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Abstract

Previous studies examining intra-firm wage dispersion and firm performance have focused on wage levels. The authors of this study argue that for purposes of comparing wage dispersion's positive incentive effects with its adverse morale effects, the dispersion of wage increases is more revealing than the dispersion of wage levels. It is reasonable to expect greater dispersion of wage increases to be associated with higher monetary incentives, but also with increased perceptions of unfairness. The authors' analysis of linked employer-employee data from Denmark for the years 1992–97 shows that the dispersion of wage growth within firms generally had a negative association with firm performance. The results are robust across industries and categories of firm size, but are mainly driven by white-collar rather than blue-collar workers.

KEYWORDS: wage increase dispersion and firm performance

THE DISPERSION OF EMPLOYEES' WAGE INCREASES AND FIRM PERFORMANCE

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Previous studies examining intra-firm wage dispersion and firm performance have focused on wage levels. The authors of this study argue that for purposes of comparing wage dispersion's positive incentive effects with its adverse morale effects, the dispersion of wage *increases* is more revealing than the dispersion of wage levels. It is reasonable to expect greater dispersion of wage increases to be associated with higher monetary incentives, but also with increased perceptions of unfairness. The authors' analysis of linked employer-employee data from Denmark for the years 1992–97 shows that the dispersion of wage growth within firms generally had a negative association with firm performance. The results are robust across industries and categories of firm size, but are mainly driven by white-collar rather than blue-collar workers.

A subject of fundamental debate in recent years has been whether the way monetary incentives are distributed affects firm performance. Both the theoretical arguments and the empirical evidence relevant to this issue are ambiguous. While there is little debate that monetary incentives affect individuals' behavior, firms' monetary incentive programs often lead to uneven rewards for the affected workers, which may negatively affect motivation due to perceptions of inequity or unfairness.

Clearly, an understanding of how these two effects interact is crucial to the creation of an efficient compensation policy in a firm. In undertaking the present study, which is aimed at improving that understanding, one large advantage we have over most researchers who have previously approached this subject is the availability of a data set that is almost ideally adapted to the investigation. In contrast to most previous studies, which have had to rely on somewhat crude measures of firm performance or wage dispersion, or have analyzed only a small number of firms or a small fraction of the work force, our study examines a large proportion of an entire nation's (Denmark's) labor market. We have access to linked information for all employees and all larger private sector firms with at least 20 employees in Denmark for a six-year observation period. The insights our findings provide into the relative importance of the two competing effects of incentive pay

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Due to privacy concerns, the data set used in this study is not publicly available. Interested researchers should submit inquiries regarding the data to Center for Corporate Performance, the Aarhus School of Business. Further information about variables and methods are available from the authors on request. Christian Grund: University of Würzburg, Department of Business and Economics, Sanderring 2, D 97070 Würzburg, Germany; ch.grund@uni-wuerzburg.de. Niels Westergaard-Nielsen: Center for Corporate Performance, Aarhus School of Business, Department of Economics, Silkeborgvej 2, DK 8000 Aarhus C, Denmark; nwn@asb.dk.

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in firms are translatable to some specific recommendations for administrators developing firms' wage policies.

Prior studies have argued that the extent of use of monetary incentives in a firm can be gauged by the dispersion of wage levels in the firm, with large dispersion, for example, reflecting large (tournament) incentives. In our view, however, such a correspondence does not automatically obtain. If glass ceilings and other barriers severely limit employees' promotion prospects, even a program of pay for performance that results in high intra-firm wage inequality will not provide a significant monetary incentive. In contrast, we would expect strong incentive effects from a program in which two colleagues know that one will get a 20% raise at the end of the year and the other will not. We therefore extend previous research by examining how firm performance responds not only to the dispersion of wage *levels*, but also to the dispersion of wage *increases*.

Theoretical Considerations and Earlier Empirical Studies

Some previous studies have argued that wage dispersion in a firm can be treated as a proxy for the extent of monetary incentives and may influence firm performance in terms of profit or value added. This is particularly the case in tournament structures, where individuals are necessarily divided into groups of winners and losers (see Lazear and Rosen 1981; Rosen 1986). Tournaments are invariably present in common internal labor markets.[1] While the winner of a promotional tournament is promoted and receives a wage increase, for example, other employees miss out. Several approaches argue that the resulting inequality can have adverse effects—stemming, for example, from perceived inequity or lack of fairness—that work against the positive incentive effects. Not surprisingly, there is explicit evidence for both kinds of effects: on the one hand, monetary incentives matter (Lazear 2000), and individual effort is affected by the prize structure of tournaments (Abrevaya 2002; Becker and Huselid 1992; Bull, Schotter, and Weigelt 1987; Ehrenberg and Bognanno 1990; Main, O'Reilly, and Wade 1993); on the other hand, fairness considerations influence human behavior as well (Camerer and Thaler 1995; Cowherd and Levine 1992; Güth, Schmittberger, and Tietz 1990).[2] In a series of experiments investigating different incentive schemes, Harbring (2004) provided evidence for both effects.

Some contributions have examined the link between wage dispersion and firm performance.[3] Winter-Ebmer and Zweimüller (1999) argued from neoclassical principles that high wage levels in a firm signal high firm performance—a link that can aid researchers when direct productivity information is not available. For a sample of white-collar employees in Austrian firms, they found an inverse U-shaped relation between wage dispersion and the level of wages. Lallemand, Plasman, and Rycx (2004) and Heyman (2005) studied the link between the dispersion of intra-firm wage levels and firm performance in Belgium and Sweden, respectively. Both found a positive relationship. Bloom (1999), using data from major league baseball, showed that the level of wage dispersion among team members was negatively related to several measures of individual and team performance. Pfeffer and Langton (1993) found decreasing research productivity and collaboration among college and university faculty with increasing wage dispersion. Some studies have focused specifically on wage dispersion among managers. Eriksson (1999) found evidence of a positive relationship between the pay spread among managers and firm profitability in Denmark. However, O'Reilly,

[1] Lazear (1992), Baker, Gibbs, and Holmstrom (1994a, 1994b), Dohmen, Kriechel, and Pfann (2004), Grund (2005), and Treble, van Gameren, Bridges, and Barmby (2001) have provided evidence for single firms.

