The current issue and full text archive of this journal is available at
www.emeraldinsight.com/0143-7720.htm

Who pays for performance?

Erling Barth
Institute for Social Research, University of Oslo, Oslo, Norway and IZA, Bonn, Germany

Bernt Bratsberg
Frisch Centre for Economic Research, University of Oslo, Oslo, Norway and Kansas State University, Manhattan, Kansas, USA

Torbjørn Hægeland
Statistics Norway and Frisch Centre for Economic Research, University of Oslo, Oslo, Norway, and

Oddbjørn Raaum
Frisch Centre for Economic Research, University of Oslo, Oslo, Norway

Abstract

Purpose – The purpose of this paper is to improve our understanding of why some firms tie compensation to worker performance as well as the variation in type of performance pay system across firms.

Design/methodology/approach – The study first presents a theoretical framework that motivates n empirical study of performance-related pay. The data are based on Norwegian establishment surveys from 1997 and 2003. The empirical analysis addresses determinants of adoption of performance pay systems.

Findings – Performance-related pay is more prevalent in firms where workers of the main occupation have a high degree of autonomy in how to organise their work. Performance pay is also more widespread in large firms, but is less common in highly unionised firms and in firms where wages are determined through centralised bargaining. Results show that performance pay is on the rise in Norway, even after accounting for changes in industry structure, bargaining regime, and union density. Finally, it is found that the incidence of performance-related pay relates positively to product-market competition and foreign ownership.

Originality/value – The paper provides new empirical evidence on the use of performance-related pay. The results support an interpretation of incentive pay as motivated by agency problems, and provide new evidence on the relationship between payment schemes and institutions such as unions and bargaining framework.

Keywords Performance related pay, Compensation, Payments, Profits, Norway

Paper type Research paper

1. Introduction

Why do different firms choose different pay schemes? Following the seminal work by Holmström and Milgrom (1987), agency problems are typically cited as the explanation why some firms tie compensation to performance. Consider, for example, the textbook case of Lazear (1995), where output depends on both worker effort and some stochastic

International Journal of Manpower
Vol. 29 No. 1, 2008
pp. 8-29

0143-7720
DOI 10.1108/01437720810861985

This research has received financial support from the Norwegian Research Council, grant no. 150666/510. The authors are grateful to John Dagsvik, Kristine Nergaard, Hege Torp, the Guest Editors of the special issue, and an anonymous referee for helpful comments.

factor. When it is costly or impossible to directly observe effort and sort out the influence of the stochastic factor, the firm may benefit from implementing an incentive pay scheme in order to motivate workers to supply effort. If workers are risk averse, however, the uncertainty associated with the stochastic factor will reduce the merits of incentive-based schemes as more uncertainty imposes a greater risk on workers. This observation has motivated a substantial body of empirical studies that examine whether or not there is a trade-off between risk and use of incentive schemes (see, e.g. the summary in Prendergast, 1999). As emphasised by Prendergast (2002), these studies have by and large not had much success in finding evidence of such a trade-off. Prendergast argues that the lack of clear empirical evidence stems from a failure of the literature to recognise the association between uncertainty and allocation of responsibility. In uncertain settings, firms seek to delegate responsibility to workers. In turn, when responsibility is delegated, firms use incentive pay schemes to constrain worker discretion. This gives rise to a second, and positive, effect of uncertainty on the use of incentives. A prediction is that output-based incentive pay schemes are more likely to be observed when there is considerable employee discretion over work tasks.

In this paper, we investigate the relationship between worker discretion over tasks and the use of performance-related pay. We first develop a simple theoretical framework, focusing on the firm's choice between a fixed pay system where the firm monitors worker effort, and a remuneration scheme with a variable pay component that is proportional to observed individual output. High monitoring costs will induce the firm to transfer authority to its employees and permit worker discretion over what tasks to spend time on. In this case, pay for performance is the optimal remuneration scheme. As in Prendergast's model, an important empirical implication of the framework is that performance-related pay is more likely to be used when worker autonomy over tasks is high. In the empirical analyses, we use data from two Norwegian establishment surveys, from 1997 and 2003, to test the hypothesis of a positive relationship between autonomy of the main occupational group in terms of defining work tasks and the incidence of performance-related pay.

Salas-Fumas (1993) provides an early analysis of the relationship between incentives and supervision with respect to compensation of managers. Using 1998 WERS data, Belfield and Marsden (2003) investigate the relationship between performance pay, monitoring environments, and establishment performance. They argue that it is the combination of pay systems and monitoring environments that drives organisational outcomes. A recent study of performance pay by Foss and Laursen (2005), using Danish establishment data, finds evidence of a positive relationship between delegation and environmental uncertainty. In the present paper, we move on to investigate the relationship between allocation of responsibility and performance-related pay. We also analyse to what extent worker autonomy is associated with different types of performance pay, such as traditional piece rates, profit sharing and group bonuses, and new forms of individual performance-related pay.

In many European countries, including Norway, wage setting has traditionally been dominated by negotiations between worker unions and employer associations. A fixed hourly wage has been the predominant type of pay. Internationally, the empirical literature displays some divergence with respect to the relationship between unionism and the incidence of performance-related pay. While Brown (1990) and Heywood *et al.*

(1997) find less use of performance-related pay in unionised establishments, Booth and Frank (1999) conclude that union status increases coverage of performance pay. Collective bargaining and union influences over decisions may affect the firm's motives for using performance-related pay in several ways. First, if some expectation regarding worker effort is part of the bargaining settlement, unions may reduce monitoring costs simply because it is easier to enforce effort rules using the trade union as a self-disciplining device. Second, union bargaining over wages may act as a rent-sharing device, and thus reduce the motive to provide other high-powered incentives. Third, unions may be expected to oppose performance-related pay schemes if measurement of output is in part left to management's discretion. Unions are likely more supportive of well-defined, and easily measured, piece rates, than of merit pay based on individual assessments using, perhaps, subjective criteria. In our empirical analyses, we therefore distinguish between bargaining levels in order to sort out the effects of bargaining regime and unionism on performance pay.

As observed by Brown (1990), Ortin-Angel and Salas-Fumas (1998), and Parent (2002), among others, there are substantial differences in the use of performance-related pay across industries, institutional settings, and other firm characteristics. In an international comparison, Brown and Heywood (2002, p. 261) find that "combinations of performance pay methods differ by country, and the recent emphasis and growth of such methods is far from uniform". In the empirical analyses, we check whether any trend in the incidence of performance pay in the Norwegian data can be due to changes in industry structure and bargaining institutions by including industry as well as bargaining level and union density at the establishment as explanatory variables in the empirical model.

Two other underlying developments may add to the explanation of trends in use of performance-related pay systems. One development is increased product-market competition, arising both from international integration as well as from deregulation policies. Increased competition in the product market is likely to yield greater uncertainty for the firm, which according to the Prendergast model will trigger more delegation of tasks within the firm and thus greater reliance on performance pay. Increased competition may also create a stronger relationship between effort and profits (Schmidt, 1997; Raith, 2003). In line with this argument, Cuñat and Guadalupe (2005) find stronger performance sensitivity of executive pay with higher product-market competition.

