkovich and Newman (1996).

by firms in the PSID, we can observe whether an employee has been paid some form of performance-pay in a given period. Our identification strategy is therefore built on the hypothesis that performance pay is an imperfect signal of "pay for the person". One cannot a priori exclude the possibility that firms that base compensation upon "job value" do not provide some perfunctory bonus pay. Yet we suppose that firms that use "pay for the person" should have a greater fraction of the variance in wages explained by factors specific to the worker, while the variance in jobs without performance-pay should be more related to factors specific to that job.

In addition, using the panel structure of the data set, we can follow workers who switch between performance-pay and non-performance-pay jobs. This allows us another way to distinguish between the job- and person-specific determinants of wages, including the relative contributions of the individual and match-specific components of variance. Consistent with our hypothesis, we find that pay is relatively more sensitive to job characteristics, as opposed to worker characteristics, in non-performance-pay jobs, while the reverse is true in performance-pay jobs. Moreover, we find strong evidence that the contribution of the job-match specific component of variance is very modest in performance-pay jobs relative to the worker-specific component of variance. In contrast, we find that the job-match component accounts for a much larger share of the variance in performance-pay than non-performance pay jobs, which is consistent with our finding on the effect of observed job characteristics. Those results are consistent with the notion that compensation in performance-pay jobs is more closely tied to worker productivity than it is in non-performance-pay jobs.

Next, we consider the implication of these results for changes in wage inequality. If the incidence of performance-pay is increasing over time, this implies that the importance of person-specific effects is also increasing with time, which in turn can lead to an increase in inequality. We shed light on this issue by linking the increase in inequality from the late 1970s to the early 1990s to the increase in the incidence of performance-pay. We first show that wage inequality is generally greater in performance-pay jobs than in other jobs, and that inequality has risen faster in performance-pay jobs than in other jobs during the 1980s.

Putting together those observations, and the fact that the incidence of performance has increased over the same time period, we find that about a quarter of the increase in the variance of wages between the late 1970s and early 1990s is associated with the increased use of performance-pay. Even more striking, we can explain nearly *all* of the increase in wage inequality above the 80th percentile.

These results show that the technology of compensation, including payment schemes and effective measurement systems, is an important ingredient for a complete understanding of how compensation varies over time and across jobs. The more difficult premise is to establish a causal relationship between advances in the technology of compensation and increased inequality. Here the evidence is more indirect. In the next section, we review the literature on compensation, and empirical work that illustrates that the form of compensation does affect the efficiency of the employment relationship. From this literature one can conclude that not only does compensation matter, but that firms are likely constrained in their ability to offer the most efficient contract. Hence part of the increased incidence in the use of performance-pay must arise from enhancements in the technology of compensation.

In Section 3, we present our formal measurement model, in which performance-pay is viewed as a indicator that firms pay wages that are closer to the marginal product of workers than firms that do not use performance-pay. We also derive a number of testable implications from the simple model. In Section 4, we present the data used for the empirical analysis and illustrate the growth in the incidence of performance-pay over time. Section 5 presents estimates from the PSID of the effect of performance-pay on the wage structure, supplemented with some corroborating evidence from the NLSY. We argue that this evidence is consistent with the view that wages on performance-pay jobs are closer to marginal products than wages on other jobs. We then show in Section 6 how the growth in performance-pay has contributed to the growth in wage inequality between the late 1970s and the early 1990s. After presenting robustness checks in section 7, we conclude with a discussion of the results in Section 8.

2 Pay-for-performance

Frederick Taylor (1911) was likely the first, in his work on scientific management, to formally observe that there are gains from monitoring workers to enhance performance. He also notes that such systems are potentially what would come to be called Pareto-improving, because the more productive workers will be paid higher wages, while firm profits will increase. He also recognized the importance of getting workers to closely associate material rewards with their improvements in output.[5] It is surprising that although these principles were clearly laid out in 1911, as the work of Steven Kerr (1975) illustrates, many firms continue to use dysfunctional compensation systems.

The recent economics literature explores a number of reasons why firms may not be able to implement efficient pay-for-performance systems. In his seminal work on asymmetric information, Akerlof (1970) shows that market mechanisms may not work when buyers cannot observe the quality of a good that is sold. Yet Alchian and Demsetz (1972) build upon this observation to suggest that firms, through their ability to monitor and reward employees, can mitigate at least some of the problems that arise due to asymmetric information.

Taylor (1911) also laments the fact that in many situations, workers choose to work at a pace that is far below their capacity. Gibbons (1987) shows that such behavior is rational when the firm cannot observe the difficulty of the job, and uses observed performance to increase the demands upon the worker without a corresponding increase in compensation (the so-called "ratchet effect"). Kanemoto and MacLeod (1992) show that if the difficulty of the job can be observed, so that variations in performance arise from variations in worker ability, then performance-pay is not undermined by the ratchet effect in a competitive labor market. Baker (1992) and Holmström and Milgrom (1991) further observe that if available performance measures are not be well-correlated with desired performance, this may lead to dysfunctional behavior in addition to low output. For example, if a programmer is paid by the number of lines of computer code generated, then she or he will produce a large number of lines of code, even though the code may be error-ridden and inefficient. Hence, the ability to introduce an effective pay-for-performance system is in part a *technological issue* that depends upon the availability of good measurement systems.

The cost of obtaining such a good performance measure is, in turn, likely to be related to job characteristics. Brown (1990) explores the choice between a fixed salary, merit pay and piece-rate compensation. Using data from the BLS industry wage survey, he finds that the choice depends upon the monitoring costs, with firms choosing standard rates when monitoring costs are high, as in the case of complex jobs. He observes that merit pay is used when workers feel that their evaluations are fair.

MacLeod and Parent (1999) consider a similar question using a number of panel data sets

[5] On page 48, Taylor observes "a reward if it is to be effective in stimulating men to do their best work, must come soon after the work is done." He goes on to observe on page 49 the importance of selecting good workers.

that allow better controls for worker heterogeneity. In addition, they consider 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. When performance measures are more subjective, then firms either use bonus pay or time pay with little explicit pay-for-performance. In addition, MacLeod and Parent show (theoretically) that firms are more likely to use straight pay when there are strong complementarities among employees. For example, in an assembly-line, the pace of the line is fixed, and hence all workers must work at a similar pace. Under a regime with strong complementarities in production, performance is constrained by the weakest link, and there is little benefit from enhancing individual performance if the performance of the weakest link is not affected. This suggests that for such jobs compensation is more tightly linked to the job rather than individual characteristics.

This evidence supports the theoretical predictions of Baker (1992) and Holmström and Milgrom (1991) that the form of compensation varies with the characteristics of the job that affect monitoring costs. Hence, the incidence of performance-pay is likely to vary over time as a function of job composition as well as the relative cost of using such a system. By itself, this does not imply that an increased use of performance-pay should result in an increase in wage inequality. If the labor market is frictionless, then selection into jobs should generate a strong relationship between ability and wages.

However, if the labor market has significant frictions, and straight time-wages cannot adjust in the short run, then we might expect an increase in performance-pay to have an impact upon inequality. There is a significant body of empirical evidence showing that this is indeed the case. MacLeod and Parent (1999) find that bonuses are much more sensitive to business cycle fluctuations than straight wages, a result complementary to the work of Card and Hyslop (1997) showing that contract wages are rigid.

The literature on inter-industry wage differences, such as Krueger and Summers (1988) and Gibbons and Katz (1992), finds that part of a worker's compensation is industry specific. Shimer (2005) shows that one can explain this evidence with a model that explicitly supposes no performance-pay and search frictions that make it impossible to achieve efficient matching. Kotlikoff and Gokhale (1992) provide some additional evidence that performance-pay is important for wage formation. They measure the wage/productivity profile of workers at a single firm, and find that sales persons have income set to their marginal products. In contrast, they find that for management work individuals' marginal products are not in general equal to their wages, and attribute that result to the cost of evaluating worker performance.

Farber and Gibbons (1996) and Altonji and Pierret (2001) provide evidence that wages are not equal to marginal products because information is imperfect and it takes time for firms to learn about the actual productivity of workers. Lazear (2000) shows that when an auto-glass firm moved to a piece-rate system, it resulted in more able workers taking these jobs, illustrating again that performance-pay enhances the productivity of the worker-to-firm match.

Our contribution to this literature is to show that if performance-pay improves the quality of a worker-firm match, then an increased incidence of performance-pay implies greater wage inequality. We then document the contribution of increased reliance on performance-pay to the wage inequality in the 1980s and 1990s.

As a whole, the existing evidence shows that when there are good performance measures, performance-pay can enhance employee productivity and improve match quality. However, the use of performance-pay is constrained by the quality of available performance measures. As a consequence, a profit maximizing firm will introduce performance-pay in a particular job only when the quality of the performance measure is sufficiently good. This suggests that the incidence of performance-pay increases with the quality of performance measures available. This may arise either from changes in the technology of monitoring or from an increase in the fraction of jobs for which there are good performance measures.

It is difficult to distinguish between these effects. However, we do know that there is a large and thriving industry devoted to the creation of knowledge management systems and better measuring tools. Consulting companies specializing in compensation, such as Hay Associates, Hewitt, and Towers Perrin have grown tremendously over the last 30 years. SAP, a major supplier of software used to monitor employee performance, has experienced sales growth from DM150 million in 1985 to $8.8 billion today. These trends illustrate the importance that firms place upon monitoring and measuring employee performance. Without such measurement, performance-pay is not possible. In the next Section we describe the empirical implication of such improved performance measures.

3 Measurement Model

The basic idea of the model is very simple. We start with the traditional distinction between cases of "wages attached to jobs" versus cases of "pay for the person". The former case corresponds to the model that Shimer (2005) uses to explain inter-industry wage differentials. In his model, firms set wages, then workers apply for jobs. Consistent with the "Hay system", this implies that compensation for a particular job is determined by the characteristics of the job, which in turn determines a constituency of applicants. The firm then hires the most able individual from the applicant pool. Since firms must make their hiring decision before employment, this implies that compensation is less sensitive to the *ex post,* realized productivity of the worker. In contrast, a performance-pay system begins with a base pay that reflects the *ex ante* productivity of the worker and is then adjusted *ex post* with additional pay that reflects the worker's realized productivity.