[2] Recent contributions, which focus on multiple agent gift-exchange experiments, include Güth et al. (2001), Maximiano, Sloof, and Sonnemans (2004), and Rossi and Warglien (2001).

[3] Turnover, tenure, and job satisfaction are also affected by the dispersion of wages (see Pfeffer and Davis-Blake 1992; Pfeffer and Langton 1993; Bloom and Michel 2002). The argument that wage policy has an impact on employee behavior is more than a half-century old (Simon 1957).

Main, and Crystal (1988) and Leonard (1990) did not confirm this result for large U.S. firms. In a U.K. study, Beaumont and Harris (2003), lacking information on individual wages, used the ratio of non-manual and manual labor costs per employee as a proxy for wage dispersion in firms, and found that this somewhat rough measure was positively related to value added per employee in the majority of manufacturing sectors. Using Swedish aggregate time-series data, Hibbs and Locking (2000) found more positive than negative effects of wage dispersion on firms' real value added. Bingley and Eriksson (2001), who focused on the skewness of the intra-firm wage distribution in Denmark, found evidence that of a U-shaped relationship with firm productivity.

This brief overview shows that the evidence is mixed, demonstrating no consistent relationship, positive or negative, between wage dispersion and firm performance. The lack of consensus may reflect, in part, a certain fragmentariness or case-study quality across the studies, which examine specific, usually narrow labor markets and employ different measures of both wage dispersion and firm performance. In revisiting the incentive pay/firm performance puzzle, we are able to make use of unusually rich and expansive linked employer-employee data covering the labor market of an entire country.

However, at the outset, we argue that no clear-cut link between wage dispersion and monetary incentives can be assumed. Even very wide wage dispersion does not imply the presence of effective monetary incentives if employees have hardly any possibility of promotion, and there is no reason to suppose that high wage dispersion cannot coexist with high promotion barriers. Indeed, Leonard (1990) provided evidence that in the United States, steeper pay differentials across hierarchies were associated with lower promotion rates. Employees are generally well aware, too, when there is little or no chance of receiving extraordinary wage increases. For example, until the mid-1980s, Merck, the U.S. pharmaceutical company, employed an "absolute" performance evaluation system. Managers were free to give one of several ratings to each employee, and bonuses were tied to these subjective performance evaluations. Under this system, the managers tended to rate all employees quite similarly, probably in order to avoid long discussions, hurt feelings, and complaints (an effect called "centrality bias"). Not surprisingly, some top performers complained that they had no opportunity to receive extraordinary wage increases. When asked to judge the performance evaluation system, one worker said, "What's the use of killing yourself [if] you still get the same 5% increase? It's demoralizing and demotivating" (Murphy 1992:39).

Hence, what really matters in terms of monetary incentives is not only the simple dispersion of wages but also the possibility of receiving extraordinary wage *increases*. Consider pay for performance contracts, which introduce formulas by which all employees are rewarded with respect to firm performance. As night follows day, the free rider problem follows the institution of such arrangements, since employees know that their individual rewards will bear little relationship to their individual efforts. From a strict economic point of view, it is dispersion of wage increases that would be expected to induce workers to exert effort.

Tournament theory (Lazear and Rosen 1981; Rosen 1986) predicts increasing effort levels with increasing wage premiums for winners of rank-order tournaments; hence, incentives are affected by differences in wage increases rather than by differences in wage levels. This argument suggests a positive link between the inequality of wage increases and individual performance. In this case, firm performance should also be affected positively. However, one drawback of tournaments is that participants usually have two ways to increase their individual winning probabilities: they can exert either a high productive effort or a counterproductive effort (for example, a worker might withhold important information from colleagues, to reduce their work effectiveness). If the problem of counterproductive effort or sabotage is relevant, a somewhat compressed wage structure is beneficial for the firm (see Lazear 1989). Drago and Garvey (1998), analyzing Australian data, found support for the proposition that employees' inclination to help one

another on the job is reduced with increasing monetary incentives in tournament structures. From a tournament perspective, the dispersion of wage increases (measured by the standard deviation) is maximized when half of the contestants receive the winner prize. Indeed, experimental evidence suggests that in tournament conditions, employees' collective effort peaks when the fraction of winner prizes is at 0.5, rather than when there are only a few winner or loser prizes (Orrison, Schotter, and Weigelt 1997; Harbring and Irlenbusch 2004).[4]

Other theories warn explicitly about too much inequality inside firms. This concern is addressed by equity theory (Adams 1963), relative deprivation theory (Martin 1981), and distributional justice theory (Cowherd and Levine 1992), as well as by theories highlighting considerations of fairness (Akerlof 1984; Akerlof and Yellen 1990), cohesiveness (Levine 1991), and the possible reduction of intrinsic motivation (Deci et al. 1999; Frey and Jegen 2001). Henceforth, without neglecting their differences in detail, we refer to these theories collectively as *fairness approaches*. These fairness approaches point out that many employees lose motivation and reduce effort or even quit their jobs if they perceive their pay as unfair or inequitable.[5] According to equity theory, for example, employees compare the relation between their own labor input (most commonly, effort) and labor output (most commonly, wages or wage increases) to the corresponding input/output relation for their colleagues. If they perceive an unfair advantage for their colleagues, they will reduce their effort in order to adjust the imbalance. Even an employee who accepts a certain wage inequality as equitable because of different task requirements may begin to view differential wage increases as unfair when the gap widens beyond some point. Differences in effort or performance may be observed concordantly across employees in some cases. However, the vast majority of employees consider themselves to be top performers (Meyer 1975; Taylor and Brown 1988). That is why it is often hard to get employees to accept widely disparate wage increases. Possible reactions to the perception of unfairness in pay increases are reduced effort or quitting because of lack of motivation.