The other development is skill-biased technological change, which adds to the knowledge intensity of production. Brown (1990) argues that in high-skilled jobs, worker output is more sensitive to differences in worker quality compared to jobs requiring less skill. A similar argument applies to effort. Effort-sensitive jobs are more likely to benefit from performance-related pay, particularly in settings where the choice between work tasks is delegated to workers. We thus include measures of product-market competition and the level of human capital at the establishment in the empirical analyses. We also investigate the association between foreign ownership and performance-related pay in order to test the notion that increased globalisation and imported management practices may have boosted the incidence of performance pay in Norwegian establishments.

A significant, although not very large, literature has investigated the relationship between performance-related pay and various measures of establishment performance.

Several papers report from case studies of particular firms (see, e.g. Lazear, 2000; Bandiera *et al.*, 2005), but there are also examples of studies using representative samples of workers, such as Booth and Frank (1999) using BHPS for the UK, and Parent (2002) providing evidence for the USA based on the NLSY. Typically, studies find a positive effect of incentive schemes on firm performance indicators such as wages and productivity. In this study we do not aim at assessing the effect of performance-related pay on establishment performance, but rather at testing hypotheses related to the agency model of the choice of method of pay.

It is worth noting that a positive relationship between performance-related pay and performance indicators is consistent with both the agency model of Holmström and Milgrom (1987) and the selection model of Lazear (1995, 2002). In our view, the agency and selection models do not represent competing explanations of performance pay, but rather separate mechanisms that are likely to be present in the labour market at the same time. Evidence in favour of one of these models cannot be used as evidence against the other. While we provide a test of the agency model, our data do not permit a good test of the merits of the selection model.

In the next section we present a simple theoretical model for the firm's choice between fixed and performance-related pay schemes. Section 3 presents our data, while results are reported in Section 4. The final section concludes.

2. Theoretical background

We present a simple theoretical framework as a basis for the discussion of why pay systems differ across firms. By relating compensation to an output-based performance measure, the firm gives workers incentives to supply effort. When the performance measure is subject to shocks, the firm has to compensate risk-averse workers. Our starting point is a simple setting along the lines of Lazear (1995, Ch. 2). The firm chooses one of two pay systems. With performance-related pay, the remuneration of a worker consists of fixed component and a share of firm revenues, as in the Holmström and Milgrom (1987) model. With a fixed-pay system, the total pay is independent of revenues (i.e. the worker share is zero). Effort is unobservable unless the firm implements a costly monitoring technology. Output is assumed to be observable. With performance-related pay, the firm exploits the incentives embedded in revenue sharing to raise effort, while monitoring is used under fixed pay to ensure that the worker supplies a given level of effort. Our focus is on the firm's choice: which pay scheme – fixed pay (FP) or performance-related pay (PRP) – maximises expected profits?

Technology and market conditions are the simplest possible, with worker i's contribution to revenues equal to the value of her observable skills (α_i), effort (e_i), and the outcome of a random event (ε_i);

$$y_i = \alpha_i + e_i + \varepsilon_i,\ \varepsilon_i \sim N\left(0, \sigma^2\right). \tag{1}$$

With PRP, workers are paid a fixed wage, w_i, and a "bonus." To reward effort, the performance-related bonus is set proportional to the worker's observed contribution to revenues (net of the observable skill component, α_i), i.e. the bonus equals $b(e_i + \varepsilon_i)$. The firm cannot, without costs, distinguish between effort and (bad) luck.

Instead of PRP, the firm may choose FP and invest in some monitoring technology to verify that workers supply a desired level of effort, $\bar{e} > 0$. To simplify the exposition,

we assume that this effort level is the same for all workers in the firm. Monitoring costs, M, are given by:

$$M = M(\bar{e}) = n\lambda\bar{e}, \tag{2}$$

where n is the number of workers and $\lambda > 0$. Higher effort requires more intensive monitoring and λ reflects the marginal monitoring cost per worker.

Ex post worker utility is given by:

$$U_i = -\exp\left\{-a\left[w_i + b(e_i + \varepsilon_i) - c(e_i)\right]\right\}, \tag{3}$$

where a reflects the level of worker risk aversion, w_i denotes the fixed wage component, $b \geq 0$, and costs of supplying effort in money terms are given by:

$$c(e_i) = \frac{e_i^2}{2p_i},\ p_i > 0. \tag{4}$$

When ε_i is drawn from a normal distribution, expected utility is given by:

$$E(U_i) = -\exp\left[-a\Phi_i\right],\ \text{where}\ \Phi_i = w_i + be_i - c(e_i) - \frac{1}{2}\,b^2 a\sigma^2. \tag{5}$$

Effort costs may be influenced by both job characteristics and individual talent. The parameter $1/p_i$ is the slope of the marginal cost function of supplying effort. A high p_i may reflect talent or ability, implying that additional revenue requires little extra effort on part of the worker. Effort costs (or, rather, the value of p_i) can also be determined by the particular task or job to be done. For simplicity, we will ignore worker heterogeneity and assume that effort costs are the same for all workers within a given firm. (Hence we drop the subscript in the following.) These costs may, however, differ across firms according to the type of production. Some firms have tasks where workers easily (i.e. high p) can increase output through extra effort (e.g., by reducing duration of breaks, work longer hours, do extra work at home, etc.). Other firms have jobs with less scope to do so.

With PRP, the optimal effort (e^*) is chosen independently by each worker and determined by equality between marginal return and marginal cost of effort, i.e. $b = e^*/p$. To retain workers in the firm, total pay must match opportunities elsewhere. Again ignoring worker heterogeneity, we write the outside option, X, for an individual worker as given by:

$$X = \gamma\frac{1}{2}\,p + \alpha,\ \gamma \geq 0. \tag{6}$$

When effort costs reflect ability, the parameter γ captures that the outside option is more favorable for more productive workers. When p reflects job characteristics, γ will be low since these are specific to the actual worker-firm match. Observable skills, α, also affect outside options. According to equation (6), the outside option is thus assumed to be increasing in both "effort productivity" and observable skills.

We consider a profit-maximising firm that determines its wage policy by comparing the two alternatives. With performance-related pay, the firm decides on the fixed wage component and the share parameter. The share parameter is set to give the correct

incentives for workers to provide effort and the fixed wage component is set to match outside options. With a fixed pay system, the firm invests in a monitoring technology, sets an optimal "effort standard," and fixes the wage level to ensure that worker utility matches that of the outside option.

Performance-related pay
With PRP, the firm's expected profits are given by:

$$\mathrm{E}\left(\Pi^{\mathrm{PRP}}\right) = n\left[e(1-b)+\alpha\right] - nw, \tag{7}$$

which the firm maximises with respect to b and w, subject to:

$$\Phi = X \text{ (individual outside option)} \tag{8a}$$

$$e^{*} = bp \text{ (individual optimal effort)}. \tag{8b}$$

It is straightforward to show that, with PRP, the optimal wage policy will be given by:

$$0 < b^{*} = \frac{p}{p + a\sigma^{2}} < 1, \tag{9}$$

similar to Holmström and Milgrom (1987) and Lazear (1995), and that compensation becomes:

$$W^{\mathrm{PRP}} = w + b^{*}e + b^{*}\varepsilon = \frac{b^{*2}}{2}\left(p + a\sigma^{2}\right) + b^{*}\varepsilon + X. \tag{10}$$