Thus, with "wages are attached to jobs", all workers working on the same job for the same firm are paid the same way. For example, each job classification may correspond to a specific wage grid that depends on seniority within the firm. A prime example of jobs that frequently set pay through such a method are union jobs where the firm and the union collectively bargain to establish a wage grid. Even outside the union sector, however, compensation consultants such as Hay have developed systems to measure the skills needed for a job, which in turn implies wages that reflect the features of the job rather than the unique abilities of the worker. While some formal models could be used to show why it could be optimal for firms, in some settings, to pay wages attached to jobs, we do not attempt to provide such an explanation in this paper. We simply note that, econometrically speaking, only job characteristics, including seniority, should have an effect on wages when wages are attached to jobs. This means that conditional on job characteristics, individual productive characteristics of workers such as education have no effect on their wages. The unconditional effect of education on earnings will still of course be positive if education helps workers get more lucrative jobs.

The resulting wage setting equation of worker i working for firm j at time t when wages are attached to jobs is:

$$y_{ijt}^J = z_{ijt}\varphi_t + \nu_{ij} + e_{ijt}$$

where z_{ijt} is a set of observed job characteristics like occupation or seniority, ν_{ij} is a "firm-specific" wage term that captures differences in wage policies across firms, and e_{ijt} is an idiosyncratic pay component. The firm-specific component ν_{ij} could be linked, for instance, to the average level of productivity of workers employed by the firm. Even if firms do not observe individual productivity, firms that turn out to have more productive workers will be able to pay higher average wages to all workers. Alternatively, ν_{ij} could capture the fact that some firms pay better than others because of reasons such as rent-sharing.

Now we may consider the other pole, the "pay for the person" case where workers are paid their marginal products, regardless of the job they hold. This corresponds to a traditional human capital pricing model where workers are simply paid for the marginal product of their human capital. As in the case of wages attached to jobs, we do not discuss here why some firms pay wages equal to marginal products while others do not. We simply note that, starting in the late 1970s, many compensation consultants (e.g. Ed Lawler) began recommending that firms pay for the worker rather than the job using formal evaluation of worker performance. One possible reason for these changes is that formal evaluation of worker performance became easier with advances in information processing technologies.

The resulting competitive wage setting equation in the pay for the person case is a traditional wage equation:

$$y_{ijt}^{W} = x_{it}\beta_t + d_t\theta_i + u_{ijt}$$

where x_{it} represents standard observed (by the econometrician) characteristics like potential experience and education, θ_i represents a worker-specific productivity term, and u_{ijt} is an idiosyncratic productivity term. The parameters β_t and d_t are the returns (in terms of productivity) to observed and unobserved characteristics.

As discussed in the introduction, existing measures of performance-pay are only an imperfect indicator of whether a firm pays wages attached to jobs, or pays for the person (competitive wages). For example, some firms may be paying an end-of-year bonus to all workers whatever their performance. In that case, the fact that bonuses are used does not mean that wages are equal to marginal products. Other firms may be paying straight wages that nonetheless end up being very to close to the actual productivity of workers. In such cases, firms pay wages attached to workers even if we do not formally observe performance-pay schemes such as bonuses, commissions, or piece-rates. To capture these possibilities, let

s^p and s^n be the probability that workers on performance-pay jobs (p) and non-performance-pay jobs (n), respectively, are actually paid their marginal product, y^W_{ijt}. For performance-pay to be an informative measure, it must be that $s^p > s^n$, i.e. that workers who are paid for performance are more likely to be paid on the basis of their marginal product than workers who are not paid for performance. Conditional on performance-pay, the expected wage of worker i at time t becomes:

$$w^p_{ijt} = x_{it}\beta^p_t + z_{ijt}\varphi^p_t + d^p_t\theta_i + \nu^p_{ij} + \varepsilon^p_{ijt},$$

for performance-pay jobs, and

$$w^n_{ijt} = x_{it}\beta^n_t + z_{ijt}\varphi^n_t + d^n_t\theta_i + \nu^n_{ij} + \varepsilon^n_{ijt},$$

for non-performance-pay jobs, where the regression coefficients satisfy:

$$\beta^p_t = s^p\beta_t \text{ and } \beta^n_t = s^n\beta_t,$$

$$\varphi^p_t = (1 - s^p)\beta_t, \text{ and } \varphi^n_t = (1 - s^n)\beta_t,$$

$$d^p_t = s^p d_t, \text{ and } d^n_t = s^p d_t.$$

The variances of the error terms satisfy:

$$var(\nu^p_{ij}) = (1 - s^p)var(\nu_{ij}), \text{ and } var(\nu^n_j) = (1 - s^n)var(\nu_{ij}),$$

$$var(\varepsilon^p_{ijt}) = (s^p)var(u_{ijt}) + (1 - s^p)var(e_{ijt}),$$

$$var(\varepsilon^n_{ijt}) = (s^n)var(u_{ijt}) + (1 - s^n)var(e_{ijt}).$$

A number of interesting predictions follow directly from this model:

1. The return to measurable worker characteristics, x_{it}, is larger in performance-pay jobs than non-performance-pay jobs. ($\beta^p_t > \beta^n_t$)

2. The return to measurable job characteristics, z_{ijt}, is smaller in performance-pay than non-performance-pay jobs. ($\varphi^p_t < \varphi^n_t$)

3. The return to unmeasurable person-specific characteristics θ_i is larger in performance-pay jobs than non-performance-pay jobs ($d_t^p > d_t^n$). A related implication is that for a given distribution of θ_i, the variance of the person-specific component will be larger in performance-pay than non-performance-pay jobs. When comparing workers on performance-pay and non-performance-pay jobs, the variance could also be different because of differences in the variance of θ_i among these two groups of workers. We will adjust for this empirically by comparing the variance of the person-specific component in performance-pay and non-performance-pay jobs for a subsample of "switchers" who are observed on both types of jobs.

4. The variance of the firm-specific component is smaller in performance-pay jobs than non-performance-pay jobs ($var(\nu_{ij}^p) < var(\nu_{ij}^n)$).

5. The variance of the idiosyncratic term in performance-pay jobs, $var(\varepsilon_{ijt}^p)$, may either be larger (if $var(u_{ijt}) > var(e_{ijt})$) or smaller (if $var(u_{ijt}) < var(e_{ijt})$) than the variance of the idiosyncratic term in non-performance-pay jobs, $var(\varepsilon_{ijt}^n)$.

The predictions will be tested in Section 4. Note, however, that it is not clear from these predictions what will be the effect of performance-pay on wage inequality. Remember that in our framework an increase in performance pay means that a higher share of workers are paid their marginal products. Predictions 1 and 3 mean that returns to (observed and unobserved) skills increase when the fraction of performance-pay jobs increases, which, in turn, results in more wage inequality. This may be partly offset, however, by the fact that inequality linked to job characteristics (prediction 2) and firm effects (prediction 4) decrease when the fraction of performance pay jobs decreases. Whether or not performance-pay results in more wage inequality is thus an empirical question that will be addressed explicitly in Section 5.

4 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, which is essential for studying the effect of pay-for-performance on wage inequality. One disadvantage of the PSID, however, is that our constructed measures of performance-pay are relatively crude and may be fairly imperfect proxies for whether or not workers are paid their marginal products. Therefore, to probe the robustness of the results based on the PSID, we re-estimate some of the key models using the NLSY. The NLSY is an excellent tool to do so because it asks workers directly whether or not their earnings are based on performance, bonuses, or commissions. This is arguably a better measure of performance-pay than what is available in the PSID. Unfortunately, however, the question about performance-pay in the NLSY was only included in the late 1980s and late 1990s. Combined with the fact that the NLSY only follows a narrow cohort of individuals over time, it is not possible to use the NLSY to look at the broad affects of performance-pay on changes in wage inequality or for insight into a wide variety of worker characteristics.

4.1 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 $1.00 and $100.00 (in $79) for the years 1976-1998, where the hourly wage rate is obtained by dividing total earnings in the previous year by hours of work.[6] Individuals in the public sector, or who are self-employed, are excluded from the analysis. This leaves us with a total sample of 30,424 observations for 3,181 workers. Summary statistics are reported in Table 1 and will be discussed below.

4.1.1 Measurement Issues

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, 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, commissions, or from bonuses paid by the employer.[7] Second, since 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,

[6]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.

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

we classify them as not having had a variable pay component.[8] 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/hour pay with piece-rates or commissions.[9] 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 the performance-pay component we construct will be noisy. 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.

Defining performance-pay jobs[10] One of the main goals of this paper is to see whether employment relationships that involve performance are systematically different from those in which no such performance-pay is ever received. Thus 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. In some sense, we are interested in the differences between types of jobs

[8] We do not count these workers as pay for performance because in some years overtime hours are reported, while in other years we only know whether they worked overtime or not.

[9] 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 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, and then report a commission: they have to choose. Our assertion that it 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, and workers in the NLSY are more likely to report having part of their compensation package contain a performance-pay component.

[10] To avoid confusion, note that we use "jobs," "employment relationship", and "job match" interchangeably. Although in most of the survey years spanning the sample period, the PSID does have information on tenure in the position, 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 much as we are in the nature of particular performance-pay employment relationships.[11] Two related measurement issues arise. The first is a simple measurement error concern. On the one hand, we are likely to misclassify performance-pay jobs as non-performance-pay jobs (false negative) if some employment relationships are terminated before performance-pay is received. This would be particularly problematic if the first receipt of performance-pay, which identifies the job as a performance-pay job, tends to occur later instead of sooner in the course of the employment relationship. On the other hand, some of the jobs are wrongly classified as performance-pay jobs (false positive) for reasons discussed earlier (e.g. end-of-year bonus). While it is a priori difficult to assess which of the false negative or false positive problems are more important, their consequence is the same: assuming there is a genuine difference between the two types of jobs, misclassification will tend to attenuate such differences. Our measurement model explicitly deals with this issue by introducing the probabilities s^p and s^n. A "false negative" means that $s^p < 1$, while a "false positive" means that $s^n > 0$.

A second related issue is an "end-point" problem: given our definition of performance-pay jobs, we may mechanically understate the fraction of workers in such jobs at the start of our sample period because most employment relationships started before 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 basic measurement 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 captured in our PSID sample, 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 observed job match observations at different points of the sample period. One simple solution to the problem is to "rebalance" the sample using regression or other methods. Therefore we create a variable that counts the number of job matches observed for each job (as opposed to the actual job duration), and then add this variable as an additional control in the regression

[11] That said, we also look at the impact within a job of an alternative definition of a performance-pay. More on that below.

models. Similarly, the corrected incidence of performance-pay over time can be computed by running a linear probability model (or a logit) in which year dummies and the number of times the job-match is observed are included as regressors. The year dummies then capture the corrected incidence of pay-for-performance job. All the graphs of the incidence of pay-for-performance, as well as all the regression results reported below, are adjusted using this procedure.[12]

Descriptive statistics Table 1 compares the sample characteristics of workers on performance-pay and non-performance-pay jobs, respectively. First, notice that 37 percent of the 30,424 observations are in performance-pay jobs, though these raw figures must be interpreted with caution because of the end-point problem discussed earlier. 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 for non-performance-pay jobs. In section 7 we show that these results are not sensitive to an alternative adjustment for the end point issue.