As a consequence, some have argued that performance should be negatively correlated with the dispersion of wage increases among employees of a firm. Among the first studies to begin to test this conjecture empirically was Levine's (1993) survey of real-world compensation executives, which asked what wage changes the respondents would recommend in a hypothetical company and in certain scenarios. The managers avoided giving different wage increases to the employees. At least one criterion apparently guiding the managers' recommendations was fairness. Consistent with that result was Bewley's (1999) later conclusion, based on another set of interviews with managers, that internal equity, internal harmony, and fairness are the main reasons for a fixed formal wage structure inside firms.

The two strands of literature described above imply two essentially opposite relationships between the dispersion of wage increases and firm performance. However, the different temporal perspectives of tournament and fairness approaches are usually not mentioned. Tournament theory focuses on incentives at a tournament's inception and during its course, with little or no explicit attention to the period following determination of a winner.[6] By the terms of standard economic theory, whatever monetary incentives are generated by a tournament simply cease at the tournament's conclusion, and

[4]Note that this relation does not ineluctably follow from tournament *theory*. From a theoretical standpoint, the marginal probability of winning a promotion tournament is the decisive factor determining the employee's effort choice. Orrison et al. (1997), as well as Harbring and Irlenbusch (2002), have even shown that, based on a tournament model with identically distributed individual error terms, effort choice is independent of the fraction of winner prizes in a symmetric equilibrium.

[5]Fehr and Schmidt (1999) integrated fairness considerations—in particular, other-regarding preferences—into a theoretical economic analysis.

[6]Waldman (2003), who focused on the time inconsistency problem, is an exception. In promotion tournaments, he contended, it might be rational, *ex post,* to hire an outsider, but doing so will destroy *ex ante* incentives for incumbents.

if there are no other incentive strategies in place, monetary incentives will continue to be absent until another tournament is begun. In contrast, equity approaches tend to highlight ongoing situations in which employees are being treated differently, as is the case, for instance, in the aftermath of a promotion tournament, when the winner receives the prize whereas the loser, who may have exerted as much effort as the winner, receives nothing. Given the different time frames, the two approaches are not mutually exclusive.[7] Both effects are likely to be relevant in common corporate compensation policies.

The exact impact of these effects on individual effort is not clear, however. It might be argued that both effects bear a linear relation to the amount of the monetary incentives. In that case, one possibility is that the composite effect is also linear. However, this is not the only possibility. If incentive effects are interpreted as acting on intrinsic motivation, a negative value for them seems implausible, since the lowest possible value for motivation would seem to be zero.[8] By this reasoning, the negative effect will be operative only up to a certain point of monetary incentives (or dispersion of wage increases) in firms, and beyond that point, positive incentive effects will emerge. If the negative effect outweighs the positive one, we get an overall v-shaped effect of monetary incentives on individual efforts. However, the slopes of the effects will differ across employees in different situations in different firms. Deci et al. (1999) surveyed the literature and identified task/reward situations in which monetary incentives are more likely to reduce intrinsic motivation than to increase it. Aggregation of the individual v-curves should yield a summary U-shaped relation between wage increase dispersion and overall effort.

The effect of monetary incentives on firm productivity depends on the production function defining how effort is transformed into production. Adams (2006) suggested the function

$$(1) \qquad F(e_1, e_2, e_3, \ldots) = \left(\sum_{i=1}^{N} e^{\rho} \right)^{1/\rho}, \quad \text{with } \rho = (0,1),$$

in which the efforts of individual workers (e_i) are aggregated to the productivity of the firm (F). This aggregation function allows for an additive aggregation for $\rho = 1$. For smaller values of ρ, team production exceeds the sum of the individual efforts, a situation that is most likely, of course, if people work together. This kind of production function implies a productivity effect that is not necessarily linear. In particular, complementarities imply that the observed productivity effect will be increasing in the overall effort level.

From a series of experiments in which people were offered monetary incentives to complete IQ tests, Gneezy and Rustichini (2000) found that pay for performance was effective only when monetary incentives were large enough, with the relationship between incentive pay and performance thus describing a U-shaped curve. Applying these results to the present study, we would expect to find that fairness norms are not necessarily stable, but can be altered or destroyed if the schedule of wage increases for employees is marked by sufficiently high inequality. Thus, it is at least arguable that the relationship between monetary incentives and effort or firm performance may not be linear.

The foregoing discussion cites considerations to support any of several incentive/effort (or incentive/firm performance) relationships, corresponding to different relative parts played by negative and positive incentive effects. Which of those two effects predominates is an empirical question that, to date, no study has resolved. In the present empirical investigation, we regress the dispersion of wage increases and its square on firm performance; examine the shape of the relationship and calculate a possible minimum (or maximum) of the function;

[7]Recent economic approaches have tried to incorporate in tournament models, as well, sentiments like relative deprivation, envy, and compassion (Kräkel 2000; Grund and Sliwka 2005). These models, too, choose an *ex ante* view, and argue that employees anticipate both the uneven outcomes that will occur in the future and the perception of fairness (or unfairness) with which they will respond. Their effort choice takes into account their anticipated aversion to inequity.

[8]This is also a underlying assumption of models on intrinsic motivation, such as that offered by James (2005).

and, finally, determine whether there is a positive or negative relationship between the dispersion of wage increases and firm performance for the majority of firms.

Data, Variables, and Methods

The data used in this study are from two sources. One is the Statistics Denmark IDA (Integrated Database for Labour Market Research) Register. IDA contains information on labor market conditions for persons and workplaces in Denmark over the years 1980–98. These data originate from various administrative registers. For our purposes, the key feature of IDA is that it provides the identities of all employees at a given workplace on a specific day in November each year. Employers are defined by their employer identification number, which is changed if there is a legal change in ownership.[9] Where fewer than half of the employees in a workplace remain in it after an ownership change, we treat the transferred workplace as new; where those remaining represent more than half of the original employees, we treat the workplace as unchanged.

