ISSN 1651-0852

FIEF Working Paper Series 2002

No. 186

Pay Inequality and Firm Performance: Evidence from Matched Employer-Employee Data

by

Fredrik Heyman*

Abstract

This paper uses a large matched employer-employee data set for Sweden to analyse several predictions from tournament theory. For white-collar workers, a positive effect of intra-firm wage dispersion on profits and average pay is found. This result is robust to controls for human capital characteristics and firm fixed-effects as well as to instrumenting the wage dispersion variable. Using data on around 10,000 managers, the same relationships are also found for executives. Further results include a positive relationship between market demand volatility and wage dispersion for managers, and a negative effect of the number of managers (contestants) on managerial pay spread.

Keywords: Wage dispersion; Firm performance; Tournament models; Matched employer-employee data
JEL classification: J31; J41

December 19, 2002

*FIEF, Wallingatan 38, SE-111 24 Stockholm, Sweden. email: fredrik.heyman@fief.se. This paper is a revised version of Chapter 4 of my 2002 Stockholm School of Economics Ph.D. thesis. I thank Mahmood Arai, Erling Barth, Mårten Palme and Jonas Vlachos as well as seminar participants at FIEF for helpful comments. Financial support from the Jan Wallander's and Tom Hedelius Foundation is gratefully acknowledged.

1 Introduction

An important factor in wage bargaining between employers and employees concerns relative wages. Different groups of workers compare wages both internally, within their own plants or firms and externally, with workers in other firms or industries. Comparisons can be made both with workers with similar tasks, education or positions in the firm hierarchy as well as with wages for executives and managers. One example of the latter is the debate in many countries on CEO compensation. The growing gap between employee- and executive compensation has been criticized as unethical with negative effects on work morale.

According to a variety of theories, described in more detail below, the wage distribution both within and between firms can have important effects on individual productivity and firm performance. One argument for high wage differentials is based on incentive effects. Higher wage differentials lead to higher individual effort, and are therefore productivity enhancing. Lazear and Rosen's (1981) tournament theory argues that if wages are based on relative productivity, then workers with higher productivity will be rewarded with higher wages. This, in turn, will increase the equilibrium effort and lead to a positive relationship between wage dispersion and productivity.

The positive effect of pay spread on firm performance hinges on the assumption that employers determine wages by themselves. This implies that they can set the wage distribution within the firm so that it maximizes the incentives for individual effort. This may apply to executive compensation, but not to broader occupational groups. For instance, wages for white-collar workers are determined through negotiations between employers and unions in Sweden. Given that unions strive for more equalized wages, the final outcome of the wage distribution within firms becomes a function of the relative strength of the two parties.

The opposite relationship between intra-firm wage dispersion

and firm performance is found in theories stressing fairness and cooperation between co-workers. Akerlof and Yellen (1990) argue that individual effort is reduced if the wage is regarded as unfair. A similar argument based on cohesiveness is found in Levine (1991).

As discussed by e.g. Prendergast (1996) and Eriksson (1999), many results from the empirical literature on issues related to the wage structure within firms are consistent with different theories. This also applies to various predictions from tournament models. As a consequence, it is difficult to distinguish between alternative explanations. This study follows Eriksson in testing several predictions from tournament theory on the same data, and not just if results are in accordance with one or two hypotheses. First of all, the general relationship between within-firm pay inequality and firm performance is studied. The analysis is carried out for both white-collar workers and managers, using different measures of intra-firm wage dispersion. In addition, three more specific implications from tournament models are tested: (i) a convex relationship between pay and job levels for managers including a particularly large increase at the very top of the hierarchy; (ii) a positive relationship between the number of executives (contestants) and wage dispersion for managers and (iii) a positive association between market demand volatility and managerial pay spread.

Estimation is based on a large matched employer-employee data set for Sweden consisting of very detailed information on approximately 170,000 individuals, including around 10,000 managers. Each individual is assigned a unique organization-number, mapping each worker to his/her establishment. These establishments then form the basis of the Swedish Establishment Survey (APU). A large number of administrative data for *all* individuals working in APU-establishments constitutes the larger individual sample. These data are then matched with balance sheet data for the firms where the individuals work through the Swedish system

of corporate registration numbers. The matched data contain detailed information on individuals and firms and, as such, the data are well suited for studying various aspects of firms' internal wage structure.

The main results are: (i) a positive and significant effect of intra-firm wage dispersion on profits and average pay, which applies to both managers and white-collar workers; (ii) a positive relationship between the degree of noisy business environment, measured as variation in sales, and wage dispersion and (iii) a negative effect of the number of managers (contestants) on managerial pay spread. The first two results are in accordance with predictions from tournament theory, while the last is not.

Previous studies have mainly focused on wage dispersion for managers. This has been a natural first step since tournament theory is primarily a theory on how wage distribution affects managerial behavior. Furthermore, suitable data for analyzing the relationship between wage distribution for wider occupational groups of workers and firm performance have previously not been available. With the creation of matched worker-firm data sets, the question of the effects of intra-firm wage spread can be addressed.

Earlier evidence on wages for managers and various aspects of predictions from tournament models includes O'Reilly *et al.* (1988), Leonard (1990), Main *et al.* (1993) and Eriksson (1999). Winter-Ebmer and Zweimuller (1999) and Bingley and Eriksson (2001) present evidence on the relationship between pay dispersion and firm performance for broader occupational groups. Except for Bingley and Eriksson and Winter-Ebmer and Zweimuller, previous studies do not control for differences in human capital accumulation, however. This means that the results can partly be driven by a systematic sorting of workers (and managers) into firms with certain characteristics. This study is the first to explicitly control for firm differences in human capital, when testing several predictions from tournament theory. In addition, issues related to unobserved firm heterogeneity and endogeneity of wage

dispersion are considered by estimating difference equations and instrumenting intra-firm wage dispersion.