Not surprisingly, the unionization rate (percent covered by a collective bargaining agreements) is much lower among performance-pay workers, suggesting that, as expected, pay structure in union firms tend to have wages attached to jobs instead of workers. Another important difference is that there is a much higher fraction of workers paid by the hour in non-performance than performance-pay jobs. On the flip side, workers on performance-pay jobs are much more likely to be salaried workers than those on non-performance-pay jobs. This is an important point, since the growth in wage inequality has been stronger among salaried than hourly workers (Lemieux (2006)). Performance-pay is thus more likely to affect the very group of workers who have experienced the largest increase in inequality, and who are also least likely to be affected by other institutional factors such as the minimum wage or unionization.

The cross tabulations shown in Table 2 confirm that performance-pay is more prevalent in high-wage occupations like professional, managerial, and sales positions than in others.

[12]Note that the PSID became a bi-annual survey after 1996. This poses a problem in aligning job information (tenure, industry, etc.) that relates to the job held at the interview to the earnings information, including bonus amounts, which are for the calendar year before the interview.

For example, the fraction of workers on performance-pay jobs ranges from only 22 percent for service workers, to 74 percent for sales workers. By contrast, performance-pay is more evenly used across industries, ranging from for a low of 29 percent in construction to a high of 61 percent in finance, insurance and real estate (FIRE).

Figure 1 provides additional descriptive information on the distribution of wages for performance-pay and non-performance-pay jobs by reporting kernel density estimates of the distribution of hourly wages. The figure shows that hourly wages have a higher mean and median, and are less evenly distributed in performance-pay than non-performance-pay jobs.

We next turn to the time trends in the prevalence of performance-pay. Figures 2a to 2e show the evolution of the fraction of performance-pay jobs for various subgroups of the workforce. In all cases, we correct for the end-point problem by estimating a linear probability model in which we include year dummies and control for the number of times each job-match is observed. The incidence of pay-for-performance jobs reported in the figures is then the predicted probabilities implied by the estimates' year effects, holding the number of observed job matches at a fixed value (close to the mean for the relevant sample analyzed). In all figures, we also report the raw incidence of performance-pay obtained by computing the fraction of workers who report some performance-pay in a given year. As argued above, this strongly 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.

Figure 2a shows that the overall incidence of performance-pay jobs has increased from a little more than 30 percent in the late 1970s to more than 40 percent in the 1990s. The incidence is computed holding the number of times a job-match is observed at 5, which is close to the average value in the sample. The simpler measure based on the fraction of workers reporting performance-pay in a given year also clearly increases over time, especially in the 1980s. Figure 2a also shows the fraction of workers covered by a collective bargaining agreement. Remarkably, the line showing the fraction of unionized workers is almost the mirror image of the performance-pay job incidence line.

As mentioned earlier, the decline in unionization has been found to be an important contributor to increased wage inequality in the United States. On the surface it would appear that one simple mechanism by which de-unionization would have increased wage dispersion is by allowing firms to offer more variable pay, possibly in the form of bonuses. However, as we can see in Figures 2b and 2c, a particularly informative way of looking at the increase in the incidence of performance-pay jobs is to break it down by how workers are paid. The incidence of performance-pay jobs increased for workers paid by the hour while unionization decreased sharply (Figure 2b). The bulk of the increase in performance-pay in Figure 2a is driven by salaried workers who are not likely to be unionized at any time (Figure 2c). The increase in the incidence of performance-pay jobs among salaried workers illustrated in Figure 2c is quite remarkable. It increases from about 30 percent in the late 1970s, to nearly 50 percent by the end of the sample period.

A strong case for a simple de-unionization explanation would have been found if, for example, the fraction of performance-pay jobs was constant over time in both the union and non-union sectors. Under this scenario, the growth in performance-pay would have been a simple composition effect linked to the decline in unionization. Figures 2d and 2e show, however, that the incidence of performance-pay jobs increased among both union and non-union workers, although the increase was somewhat steadier among non-union workers.

Next, in Figure 3, we show the distribution of the share of performance-pay in total labor earnings. To compute the share we use the amounts directly reported by respondents over the 1993-1999 period for the amounts earned in commission, bonuses, and tips earned in the previous calendar year.[13] Given that the median share is about 3.5% of total earnings, it is clear that performance-pay, per se, only represents a relatively modest component of total compensation. We thus interpret the presence of performance-pay as only an indicator that wages (both the straight wage and the performance-pay component) are paid more competitively in performance-pay than non-performance-pay jobs.

4.2 Performance-pay in the NLSY and other data sources

As mentioned earlier, we also provide supporting evidence from the NLSY that asks more explicitly about pay-for-performance in the 1988, 1989, 1990, 1996, 1998 and 2000 waves of

[13]Note that it is also possible to back out an estimate of bonus amounts earned in pre-1993 data by using the set of questions on amounts earned in overtime, bonuses, or commissions and the questions on overtime work and pay method. Turning to "missing" all observations in which respondents either worked overtime or report commissions earnings, we get an estimate of bonuses earned. The resulting distribution of the share of bonuses earned is very similar to the one shown in Figure 3.

the panel. To simplify the analysis, we pool the 1988-1990 observations into a "late 1980s" period, and the 1996-2000 observations into a "late 1990s" period. As in the case of the PSID, we focus only on males. We also impose a couple of additional sample restrictions similar to those used by Gibbons, Katz, Lemieux, and Parent (2005). As in the case of the PSID, we classify a job as a performance-pay job when the worker reports performance-pay at least once on that job. Note, however, that the limited number of years in which performance-pay is measured means that we are less likely to "catch" performance-pay jobs. We nonetheless find that the incidence of performance pay jobs increases from 26.1 percent in the late 1980s to 30 percent in the late 1990s, broadly consistent with the evidence from the PSID.

As an additional check of the robustness of trends in performance-pay, we also looked at another source of information based on a survey of Fortune 1000 corporations conducted between 1987 and 2003 (see Lawler III (2003)). The surveys asks firms about the fraction of their workers with some forms of performance-pay and reports results in categories such as 0 to 9 percent, 10 to 19 percent, etc. We compute the implied fraction of workers with performance-pay using the mid-points of these intervals. The implied fractions are 20.7 in 1987, 27.1 in 1990, 34.7 in 1996, and 44.5 in 2002. Once again, these trends confirm the growth in performance-pay measured (imperfectly) in the PSID data.

5 The wage structure in performance-pay and non-performance-pay jobs

The model of Section 3 provides a number of testable implications about how the structure of wages should differ in performance-pay and non-performance-pay jobs. In this section, we present the main estimation results and discuss how they relate to the predictions of the model of Section 3.

Table 3 reports a number of simple regression estimates of the effect of performance-pay on wages (full compensation, including the pay for performance-payments). Note that there is no particular reason to expect that pay-for-performance jobs pay more (or less) than non-performance-pay jobs. The main predictions outlined in Section 3 have to do, rather, with differences in the returns to measured and unmeasured characteristics in the two pay regimes.

The first column of Table 3 reports the results of a simple OLS regression of the log hourly wage on a dummy for performance-pay jobs. The regressions reported in Table 3 also control for education, experience, seniority, the number of times the job match is observed, occupation, and industry. The estimated effect is positive (7.21 percent) and statistically significant. The second column shows that the effect of having a pay-for-performance job declines by half when a dummy for performance-pay received during the year is included. When worker-specific fixed effects are introduced in columns 3 and 4, the effect of performance-pay jobs becomes essentially zero and insignificant, while the effect of receiving pay-for-performance in a given year remains positive and significant.

These results suggest two interesting observations. First, including standard controls for observed and unobserved workers characteristics (column 4) explains the whole difference in raw wages between performance pay and non-performance-pay jobs documented in Table 1. This is a useful result since there is no reason, a priori, to expect that performance-pay jobs should pay more after adjusting for differences in workers' characteristics. This suggests that the relevant heterogeneity is captured by the covariates and the worker-specific fixed effect. A second useful observation is that the estimated effect of pay-for-performance-payment in a given year is around 5-6 percent in column 4 and in column 5 where we further control for worker-job fixed effects (the effects of performance-pay jobs are no longer identified in this specification). This is quite similar to the average magnitude of performance-pay income reported in Figure 3, and suggests that performance-pay is not merely *displacing* base pay, but results in a *increased* compensation even after controlling for individual and job-specific characteristics.

Table 4 provides a first direct test of some of the implications of the model of Section 2. Columns 1 and 2 report separate estimates of a standard wage equation for performance-pay and non-performance-pay jobs, respectively. Once again, the estimated models include both standard human capital characteristics like education and experience (the variables x_{it} in Section 3), and job characteristics such as seniority as well as industry and occupation dummies (the variables z_{ijt} in Section 3). As expected, the return to education and potential experience is larger in performance pay than non-performance-pay jobs. The return to education is 40 percent larger in performance-pay than non-performance-pay jobs (0.093 vs. 0.066) while the return to experience is 60 percent larger (0.0093 vs. 0.0058). The same pattern of results can be observed in Figure 4, which shows in more detail the relationship between wages and education in performance-pay and non-performance-pay jobs. The results also remain relatively unchanged when a person-specific fixed effect is introduced in columns 3 and 4. For instance, the coefficient on education is 0.018 larger in performance-pay jobs than in other jobs (compared to a 0.027 difference in OLS models). Note that we estimate a pooled model with interactions because education is almost time-invariant (for a given person) in our PSID sample. This means that we cannot separately identify the effect of education from the fixed effect when running separate models for performance-pay and non-performance pay jobs. The interaction term between performance-pay and education is still identified, however, because of the "switchers" who are observed in both performance-pay and non-performance-pay jobs. The results for education mean, for example, that more-educated workers get a bigger wage gain from switching from a non-performance-pay to a performance-pay job than less-educated workers. Overall, the results support the implication of the model that returns to observed qualities such as education are higher in performance-pay than non-performance-pay jobs.