At the behest of the Center for Corporate Performance, Statistics Denmark later aggregated its workplace-level data to the firm level. Furthermore, for a subsample of firms with more than 20 employees, for the period 1992–97, the data were merged with financial data, including information on profits, total revenues, total costs, investments, and capital.

The data on individuals include information on gender, age, education, occupational status, and wages. For each firm and year, we are able to calculate descriptive statistics (means and standard deviations) of these variables. Thus, the great advantage of our data is that we can observe not only firm and employee samples, but also the whole population of firms (the demand side of the labor market) and employees (the supply side). Furthermore, these data allow us to follow firms and employees over time. By aggregating the employee information and matching it to the firms, we can construct an unbalanced panel data set with the firm-year as the unit of observation.

It is argued above that wage increases, and especially wage increase dispersions, are the crucial objects of investigation in this study. In order to analyze wage increases, we have to restrict our data set to employees who stay in a firm for two or more consecutive years. A second restriction applies to firm size. It would not be very meaningful to calculate the dispersion of wages and wage growth for firms with very few employees. Hence, for each year, we restrict our data set to firms with at least 20 employee observations.

We measure firm performance with the log of value added per employee. Value added is defined as net revenue (after rebates and tax) less goods purchases (freight, raw and auxiliary materials, and external wages).[10] The central aim of this contribution is to analyze the link between the dispersion of wage increases ($wage_t / wage_{t-1}$) and firm performance (log of value added (t)). We take the coefficient of variation (the standard deviation divided by the mean) of individual wage increases in firms as a measure of wage increase dispersion.[11] We use hourly gross wages as our wage variable. All values for value added and wages are deflated using the Danish Consumer Price Index with basis year 1997. In order to examine possible non-linear effects of the dispersion of wage increases on firm performance, as discussed above and as illustrated in Figure 1, we also make use of the square of the coefficient of variation.

Other variables are supposed to affect value added, as well. In particular, wages must be paid from value added. Therefore, high wages are generally associated with high value added. For comparability with previous studies, we examine wage level dispersion alongside wage increase dispersion. In addition, we include employees' mean

[9]A detailed description of the data is given at www.ccp.asb.dk.

[10]Two other studies using value added as a performance indicator are Hibbs and Locking (2000) and Beaumont and Harris (2001).

[11]Allison (1978) discussed several measures of wage inequality and found that the coefficient of variation is often the best choice.

Table 1. Descriptive Statistics for the Entire Sample: Denmark, 1992–1997.

Variable	*Mean*	*Standard Deviation*
Value Added per Employee (in 1,000 DKK)[a]	436.22	331.87
Percentage Blue-Collar	0.652	0.247
Percentage Female	0.269	0.213
Mean Hourly Wage (in DKK)[a]	155.73	28.77
Wage Dispersion[b]	0.330	0.153
Dispersion of Wage Growth[b]	0.177	0.164
Mean Education (in months)	142.98	12.77
Dispersion of Education[b]	0.202	0.053
Mean Age (in years)	37.68	3.892
Dispersion of Age[b]	0.283	0.046
Firm Size (number of employees)	123.04	447.90
Number of Observations	22,178	

[a]In 1997 prices.
[b]Dispersion measured by the coefficient of variation (s.d./mean).

age and the dispersion of employees' ages in the analysis. Lazear (1998:169ff.) argued that there are usually complementarities among the different kinds of human capital of young and old workers. Young employees have new ideas and skills applicable to new technologies, whereas older workers have knowledge about intra-firm structures and the relevant markets and networks. Usually both kinds of human capital are necessary for firm productivity.[12] Hence, a mixture of age groups seems to be beneficial. On the other hand, communication problems among these groups might arise. Organizational demographers have argued that interpersonal dissimilarities cause problems in communication, integration, and cohesion (Pfeffer 1981, 1983, 1985). Additional control variables are work force education level, percentage female, percentage blue-collar, firm size, and industry branch.

To ensure that a few extreme observations do not skew the results, we delete some outliers: firms with very high or low (negative) value added per employee, firms with extreme variations in the numbers of employees from year to year, and firms with extreme employee turnover.[13] We also exclude the top managers of the firms, since one of our objects is to examine the influence of the subgroups of blue-collar and white-collar workers. The results are robust with respect to all of these restrictions. The resulting data set has some 22,000 observations. We have information on about 5,736 different firms for the six-year observation period 1992–97. Some descriptive statistics are given in Table 1. The mean value added per employee is approximately 400,000 DKK, which equates with around $84,000 U.S. or 53,000 (Euros). The descriptive statistics are reasonably stable over the observation period. In particular, neither the dispersion of wage levels nor the dispersion of wage increases in firms varies much over the years.

For comparison with previous studies, we start our multivariate analysis by regressing only the dispersion of the wage levels (with standard control variables) on the log of value added. First, we use simple OLS to examine differences between firms. Taking into account unobserved heterogeneity, we continue

[12]A second argument for having different age groups in a company comes from overlapping generations models. Cremer (1986) showed that an overlapping generations structure with several age cohorts can be a decisive factor in inducing cooperation among employees, who forbear from shirking in prisoner dilemma situations.

[13]Note that we analyze the dispersion of wage increases and, therefore, need two consecutive years' information for each employee. Our restriction of the sample reduces the number of observations by about 4%, mainly because of some firms that more than doubled or halved their work forces from one year to the next. Firms we excluded because of their extremely high or low value added account for only 0.5% of observations. None of our results are affected by these restrictions.

to estimate fixed effects panel regressions. In a second step, we include the dispersion of wage increases and its square as explanatory variables. Further on, we split the firms' work force between blue-collar and white-collar workers and examine whether unequal wage increases in either or both of these groups are related to firm performance. Finally, we perform several robustness checks, including a look at lead effects.