The present study also adds to the previous literature in that it is the first to study aspects of tournament models, including the effect of wage dispersion on firm performance, on Swedish data. In an international perspective, the Swedish wage distribution is very compressed and characterized by strong unions and a higher degree of centralized wage negotiations than most other countries.[1] Given these characteristics, it is of interest to compare results to those for countries with more dispersed wages. One issue to consider is whether the characteristics of the Swedish wage structure influence the findings in many studies of a positive relationship between managerial pay spread and firm performance.

The remainder of the paper is organized as follows. The theoretical background and previous empirical evidence are presented in Sections 2 and 3, respectively. Section 4 describes the data and the empirical setup. The results are presented in Section 5. Finally, the paper is concluded in Section 6.

2 Theoretical Background

2.1 Predictions From Tournament Models

A central question in labor economics concerns wage determination. In the classical competitive framework, wages are determined by individual productivity. However, numerous studies have found wages to be distributed in a way that cannot be explained by productivity differences. There are several reasons why observed wages may be more equally distributed than productivity differences between employees. If individual productivity cannot be observed, or this is too costly, wage differences cannot reflect differences in productivity between employees. Another explanation is that employees are more risk averse than employ-

[1] See OECD (1996) for an overview of earnings inequality in OECD countries.

ers, so that workers are willing to accept wages that are more compressed than the actual productivity distribution.

These explanations treat individual productivity as exogenous in the sense of not being related to the actual pay distribution. However, there are reasons to believe that the determination of wages within and between firms affects worker behavior and thereby, their productivity. Theories linking wage dispersion and productivity (and firm performance) give rise to conflicting predictions of whether this relationship is positive or negative.

A common argument against an egalitarian wage distribution is that it has negative incentive effects. According to this line of argument, high wage spreads lead to increased effort and also increase the employee motivation to engage in, for instance, more education and on-the-job training. These incentive effects would then result in higher productivity and improved firm performance.

The tournament model analyzes the effect of wages on incentives in the presence of costly monitoring of individual productivity and effort (see Lazear and Rosen (1981)). The model postulates that it is efficient to reward workers according to their relative performance rather than to absolute performance. The wage gap between different jobs is interpreted as the tournament prize. A high wage gap between employees (players) provides incentives for workers to do their best, which means that the equilibrium effort is increasing in the difference between winning or losing the prize (Equation (6) in Lazear and Rosen (1981)).

Another prediction from tournament models is that wage differentials are expected to increase, the higher one moves up the hierarchy (see Rosen (1986)). The reason for this is that winning a contest at every level below the highest, does not only give the prize, but also the possibility to win further prizes higher up the hierarchy (an option value). There are no further prizes at the highest level so to induce enough incentives at that stage, the prize structure must include an extraordinarily large increase at the very top of the hierarchy. This means that the optimal compen-

sation schedule implies a convex relationship between wages and hierarchal job level, including additional weight on top-ranking prizes (Equations (14)-(16) in Rosen (1986)).

In an extension of tournament models with many contestants, McLaughlin (1988) analyzes the effect of the number of contestants (n) on the prize structure, effort and incentives. He shows that in the case of risk-neutral contestants, the prize spread increases with the number of contestants (Equation (47) in McLaughlin (1988)). The intuition behind this result is that if n is large, a marginal increase in effort only has a small effect on the probability of winning. Therefore, a big prize spread is required to induce effort. Empirically, this means that controlling for other economic determinants of managerial pay, the wage gap between the CEO and the vice presidents should be positively related to the number of vice presidents.

Another implication of tournament models concerns the effect of market uncertainty on the optimal pay structure. Various versions of tournament models show that the greater is the importance of variability of demand, the lower is the optimal effort level. If luck is an important factor in determining output, employees will be less motivated to try hard to win the promotion. This means that in markets where stochastic shocks in output are important, the wage gap must be sufficiently high to counterbalance the negative effect on effort of the random component (Equation (6) in Lazear and Rosen (1981)). Empirically, this implies that we will observe large wage spreads in markets characterized by a high degree of demand and output uncertainty.

To sum up, tournament theories give rise to the following four testable predictions:

Prediction 1: A positive relationship between wage dispersion and firm performance.

Prediction 2: A convex relationship between wages and job levels, including an extra large increase at the top of the hierarchy.

Prediction 3: A positive relationship between the number of contestants in a tournament and wage dispersion.

Prediction 4: A positive relationship between the degree of market demand volatility ("noisy business environment") and wage dispersion.

2.2 Predictions From Alternative Models of Wage Determination

The prediction of a positive relationship between wage dispersion and firm performance is controversial from a theoretical perspective. One argument against using relative wages for enhancing productivity, based on the risk for uncooperative behavior, is presented in Lazear (1989). He shows that when employee compensation is based on relative comparisons, workers may engage in uncooperative behavior *vis-à-vis* fellow workers. Relative compensation implies that workers can increase their chances of winning a contest by either increasing their own effort, or negatively affecting the productivity of co-workers. If the latter behavior is frequent in a firm, increasing wage compression can be productivity enhancing. The importance of unproductive uncooperative behavior is related to the organization and composition of the work force. The higher the share of very competitive "aggressive" individuals in a firm, the higher are the positive effects of a flat wage distribution.