In contrast to that general principle, the effect of seniority is lower in performance-pay than non-performance-pay jobs. This is consistent with the view that seniority is a job characteristic that matters when wages are attached to jobs, but not when wages are paid for the person. The difference remains significant (and quantitatively larger) when worker fixed effects are added in columns 3 and 4. The other key set of job characteristics we focus on are occupation dummies. Table 5 shows both OLS and fixed effect estimates of the (one-digit) occupation effects for performance-pay and non-performance-pay jobs (the other variables shown in Table 4 are included in these regressions but not reported in the table). As in Gibbons, Katz, Lemieux, and Parent (2005), including worker-specific fixed effects dramatically reduces the magnitude of the occupation effects, especially for performance-pay jobs. While the standard deviation of the occupation effects is larger in performance-pay jobs (0.180) than in other jobs (0.167) when using OLS, it is smaller in performance-pay jobs (0.056) than in non-performance-pay jobs (0.060) after controlling for fixed effects. This is, once again, consistent with the predictions of Section 3.

Table 6 explores the other predictions of the model about how the variance of the different components of the error term compare for performance-pay and non-performance-pay jobs.[14] The most interesting comparison is column 2 vs. column 4 of Panel B. Only "switchers" who are observed on both performance-pay and non-performance-pay jobs are used in Panel B.

[14]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.

This means that the underlying variance of the person-specific component θ_i is the same for the performance-pay and non-performance-pay samples. As a result, the relative return to this component in performance-pay and non-performance pay jobs, d_t^p/d_t^n, is equal to the square root of the ratio of the estimated variance of θ_i in performance-pay and non-performance-pay jobs. These variances are 0.093 and 0.043, which implies that the ratio d_t^p/d_t^n is equal to 1.47. In other words, d_t^p is 47 percent larger than d_t^n.

This is very interesting, since we found in Table 4 that the return to education and experience in performance-pay jobs also exceeded the return on non-performance-pay jobs by factor in the 40-60 percent range. Strictly speaking, the model implies that all these returns should be proportional with a factor a proportionality given by s^p/s^n. This simple model thus appears to be a parsimonious way of modeling the wage structure in performance-pay and non-performance pay jobs.

Also consistent with the theoretical predictions, the results indicate that the variance of the job-specific term is much smaller in performance-pay (0.006) than non-performance-pay jobs (0.033). In intuitive terms, this suggests that the firm an individual works for explains quite a bit of the wage variation in non-performance-pay jobs, but much less in performance-pay jobs. This provides evidence that pay-for-performance is indeed a good proxy for whether wages are attached to workers instead of jobs. Finally, the variance of the "residual" or idiosyncratic term is slightly smaller in performance-pay than in non-performance-pay jobs. Remember, however, that the model did not have specific predictions about whether this variance should be larger for one type of job than for the other.

We also present some complementary evidence from the NLSY in Table 7. As in the case of the PSID, we run separate wage regressions for performance-pay and non-performance-pay jobs. We also exploit the fact that the Armed Forces Qualifying Test (AFQT) score, which is available in the NLSY, can be used as a proxy for unobserved productive characteristics. Since the AFQT score is purely a measure of worker characteristics, as opposed to job characteristics, its effect on wages should be larger in performance-pay than in non-performance-pay jobs. Table 7 confirms that both in the late 1980s and late 1990s, returns to productive worker characteristics (education, experience, and the AFQT score) are larger in performance-pay than non-performance-pay jobs.

In summary, our analysis of the PSID data supports the view that wages on performance-pay jobs are more closely linked to productive characteristics than wages on non-performance-pay jobs. Relative to performance-pay jobs, wages on these other jobs depend more on the characteristics of the jobs people hold than on the productive characteristics of the individuals. The fact that the results from the NLSY, where we use a different measure of pay for performance, are similar to the main PSID results, highlights the robustness of our main findings. The next Section explores the implications of these findings for the growth of wage inequality between the late 1970s and the early 1990s.

6 Performance-pay and the growth in wage inequality

In this Section, we first perform a variance decomposition that is very similar to what has been done to quantify the contribution of de-unionization to the growth in wage inequality. We then look at the impact of performance-pay on broader measures of wages inequality, such as the 90-50 and the 50-10 gap. As in the case of unions, we decompose the effect of performance-pay into a between- and within-group component. The between-group component, or "wage gap" effect, reflects the fact that a positive wage gap between performance-pay and non-performance-pay jobs tends to increase inequality. The within-group (groups being performance-pay and non-performance-pay jobs) component can be divided in two subterms. First, higher returns to measurable characteristics (education and experience) in performance-pay jobs create more wage dispersion within the performance-pay sector. Similarly, differences in the variance of the error term can also contribute to the effect of performance-pay on overall inequality. This latter term could be further split up into the three error components discussed above (person-specific, firm-specific, and the idiosyncratic or residual term). Finally, we use the procedure of DiNardo, Fortin, and Lemieux (1996) to adjust for differences in the distribution of observed characteristics when computing the various counterfactuals. See Dinardo and Lemieux (1997) for a very similar "reweighting" decomposition applied to unionization.

Before presenting the decomposition results, we first report some descriptive information on the trends in wage inequality to be explained. Figure 5 summarizes the changes in wage inequality in our PSID data by showing the evolution of the standard deviation of wages in performance-pay, non-performance-pay, and all jobs between 1977 and 1996. As expected, the figure indicates a substantial increase in inequality over time. For example, Panel A of Figure 5 shows that the standard deviation of hourly wages for all jobs increased from about

0.52 in 1977 to over 0.60 in the early 1990s, before going down a bit in the 1990s. More interestingly, the standard deviation for performance-pay jobs increased generally faster than in non-performance-pay jobs. This pattern is even clearer in Panel B, which focuses only on full-time/full-year workers. Along with Figure 2a, these results suggest that performance-pay jobs are closely linked to the growth of wage inequality since 1) inequality grew faster in performance-pay jobs, and 2) the growing incidence of performance-pay jobs means that an increasingly large fraction of workers are employed in this more unequal sector.

The decomposition results are reported in Table 8. Although we performed the decomposition for all workers, wages are weighted by the number of hours of work to get a distribution of wages that is representative over all the hours worked in the economy, as in DiNardo, Fortin, and Lemieux (1996). As indicated at the bottom of the table, the variance grew by 0.1072 over the period considered (1976-79 to 1990-93). The question is, how much of this can be attributed to the rising incidence in performance-pay jobs from 30.5 percent (column 2) to 45.8 percent (column 5)? In terms of the three components discussed above, the between or wage gap component (row 7) increased from 0.0038 in the 1976-79 to 0.0126 in 1990-93. The within-group component associated to observables increased from 0.0091 to 0.0285 (row 3). Finally, the effect related to the variance of the error term (row 6) decreased from 0.0049 to 0.0027, offsetting in part the two other factors. We show at the bottom of the table that the three terms combined together explain 0.0259, or 24 percent, of the overall increase in the variance.

Note that the contribution of performance-pay to the growth in wage inequality does not solely reflect the fact that a higher fraction of the work force is now paid under a compensation system (performance-pay) that generates more inequality. Table 8 also shows that the inequality-enhancing effect of performance-pay has increased over the course of time. For instance, row 1 shows that the effect of switching the returns to observables from those in non-performance-pay jobs to those of performance-pay jobs increases the variance by 0.0299 in 1976-79. By 1990-93, the effect more than doubles to 0.0622. This is consistent with the evidence in Figure 5 that also shows a larger increase in inequality in performance-pay than non-performance pay jobs. A possible explanation for this finding is that underlying changes in the relative demand for skilled workers, such as skill-biased technical change, are directly translated into inequality growth in the pay for performance sector, while wages are less responsive to these changes in more traditional compensation systems where wages are attached to jobs.

One drawback of the variance as a measure of inequality is that it summarizes the overall wage dispersion without indicating in which part of the distribution performance-pay has the largest effect. As mentioned earlier, we expect performance-pay to play a more important role in the top end than in the low end of the wage distribution–exactly the place where there has been the largest expansion in wage inequality (Autor, Katz, and Kearney (2006)). One advantage of the reweighting procedure used in Table 8 is that any measure of dispersion, such as the 90-50 or the 50-10 gap, can be computed in both the actual and reweighted sample. The overall effect of performance-pay jobs (which combines both the between- and within-group effects discussed above) is obtained by simply contrasting the actual and counterfactual measure of wage dispersion.

Figure 6 shows the difference between the actual and counterfactual wages distribution at each wage percentile. The striking feature of the figure is that the effect of performance-pay jobs is concentrated at the top end of the wage distribution. It is also clear that the effect becomes larger in the early 1990s than in the late 1970s. Figure 7 then compares the growth in wage inequality that would have prevailed with and without performance-pay jobs, by showing the change in real wages at each percentile in the actual (with performance-pay jobs) and counterfactual wage distribution (without performance-pay jobs). The figure shows that essentially all the growth in wage inequality above the 80th percentile is due to performance-pay jobs. This is also confirmed in Table 9, which shows the impact of performance-pay jobs on a number or inter-quantile gaps such as the 90-50 gap and the 99-90 gap.

7 Robustness Check

As noted above, given our definition of performance-pay jobs, we mechanically understate the fraction of workers in such jobs at the start and the end of our sample period. To correct for this truncation problem, we simply condition in all our estimations on the number of times a job-match is observed. To see whether our results are sensitive to the procedure used to correct for the end-point problem, we re-estimated the same models using a different sample made of "complete" job matches. By complete, we mean that the number of times a job match is observed closely corresponds to the maximum tenure attained by the worker in the match. More precisely, we keep all job matches for which the maximum tenure level is within one integer of the number of times the job match appears in the sample. Given that some jobs start with tenure close to zero, we would lose those employment relationships if we kept only the job matches for which the maximum tenure attained was strictly equal to the number of times the match is observed.[15]

Applying this sample selection, we end up with a sample of 17,540 observations. Appendix Table A1 reports that for this alternative sample most of the main results were the same as those from our base sample. As can be seen, the only results that differ somewhat relate to the contribution of performance-pay jobs to the increase in inequality between the late 1970s and the early 1990s and to the error component model. Performance-pay jobs now account for over 29 percent of inequality growth, while the results for the error component model in the case of performance-pay jobs show a zero effect for the contribution of the job match component to the residual variance. There is little reason to believe that our treatment of truncated job durations drives the results reported in Tables 3 to 9.

8 Conclusion

An increasing proportion of jobs in the U.S. labor market include a performance-pay component in addition to regular wages and salaries. In this paper, we look at the effect of growth of performance-pay on wage inequality. The basic premise is that performance-pay jobs represent a more accurate measure of employee performance, and hence rewards are more sensitive to productive characteristics of workers rather than to job characteristics. We develop a simple model to illustrate this point and derive several testable implications. Consistent with predictions, we show that compensation in performance-pay jobs is more closely tied to both observed (by the econometrician) and unobserved productive characteristics of workers. We conclude that the growing incidence of performance-pay accounts for 24 percent of the growth in the variance of male wages between the late 1970s and the early 1990s, and for most of the growth in top end wage variance (above the 80th percentile) during this period.