The optimal share parameter, b^{*}, is decreasing in a (degree of risk aversion), σ^{2} (variance of random shocks that separate effort from observed production), and $1/p$ (slope of marginal effort costs). The worker receives her outside option, a share of the random event, and is compensated for the risk associated with PRP as well as the (optimal) effort supplied. The expected firm profits are then given by:

$$\mathrm{E}\left[\Pi^{\mathrm{PRP}}\right] = \frac{n}{2}\left(b^{*} - \gamma\right)p. \tag{11}$$

Fixed pay
With FP, the expected profits of the firm are given by:

$$\mathrm{E}\left(\Pi^{\mathrm{FP}}\right) = n(\bar{e} + \alpha) - nw - n\lambda\bar{e} \tag{12}$$

which are maximised with respect to $\bar{e}$ and W, subject to:

$$\Phi = X \text{ (individual outside option)}. \tag{13}$$

It follows directly from the first-order conditions that the optimal common effort level is determined by:

$$\frac{\bar{e}}{p} = 1 - \lambda, \tag{14}$$

where the marginal effect of increased effort on revenues net of monitoring costs (i.e. $1 - \lambda$) is equal to the marginal cost of supplying effort ($\bar{e}/p$). Pay is given by the fixed wage, determined by the outside option constraint ($\Phi = X$):

$$W^{\mathrm{FP}} = \frac{\bar{e}^{\,2}}{2p} + X. \tag{15}$$

The FP wage is the sum of the outside option and a compensation for the effort costs associated with the common effort level. The firm's expected profits are given by:

$$E\left(\Pi^{\mathrm{FP}}\right) = \frac{n}{2}\left[(1 - \lambda)^2 - \gamma\right]p. \tag{16}$$

The optimal wage policy

Comparing the two alternative pay regimes, it is straightforward to show that:

$$E\left(\Pi^{\mathrm{PRP}}\right) > E\left(\Pi^{\mathrm{FP}}\right) \Leftrightarrow b^* > (1 - \lambda)^2 \text{ or } e^* > (1 - \lambda)\bar{e}. \tag{17}$$

Profits under PRP are higher if and only if the optimal effort supplied individually by workers is higher than the optimal common effort level, net of monitoring costs, set by the firm in the FP regime. It follows that there exists a critical value of marginal monitoring cost, $\tilde{\lambda} > 0$, where the firm chooses PRP when $\lambda > \tilde{\lambda}$. This critical value is determined by risk aversion, effort costs, and the dispersion of productivity shocks:

$$\tilde{\lambda} = 1 - \sqrt{\frac{p}{p + a\sigma^2}}. \tag{18}$$

Note that the choice of pay system is independent of outside options (α and γ).

The predictions of the model can be summarised as follows. According to equation (18), PRP is more likely when:

- the marginal cost function of effort is flat (p is high);
- marginal monitoring costs per worker are high (λ is high)[1];
- worker risk aversion is low (a is low $\Rightarrow$ b^* is large $\Rightarrow$ e^* is high); and
- there is little noise in the output signal ($\sigma^2 \to 0 \Rightarrow b^* \to 1 \Rightarrow e^*$is high).

We have no direct empirical counterparts to the parameters in the theoretical model, but the theory predicts several patterns to be expected in the data. In firms where employees perform their tasks autonomously, monitoring costs are likely to be high and the prevalence of performance-related pay is high. Individual pay for performance is more likely when output is highly sensitive to variations in effort. In light of our model, where revenues equal efforts (plus shocks and observable skills), high sensitivity with respect to effort can be interpreted in terms of low effort costs (a high p), as an increase in effort costs will be associated with a large increment in revenues. If the productivity of a high-skilled worker is particularly sensitive to effort, we would

expect a greater propensity of performance pay in firms with many high-skilled workers. High-skilled employees typically perform individual or autonomous tasks that add to the attractiveness of a performance-pay scheme. We extend this discussion about theoretical predictions when we present our empirical results in section 4.

3. Data sources, samples, and variable construction

The core of our data material consists of the Norwegian Flexibility Survey from 1997 and the Norwegian Work and Establishment Survey from 2003. Both surveys were carried out as computer assisted telephone interviews with either the manager or the chief personnel officer of the establishment. In both surveys, random, but stratified (with respect to establishment size, age and sector), samples were drawn from the population of Norwegian establishments with more than ten employees.

The survey instruments included questions concerning standard establishment characteristics, their main products and markets, employees, recruitment and training practices, use of external labour, compensation policies and wage determination, employer-employee cooperation, etc. Questions concerning employees typically related to the "main occupational group" at the establishment[2]. In addition, the survey data were matched with detailed data about the establishment and all its employees taken from various administrative registers. The register data are annual and cover the period 1995-2003.

The response rates of the surveys were 76 per cent in 1997 and 77 per cent in 2003. The net samples consist of 2,130 establishments in 1997 and 2,358 in 2003. Of these, 1,154 establishments are represented in both surveys. In the present study, we focus on the private sector. This leaves us with 1,556 establishments with valid data on key variables in 1997 and 1,426 in 2003. Of these, 775 establishments are represented in both surveys.

Performance-related pay

Both establishment surveys contained questions about performance-related pay. Unfortunately, these questions were not identical in the two surveys. In 1997, respondents were asked whether or not "the main occupational group receives any pay through incentive pay systems, bonuses, or profit sharing?" In 2003, the survey instrument instead included separate questions about six different forms of performance-related pay:

(1) A: individual and group piece-rates.

(2) B: commissions.

(3) C: group bonuses.

(4) D: profit sharing.

(5) E: individual bonuses.

(6) F: individual performance assessments.

Respondents were also asked to estimate the share of total wages associated with each type of performance pay.

It seems reasonable to assume that respondents who in 2003 answered affirmative on the use of at least one the five former pay types (A-E) would have answered "yes" to the 1997 question. It is not obvious, however, how establishments with type F,

"individual performance assessments," would have interpreted the 1997 question. In addition, it is not clear whether the answers refer to permanent or variable elements of compensation. In the empirical analyses, we therefore use three alternative definitions of performance-related pay in 2003:

(1) *Strict definition*. Answered "yes" on at least one of the types A-E.

(2) *Medium definition*. Answered "yes" on at least one of the types A-F. If "yes" on F only, its share of total wages must be at least 3 per cent.

(3) *Wide definition*. Answered "yes" on at least one of the types A-F.

In the next section, we also report results from analyses based on 2003 data where we distinguish between different types of performance pay, classifying types A and B as "Traditional schemes," C and D as "Group-based schemes," and E and F as "Individual-based schemes."

Other important firm characteristics

Among other questions, managers were asked to what extent (very large, large, some, or no) employees are free to organise their own work. If the answer is large or very large, we classify the establishment as having a high degree of employee autonomy (dummy variable). The exact wording of the response categories of the autonomy question was, however, not completely identical in the two surveys.

We define the establishment as an export establishment if the manager reports their main product market to be outside of Norway. Similarly, the establishment is defined as being exposed to high product market competition if the manager states that the degree of competition is "very large" or "quite large," as opposed to "quite small" or "very small."

We also use information from the manager interview about wage determination at the establishment; whether or not workers in the main occupational group are covered by individual or collective agreements, and whether or not collective agreements are negotiated at the central or local level, or both. We collect information about the union density at the establishment from the manager surveys. If not available in the survey data, we computed densities from data on individual payments of union membership dues identified through registers and aggregated to establishment level.

It should be noted that information on foreign ownership is not available in 1997. In the estimations, we therefore impute the 1997 value using 2003 data for the establishments that are observed both years. For the other establishments, we set the variable to zero, and include a dummy variable indicating that information on foreign ownership is missing.