A link between wage distribution, job morale and productivity can also be found in equity and relative deprivation theories (see Cowherd and Levine (1992) and references therein). According to equity theory of human behavior in social exchange, wages should be distributed so that the ratio between the value of labor input (e.g. effort) and output (e.g. wage) is perceived as fair, which is the case if it is similar to that of a relevant comparison group. However, the perception of an unfair ratio has negative consequences for the firm in terms of decreasing individual effort

or individuals leaving the organization as a result of not receiving fair wages. Based on equity theory, Akerlof and Yellen (1990) present a model seeking to explain why a compressed wage structure can be productivity enhancing. According to their fair-wage hypothesis, employees withdraw effort, hence becoming less productive, as their wage becomes lower than the "fair" wage.

The relative deprivation theory is closely related to equity theory. According to relative deprivation theory, individuals experience deprivation when comparing their wages to those of a reference group, and find that they receive less. The relevant reference group can differ between individuals and groups. For instance, the reference group can be workers in the same occupation within the firm, managers in the same firm or workers in dissimilar occupations within the firm. A wage structure that is too dispersed, thus leaving groups of workers dissatisfied with their relative wages, can result in absenteeism, strikes or sabotage.

Finally, Levine (1991) presents a model where firms want to reduce wage differentials based on efficiency wage considerations. The reason being that a more compressed wage structure increases cohesiveness (and productivity) within a firm. This paper defines cohesiveness as "the propensity to obey group norms because approval of the group is valued". To maintain cohesiveness, firms will pay an efficiency wage to those at the low end of the wage distribution.

3 Previous Studies

Most empirical studies investigating the effect of firm pay structure on firm performance have focused on compensation to top executives. A seminal paper is Leonard (1990). He studies the effects of executive compensation policy on performance for a sample of large US firms and finds no statistical relationship between the standard deviation of pay and the steepness of pay for managers and corporate performance. Consistent with tournament

theory, wage differentials between management levels are found to be larger at higher levels in the hierarchy. Ang *et al.* (1998) present similar results regarding the effect of executive wage dispersion on firm performance. They investigate the pay gap between CEO's and other members of top management teams for a sample of Israeli firms, and find no support for the tournament model.

Main *et al.* (1993) and Eriksson (1999) find a positive relationship between managerial pay dispersion and firm performance. Using survey data on the pay for top executives in 200 US firms, Main *et al.* (1993) investigate the role of the pay distribution among the top-management team. They find a positive and significant relationship between wage dispersion among executives, measured as the coefficient of variation, and the return on assets. However, the positive effect is insignificant when they instead use stock market returns as a measure of firm performance. Consistent with tournament theory, they also find a positive and significant effect of wage dispersion on average wages. Similar results are found in Eriksson (1999) who uses information on managers for a panel of Danish firms. He finds a weak positive effect of the coefficient of variation in wages for managers on firm performance, measured as profits per sales. Furthermore, consistent with tournament theory, Eriksson finds the mean wage for managers to be higher in firms with more variation in executive compensation.

Several papers testing predictions from tournament theory study how wage differentials between managers vary along the corporate ladder. Leonard (1990) and Main *et al.* (1993) find a convex pay structure including an extraordinarily large increase at the top of the hierarchy. Eriksson (1999) reports increasing pay differences, but finds no additional reward at the top. Additional evidence, consistent with a convex wage structure, is found in Lazear (1992) and Baker *et al.* (1994), both analyzing detailed data from two different large US firms.

Evidence on the effect of the number of contestants on wage

dispersion is scarce. Studies considering the relationship between the managerial pay structure and the number of managers show mixed results. O'Reilly *et al.* (1988) find a negative relationship whereas Main *et al.* (1993) and Eriksson (1999) both find this relationship to be positive.

The prediction of Lazear and Rosen's (1981) tournament model of a positive relationship between the degree of market demand volatility and wage dispersion has only been tested by Eriksson (1999). He reports a positive and statistically significant relationship between the coefficient of variation of firm sales and the pay spread for managers.

As an alternative measure of firm performance, Cowherd and Levine (1992) consider the effects of wage equality between lower-level employees and managers on product quality. Using data on 102 US establishments, they find that pay equality is positively related to product quality. Their results are consistent with predictions from equity and relative deprivation theories, stressing the importance of the within firm wage structure on managerial goals, effort and cooperation.

All papers presented above study the pay structure for managers, while other papers use wage data for broader groups of workers. Using Swedish data on individual wages and aggregated industry information on productivity, Hibbs and Locking (2000) investigate the relationship between wage dispersion and productive efficiency. They find a positive effect of within-plant and within-industry wage dispersion on industry productivity (alternatively measured as real value added or labor productivity). The opposite is true for between-plant and between-industry wage dispersion, which are negatively related to productivity.[2]

The studies presented above do not take firm differences in hu-

[2] The between-industry wage dispersion results are consistent with theories stressing the positive structural effects of a compressed wage structure. This is done by shifting labor and capital from less productive to more productive firms and industries (see Moene and Wallerstein (1997)).

man capital into account.[3] To my knowledge, only Bingley and Eriksson (2001) use such data to test predictions from tournament theory on the effects of wage spread and skewness for the whole wage distribution on employee productivity and firm performance in Denmark. In this analysis, the authors explicitly take firm differences into account in the composition of human capital. Sickness absenteeism is used as a proxy for individual effort and total factor productivity as a measure of firm productivity. Firm productivity is increasing in wage dispersion for white-collar workers up to a point, after which it becomes counter-productive. Only weak productivity effects are found for blue-collar workers.

A related paper also analyzing the effects of the entire firm wage distribution is Winter-Ebmer and Zweimüller (1999). They test theories on the relationship between within-firm pay structure and firm performance on wage data for Austrian firms. However, they lack direct information on firm performance and instead, they proxy firm performance with the total firm wage level. The results are similar to those of Bingley and Eriksson (2001).