These results dovetail with the long-standing view in labor economics that labor markets are not perfectly competitive, and that matching workers to jobs is a costly, time-consuming

[15]For example, an employment spell observed twice in successive years with starting tenure rounded to zero and maximum tenure of 1 is kept in the sample, as it clearly represents a complete spell.

activity. The extent to which wages reflect the marginal product of a worker depends upon the time it takes for the firm to find the best match. Given that there is chance that an optimal match is not found, then as Shimer (2005) shows, this can result in persistent inter-industry wage differences, with the empirical implication that wages are a function of both job and worker characteristics.

Performance-pay allows compensation to be more closely tailored to individual performance with less need for a costly search. This implies that for a given job, there will be more variation in individual compensation, and hence if there is an increase in the use of performance pay this should result in an increase in wage inequality. We show evidence that this indeed happened from the 1970s to the 1990s. We speculate that this may be the result of improvements in the monitoring and measurement of employee performance. We also demonstrate that inequality increased faster in performance-pay than non-performance-pay jobs. This is consistent with wages in performance-pay jobs being more responsive to underlying changes in underlying productivities of workers due, for instance, to skill-biased technical change.

These results are not inconsistent with the view that skill-biased technical change can explain the recent rise of inequality, as discussed by Acemoglu (2002). Yet our results provide new insights into this process. In particular, pay for *individual* performance is more effective when workers performance is both separable from the contribution of other workers and measurable. The fact that pay-for-performance is associated with an increase the variance of wages implies that complementarities in production may now be less important than an individual's contribution to total output. This suggests that a complete understanding of the recent increase in wage inequality may require a deeper understanding of technical change itself. Moreover, the results highlight the point that compensation practices are themselves a form of technology that adapt to new circumstances, and hence are worthy of future study.

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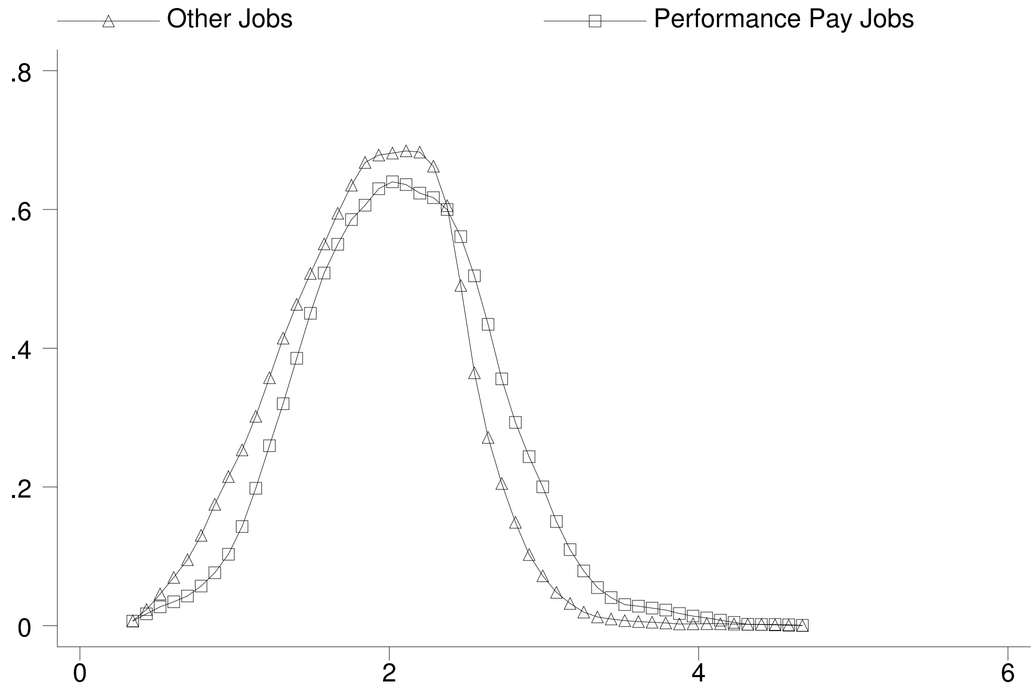