Our sample is restricted to the private sector. Because of the reorganisation of former government monopolies, establishments within postal services and the national telecommunications company (Telenor) were classified as belonging to the public sector in 1997 and to the private sector in 2003.

Table I shows summary statistics for our sample, separately by year and by use of performance-related pay. Except for workforce characteristics and union density, all variables are dummy variables; hence the numbers reflect the share of establishment observations with this characteristic. The table shows that the share of firms with performance-related pay is around 43 per cent in the 1997 sample. In 2003, the share is 46, 55, or 61 per cent, depending on how we define performance-related pay. The

Table I.
Sample descriptive statistics, by year and use of performance-related pay

	1997 (1)		2003 (2)		Establishments without performance pay (3)		Establishments with performance pay (4)	
	n	SD[b]	*n*	SD[b]	*n*	SD[b]	*n*	SD[b]
Performance pay	0.4274							
Strict definition 2003			0.4642					
Medium definition 2003			0.5533					
Wide definition 2003			0.6115					
Autonomy	0.7185		0.5891		0.6348		0.6795	
Exports	0.1909		0.1971		0.1675		0.2215	
High competition	0.8824		0.8219		0.8109		0.8982	
Foreign ownership [a]	N/A		0.2454		0.1837		0.2953	
Fewer than 20 employees	0.2012		0.1879		0.2225		0.1657	
Share college	0.1980	0.1923	0.2129	0.2256	0.1927	0.2005	0.2182	0.2168
Share females	0.3650	0.2667	0.3607	0.2678	0.3896	0.2781	0.3350	0.2522
Share part-time	0.1930	0.2324	0.1919	0.2373	0.2226	0.2451	0.1608	0.2189
Individual bargaining (omitted)	0.2365		0.1732		0.1492		0.2662	
Local union bargaining	0.5360		0.6017		0.5661		0.5688	
Central union bargaining	0.2275		0.2251		0.2847		0.1651	
Union density	0.5070	0.3560	0.5507	0.3738	0.5735	0.3624	0.4800	0.3726
Oil, mining, energy	0.0212		0.0372		0.0190		0.0392	
Non-durables (omitted)	0.1887		0.1585		0.1957		0.1506	
Durables	0.1497		0.1417		0.1420		0.1499	
Construction	0.0733		0.0673		0.0445		0.0977	
Wholesale	0.1317		0.0968		0.0753		0.1568	
Retail, hotels, restaurants	0.1703		0.1438		0.1747		0.1396	
Transportation	0.0630		0.0659		0.0897		0.0378	
Post and telecom	0		0.0344		0.0229		0.0096	
Finance and real estate	0.0315		0.0323		0.0295		0.0344	
Business services	0.1041		0.1262		0.0818		0.1492	
Health and social services	0.0386		0.0477		0.0700		0.0144	
Education, personal service	0.0289		0.0484		0.0550		0.0206	
2003 observation	0		1		0.4169		0.5426	
Observations	1,556		1,426		1,528		1,454	

Note: [a] Foreign ownership not available in 1997 sample; means in columns (3) and (4) refer to 2003 sample; [b] For continuous variables. In (3) and (4), establishments are classified according to the medium 2003 definition of performance-related pay

fraction of establishments with high employee autonomy is lower in 2003 than in 1997. This may reflect differences in wording of the question in the two surveys. What is clear from the table is that worker autonomy is more prevalent among establishments with performance-related pay. Establishments with performance-related pay tend to be larger, have higher shares of college-educated workers, and have lower shares of female and part-time workers.

Interestingly, union density and the incidence of local bargaining is higher in the 2003 sample than in the 1997 sample. Firms with performance pay have lower union densities and are less likely to set wages through centralised bargaining only. In Figure 1, we display the sample proportions of performance-related pay for each bargaining regime, separately by year. The figure shows the same pattern across bargaining regimes as in the table, with less performance pay the more centralised bargaining. Importantly, the figure also illustrates that the use of performance-related pay increased between 1997 and 2003, regardless of the type of wage-setting regime[3].

4. Empirical results

Changes in the use of performance pay

We begin the empirical analysis with a closer examination of trends in performance pay over the sample period. A first look at the data indicates that the use of performance-related pay in the private sector of Norway increased from 1997 to 2003. Table II, panel A, shows that this conclusion holds regardless of which definition of performance-related pay we use in the 2003 data. Using the strict definition, the increase is 3.7 percentage points. Using the medium or wide definition, the increase is 12.6 or 19.4 percentage points, respectively.

As was evident in Table I and Figure 1, however, there are large differences in the use of performance-related pay across industries and wage bargaining regimes. Changes over time in industry structure and wage bargaining regimes might therefore explain the observed changes in use of performance-related pay. To address this issue, we also include industry dummies and information on wage bargaining regimes in the

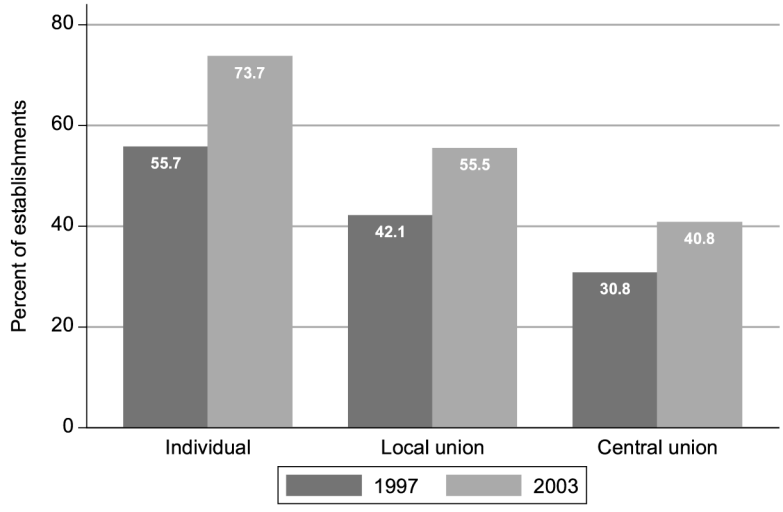

Figure 1.
Performance pay by bargaining regime

Table II.
Incidence of performance-related pay 1997 and 2003, pooled cross-section probit regressions