4 Data and Empirical Specification

The data on individuals originate from the Swedish Level of Living Surveys (LNU) in 1991, a representative survey of non-agricultural workers aged 18-64. Each individual has a unique organization-number, mapping each worker to his or her employer. These firms then form the basis of the Swedish Establishment Survey (APU).[4] By matching the organization number for the firms in APU with employment data from Statistics Sweden, information on all individuals working in these firms sometime during 1987, 1991 or 1995 is available. Individuals working in non-agricultural private APU-establishments in 1991 and 1995 constitute the worker data

[3] Eriksson (1999) has information on human capital characteristics, but only uses these data when studying the convexity of the managerial pay structure.

[4] For more information on the data, see le Grand *et al* (1996).

set. Each year contains approximately 170,000 employees.

For these individuals, rich information is obtained by matching data from several Swedish data sources. Data on wages and job characteristics are provided by Statistics Sweden (*SCB*) and from data collected by the Swedish Trade Union Confederation (*LO*) and the Swedish Employers' Confederation (*SAF*). Information on employment, including total labor market experience and seniority, originates from the Swedish Employment Register. Data on individual characteristics such as age, gender and birth origin are from the Population Census from *SCB* (*Registret över totalbefolkningen*). Detailed information on education, including grades from high school, are from the Swedish Education Register (*Utbildningsregistret*). See the Appendix for a detailed description of the data.

Managers are classified according to the international standard classification of occupations (ISCO-88). Corporate managers are divided into four subgroups: Directors and chief executives, Production and operations department managers, Other department managers and Lower level decision makers. Classification codes for managers are only available in 1995. Data for 1995 on executives consist of about 10,000 managers in 560 firms, for all of whom information on individual characteristics are available.

The unique organization number for each employing firm is utilized to match the individuals with balance sheet data for the firms where they work. Balance-sheet information is available for the period 1987-1996. Before matching individuals and firms, those firms in the balance-sheet data that are observed for less than two years or with less than 2 employees are removed. The balance-sheet information data for 1991 and 1995 are transformed into four-year averages. The reason for this is twofold. First, measurement errors in variables, such as profits per employee, are reduced when four-year averages are uses. Second, due to high variability in both firm performance variables and firm size, four-year averages yield a better measure of long-run profitability,

removing the transitory variation in profits.

Annual profits after capital depreciation per employee are used as a measure of firm performance. 146 firms with a four-year average profit-per-employee below -65,000 SEK in 1991 (the 1st percentile) and above 273,000 SEK (the 99th percentile) are removed. For the data from 1995, I remove 124 firms with a four-year average profit-per-employee below -94,000 SEK (the 1st percentile) and above 687,000 SEK (the 99th percentile). These extreme values are most likely due to measurement errors in the profits or firm-size variables.

When analyzing the effect of intra-firm wage dispersion on firm performance, it is important to compute wage dispersion for a relevant group of employees. There are several ways of measuring wage dispersion within the firm. Wage dispersion can be defined for different groups of workers, such as between white- and blue-collar workers, or between managers and the rest of the work force. It can also be defined for similar workers in terms of various observable productivities. In the latter case, the residual inequality, after controlling for human capital variables, is the relevant measure of wage dispersion.

This study analyzes the wage distribution for both unequal and observationally equal employees. The former include the white/blue collar wage gap and various measures of wage dispersion for white-collar workers. The latter concept refers to unexplained residual inequality for white-collar workers and wage dispersion for managers.[5] To compute conditional wage differentials for white-collar workers, I follow Winter-Ebmer and Zweimuller (1999) and Bingley and Eriksson (2001) and estimate individual wage equations for each year, 1991 and 1995, and each firm as

$$\ln W_{ijt} = \beta_0 + \beta_1' \mathbf{X}_{ijt} + \varepsilon_{ijt} \ ,$$

[5] Within firms, the group of managers is, in many respects, a much more homogeneous group than white-collar workers, a category including employees with a variety of tasks.

where W_{ijt} is the full-time equivalent monthly wage for worker i in firm j at time t; $\mathbf{X}_{ijt}$ is a vector of individual characteristics including gender, education, labor market experience, labor market experience squared and tenure and ε_{ijt} is the usual error term. Estimations are based on firms with at least five white-collar employees.

The variance in the residuals for each firm and each year is used as a measure of conditional wage dispersion. This measure is the residual inequality after controlling for observable human-capital characteristics and is then used as an independent variable in employee-weighted regressions on firm performance. Other measures of wage dispersion for white-collar workers that will be used are the coefficient of variation of wages, the 90-10th percentile wage ratio and the white/blue-collar wage ratio. These measures represent raw measures of wage dispersion and do not account for individual differences in human capital accumulation, such as education and labor market experience.

All equations include control for firm differences in human capital of the work force and for industry and firm size. Firm differences in human capital are accounted for by including the share of the work force that (i) have more than 5 years of labor market experience, (ii) have more than 3 years of tenure, (iii) have attended at least long upper secondary school and (iv) are younger than 25 and older than 50 years, respectively. The share of women, the share of white-collar workers and the share of workers with foreign origins are also included.

The effect of pay spread for white-collar workers on firm performance will be estimated on both cross section for 1991 and 1995 as well as first-difference equations for 1991-1995. The latter method deals with the effect of unobserved firm heterogeneity. To exploit the question of endogeneity in wage dispersion, IV-equations are estimated. Lagged, predetermined values of wage dispersion are used as instruments. In the analyses of managers, the coefficient of variation in managerial wages, the wage difference and the wage

ratio between the CEO and other managers will be used.