Panel Study of Income Dynamics−Male Heads, 1976−1998

Fig 1. Distribution of Log Average Hourly Wages

Figure 2a. Performance Pay Job Incidence

Panel Study of Income Dynamics 1976−1998

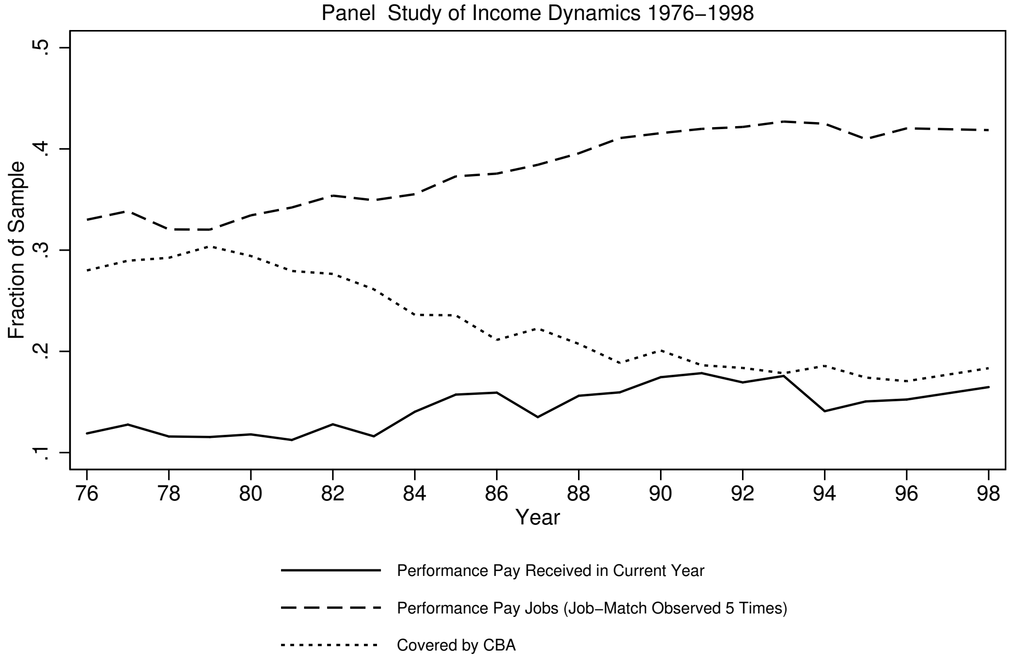


Figure 2b. Performance Pay Incidence for Hourly Paid Workers

Panel Study of Income Dynamics 1976–1998

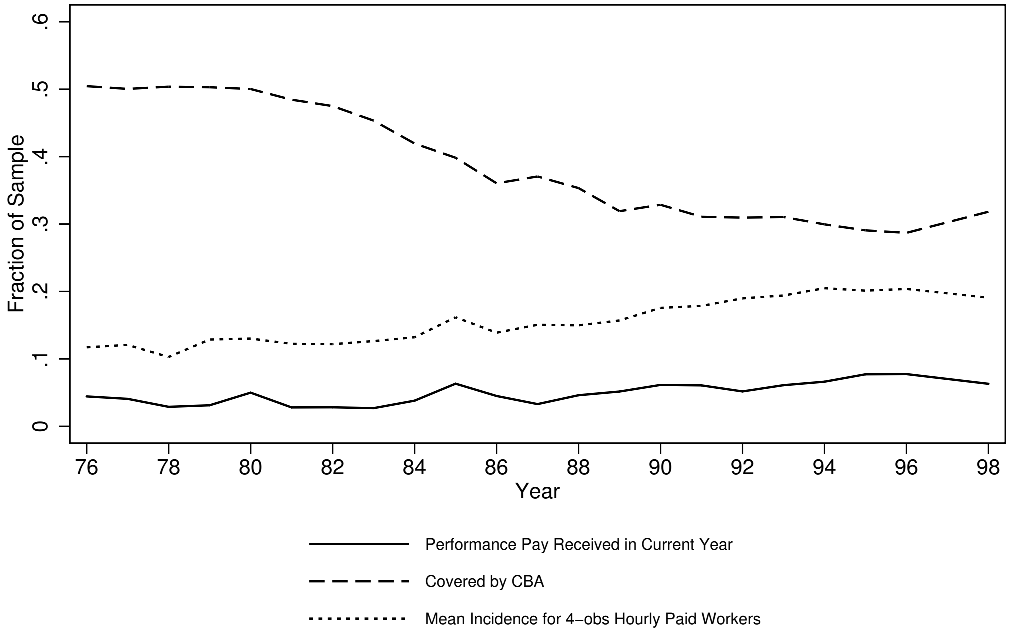


Figure 2c. Performance Pay Incidence for Salaried Workers

Panel Study of Income Dynamics 1976–1998

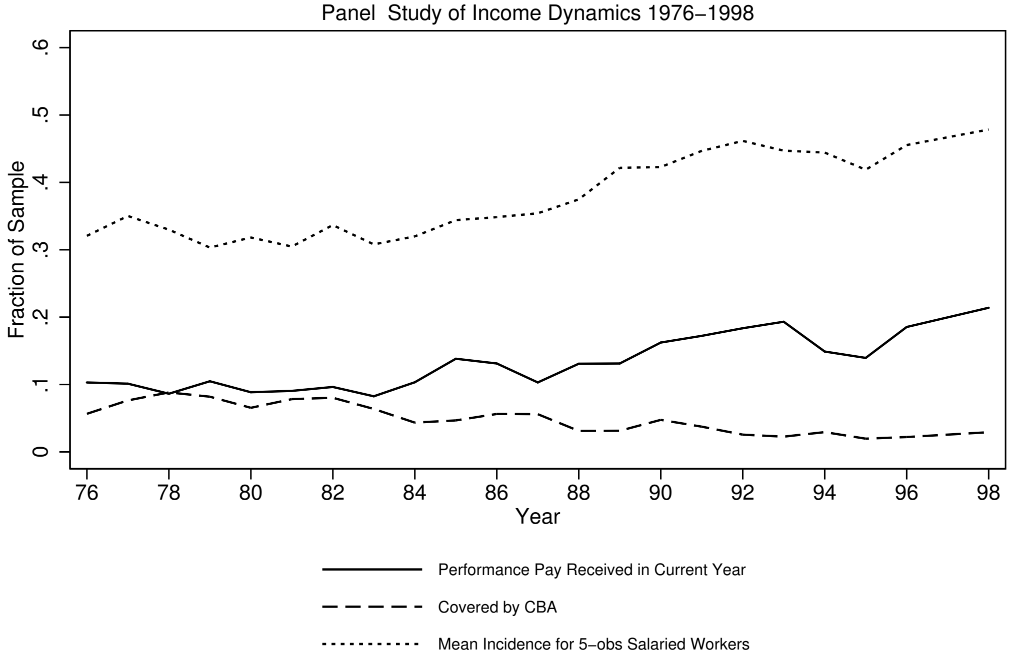


Figure 2d. Performance Pay Incidence for Union Workers

Panel Study of Income Dynamics 1976−1998

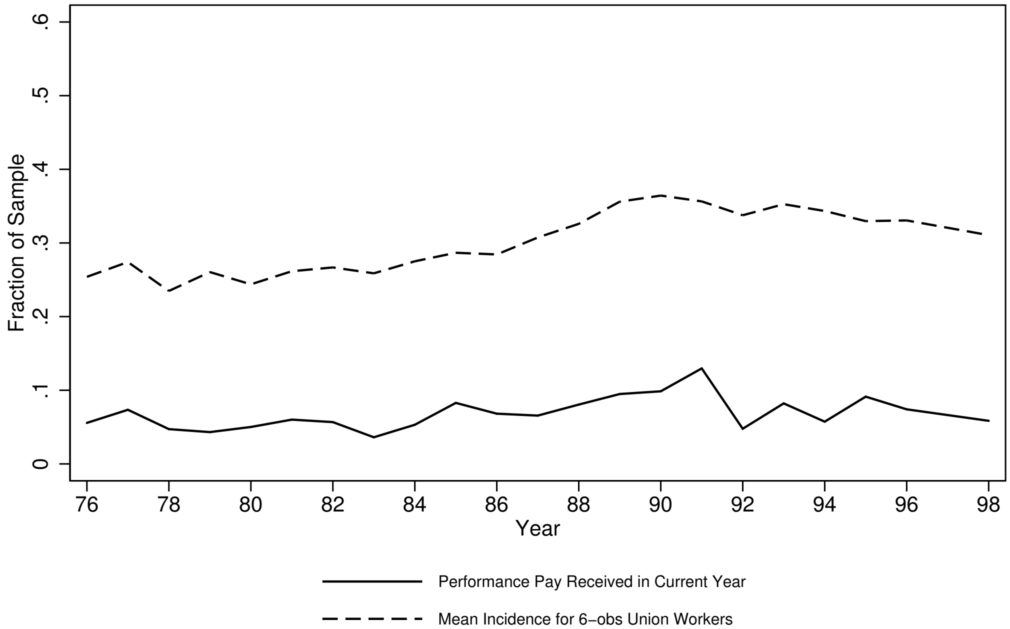


Figure 2e. Performance Pay Incidence for Non Union Workers

Panel Study of Income Dynamics 1976−1998

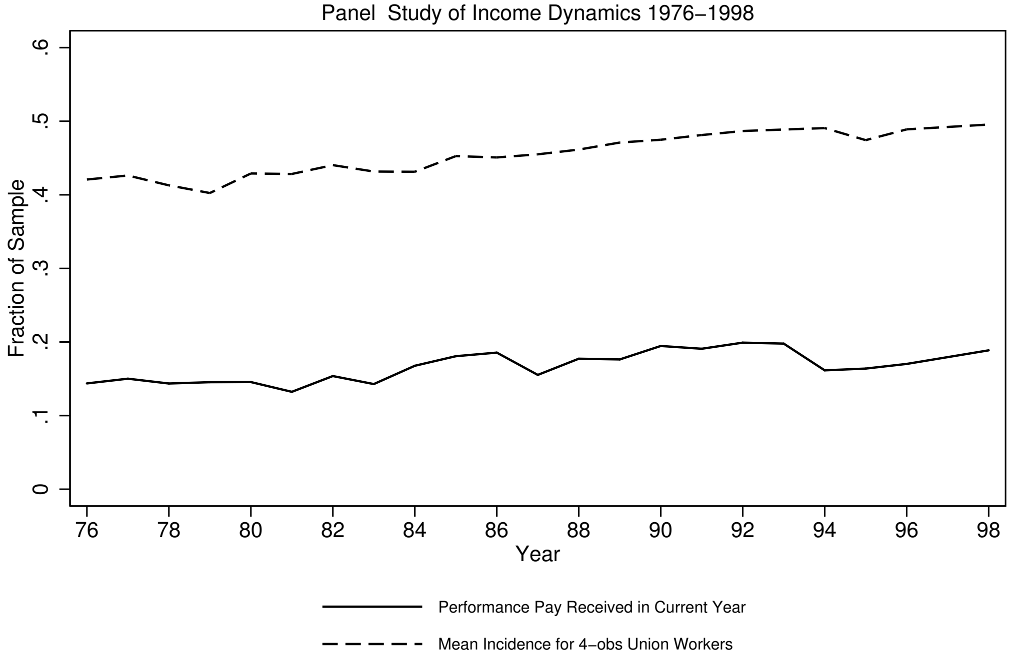
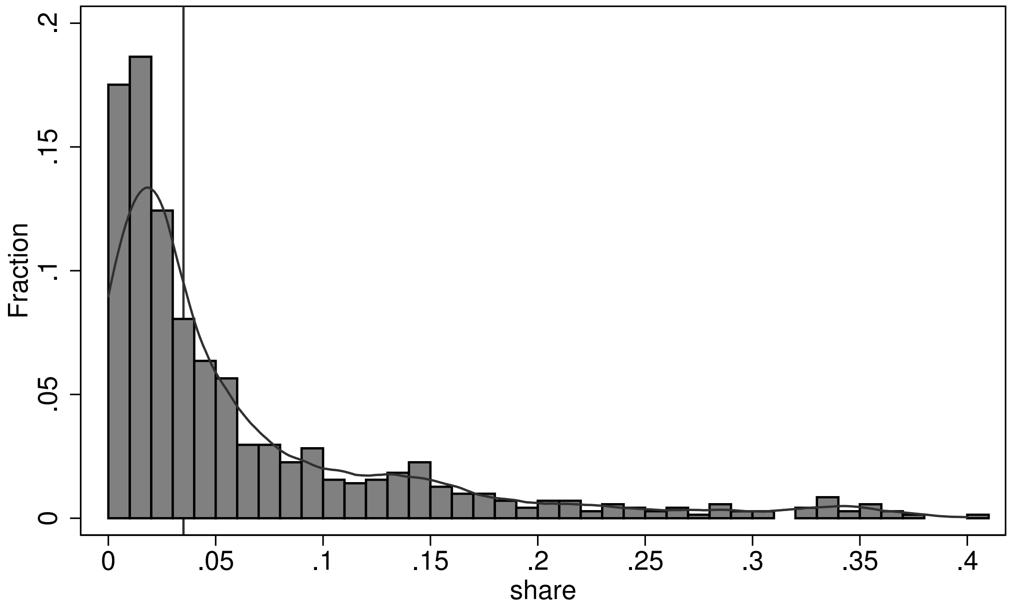


Figure 3. Share of Performance Pay in Total Earnings
PSID 1992–1998



Vertical Line Indicates Median Share (3.5%)