	Strict definition		Medium definition		Wide definition	
	n	Standard errors	*n*	Standard errors	*n*	Standard errors
A. Specification 1 (only 2003 dummy)						
2003 observation	0.0369**	0.0182	0.1259***	0.0182	0.1841***	0.0180
Pseudo-R^2	0.0010		0.0115		0.0246	
Log likelihood	−2,046.8		−2,042.4		−2,014.7	
Chi-squared (1)	4.1		47.3		101.6	
p-value	0.0431		0.0000		0.0000	
B. Specification 2						
2003 observation	0.0686***	0.0191	0.1615***	0.0191	0.2202***	0.0189
Local bargaining	−0.0577*	0.0298	−0.0614**	0.0304	−0.0653**	0.0307
Central bargaining only	−0.1469***	0.0314	−0.1813***	0.0321	−0.2100***	0.0325
Union density	−0.0858***	0.0323	−0.0950***	0.0327	−0.1012***	0.0329
Oil, mining, energy	0.1041*	0.0586	0.2217***	0.0534	0.2134***	0.0524
Durables	0.0402	0.0328	0.0632*	0.0328	0.0632*	0.0327
Construction	0.2453***	0.0388	0.2294***	0.0378	0.2058***	0.0375
Wholesale	0.2062***	0.0365	0.1889***	0.0359	0.1735***	0.0356
Retail, hotels, restaurants	0.0097	0.0361	0.0286	0.0365	0.0341	0.0365
Transportation	−0.1287***	0.0414	−0.1544***	0.0426	−0.1670***	0.0434
Post and telecom	−0.2490***	0.0617	−0.1895**	0.0699	−0.1176	0.0743
Finance and real estate	0.1127**	0.0568	0.1141**	0.0563	0.1337**	0.0552
Business services	0.1556***	0.0374	0.1626***	0.0367	0.1614***	0.0362
Health and social services	−0.3332***	0.0345	−0.2979***	0.0420	−0.2893***	0.0449
Education, personal services	−0.2219***	0.0449	−0.2073***	0.0489	−0.1430***	0.0530
Pseudo-R^2	0.0834		0.0919		0.1016	
Log likelihood	−1,878.0		−1,876.2		−1,855.7	
Chi-squared (15)	341.7		379.7		419.7	
p-value	0.0000		0.0000		0.0000	

Notes: There are 2,982 observations. The table lists estimated marginal effects on the probability of performance pay. Models are estimated using the "dprobit" command in Stata 9 (StataCorp, 2005). For continuous variables, the marginal effect is evaluated at the mean values of explanatory variables. For dummy variables, the marginal effect is computed as the increment in probability from a discrete change, holding other explanatory variables constant at their mean value. Reference groups are non-union bargaining and non-durables manufacturing; * Statistically significant at the 0.10 level; ** at the 0.05 level; *** at the 0.01 level

probit regressions (see Table II, panel B). Controlling for such factors, we find that the increase in the use of performance-related pay is even stronger than what the changes in unconditional averages tell us. As in panel A, the estimated change in the use of performance-related pay from 1997 to 2003 depends on which definition we use in the 2003 data. The estimated increase is 6.9, 16.2 or 22.0 per cent, if we use the strict, medium or wide definition, respectively.

These empirical patterns imply that changes in industry structure and wage bargaining regimes actually contributed to a decline in the use of performance-related pay in the period from 1997 to 2003. As Table I revealed, union density increased over the sample period. There has also been and an increase in collective agreements with local bargaining at the expense of regimes without collective agreements. Using the numbers for 1997 and 2003 from Table I and the coefficients for the medium definition in Table II, we find that changes in unionisation and wage bargaining regimes contributed to a decline of 0.8 percentage point in the period. Similarly, changes in industry structure contributed to a decline of 1.7 percentage points.

The impact of bargaining regime on the incidence of performance-related pay appears substantial. Establishments with central bargaining only are less likely to have performance-related pay; using the middle definition, the probability of performance pay is 21 percentage points lower than in establishments with individual agreements only. In establishments where there is local collective bargaining, the probability is around six per cent lower than in firms without any collective agreement. Even conditional on wage bargaining regime, the use of performance-related pay is lower in establishments with a high share of unionised employees. Using the medium definition, an increase in the union membership rate of 50 percentage points reduces the probability of performance-related pay by 4.8 percentage points.

There are also significant differences in the use of performance-related pay across industries. Construction, wholesale trade, oil, mining and energy, and business services are the industries where performance pay is most prevalent. Private-sector health services, education, transportation, and post and telecommunications have the smallest incidences. However, the picture varies somewhat with respect to definition of performance-related pay. For example, the oil, mining and energy industry appears to have relatively more performance pay if we apply the medium or wide definition rather than the narrow definition. Thus, individual performance assessments appear to be an important form of performance pay in the oil industry. The same applies to the post and telecommunications industry. The indication is that there may be substantial differences across industries, not only with respect to the prevalence of performance pay, but also what type of performance pay they use. We return to this issue towards the end of this section.

Determinants of performance-related pay

Having established that there has been an increase in the use of performance-related pay in recent years in Norway, even within industries and wage-bargaining regimes, we now turn to the determinants of use of performance-related pay. A clear prediction from the theoretical framework is that when it is costly to observe worker effort and workers have autonomy over tasks, establishments are, all else equal, more likely to choose performance-related pay. We extend the model specification from Table II by adding further establishment characteristics to the list of explanatory variables.

Because we now are concerned with the statistical strength of relationships between firm characteristics and performance pay, we use a random-effects probit model to account for the fact that an establishment may contribute two observations to the pooled sample. The random effect will capture any serial correlation of error terms from the same establishment. Estimation is based on the "xtprobit" command in Stata 9; see StataCorp (2005) for details on the likelihood function and numerical algorithm. Table III presents separate estimation results for the three alternative definitions of performance-related pay.

Consistent with the theoretical model, we find that establishments where employees have a high degree of autonomy in organising their own work are significantly more likely to have performance-related pay. In firms with a high degree of worker autonomy, it may be more costly to monitor worker effort; hence they are more likely to use performance pay. The difference in probabilities of performance pay between firms with "high autonomy" and "low autonomy" ranges from 4.7 to 6.9 percentage points, depending on the exact 2003 definition of performance-related pay.

Product market conditions appear to be important for the choice between fixed or performance-related pay. Firms that face high competition in their product markets or export their main product have significantly higher incidences of performance-related pay than other firms. Firms that are exposed to competition in the product market may need to have a stronger focus on productivity than firms with market power. This may be an explanation of why performance pay is more common in such firms.

Foreign ownership is positively related to the use of performance pay, even after controlling for bargaining regime as well as product-market competition and production for export markets. The estimated effect is strongest when we use the strict definition (11.3 percentage points) and smallest if we use the wide definition of performance pay (6.2 percentage points). The finding is consistent with the notion that performance-related pay might be a management practice imported from abroad[4].

It is also interesting to note that performance-related pay is much less common in smaller establishments. In small firms, it is easier, all else equal, to observe how hard individual employees work, i.e. it is cheaper to implement a monitoring technology and choose fixed pay, than in large firms. Consequently, a lower incidence of performance pay in small establishments is consistent with the main prediction from the theoretical model. Relative to larger firms (20 or more employees), we find that smaller establishments are 14-15 percentage points less likely to use performance-related pay schedules.

Looking at employee characteristics, the only finding that is statistically significant across all definitions is that performance-related pay is less common in establishments with a high share of part-time employees. A 10 percentage point increase in the share of part-time workers is associated with a 3 percentage point lower probability of performance-related pay. Certain types performance-related pay can be more difficult to implement when there are large differences between employees with respect to hours worked. In terms of the theoretical model, in firms with a large part-time workforce, random events may contribute to a larger part of the variation in output and consequently the effort under the optimal sharing rule will be lower than under fixed pay (with monitoring).