One problem in testing whether wage dispersion increases with the number of contestants is how the contestants should be defined. Since I lack information identifying vice presidents, I follow Main *et al.* (1993) and Eriksson (1999) in defining the contestants to be all individuals reported as being part of the management team. This group is approximately equal to those who could be seen as active in the tournament. Finally, in testing the effects of output uncertainty, the coefficient of variation in firm sales during the 1992-1995 period is used.

5 Results

5.1 The Effect of Wage Dispersion on Firm Performance

5.1.1 *White-collar workers*

Tables 1 and 2 show results on the effect of wage dispersion on firm performance for 1991 and 1995, respectively. Columns 1 through 4 show the results where firm performance is used as dependent variable along with different measures of wage dispersion. Columns 5 and 6 in Table 1 show results where the wage rate is used as dependent variable. Columns 5-7 in Table 2 report results when wage dispersion is instrumented with lagged values of wage dispersion.

Column 1 in Tables 1 and 2 shows the effect of conditional wage dispersion (residual inequality) on profits to be positive and significant. The positive relationship between wage dispersion for observationally equal employees and firm performance is consistent with tournament theory. Quantitatively, for 1991, a one standard deviation increase in pay dispersion is associated with a 3,970 SEK increase in firm profits per employee. Given that the mean profits in 1991 is 29,021 SEK, the estimate indicates that a one standard deviation increase in conditional wage dispersion

Table 1. The effect of firm-level wage dispersion for white-collar workers on profits per employee and log average wage in 1991. Firm-size WLS estimations. Standard errors in parentheses.

	1	2	3	4	5	6
	Profits per employee				Log average wage	
Residual inequality	283.4**				1.53***	
	(116.0)				(.20)	
Coefficient of variation		725.1*				5.19***
		(399.2)				(.69)
90-10th percentile ratio			259.2**			
			(127.9)			
White/blue-collar ratio				1551.4***		
				(211.3)		
Log firm size	10.3***	10.3***	10.3***	9.1***	.02***	.02***
	(1.37)	(1.37)	(1.37)	(1.93)	(.00)	(.00)
Human Capital	YES	YES	YES	YES	YES	YES
Industry	YES	YES	YES	YES	YES	YES
R^2 (overall)	0.33	0.32	0.32	0.49	0.63	0.63
No. of employees	63 798	63 862	61 862	53 699	63 798	63 862
No. of firms	525	531	531	260	525	531

Notes: *** indicate significance at the 1%-level, ** significance at the 5%-level and * significance at the 10%-level. Human capital corresponds to control for workers' experience, seniority, education, gender, age, blue-collar workers and birth origin. The industry classification corresponds to 14 industries. F-tests for the joint insignificance of the human-capital variables are rejected in all equations, except equation (4). F-tests for the joint insignificance of the industry dummies are rejected in all equations.

Table 2. The effect of firm-level wage dispersion for white-collar workers on profits per employee in 1995. Firm-size WLS estimations. Standard errors in parentheses.

	1	2	3	4	5	6	7
	Profits per employee						
	OLS	OLS	OLS	OLS	IV	IV	IV
Residual inequality	926.4***				3316.8***		
	(167.2)				(813.6)		
Coefficient of variation		3843.9***				13350.9***	
		(562.0)				(2647.0)	
90-10th percentile ratio			1035.2***				3412.1***
			(183.5)				(814.7)
White/blue-collar ratio				366.5			
				(456.7)			
Log firm size	14.0***	13.2***	14.8***	22.9***	32.64***	36.32***	33.91***
	(2.05)	(2.02)	(2.04)	(4.77)	(6.62)	(6.40)	(6.59)
Human Capital	YES	YES	YES	YES	YES	YES	YES
Industry	YES	YES	YES	YES	YES	YES	YES
R^2 (overall)	0.20	0.21	0.20	0.23	0.31	0.33	0.31
No. of employees	97 746	97 900	97 900	75 212	46 203	46 223	46 223
No. of firms	1 067	1 080	1 080	432	266	268	268

Notes: *** indicate significance at the 1%-level. Human capital corresponds to control for workers' experience, seniority, education, gender, age, blue-collar workers and birth origin. The industry classification corresponds to 14 industries. F-tests for the joint insignificance of the human-capital variables are rejected in all equations, except for equation 7. The same applies to F-tests for the joint insignificance of the industry dummies. Columns 5-7 are estimated using instrumental variable analysis. Lagged (predetermined) values of wage dispersion, i.e. values for 1991, are used as instruments for wage dispersion in 1995. Results on instrumenting the white/blue-collar wage ratio, not reported in the Table, show a significant and positive effect of the white/blue-collar wage ratio on profits per employee.

increases profits per employee by approximately 15 percent, evaluated at the mean. The corresponding figure for 1995 is 37 percent.[6] These two periods are characterized by different business cycle phases. In the 1991-1995 period, Sweden experienced its deepest recession since the 1930s, with a substantial fall in GDP and an increase in total unemployment from 5 to 15 percent.

The results for alternative measures of wage dispersion are presented in columns 2-4. These are the coefficient of variation in pay, the 90-10th percentile ratio and the white/blue-collar wage ratio. It is evident from these columns that the results are qualitatively robust for different measures of wage dispersion. Regardless of measure used, wage dispersion is positively related to firm performance, the only exception being the coefficient for the white/blue-collar wage ratio that is insignificant in 1995.

Results are also robust for including various other variables in the equations. For instance, the capital-labor ratio may affect the relationship between pay structure and firm performance. It can also influence workers' possibilities of extracting rents from the firm, depending on the size of labor costs in relation to the cost of capital.[7] A positive relationship between the capital-labor ratio and wages can also influence the intra-firm wage distribution and profits. However, including firms' capital-labor ratio does not change the effect of wage dispersion on firm performance. I have also estimated models using the log of wage dispersion to take a convex relationship into consideration. With a few exceptions, the results remain unchanged.