Results

First of all, it is not surprising that the mean wage in firms is positively related to value added, since wages must be paid *from* value added. Regression models (1) and (2), for which the results are shown in Table 2, provide additional evidence on the link between wage dispersion and firm performance. As mentioned earlier, the literature provides some evidence for both positive and negative effects. In contrast to most other studies, ours is not limited to certain firms or certain individuals (for example, executives). The OLS regression (model 1) shows an inverse-U-shaped relation between the dispersion of wage levels and firm performance across firms. In general, however, firms with larger wage dispersion have higher levels of value added. Therefore, these results are in line with the results of previous studies that had to rely on somewhat crude measures of wage dispersion or firm performance (Beaumont and Harris 2003; Winter-Ebmer and Zweimüller 1999).

However, there could be differences across firms—in terms of product markets, for example, or production technology—that are not captured by the control variables and that affect value added and wage dispersion simultaneously. If there are, biased and inconsistent parameter estimates could result. The firm fixed effects estimation (model 2), indeed, reveals that there is no causal effect of wage dispersion *per se* that is not explained by firm-specific factors. This does not rule out the possibility that, as reported by previous studies, unobserved variables have positive or negative effects within clearly delimited parts of the labor market. However, on aggregate we cannot find a statistically significant association between wage dispersion and firm performance.

Models (3) and (4) incorporate the dispersion of wage growth and its square. The results with respect to the other independent variables are not affected dramatically. There is a U-shaped association between wage growth dispersion and firm performance across firms (see Figure 1). This result also holds for the fixed effects estimation (model 4). Up to a minimum for the coefficient of variation of wage growth at about 0.6, the relationship is negative. Hence, in this range, constraints imposed by fairness considerations prevail over the incentive effects of pay for performance. However, once fairness considerations are crowded out by rising monetary incentives, we may find that value added rises with further wage growth dispersion, as Gneezy and Rustichini (2000) observed in their experiments. Indeed, for values greater than 0.6 we find a positive link. However, in the vast majority of firms (98%), the dispersion of wage increases is less than 0.6. Hence, marginal increases in wage growth dispersion are associated with reductions of value added for the majority of firms. This is in line with the above-cited results from interviews with managers (see Levine 1993; Bewley 1999), which showed that workers' aversion to inequality reduces their receptiveness to performance-related pay.

The results for the control variables show that the percentage of female employees, the mean age, and the dispersion of employees' ages all bear an inverse-U-shaped relationship with value added. In contrast, the effect for firm size is U-shaped. The percentage of blue-collar workers and education level are negatively related to value added for a given wage level.

These results are robust to different specifications of the regressions and subsamples of the data. We find the same relationships for single industries (for example, manufacturing, construction, and retail) and for a more expanded classification of industries and different firm size categories. Nor does including the mean wage growth of firms change the results. One can argue that it is not value added, but profit (defined as value added minus wage costs), that matters. Regres-

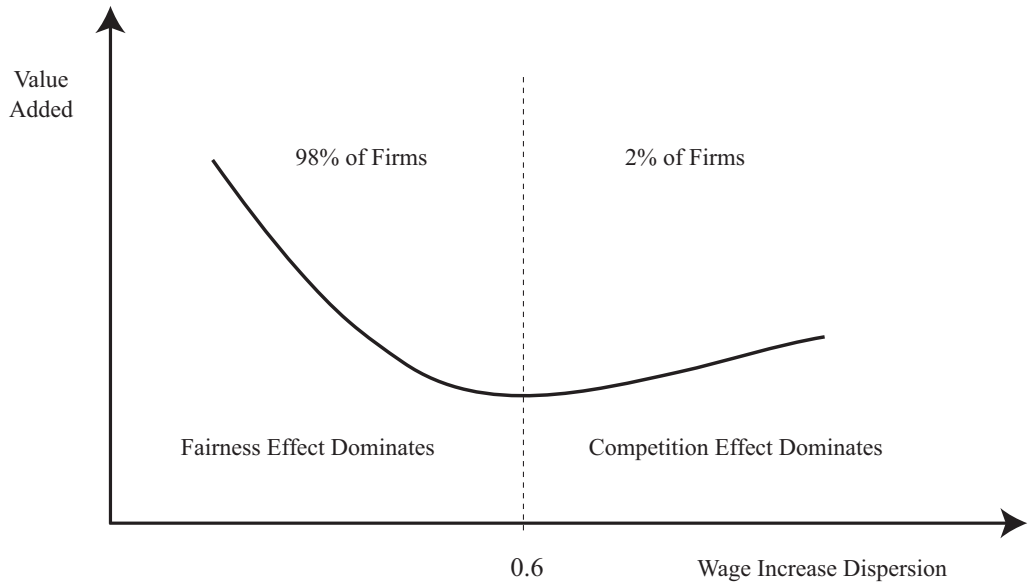
Table 2. Regressions on Firm Performance.
(Dependent Variable: log [value added per employee])[a]