In the theoretical model, the costs of supplying effort (determined by p) play a central role. In some jobs it is easier, and less costly, to increase effort in a way that

Table III.
Determinants of use of performance-related pay; random-effects probit regressions

	Strict definition		Medium definition		Wide definition	
	n	Standard errors	*n*	Standard errors	*n*	Standard errors
Autonomy	0.0471 *	0.0267	0.0628 **	0.0265	0.0688 ***	0.0257
Exports	0.1131 ***	0.0359	0.0914 ***	0.0347	0.0921 ***	0.0330
High competition	0.1254 ***	0.0349	0.1206 ***	0.0356	0.1054 ***	0.0350
Foreign ownership	0.1135 ***	0.0368	0.0826 **	0.0354	0.0622 *	0.0337
Fewer than 20 employees	−0.1532 ***	0.0313	−0.1523 ***	0.0318	−0.1378 ***	0.0312
Share of employees with college education	−0.0307	0.0747	0.0603	0.0737	0.1286 *	0.0710
Share females	0.0710	0.0713	0.0859	0.0695	0.1139 *	0.0664
Share part-time	−0.2929 ***	0.0808	−0.3148 ***	0.0790	−0.2875 ***	0.0748
Local bargaining	−0.0686 *	0.0396	−0.0671 *	0.0393	−0.0635 *	0.0379
Central bargaining	−0.1639 ***	0.0415	−0.1911 ***	0.0424	−0.2117 ***	0.0416
Union density	−0.1542 ***	0.0438	−0.1568 ***	0.0431	−0.1535 ***	0.0412
2003 observation	0.0969 ***	0.0273	0.2127 ***	0.0277	0.2756 ***	0.0271
rho	0.4022 ***		0.3549 ***		0.2954 ***	
Log likelihood	−18,060.9		−18,120.8		−17,990.9	
Chi-squared (25)	2,270.4		2,440.8		2,720.4	
p-value	0.0000		0.0000		0.0000	

Notes: The sample consists of 2,982 observations of 2,207 establishments. The table lists estimated marginal effects on the probability of performance pay. Models are estimated using the "xtprobit" command in Stata 9 (StataCorp, 2005). "rho" denotes the proportion of the overall error variance that is attributed to the establishment components. See note to Table 2 for calculations of marginal effects. Regressions also include indicators for industry as well as an indicator for missing data on foreign ownership; * Statistically significant at the 0.10 level; ** at the 0.05 level; *** at the 0.01 level

increases output than in others. This will typically be in jobs where discretion over tasks is high. Following Brown (1990), it is likely that the productivity of high-skilled workers is more sensitive to effort, either because of their inherent or acquired characteristics or because they are assigned to jobs where it is easier to influence output through effort. This should imply a higher incidence of performance-related pay in establishments with a large share of highly educated workers. Table III reveals a mixed picture. We find a positive and weakly significant effect only when we use the wide definition of performance-related pay, where we include individual performance assessments even when they have a minor impact on total wages.

The results with respect to bargaining regime and union density uncovered in Table II hold even when we include more establishment characteristics: the further away from the individual level wages are set, and the higher the union density, the smaller is the incidence of performance pay. Unions may have preferences against high wage inequality, also within firms. If performance-related pay results in greater wage inequality within firms, as found in Barth *et al.* (2006), and unions have some influence on the choice of pay system, this may explain the negative association. Unions are also likely to oppose wage systems that leave parts of the performance assessment at the discretion of management. Further, wage bargaining may act as a substitute for performance-related pay, as local bargaining may act as a profit sharing device. From the theoretical model, we find that more risk-averse employees imply less performance pay. If membership in a trade union is perceived as insurance against fluctuating wages, a high union density may reflect that workers in the firm on average are more risk averse. The theoretical framework predicts that increased risk aversion will raise the compensation for the uncertainty embedded in performance pay systems and thereby make fixed pay relatively more favourable to the firm. It is also likely that unions effectively reduce costs of monitoring effort. In a bargaining context, unions may share the interest of the employer in terms of monitoring effort of workers, and unions may have more efficient means of policing effort through peer control, group pressure, etc.

In the estimations in Table IV, we also control for industry. The results are very similar to those in Table III, and are not reported in the table.

Traditional, group-based, and individual-based forms of pay

So far we have only discussed the determinants of use of performance-related pay in general. However, the discussion of results using the three alternative definitions indicated that there may be important differences in the effects of firm characteristics across types of performance pay. As the 2003 survey separated between several different types of performance pay, we are also able to study how different establishment characteristics influence the choice of specific forms of performance pay. Table IV reports the results from analyses where we distinguish between "traditional" (i.e. piece rates and commissions), "group-based" (profit sharing and group bonuses), and "individual-based" (individual bonuses and performance assessments) performance pay schemes. Because firms can combine two or more forms of performance pay, regression errors are likely correlated across equations. In order to account for any cross-equation correlation of regression errors, we base estimates on multivariate probit regressions. For this purpose, we employ the simulated maximum estimator developed by Cappellari and Jenkins (2003) in their Stata "mvprobit" module.

Table IV.
Determinants of use of traditional, group-based, and individual-based forms of performance pay; multivariate probit regressions

	Traditional (1)		Group (2)		Individual (3)	
	n	Standard errors	*n*	Standard errors	*n*	Standard errors
Autonomy	0.0626	0.0994	0.1076	0.0796	0.2537***	0.0782
Exports	0.0515	0.1365	0.0900	0.1028	0.0185	0.1026
High competition	0.3881**	0.1544	0.2322**	0.1112	0.1042	0.1026
Foreign ownership	0.1891*	0.1072	0.2471***	0.0850	0.1062	0.0854
Fewer than 20 employees	−0.2184*	0.1304	−0.2365**	0.1038	−0.2925***	0.1009
Share of employees with college education	−1.5292***	0.2984	−0.1704	0.2084	0.7146***	0.1974
Share females	0.1627	0.2525	0.3197	0.2096	0.1857	0.1989
Share part-time	0.0223	0.2847	−1.0184***	0.2517	−0.5961***	0.2277
Local bargaining	0.2269	0.1548	−0.2048*	0.1228	−0.1046	0.1184
Central bargaining	0.0120	0.1769	−0.3374**	0.1422	−0.4699***	0.1378
Union density	−0.3083**	0.1559	−0.1578	0.1289	−0.2885**	0.1257
Oil, mining, energy	−0.5905	0.4580	−0.1503	0.2149	0.6615***	0.2073
Durables	−0.2968	0.1865	−0.0877	0.1343	0.0484	0.1386
Construction	1.2153***	0.1892	0.1136	0.1706	0.1099	0.1761
Wholesale	0.0540	0.1977	0.1862	0.1527	0.4318***	0.1554
Retail, hotels, restaurants	−0.1867	0.2213	0.1470	0.1737	0.4249**	0.1698
Transportation	0.0173	0.2216	−0.7424***	0.2018	−0.2498	0.1883
Post and telecom	−0.3243	0.3519	−0.7600***	0.2932	0.0276	0.2361
Finance and real estate	0.9626***	0.2632	0.5536**	0.2231	0.3062	0.2223
Business services	0.8031***	0.1896	0.0243	0.1551	0.3138**	0.1536
Health and social services	−3.8308	79.6437	−0.8203***	0.2824	−0.3113	0.2287
Education, personal services	0.4846*	0.2708	−0.6572***	0.2389	−0.2115	0.2080
Constant	−1.470***	0.2513	−0.4028**	0.1934	−0.6163***	0.1863
Correlation	0.1315**[a]	0.0516	0.0725[b]	0.0453	0.2398***[c]	0.0504
$\varphi(\bar{X}b)$	0.1437		0.3299		0.3552	