Figure 4. Education and Wages
Dependent Variable: Log Hourly Earnings

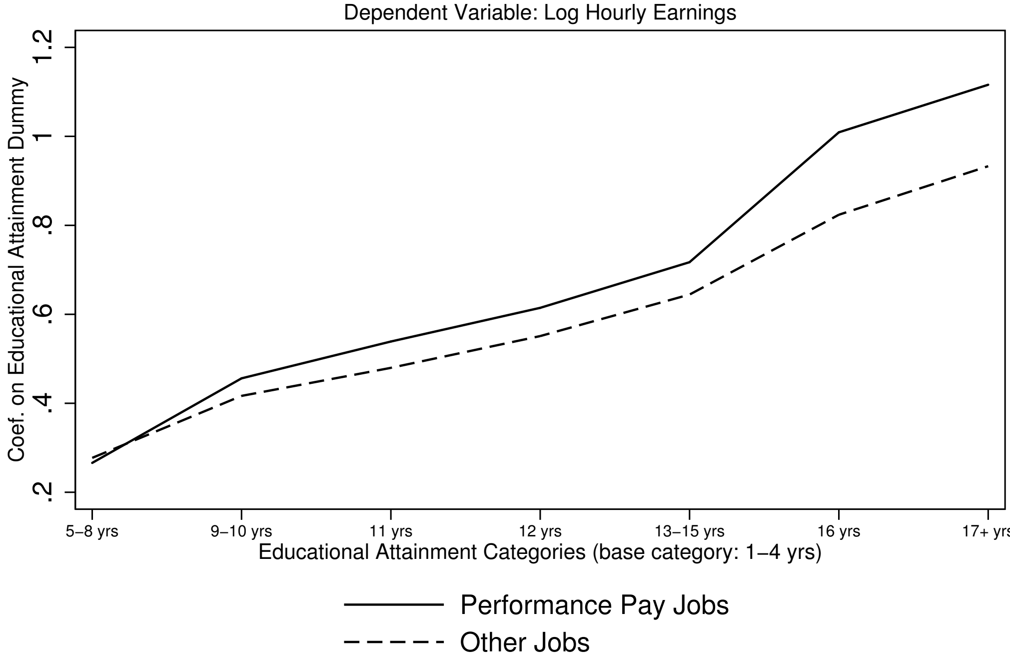


Figure 5. Wage Inequality

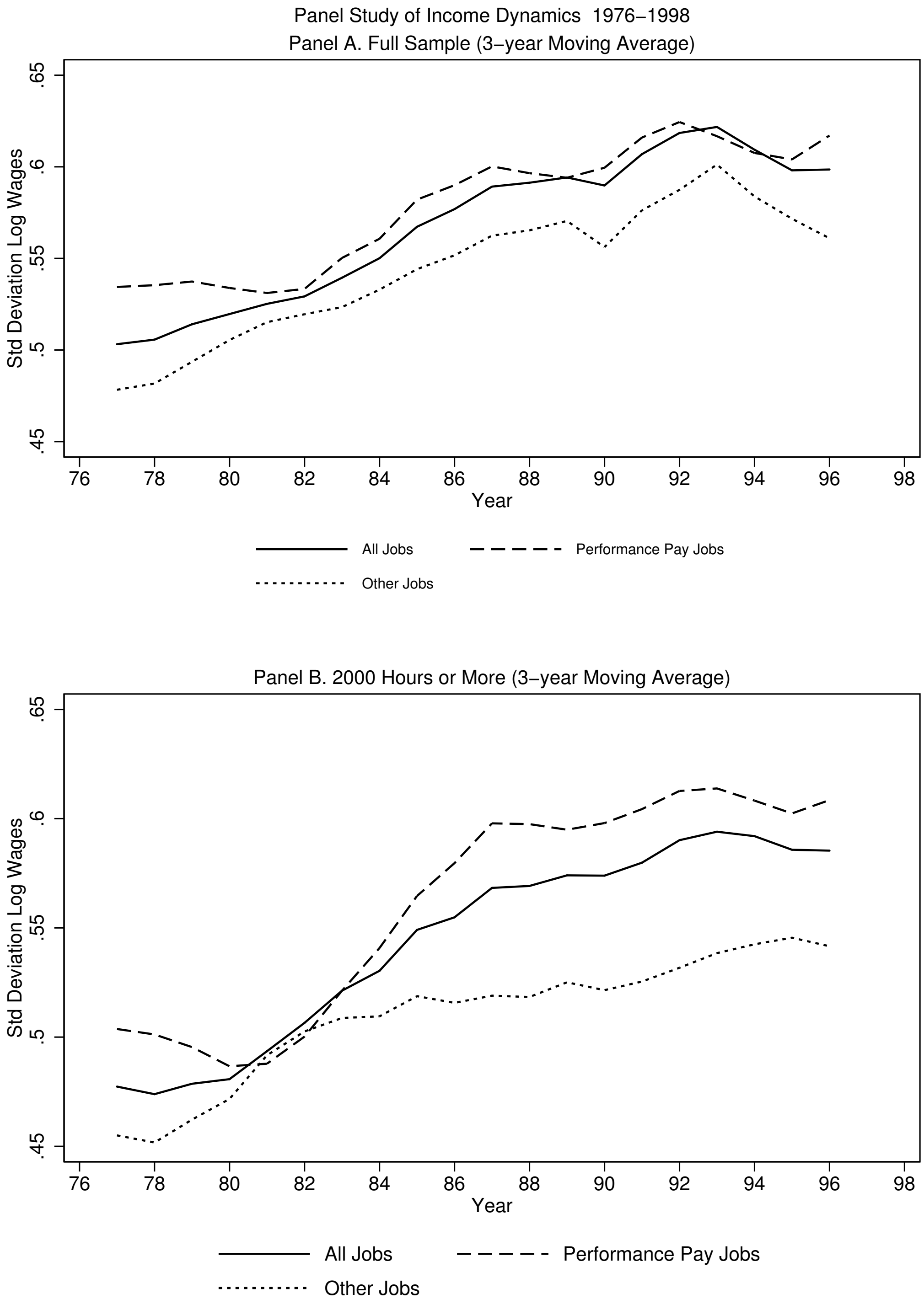
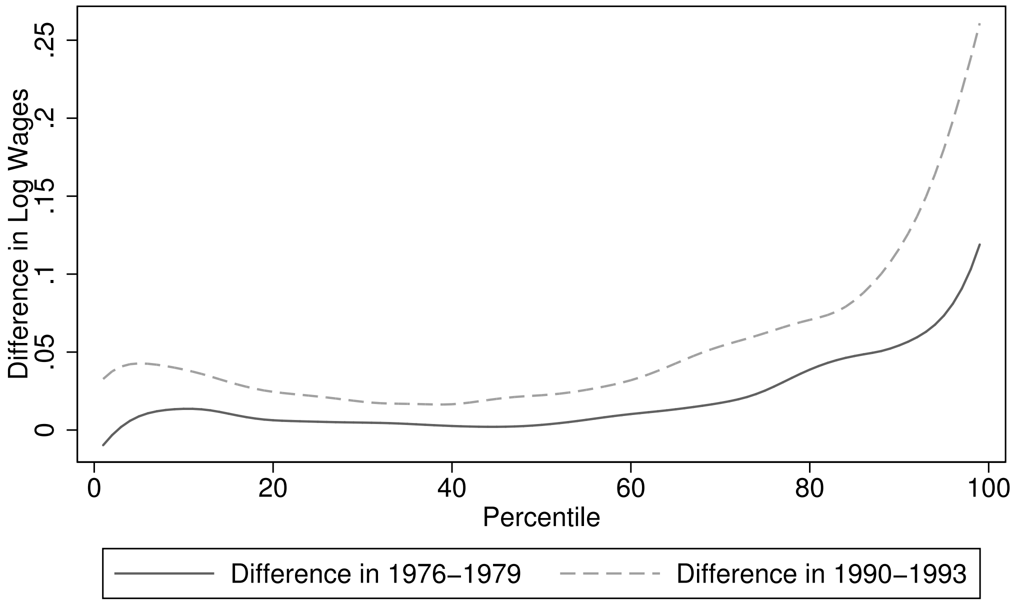
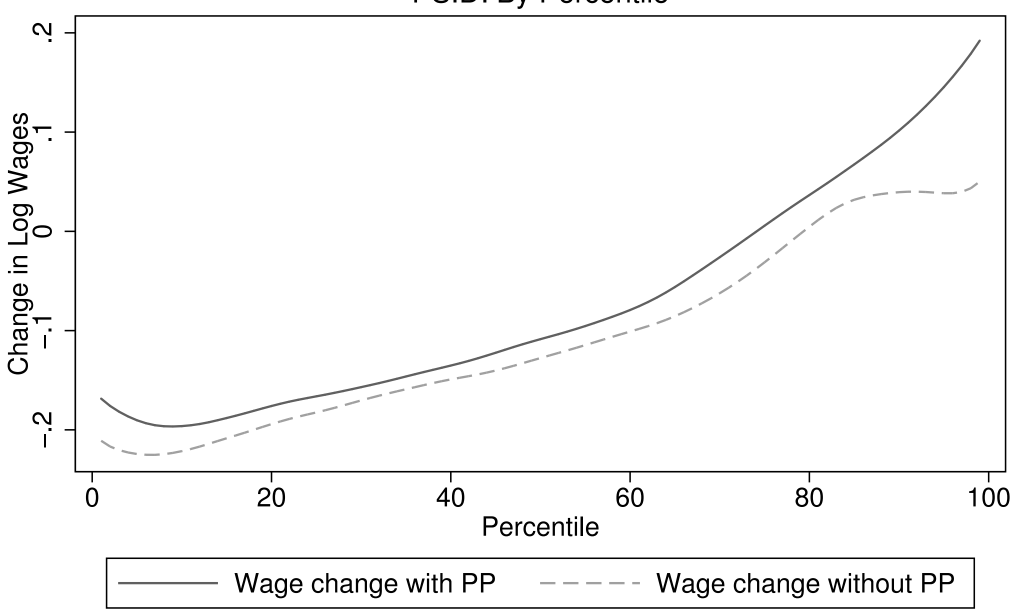


Figure 6. Change Over Time in Differences Between PPJ and Non−PPJ
PSID: By Percentile



Smoothed by Locally Weighted Regression

Figure 7. Change Over Time in Wages by Percentile with and without PPJ
PSID: By Percentile



Smoothed by Locally Weighted Regression

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

	Non Performance Pay Jobs	Performance Pay Jobs
Average Hourly Earnings ($79)	8.39	10.63
Education	12.53	13.32
Potential Experience	18.76	18.81
Employer Tenure	7.61	9.15
Married	0.75	0.78
Covered by CBA	0.28	0.15
Non White	0.13	0.10
Paid by the Hour	0.65	0.32
Paid a Salary	0.32	0.50
Annual Hours Worked	2105.73	2270.46
# workers (Tot:3181)	2790	1449
# Job Matches (Tot: 8631)	6573	2058
# Observations (Tot: 30424)	19125	11299

Notes. 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.

Table 2. Incidence of Performance Pay Jobs by Industry and Occupation, 1976-1998

Industry categories (1 digit)	Occupation categories (1 digit) Professionals	Managers	Sales	Clerical	Craftmen	Operatives	Laborers	Services	Total
Min.& Durables	0.47*	0.64	0.73	0.42	0.27	0.24	0.26	0.18	0.35
	0.08**	0.17	0.46	0.07	0.06	0.05	0.07	0.03	0.08
Non-Durables	0.57	0.67	0.76	0.36	0.29	0.42	0.25	0.08	0.44
	0.13	0.22	0.45	0.10	0.01	0.13	0.03	0.01	0.13
Transpo., Utils	0.31	0.56	0.78	0.32	0.33	0.33	0.30	0.11	0.37
	0.06	0.14	0.35	0.07	0.05	0.15	0.08	0.06	0.10
FIRE	0.74	0.71	0.81	0.33	0.22	0.14	0.16	0.23	0.61
	0.26	0.29	0.66	0.11	0.09	0.01	0.09	0.10	0.33
Bus.,Prof. Serv.	0.34	0.55	0.68	0.37	0.42	0.31	0.10	0.12	0.36
	0.12	0.18	0.31	0.18	0.17	0.04	0.07	0.04	0.13
Personal Serv.	0.31	0.53	0.39	0.10	0.30	0.32	0.07	0.37	0.36
	0.05	0.16	0.39	0.03	0.08	0.03	0.01	0.13	0.11
Whol-Tr.& Oth Serv.	0.58	0.67	0.78	0.43	0.36	0.45	0.31	0.10	0.57
	0.14	0.30	0.49	0.12	0.10	0.14	0.09	0.01	0.27
Retail Trade	0.32	0.57	0.67	0.29	0.44	0.30	0.26	0.31	0.46
	0.10	0.26	0.57	0.08	0.21	0.10	0.09	0.16	0.25
Construction	0.66	0.46	0.64	0.23	0.26	0.17	0.21	0.00	0.29
	0.26	0.17	0.52	0.14	0.08	0.04	0.06	0.00	0.10
Agriculture & Fishing	0.89	0.80	0.79	0.09	0.08	0.31	0.35	0.17	0.38
	0.35	0.25	0.51	0.09	0.04	0.10	0.13	0.01	0.15
Total	0.44	0.60	0.74	0.34	0.31	0.31	0.27	0.22	0.40
	0.11	0.22	0.54	0.09	0.09	0.10	0.08	0.09	0.15

*%Performance Pay Jobs; **%Received either a bonus or a commission/piece rate in a given year.