Independent Variable	*OLS* *(1)*	*Fixed Effects* *(2)*	*OLS* *(3)*	*Fixed Effects* *(4)*
Mean Wage[b]	0.006***	0.002***	0.006***	0.002***
	(40.43)	(8.15)	(41.25)	(8.33)
Wage Dispersion[c]	0.393***	–0.038	0.498***	–0.021
	(7.78)	(1.09)	(9.76)	(0.58)
Wage Dispersion Squared	–0.333***	–0.018	–0.358***	–0.026
	(9.39)	(0.81)	(10.08)	(1.18)
Wage Growth Dispersion[c]	—	—	–0.728***	–0.121***
			(11.79)	(3.36)
Wage Growth Dispersion Squared	—	—	0.480***	0.102***
			(8.53)	(3.22)
Percentage Blue-Collar	–0.614***	–0.068***	–0.591***	–0.067***
	(29.33)	(3.88)	(28.23)	(3.83)
Percentage Female	0.882***	0.303***	0.866***	0.305***
	(15.95)	(3.39)	(15.72)	(3.40)
Percentage Female Squared	–1.305***	–0.417***	–1.275***	–0.419***
	(20.19)	(3.70)	(19.80)	(3.72)
Mean Education (months)	–0.005***	–0.002***	–0.005***	–0.002***
	(9.37)	(2.78)	(9.40)	(2.88)
Dispersion of Education[c]	0.287**	–0.207	0.311***	–0.205
	(2.49)	(1.55)	(2.71)	(1.54)
Mean Age (years)	0.058***	0.027**	0.047***	0.025
	(5.16)	(2.06)	(4.18)	(1.93)
Mean Age Squared	–0.001***	–0.0003**	–0.001***	–0.0003
	(5.87)	(2.01)	(5.09)	(1.91)
Dispersion of Age[c]	1.682***	0.894	1.747***	0.925
	(2.90)	(1.79)	(3.02)	(1.85)
Dispersion of Age Squared	–4.734***	–1.571	–4.658***	–1.591
	(4.81)	(1.84)	(4.75)	(1.86)
Firm Size (no. employees) * 100	0.007***	–0.030***	0.009***	–0.029***
	(6.17)	(6.73)	(7.32)	(6.59)
Firm Size Squared * 1,000,000	–0.003***	0.009***	–0.004***	0.009***
	(3.48)	(5.53)	(4.29)	(5.43)
Industry Dummies (5)	Yes	Yes	Yes	Yes
Year Dummies (6)	Yes	Yes	Yes	Yes
Intercept	4.756***	5.500***	5.013***	5.540***
	(22.52)	(21.38)	(23.73)	(21.52)
R^2	0.269[d]	0.035[e]	0.275[d]	0.036[e]
Number of Observations	22,178	22,178	22,178	22,178

Note: Absolute t-values in parentheses.
[a]Value added in 1,000 DKK.
[b]Hourly gross wage in DKK.
[c]Dispersion measured by the coefficient of variation (s.d./mean).
[d]Adjusted R^2 is reported.
[e]Within-R^2 is reported.
**Statistically significant at the .05 level; ***at the .01 level.

sions on profits lead to comparable results, however. Using the standard deviation or the gini coefficient instead of the coefficient of variation as the dispersion measure does not

Figure 1. The Link between Wage Increase Dispersion in Firms and Value Added per Employee.



change the results, either. Furthermore, the results are robust to inserting the lag of value added as an additional independent variable, although doing so does result in the loss of about 5,500 observations.

Because our data span a six-year period (1992–97), we are able to analyze differences or developments over time. Estimates of OLS regressions for each year provide further confirmation of the U-shaped relationship between wage growth dispersion and firm performance (see Table 3). As discussed above, our main results include the finding that marginal increases in wage growth dispersion are associated with reductions of value added for the vast majority of firms. Now we can revisit this issue by calculating the minimum of the U and the fraction of firms to the right of the minimum for each year. The results confirm that the positive association between wage growth dispersion and value added (the right-hand side of the U) was relatively unimportant. However, its relevance appears to have been growing over time. The fraction of affected firms tripled from 1% to 3% over the observation period.[14] If further research were to show that this change has continued to the present, it would not be unreasonable to speculate that we are observing an important long-term trend.

Often, a firm's production process is organizationally strictly separated from its administration. That is why it seems appropriate to look at blue-collar and white-collar workers separately when computing mean wages, wage dispersion, and wage increase dispersion. In addition, we investigate possible relationships between the two groups' changing wages by tracking their relative wages.[15] Many firms are characterized by a substantial preponderance either of blue-collar employees or of white-collar employees. To get meaningful results, we limit the data set to firms with at least 10 blue-collar and 10 white-collar observations

[14]The average coefficient of variation of firms (0.18) remains constant over time. The standard deviation of the coefficient of variation (0.13) does not change, either.

[15]Note that this was the only measure of firms' wage dispersion used in Beaumont and Harris (2003).

Table 3. Cross-Section Regressions on Firm Performance.
(Dependent Variable: log [value added per employee])

Year	*Description*	*OLS*	*Minimum*	*Fraction of Firms Right of the Minimum*
1992	Wage Growth Dispersion Wage Growth Dispersion Squared	–0.653*** (4.12) +0.363** (2.47)	0.899	0.9%
1993	Wage Growth Dispersion Wage Growth Dispersion Squared	–0.936*** (6.75) +0.607*** (5.05)	0.771	1.3%
1994	Wage Growth Dispersion Wage Growth Dispersion Squared	–0.516*** (3.50) +0.343** (2.11)	0.753	1.5%
1995	Wage Growth Dispersion Wage Growth Dispersion Squared	–0.718*** (5.48) +0.499*** (4.49)	0.719	1.6%
1996	Wage Growth Dispersion Wage Growth Dispersion Squared	–0.631*** (3.93) +0.479*** (3.05)	0.659	2.1%
1997	Wage Growth Dispersion Wage Growth Dispersion Squared	–0.999*** (4.52) +0.965*** (4.01)	0.518	3.0%

Notes: Included are controls for mean wage, wage dispersion and its square, percentage blue-collar, percentage female, percentage women squared, mean education, dispersion of education, mean age, mean age squared, dispersion of age, dispersion of age squared, firm size, firm size squared, industry dummies (5), and year dummies (6) as in the regressions of Table 2. Absolute t-values are in parentheses.

**Statistically significant at the .05 level; ***at the .01 level.

in a particular year. Hence, the sample size is reduced to 11,000 observations and about 3,500 different firms.