Notes: [a] equation nos (1) and (2); [b] equation nos (2) and (3); [c] equation nos (3) and (1); Sample size is 1,426 (2003 data only). Coefficients reflect changes in the inverse cumulative standard normal distribution, *z*. Estimation is based on the mvprobit module by Cappellari and Jenkins (2003). The (joint) log likelihood value is −2,061.0; and the likelihood ratio test for the joint significance of the explanatory variables yields the chi-squared (69 degrees of freedom) statistic of 450.0 (*p*-value = 0.0000). The row labeled "Correlation" lists the estimated correlation coefficient between errors of the equations. The likelihood ratio test for the joint significance of the three correlation coefficients yields the chi-squared (3 degrees of freedom) statistic of 30.228 (*p*-value = 0.0000). See text for definitions of forms of pay; * Statistically significant at the 0.10 level; ** at the 0.05 level; *** at the 0.01 level

The table shows that a high degree of worker autonomy is particularly associated with a higher probability of individual-based pay schemes. In the table, the coefficients refer to changes in the value of *Z*, where *Z* has a standard normal distribution. In order to evaluate the marginal effect of explanatory variables on the probability that the firm adopts a performance pay scheme, we rescale the coefficient estimate with the value of the standard normal density function evaluated at the predicted mean of the *Z*-variable[5]. As such, evaluated at sample means of the explanatory variables, the estimated effect of workplace autonomy on individual-based performance pay is 9.0 percentage points (0.2537*0.3552; the scale factor is reported in the last row of the table). Establishments with high product market competition and foreign ownership are more likely to have traditional and group-based schemes. The finding in Table III that establishments with a highly educated workforce may be slightly more likely to have performance-related pay, masks large differences with respect to the different types of pay. In fact, such establishments are less likely to have traditional schemes than fixed pay, but more likely to have individual-based schemes. This pattern may reflect that monitoring problems associated with output as well as effort are more important for this group, thus favouring individual-based forms of pay for performance over other forms. A high share of part-time workers reduces the use of non-traditional pay schemes. A high union density rate is associated with less use of all three forms of performance pay. Note, however, that union density effect on group-based schemes is not statistically significant and is smaller in size than those of the two pay types, indicating that collective preferences for pay equality is particularly important when union membership is high. Firms with central bargaining only are less likely to use the non-traditional pay schemes. Finally, the negative effect of local bargaining that we found in Table III is driven by less use of group-based schemes. This is consistent with the view that local bargaining acts as a profit-sharing mechanism and may substitute for group-based performance-related pay systems. Figure 2 summarises the patterns of use of pay method according to bargaining

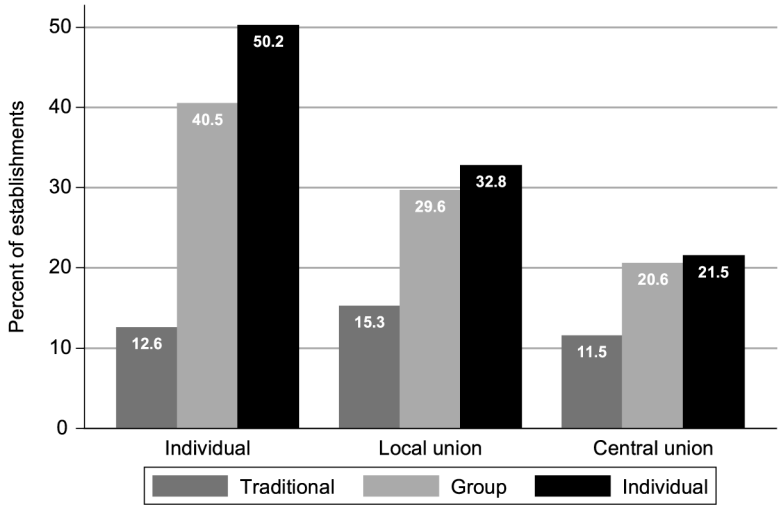

Figure 2.
Forms of performance pay by bargaining regime, 2003

regime, showing that the incidences of non-traditional pay schemes are less prevalent in establishments with union bargaining.

In Table IV, the estimated industry coefficients show that there are large differences across industries in what types of performance pay that is used. We see that the high incidence of performance pay in the wholesale and oil and energy sectors is driven by their use of the individual-based schemes. The construction, finance and business services industries mainly use traditional schemes, reflecting their larger use of group piece-rates in construction and commissions in finance and business services.

5. Conclusions

Our theoretical analysis of pay systems emphasises the role of costs involved in monitoring worker effort in combination with standard factors embedded in the agency model like risk aversion, uncertainty, and the sensitivity of output to effort. Theory predicts that the choice of performance-related pay schemes is positively associated with delegation of decisions over tasks. Using data from two Norwegian employer surveys, we find that the use of performance-related pay is positively associated with autonomy of the main occupational group in terms of defining work tasks. In our analyses, the positive association remains even after we include extensive controls for workforce and establishment characteristics. Worker autonomy has the strongest positive effect on individual-based pay schemes such as individual bonuses and performance assessments. On the other hand, we find no indication that worker autonomy has any impact on the incidence of group bonuses or profit sharing.

The observation that the incidence of performance-related pay is higher with autonomous employees is consistent with an agency model interpretation of performance pay, and lends support to the hypothesis of Prendergast (2002) about a positive relationship between incentive pay and delegation of tasks. Our empirical results also suggest that the relationship is economically significant. We find that employees in firms where the main occupational group enjoys considerable freedom in choosing how to organise their own work, have a six percentage points higher incidence of performance-related pay than employees in firms with less freedom to choose how to organise one's work. Likewise, workplace autonomy is associated with an increase in the incidence of individual-based performance pay schemes of nine percentage points. Evaluated at sample means, autonomy is estimated to raise the likelihood of performance pay by 13 per cent, and that of individual-based pay of 27 per cent. We also find, in line with previous literature, a higher incidence of pay for performance in larger establishments (see, e.g. Brown, 1990; Foss and Laursen, 2005).

We find that collective bargaining reduces the incidence of performance pay. In particular, centralised bargaining over wages has a strong negative effect. Adding local bargaining diminishes the negative effect of collective bargaining. It is worth noting that local bargaining in effect may act as a profit sharing device, thus providing a substitute measure for other profit sharing schemes. This interpretation is consistent with the observation that local bargaining has a larger negative impact on group-incentive arrangements than on individual-based performance-related pay. In addition to the effects of bargaining level, union density has by itself a negative effect on pay for performance. There are several reasons why unions might oppose pay-for-performance schemes. In light of our model, it is likely that unions make monitoring of effort less costly. In a bargaining context, the union may share the

interest of the employer in terms of monitoring effort levels, and the union may have more efficient means, such as peer control and group pressure, to enforce effort rules. Unions also tend to oppose wage systems that lead to increased wage dispersion, and might be expected to dislike wage systems that tie pay to individual performance assessments at the discretion of management. Our empirical results reveal that a more powerful union in terms of establishment membership does not reduce the likelihood of group bonuses or profit sharing.

It turns out that product-market competition is associated with a higher probability that the firm employs performance pay schemes. This effect is largest for the traditional types of performance-related pay. We find a positive association between the educational attainment of employees and use of individual-based types of performance pay. At the same time, the use of traditional piece rates is significantly lower in firms with a high fraction of college graduates. We interpret this pattern as follows: It is likely that the quality and effort of high-skilled workers have larger impacts on productivity than the quality and effort of other groups of workers. If this is the case, paying for performance has a greater effect on output for high- than for low-skilled workers. On the other hand, educational attainment of the workforce is negatively associated with traditional performance-related schemes, which typically are tailored towards blue-collar jobs. Finally, we find no significant linkage between educational attainment and group-based incentives schemes.