Columns 5 and 6 in Table 1 show results on the relationship between mean wages and wage dispersion in 1991. According to tournament models, wages are, on average, higher in firms with

[6] The quantitative difference between the two periods is partly due to differences in firm sample. Estimating the effect of conditional wage dispersion on firm performance for a panel of firms present in both 1991 and 1995 yields no significant difference between the two periods.

[7] Arai (1999) finds a positive relationship between firms' capital-labor ratio and individual wages.

more dispersed wages. The estimated coefficient for the conditional wage dispersion variable and the coefficient of variation are both significant and positive, thereby being consistent with tournament theory.[8]

All equations presented in the paper have also been estimated using a sub-sample of firms with at least 50 employees. The reason for this sensitivity analysis is that there may be systematic organizational differences between small and large firms that can influence the results. Unreported results show very similar qualitative effects for the sample of large firms, as compared to those reported in the tables. Quantitatively, the estimated coefficients are, in most cases, larger for larger firms.

An issue to consider is endogeneity of the wage dispersion variable and the causality of the wage dispersion – firm performance relationship. According to bargaining models of wage determination and the rent-sharing hypothesis, wages are positively affected by profits. If high profits also lead to a more dispersed wage structure within the firm, then we will observe causality going from profits to wage dispersion. To exploit the question of endogeneity in wage dispersion, instrumental variable regressions are estimated. Lagged values of wage dispersion are used as instruments for wage dispersion. Studying the effect of intra-firm wage dispersion on profits in 1995, wage dispersion in 1995 is instrumented with lagged predetermined values of wage dispersion in 1991.

Results reported in columns 5-7 in Table 2 confirm that profits affect wages. The point-estimates are higher in the IV-equations as compared to the OLS-estimates. This may be, however, due to differences in the sample of firms. In the IV-equations only those firms that are present in both 1991 and 1995 are included. This means that fewer firms are included in the IV-equations as

[8] A higher average wage in firms with more dispersed wages is also found in 1995. Results on the relationship between intra-firm wage dispersion and average wage, not reported in Table 2, can be obtained from the author up on request.

compared to the estimated OLS-equations in columns 1-4. OLS-estimates on the same sample as in column 5-7 reveal that only the IV-estimate of residual inequality is significantly higher at the 5 percent significance level than the corresponding OLS-estimate.

The cross-section estimates presented above may be biased if variables correlated with wage dispersion are omitted. Unobserved firm heterogeneity may lead to an overestimation of the effect of wage dispersion on firm performance if, for instance, high ability individuals are sorted into high profit firms where wages are higher and more dispersed. In order to deal with unobserved firm heterogeneity, difference equations are estimated on a panel of firms present in both 1991 and 1995. Results from the first-difference estimates are presented in Table 3.

A Hausman test is used to discriminate between the fixed-effects and the random-effects models. This is a test for correlation between the firm-specific effects and the independent variables. Results of the Hausman tests indicate that the firm-effects are not correlated with the independent variables in the equations with profits as the dependent variable. This means that the random-effects estimator is efficient, taking both cross-section and time-series variation into account. The Hausman tests also show that exogeneity of the wage dispersion variable cannot be rejected. This, in turn, means that I can rely on consistent cross-section estimates.

The Breusch and Pagan LM-test is used to test for individual random-effects. The null-hypothesis is that the variance in the firm-specific effects equals to zero. A rejection of the null shows that firm-specific effects are present. As can be seen in Table 3, the estimated test statistic is significantly different from zero.

Results from the estimated random-effects models show a positive and statistically significant effect of wage dispersion on profits. For the conditional wage dispersion measure, the quantitative effect is in the range of the estimates obtained in cross-section estimations for 1991 and 1995. Similar results are found for the

Table 3. The effect of firm-level wage dispersion for white-collar workers on profits per employee and log average wage. Results from first–difference estimations for 1991-1995. Standard errors in parentheses.

	1	2	3	4	5	6
	Profits per employee				Log average wage	
Residual inequality	275.1***				1.27***	
	(93.3)				(.17)	
Coefficient of variation		561.7*				6.32***
		(345.7)				(.59)
90-10th percentile ratio			187.7*			
			(114.5)			
White/blue-collar ratio				753.3***		
				(262.8)		
Log firm size	3.5	3.1	3.3	5.1	-.03*	-.03*
	(2.7)	(2.7)	(2.7)	(4.0)	(.01)	(.01)
Human Capital	YES	YES	YES	YES	YES	YES
Hausman test	11.2	11.1	10.8	9.8	31.9***	25.2***
Breusch and Pagan test	33.2***	33.9***	34.4***	18.6***	80.9***	95.7***
R^2 (overall)	0.06	0.05	0.04	0.09	0.35	0.42
No. of firms	267	268	268	171	267	268

Notes: *** indicate significance at the 1%-level and * significance at the 10%-level. Human capital corresponds to control for workers' experience, seniority, education, gender, age, blue-collar workers and birth origin. Equations 1-4 are estimated with a random-effects model and equations 5 and 6 with a fixed-effects model. F-tests for the joint insignificance of the human-capital variables are rejected in all equations, except equation (4).

other pay spread variables presented in columns 2-4. For instance, an increase in the coefficient of variation in wages by one standard deviation increases firm profits by approximately 20 percent, evaluated at the mean of profits. Regressions of average pay on wage dispersion, again controlling for firm differences in human capital accumulation and firm size, show significantly lower wages

in firms with less dispersed wages (see columns 5 and 6 in Table 3).[9] This is, once more, consistent with tournament theory.