It turns out that firms' wage policies do not play a crucial role for blue-collar workers (see Table 4). For this group, neither the mean wage, nor wage dispersion, nor the dispersion of wage increases has a statistically significant effect on value added. More influential mediators between blue-collar workers and firm performance than these monetary variables, apparently, are such factors as monitoring and technological conditions. White-collar wages exceed blue-collar wages by around 20%, on average. This wage differential has no statistically significant association with firm performance.

In contrast to the results for blue-collar workers, the results for white-collar employees show the same patterns as in Table 2, confirming the overall results. Wage level dispersion has statistically significant effects only in the OLS analysis, not in the fixed effects regression. As for wage increase dispersion, it exhibits a U-shaped association with firm performance among white-collar workers, consistent with our general results. We conclude that the overall results must be driven by statistically significant effects among white-collar workers.

Could the observed effects be counterpoised by opposite effects in subsequent years? For example, might less capable employees faced by increased wage growth dispersion first reduce their effort, and quit their jobs only after a certain period has elapsed? Firms with high wage growth dispersion could benefit from this sorting effect in the long run. To examine possible effects over longer periods, we re-run the model (4) specification of Table 2, but with the value added of the subsequent year as the dependent variable; and we then repeat the analysis once more, this time with a two-year-lagged value added as the dependent variable. To perform these progressively restrictive analyses we must sacrifice a considerable number of observations, because information for value added is only available through 1997. The estimates indicate that countervailing effects such as sorting of employees across firms do not heavily influence our overall results. With one-year-lagged value added as the dependent variable, the familiar U-shaped relationship between the dispersion of wage increases and firm performance remains in

Table 4. Regressions on Firm Performance, Separately for Blue-Collar and White-Collar Workers. (Dependent Variable: log [value added per employee / 1000])[a]

Independent Variable	*OLS* *(1)*	*Fixed Effects* *(2)*
Mean Blue-Collar Wage[b]	0.003**	0.0002
	(3.57)	(0.32)
Blue-Collar Wage Dispersion[c]	0.068	0.067
	(0.87)	(1.18)
Blue-Collar Wage Dispersion Squared	–0.029	–0.062
	(0.45)	(1.48)
Blue-Collar Wage Growth Dispersion[c]	–0.343**	–0.020
	(4.70)	(0.44)
Blue-Collar Wage Growth Dispersion Squared	0.179**	0.010
	(3.30)	(0.32)
Mean White-Collar Wage[b]	0.004**	0.001*
	(6.25)	(1.99)
White-Collar Wage Dispersion[c]	0.668**	0.073
	(8.30)	(1.19)
White-Collar Wage Dispersion Squared	–0.457**	–0.083
	(7.33)	(1.95)
White-Collar Wage Growth Dispersion[c]	–0.443**	–0.155**
	(5.51)	(3.10)
White-Collar Wage Growth Dispersion Squared	0.302**	0.127**
	(4.63)	(3.28)
Mean White-Collar Wage / Mean Blue-Collar Wage	–0.223*	–0.079
	(2.34)	(1.08)
Control for percentage blue-collar, percentage female, percentage female squared, mean education, dispersion of education, mean age, mean age squared, dispersion of age, dispersion of age squared, firm size, firm size squared, industry dummies (5), and year dummies (6	Yes	Yes
Intercept	5.858**	5.559**
	(15.97)	(10.04)
R^2	0.210[d]	0.027[e]
Number of Observations	11,134	11,134

Note: Included are firms for which the data show at least 10 blue-collar and 10 white-collar employees. Absolute t-values are in parentheses.

[a]Value added in 1,000 DKK.

[b]Hourly gross wage in DKK.

[c]Dispersion measured by the coefficient of variation (s.d./mean).

[d]Adjusted R^2 is reported.

[e]Within-R^2 is reported.

**Statistically significant at the .05 level; ***at the .01 level.

evidence (see Table 5); with the two-year-lagged value added, there is no longer a statistically significant relationship. Results for regressions on differences of log value added over consecutive years also support our results, although the level of statistical significance decreases.

Evidence from previous studies suggests that task interdependence in a firm—that is, the degree to which cooperation among employees is essential to the firm's productivity—is a key determinant of the way inequality among employees affects individual, group, and firm performance (see Siegel and Hambrick 2005 and sources cited therein). It seems likely that task interdependence also differs across firms within industries. Unfortunately, we have no information on firms' task interdependence. We are able to make cross-industry

Table 5. Wage Growth Dispersion and Value Added in t, $t + 1$, and $t + 2$.

	Fixed Effects Estimations		
	Value Added (t)	*Value Added (t + 1)*	*Value Added (t + 2)*
Wage Growth Dispersion	–0.121***	–0.171***	–0.007
	(3.36)	(4.15)	(0.14)
Wage Growth Dispersion Squared	0.102***	0.132***	0.014
	(3.22)	(3.74)	(0.34)
Within-R^2	0.036	0.013	0.012
Number of Observations	22,178	17,689	13,002

Note: Same specification as reported in Table 2, model (4). Absolute t-values are in parentheses.
***Statistically significant at the .01 level.

comparisons, however, which reveal no substantial differences.

We are aware that our focus on wage increases in firms has limited our sample to incumbents, and we recognize that leavers and new hires, who are omitted from our analysis, are not irrelevant to wage dispersion. Not only is a firm's wage policy affected over time by leavers and new hires, but that policy presumably also affects the selection process that helps determine who joins and leaves the firm. In one trial estimation, we find that implementing an additional control variable indicating the firm's annual turnover does not change the results. Clearly, however, the nature of the two-way interchange between wage policy and wage dispersion, on the one hand, and leavers and new hires, on the other, remains unresolved. We must leave the investigation of these dynamics to future research.