Table 3. Performance Pay Jobs and Log Average Hourly Earnings
(Standard Errors in Parentheses)

	Specification				
Variable	Levels	Levels	Within-Worker	Within-Worker	Within-Job
Performance Pay Job Dummy	0.0721	0.0324	0.0250	-0.0033	-
	(0.0140)	(0.0153)	(0.0113)	(0.0118)	
Performance Pay Received in Past Year	-	0.1077	-	0.0600	0.0493
		(0.0156)		(0.0085)	(0.0060)
Industry Dummies	Yes	Yes	Yes	Yes	Yes
Occupation Dummies	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes
Number of Obs.: 30,424					

Performance job dummy=1 if either a bonus or commission/piece rate earnings are received at any time during the employment relationship; performance pay received in past year=1 if either a bonus, commissions/piece rates earnings are received in past calendar year. Other covariates are cubic functions of potential experience and tenure, the number of times a job-match is observed, years of completed schooling, calendar year average of the unemployment rate in the county of residence, and dummies for being married, nonwhite, and for union status and region of residence. Standard errors are adjusted for clustering at the job-match level.

Table 4. Skills Related Wage Differentials and Performance Pay Jobs
(Standard Errors in Parentheses)

			Specification	
Variable	OLS-PPJ	OLS-Other Jobs	OLS-Pooled	Fixed-Effects-Pooled
Performance Pay Job Dummy			-0.4366	-0.2318
			(0.0893)	(0.0394)
Years Of Education	0.0926	0.0656	0.0632	0.0238
	(0.0063)	(0.0036)	(0.0036)	(0.0035)
Education X Performance Pay Job			0.0361	0.0177
			(0.0065)	(0.0029)
Potential Experience	0.0093	0.0058	0.0057	-0.0018
	(0.0012)	(0.0007)	(0.0007)	(0.0014)
Experience X Performance Pay Job			0.0039	0.0028
			(0.0013)	(0.0006)
Tenure	0.0049	0.0058	0.0066	0.0074
	(0.0016)	(0.0009)	(0.0009)	(0.0005)
Tenure X Performance Pay Job			-0.0032	-0.0020
			(0.0017)	(0.0008)
Number of Observations	11299	19125	30424	30424

Other covariates are the same as those in Table 3, except for the higher order terms in experience and tenure.

Table 5. Performance Pay Jobs and Interoccupation Wage Differentials
(Standard Errors in Parentheses)

	Specification			
	OLS-PPJ	FE-PPJ	OLS-Other Jobs	FE-Other Jobs
Professionnals	0.000	0.000	0.000	0.000
Managers	0.094	0.083	-0.057	-0.014
	(0.034)	(0.013)	(0.028)	(0.013)
Sales	-0.101	-0.043	-0.200	-0.060
	(0.043)	(0.018)	(0.047)	(0.020)
Clerical	-0.311	-0.040	-0.322	-0.132
	(0.048)	(0.018)	(0.026)	(0.015)
Craftsmen	-0.172	-0.003	-0.216	-0.052
	(0.033)	(0.016)	(0.024)	(0.014)
Operatives	-0.359	-0.039	-0.328	-0.094
	(0.038)	(0.018)	(0.026)	(0.014)
Laborers	-0.365	-0.082	-0.397	-0.114
	(0.054)	(0.025)	(0.031)	(0.017)
Service Workers	-0.362	-0.099	-0.494	-0.176
	(0.052)	(0.029)	(0.030)	(0.018)
Standard Deviation of Occupation Dummies	0.180	0.056	0.167	0.060
Number of Observations	11299	11299	19125	19125

Other covariates are the same as those in Table 4. Standard errors are adjusted for clustering at the job-match level.

Table 6. Error Component Models by Type of Job
(Standard Error in Parentheses)

Panel A: Full Sample

Parameter	Performance Pay Jobs [1]	Performance Pay Jobs [2]	Non Performance Pay Jobs [3]	Non Performance Pay Jobs [4]
Variance of Worker Component	0.103	0.096	0.065	0.052
	(0.001)	(0.003)	(0.001)	(0.001)
Variance of Job-Match Component	-	0.008	-	0.022
		(0.003)		(0.001)
Variance of Residual Term	0.091	0.090	0.112	0.103
	(0.003)	(0.003)	(0.002)	(0.002)
# Workers	1449	1449	2790	2790
# Cross-Products	74976	74976	117983	117983

Panel B: Workers Who Worked in Both Types of Jobs

Parameter	Performance Pay Jobs [1]	Performance Pay Jobs [2]	Non Performance Pay Jobs [3]	Non Performance Pay Jobs [4]
Variance of Worker Component	0.098	0.093	0.058	0.043
	(0.001)	(0.003)	(0.002)	(0.002)
Variance of Job-Match Component	-	0.006	-	0.033
		(0.003)		(0.003)
Variance of Residual Term	0.093	0.092	0.124	0.106
	(0.003)	(0.003)	(0.003)	(0.004)
# Workers	1058	1058	1058	1058
# Cross-Products	41992	41992	26796	26796

Unweighted 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 used in previous tables.

Table 7: Skills Related Wage Differentials and Performance Pay Jobs in the NLSY (Standard Errors in Parentheses)

	1986-88		1996-2000	
Variable	PP jobs	Other jobs	PP jobs	Other jobs
Years of Education	0.0700	0.0550	0.0960	0.0750
	(0.0060)	(0.0030)	(0.0080)	(0.0040)
Potential Experience	0.0470	0.0440	0.0430	0.0280
	(0.0050)	(0.0020)	(0.0040)	(0.0020)
AFQT score (/10)	0.0420	0.0330	0.0530	0.0440
	(0.0050)	(0.0030)	(0.0070)	(0.0030)
Number of Observations	1553	4726	1053	2870

Table 8. The Contribution of Performance Pay Jobs (PPJ) to the Variance of Log Hourly Earnings
PANEL STUDY OF INCOME DYNAMICS

WEIGHTED BY HOURS WORKED, CONTROLLING FOR NUMBER OF TIMES JOB IS OBSERVED

	[1]	[2]	[3]	[4]	[5]	[6]
		1976-1979			**1990-1993**	
Wage Compression/Expansion Between Groups of Workers	Actual Variance	Variance w/o Performance Pay Jobs	Performance Pay Job Effect	Actual Variance	Variance w/o Performance Pay Jobs	Performance Pay Job Effect
	Fraction of PPJ	0.3048		Fraction of PPJ	0.4581	
1. Var(XB | PPJ=1)	0.1302	0.1003	0.0299	0.1935	0.1313	0.0622
2. Var(XB | PPJ=0)	0.0995	0.0995	0.0000	0.1322	0.1322	0.0000
3. Average Between-Group Variance: (%PPJ*row 1 + (1-%PPJ)*row 2)	0.1089	0.0997	0.0091	0.1603	0.1318	0.0285
Wage Compression/Expansion Within Groups of Workers						
4. Var(e | PPJ=1)	0.1434	0.1272	0.0162	0.1823	0.1765	0.0058
5. (Var(e | PPJ=0)	0.1266	0.1266	0.0000	0.1756	0.1756	0.0000
Total Within-Group Variance						
6. Var(e): (%PPJ*row 4 + (1-%PPJ)*row 5)	0.1317	0.1268	0.0049	0.1787	0.1760	0.0027
Wage Gap Effect						
7. %PPJ*(1-%PPJ)*(Δ_hat2 - (Δ_hat - Δ)2)	0.0038	0.0000	0.0038	0.0126	0.0000	0.0126
Overall Variance of Wages						
8. Var(Xb + e): (row 3 + row 6 + row 7)	0.2444	0.2265	0.0179	0.3516	0.3078	0.0438

Change in Overall Variance (col. 4 – col. 1):	**0.1072**
Change in Performance Pay Job Effect (col. 6 – col. 3):	**0.0259**
Share of Performance Pay Job Effect:	**24.17%**

Notes. 1Computations for the counterfactual variances (columns 2 and 5) done using the weighting methodology in DiNardo-Fortin-Lemieux to produce the counterfactual predicted wage for performance pay job workers. Δ_hat2 refers to the squared value of the actual mean difference between performance pay job workers' log wages and non performance pay job workers' while (Δ_hat – Δ)2 is the squared difference between the actual mean difference and the difference in the returns (the B's) across both types of jobs evaluated at the average value of performance pay job workers' X's.

Table 9. Other Measures of Hourly Earnings Dispersion
(PSID)

	1976-79		1990-93	
Gap	Actual	Counterfactual	Actual	Counterfactual
50-10	0.6757	0.6969	0.7712	0.7748
75-50	0.2853	0.2633	0.3935	0.3630
90-50	0.5509	0.5106	0.7509	0.7058
90-75	0.2656	0.2473	0.3574	0.3428
95-90	0.1966	0.1847	0.2336	0.1452
99-75	0.8894	0.7611	1.1126	0.8201
99-90	0.6238	0.5138	0.7552	0.4773
99-95	0.4272	0.3291	0.5216	0.3322

Sample sizes: 5261 for 1976-79 sample and 5665 for 1990-93 sample.

Table A1: Summary Results From Alternative Sample Made of Complete Job Matches
(Standard Error in Parentheses)

Performance Pay Jobs and Log Average Hourly Earnings (Table 3)

	OLS	Within-Worker	Within-Job
Performance Pay Job Dummy	0.0280	-0.0043	-
	(0.0212)	(0.0152)	
Performance Pay Received	0.1229	0.0682	0.0556
in Past Year	(0.0206)	(0.0114)	(0.0084)

Number of Observations: 17540

Skills Related Wage Differentials and Performance Pay Jobs (Table 4)

	OLS-PPJ	OLS-Other Jobs	Fixed-Effects Pooled
Years Of Education	0.0918	0.0589	0.0324
	(0.0083)	(0.0049)	(0.0051)
Education X Performance Pay Job	-	-	0.0177
			(0.0040)
Number of Observations	6183	11357	17540

Error Component Models by Type of Job (Table 6, Panel B)

	Perf. Pay Jobs	Non Perf. Pay Jobs
Variance of	0.102	0.043
Worker Component	(0.005)	(0.003)
Variance of Job-	0.000	0.029
Match Component	(0.005)	(0.004)
# Workers	682	682
# Cross-Products	19682	14233

Contribution of Perf. Pay Jobs (PPJ) to the Variance of Wages (Table 8)

	1976-79	1990-1993
Overall Variance	0.2378	0.3752
Variance w/o Perf. Pay Jobs	0.2262	0.3233
Performance Pay Job Effect	0.0116	0.0519
Change in Overall Variance	0.1374	
Change in Perf. Pay Job Effect	0.0403	
Share of PPJ Effect in	0.2931	
Overall Increase in Variance		

Notes. Covariates are the same as those in the corresponding table for the main sample. Complete job matches are defined as employment relationships in which the maximum tenure level attained by the worker is within one integer of the number of times the job-match is observed in the sample.