Even when controlling for a full set of explanatory variables, the data reveal a significant underlying growth trend in use of performance-related pay in Norwegian private-sector establishments. Higher prevalence of performance-related pay over the sample period may reflect what Brown and Heywood (2002) describe as an "accelerating nature of experimentation and change in payment methods." If this is true, there exists both a great deal of uncertainty among management about optimal methods of pay, as well as quite some leverage in terms of what types of payment schemes that prevail in the market at the same time.

Notes

1. Relaxing the implicit assumption that marginal and average monitoring costs are equal, higher marginal monitoring costs will reduce the optimal effort level and thereby firm profits, while higher average monitoring costs will have a direct, negative effect on profits. In either case, PRP is more likely the higher are monitoring costs.
2. During the survey, managers were first asked about the main product or service of the establishment, and then asked to name the main occupation involved in processing that product/service. In the data, responses to the product or service question correspond closely with the standard industry classification of the establishment available from registers. Responses to the main occupation question also adhere to standard occupational classifications. To illustrate, the most frequently listed occupations within the ship-building and construction industries (to name two of the largest three-digit industries in the data) are "production workers," "metal workers," "carpenters," and "construction workers."
3. The figure uses values from the medium definition of performance pay in 2003. The alternative definitions also indicate increases for all bargaining regimes. To illustrate, using the strict definition the 2003 proportions are 64.0 (individual bargaining), 45.5 (local union), and 35.5 (central union).

4. We are, however, unable to rule out any reverse effect – that foreign investors seek out firms with performance pay schemes. Moreover, foreign ownership and performance pay may both be influenced by a third and unobserved firm characteristic. Estimated effects of other explanatory variables are hardly affected if we drop the foreign ownership variable from the models.
5. This follows from $\partial\Phi/\partial x = (\partial\Phi/\partial z)(\partial z/\partial x) = \phi(\partial z/\partial x)$, where Φ denotes the cumulative standard normal distribution function and ϕ the standard normal density function.

References

Bandiera, O., Barankay, I. and Rasul, I. (2005), "Social preferences and the response to incentives: evidence from personnel data", *Quarterly Journal of Economics*, Vol. 120 No. 3, pp. 917-62.

Barth, E., Bratsberg, B., Hægeland, T. and Raaum, O. (2006), "Performance pay and within-firm wage inequality", paper presented at the Oslo Workshop on Employer Surveys, Institute for Social Research, Oslo, January.

Belfield, R. and Marsden, D. (2003), "Performance pay, monitoring environments, and establishment performance", *International Journal of Manpower*, Vol. 24 No. 4, pp. 452-71.

Booth, A. and Frank, J. (1999), "Earnings, productivity, and performance-related pay", *Journal of Labor Economics*, Vol. 17 No. 3, pp. 447-63.

Brown, C. (1990), "Firm's choice of method of pay", *Industrial and Labor Relations Review*, Vol. 43 No. 3, pp. 165S-82S.

Brown, M. and Heywood, J.S. (Eds) (2002), *Paying for Performance: An International Comparison*, M.E. Sharpe, Armonk, NY.

Cappellari, L. and Jenkins, S.P. (2003), "MVPROBIT: stata module to calculate multivariate probit regression using simulated maximum likelihood", available at: http://ideas.repec.org/c/boc/bocode/s432601.html

Cuñat, V. and Guadalupe, M. (2005), "How does product market competition shape incentive contracts?", *Journal of the European Economic Association*, Vol. 3 No. 5, pp. 1058-82.

Foss, N.J. and Laursen, K. (2005), "Performance pay, delegation and multitasking under uncertainty and innovativeness: an empirical investigation", *Journal of Economic Behavior and Organization*, Vol. 58 No. 2, pp. 246-76.

Heywood, J., Siebert, W.S. and Wei, X. (1997), "Payment by results systems: British evidence", *British Journal of Industrial Relations*, Vol. 35 No. 1, pp. 1-22.

Holmström, B. and Milgrom, P. (1987), "Aggregation and linearity in the provision of intertemporal incentives", *Econometrica*, Vol. 55 No. 2, pp. 303-28.

Lazear, E.P. (1995), *Personnel Economics*, MIT Press, Cambridge, MA.

Lazear, E.P. (2000), "The use of performance measures in incentive contracting", *American Economic Review*, Vol. 90 No. 2, pp. 415-20.

Lazear, E.P. (2002), "Performance pay and productivity", *American Economic Review*, Vol. 90 No. 5, pp. 1346-61.

Ortin-Angel, P. and Salas-Fumas, V. (1998), "Agency-theory and internal-labor-market explanations of bonus payments: empirical evidence from Spanish firms", *Journal of Economics and Management Strategy*, Vol. 7 No. 4, pp. 573-613.

Parent, D. (2002), "Performance pay in the United States: its determinants and effects", in Brown, M. and Heywood, J.S. (Eds), *Paying for Performance: An International Comparison*, M.E. Sharpe, Armonk, NY, Ch. 2.

Prendergast, C. (1999), "The provision of incentives in firms", *Journal of Economic Literature*, Vol. 37 No. 1, March, pp. 7-63.

Prendergast, C. (2002), "The tenuous trade-off between risk and incentives", *Journal of Political Economy*, Vol. 110 No. 5, pp. 1071-102.

Raith, M. (2003), "Competition, risk and managerial incentives", *American Economic Review*, Vol. 93 No. 4, pp. 1425-36.

Salas-Fumas, V. (1993), "Incentives and supervision in hierarchies", *Journal of Economic Behavior and Organization*, Vol. 21 No. 3, pp. 315-31.

Schmidt, K.M. (1997), "Managerial incentives and product market competition", *Review of Economic Studies*, No. 64 No. 2, April, pp. 191-213.

StataCorp (2005), *Stata Statistical Software: Release 9*, StataCorp LP, College Station, TX.

About the authors

Erling Barth is Research Director at the Institute for Social Research, Oslo and Professor at the Department of Economics, University of Oslo. He is also a Research Fellow at IZA, Bonn. He earned his PhD in Economics from the University of Oslo. His research interests include education, productivity, immigration, the wage structure, gender wage differentials, labour mobility, firms' behaviour and the impact of labour market institutions. Erling Barth is the corresponding author and can be contacted at: eba@socialresearch.no

Bernt Bratsberg is Senior Research Fellow at the Ragnar Frisch Centre for Economic Research, University of Oslo, and Professor of Economics at Kansas State University. He received his PhD in Economics from University of California, Santa Barbara. Bratsberg has published in the areas of immigration, wage inequality and unions.

Torbjørn Hægeland is Head of Research, Labour Market and Firm Behaviour, at Statistics Norway and Scientific Adviser at The Ragnar Frisch Centre for Economic Research, University of Oslo. He holds a PhD in Economics from University of Oslo, Norway. His research fields are mainly empirical labour economics and economics of education.

Oddbjørn Raaum is a Senior Research Fellow at The Ragnar Frisch Centre for Economic Research, University of Oslo. He holds a PhD in Economics from University of Oslo, Norway. His research areas and academic publications cover topics like wage formation, labour market policies, education economics, labour market performance among immigrants and the impact of family background on adult socio-economic outcomes.