Discussion and Conclusion

At least two features distinguish our study from others that have examined incentive effects, fairness effects, and firms' wage policies. First, because of the richness of our data set, which provides linked employer-employee data for all employees and firms in the Danish private sector, our results do not depend on characteristics specific to a particular employment relationship, such as that in sports. Second, whereas previous studies of firm performance have examined the effects of wage dispersion, we have focused instead on the dispersion of wage *increases,* because we believe this measure is a better proxy for the extent of monetary incentives in firms. Cross-section analysis of the link between the dispersion of wage *levels* and firm performance shows a positive correlation, but we find that this result does not hold when we control for unobserved heterogeneity in a firm fixed effects panel estimation.

Our main finding, shown by numerous tests to be highly robust, is that there is a U-shaped relationship between wage increase dispersion in firms and firm performance, and that the vast majority of firms are on the decreasing part of the U-curve—that is, in most firms, marginal increases in the dispersion of wage increases will tend to reduce firm performance because the incentive effects of the increased dispersion are overmatched by the perceptions of unfairness it engenders. On this basis, we would argue that fairness considerations are more important than competition effects in general. The results are primarily driven by white-collar rather than blue-collar workers.

One clear policy implication of our findings is that management should be extremely cautious when deviating from the established distribution of wages among employees, because unconsidered changes to this equilibrium may cause financial losses. Although employees may perceive a certain dispersion of wage levels as fair (for example, because of differences in human capital or tasks), increases in the existing wage dispersion will usually lower the value added because the negative productivity impact stemming from employees' perception of

unfairness will exceed the positive incentive impact. Employees seem to react extremely sensitively to the amount of wage increase dispersion. Fehr and Rockenbach's (2003) experimental study yielded evidence about the psychological mechanism at work. The results suggested that people normally cooperate to a certain extent, and the degree of cooperation is affected by the possibility that certain incentives—which are perceived as a "fine"—can be implemented. If the fine is imposed, cooperation decreases; but if a fine is possible and yet not imposed, cooperation is actually strengthened. As applied to the 98% of firms in our sample where we found a negative correlation between changes in wage dispersion and value added, Fehr and Rockenbach's conclusions would imply that inequality-averse employees in these firms perceived high amounts of wage increase dispersion as fines. Although increasing the wage growth dispersion leads to a positive incentive or competition effect, cooperation among employees as well as between employees and management may be damaged. In contrast, employees' cooperation, which typically has large implications for firm performance, seems to be maximized when management diplomatically lets them know that (a) it could dispense highly dispersed wage increases but (b) it refrains from doing so. Our results also show that these dynamics operate most strongly within the white-collar group. The reason may be that blue-collar wages are, to a much higher degree, regulated according to contracts and to union rules, so that fairness considerations are already built into the permissible wage changes.

We have not found that our general results differ by industry or firm size. However, the effect of the dispersion of wage increases on firm performance might be conditioned by certain features of human resource management in firms or by corporate culture. Often, monetary incentives occur in conjunction with intensive monitoring. In contrast, monetary incentives might be unnecessary where the corporate culture is marked by trust between management and subordinates (Deckop, Mangel, and Cirka 1999; for experimental evidence in support of this theory, see Falk and Kosfeld 2004). Unfortunately, we are not able to explicitly differentiate firms in terms of corporate culture. However, our results harmonize with previous experimental studies in suggesting that firms with "trust cultures" tend to be more successful than those with "monitoring cultures." Corporate culture also differs across countries. Following Hofstede's (2006) cultural taxonomy, Denmark can be characterized as a country with a high degree of individualism and a low degree of masculinity, for instance. Another characterization of Denmark's corporate culture is suggested by the work of Gelfand et al. (2004), who contributed to the huge international GLOBE project on culture. Gelfand et al. split the one-dimensional individualism-collectivism scale into two dimensions: the degree of collectivism at the institutional level and at the in-group level. Denmark has a collectivistic culture at the institutional level, indicating that individuals are integrated into strong cohesive groups and are likely to engage in group activities, for instance. However, it ranks first out of 62 countries in individualism at the in-group or firm level, a characteristic that, according to Gelfand et al., is often associated with less organizational citizenship behavior and with an equity model in which individuals are expected to be rewarded in direct relation to their individual contributions to task success. One may speculate that our results partly reflect the interrelation of these two types of collectivism and individualism. Comparable studies of other countries would reveal whether the results we find hold for cultures besides Denmark's, and might help identify which cultural elements most strongly condition the interplay between wage policy and firm performance.

Our results may also be interpreted as indicating that extraordinarily high wage increases (for example, based on top past performance) are not, in general, associated with further increases in individual productivity. On the contrary, these high wage increases—accompanying promotions, as a rule—may lead to an inefficient employee-job allocation, fulfilling the Peter Principle (Peter and Hull 1969; Lazear 2004).

Wage increases for employees are often based on some kind of performance ap-

praisal (Fletcher 2001). Possibly the design of a firm's appraisal scheme mediates the link between wage growth dispersion and firm performance. Unfortunately, we have no information on performance appraisals at either the individual or firm level. Fletcher (1997) pointed out that many firms express dissatisfaction with their appraisal schemes. If an appraisal scheme is not transparent or is too complicated, it seems likely that employees will not react to monetary incentives by exerting increased effort. If that is the case, then firms wishing to convince employees of the fairness of differential wage increases would do well to ensure that their appraisal schemes are transparent and that the rating errors associated with them are minimized (Delery et al. 1998). Since the end of our observation period (1992–97), many firms have implemented new forms of performance appraisal, such as the balanced scorecard (Kaplan and Norton 1996). Once extensive data are available for the 21st century, a replication of our study might therefore be of interest.

Future research might also establish whether our findings hold up in other institutional environments. The weight workers give fairness considerations could easily prove variable across countries. One relevant factor, for example, could be the extent of unionization, as unions may influence both the dispersion of wage increases and the perceived fairness of that dispersion. Probably the main difficulty for researchers who wish to undertake studies like the present one will be in finding data sets that, like the one we obtained for Denmark, allow meaningful evaluations.

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