5.1.2 *Managers*

Table 4 shows results on the relationship between managerial wage spread and profits (column 1-5) and the association between average pay for managers and wage dispersion (columns 6 and 7). All equations include control for human capital, industry and firm size.

Column 1 in Table 4 shows a significant positive association between the coefficient of variation in CEO wages and profits per employee. Quantitatively, the estimated coefficient means that a one standard deviation increase in the coefficient of variation of wages for managers is associated with an approximately 29,000 SEK increase in mean profits per employee for those firms in 1995 with information on managers. This amounts to 62 percent of the mean profits per employee in the sample.[10] Columns 3 and 5 show results when alternative measures of executive wage spread are used. These are the wage difference between the CEO and other managers in the firm, and the wage ratio between the CEO and other managers, respectively.[11] Once more, results show a positive effect of managerial pay spread on profits.

As stressed by Main *et al.* (1993), Lazear's tournament model suggests control for the average pay of managers and the degree of task independence among executives. To take the former into consideration, equations are estimated including firms' mean wages. This is done in order to take the part of the positive effect of pay dispersion on profits that can be due to a relationship between

[9] Equations with average pay as the dependent variable are estimated with a fixed-effects model. Results of the Hausman test indicate rejection of the random-effects model, given the specification.

[10] It should be noted that a one standard deviation increase in wage dispersion is associated with a large increase in wage dispersion; around 30 percent evaluated at the mean.

[11] I have also experimented with other measures of wage dispersion that do not alter the results.

Table 4. The effect of firm-level wage dispersion for managers on profits per employee and log average wage in 1995. Firm-size WLS estimations. Standard errors in parentheses.

	1	2	3	4	5	6	7
	Profits per employee					Log average wage	
Coefficient of variation	3233.2*** (485.8)	3372.2*** (489.3)				2.72*** (.83)	
CEO - other managers' diff.			127.8*** (26.6)	132.5*** (28.7)			-.19*** (.04)
CEO - other managers' ratio					1258.1*** (258.4)		
Log average wage		-51.2** (25.3)		25.0 (56.8)			
Log firm size	11.2*** (3.1)	10.4*** (3.2)	24.4*** (5.8)	25.0*** (5.9)	24.3*** (5.7)	-.02*** (.01)	-.02*** (.01)
Human Capital	YES	YES	YES	YES	YES	YES	YES
Industry	YES	YES	YES	YES	YES	YES	YES
R^2 (overall)	0.26	0.27	0.45	0.45	0.45	0.42	0.58
No. of employees	87 473	87 473	56 038	56 038	56 038	87 473	56 038
No. of firms	561	561	185	185	185	561	185

Notes: *** indicate significance at the 1%-level and ** significance at the 5%-level. Human capital corresponds to control for workers' experience, seniority, education, gender, age, blue-collar workers and birth origin. The industry classification corresponds to 14 industries. F-tests for the joint insignificance of the human-capital variables are rejected in all equations. The same applies to F-tests for the joint insignificance of the industry dummies.

mean wages and profits into account. A positive relationship between wages and profits is compatible with various versions of efficiency-wage models, predicting higher profits for firms paying higher wages (see Akerlof and Yellen (1986)). Results controlling for the average pay among managers, reported in columns 2 and 4, show that inclusion of this variable does not change the estimated coefficient for the coefficient of variation variable.[12]

[12] The estimated coefficient for log average pay is negative and significant in the regression

Considering the issue of team interdependence, wage dispersion must be modified if competition among managers leads to negative effects, such as sabotage or uncooperative ("hawkish") behavior.[13] To take team interdependence into account, Main *et al.* (1993) and Eriksson (1999) include the proportion of executives holding jobs with profit center head titles as a measure of executive team interdependence. Due to lack of information on profit center head titles, this could not be done in this study. However, neither Main *et al.* (1993) nor Eriksson (1999) find a significant effect of the team interdependence variable.

Finally, results on the relationship between average pay for managers and wage dispersion are mixed. I do find a positive and significant effect when the coefficient of variation in managerial pay is used as an independent variable (column 5), but the opposite is found when the wage difference between the CEO and other managers is used as a measure of executive pay spread (see column 6).

5.2 Basic Managerial Pay Structure

As described above, the tournament model suggests that the wage gap between executives (players) in one rank and those in the next should be sufficiently large to create incentives for managers to do their best. This pay gap (the prize of the tournament) is expected to increase, the higher one moves up the hierarchy, thereby implying a convex wage structure for managers.

---

with coefficient of variation as a measure for wage dispersion, whereas it is positive, but insignificant, when the wage gap between the CEO and other managers is used. Besides the difference in definition of wage spread, the reason behind this seems to be the differences in the sample of firms. Estimating equation 2 on the same sample as in equation 4, leaves the estimated coefficient for lag average wage insignificant. However, the coefficient of variation is still positive and significant. It should also be noted that the mean wage and the measures of managerial wage dispersion are highly correlated, as is confirmed by significant raw correlations.

[13] In the terminology of Lazear, the effect of pay dispersion among managers depends on whether the firm's managers mainly consist of "hawks" or "doves".

Table A1 in the Appendix presents the mean wages for the four managerial levels. As can be seen from the table, the mean wage increases when moving up the hierarchy. Starting from the highest level, managers on level 1 have a 70 percent higher mean wage than those on level 2. The corresponding wage increases between levels 4 and 3 and between 3 and 2 are 43 and 14 percent, respectively. Wages increase when moving up the corporate ladder, and there also seems to exist an extra high wage gap at the very top. However, data do not reveal a convex pay structure for managers. These figures can be compared with Main *et al.* (1993) and Leonard (1990), who find a convex pay structure including an extraordinarily large increase at the top of the hierarchy and with Eriksson (1999), reporting increasing pay differences but no additional reward at the top.

The wage differences in Table A1 do not account for differences in human capital between managers, nor for differences in firm size and industry affiliation. It may be the case that observed pay gaps are due to differences in individual and firm characteristics and that there exists a systematic sorting into different management levels. Column 1 in Table 5 shows results from estimating a wage equation on executive job levels and individual and firm characteristics.

The estimated wage differences between levels are now somewhat lower, but still, moving from the second highest to the highest level is associated with the largest percentage increase. The percentage pay differences between levels, starting from the lowest level, are 32, 8 and 54 percent, respectively. Including level dummies leads to a large increase in explanatory power. 42 percent of the variance in pay is explained by a model controlling for individual-, firm- and industry factors, as compared to 62 percent when executive level dummies are included.

Executive pay is increasing in experience and schooling and is lower for women than for men. It is also higher in large firms. However, managers are not rewarded for tenure within the firm,

Table 5. The effect of individual and firm characteristics on wage differences between managerial levels and on wage dispersion. Robust standard errors in parentheses.

	1	2	3	4	5	6
	Log Monthly Wage				Wage Dispersion	
	All Managers	All Managers	Level 1 Managers	Level 2 Managers	Level 1 Managers	Level 2 Managers
Level 1	.77***	.78***				
	(.02)	(.02)				
Level 2	.35***	.35***				
	(.01)	(.01)				
Level 3	.25***	.28***				
	(.001)	(.007)				
Log firm size		.00**	.03***	-.01***	.05***	.00
		(.00)	(.01)	(.00)	(.01)	(.00)
Female	-.16***	-.15***	-.28***	-.18***	-.09**	.01
	(.01)	(.01)	(.05)	(.01)	(.04)	(.01)
Experience	.04***	.03***	.01	.04***	.01	-.01**
	(.00)	(.00)	(.01)	(.00)	(.01)	(.00)
Experience^2/100	-.06***	-.006***	-.00	-.05***	-.02	.02***
	(.00)	(.00)	(.03)	(.01)	(.02)	(.001)
Seniority/10	-.01**	-.02***	-.09***	-.03***	-.08***	-.01
	(.00)	(.00)	(.02)	(.017)	(.02)	(.01)
Education level	YES	YES	YES	YES	YES	YES
Industry	NO	YES	YES	YES	YES	YES
R^2	0.61	0.62	0.24	0.28	0.34	0.15
N	9 996	9 996	516	3 159	495	1 815

Notes: *** indicate significance at the 1%-level and ** at the 5%-level. The industry classification corresponds to 14 industries. The dependent variable in columns 5 and 6 is the wage gap between the CEO and other managers. F-tests for the joint insignificance of the industry dummies are rejected in all equations.

the coefficient for seniority is in fact negative. This effect is consistent with the notion that the most able managers are the first to be promoted, while the others remain longer in the firm and receive lower wages. The same pattern is observed in columns 3

and 4, where separate equations are estimated for the two highest management levels.

Human capital and firm characteristics also affect the prize of the tournament, as measured by the difference in pay between the CEO and other executives. Column 5 and 6 show the wage gap to be positively related to the size of the firm and negatively related to firm tenure. It is, however, not significantly affected by education and experience.

5.3 The Effect of the Number of Contestants

In an extension of tournament models with many contestants, McLaughlin (1988) shows that, in the case of risk-neutral contestants, the prize spread increases with the number of contestants. Empirically, this means that after controlling for other economic determinants of managerial pay, the more vice presidents, the larger the observed wage gap between the CEO and the vice presidents. The effect of the number of contestants on managerial pay spread is presented in Table 6.

Column 1 shows results for a specification with only the number of contestants and firm size as independent variables. The dependent variable is the log difference between CEO compensation and the average wage for the other executives. The coefficient for the number of contestants is negative and highly significant. This result is clearly at odds with the prediction in tournament models with risk-neutral players of a positive relationship between the number of participating contestants and the managerial pay gap. The results are not altered when industry dummies are added to control for fixed industry effects (column 2) or controls for differences in human capital accumulation between firms (column 3). The point-estimates for the effect of the number of contestants in columns 1-3 are not significantly different.

Table 6. The effect of the number of contestants on wage dispersion for managers. Firm-size WLS estimations. Standard errors in parentheses.

	1	2	3	4	5	6
	Wage gap			Coefficient of variation		
Number of managers/100	-.08***	-.09***	-.12**	-.001***	-.001***	-.001***
	(.01)	(.00)	(.01)	(.000)	(.000)	(.000)
Log firm size	.10***	.14***	.13***	.003***	.003***	.003***
	(.02)	(.02)	(.02)	(.000)	(.000)	(.000)
Human Capital	NO	NO	YES	NO	NO	YES
Industry	NO	YES	YES	NO	YES	YES
R^2 (overall)	0.15	0.46	0.54	0.13	0.20	0.26
No. of employees	56 038	56 038	56 038	87 458	87 458	87 458
No. of firms	185	185	185	560	560	560

Notes: *** indicate significance at the 1%-level and ** at the 5%-level. Human capital corresponds to control for workers' experience, seniority, education, gender, age, blue-collar workers and birth origin. The industry classification corresponds to 14 industries. The dependent variable in columns 1-3 is the wage gap between the CEO and other managers and in column 4-6, the coefficient of variation for log executive pay. F-tests for the joint insignificance of the human-capital variables are rejected in equations (3) and (6). The same applies to F-tests for the joint insignificance of the industry dummies in equations (2), (3), (5) and (6).

The same pattern also emerges when the coefficient of variation in executive pay is used as dependent variable (see columns 4-6 in Table 6). The results in Table 6 are in line what is found by O'Reilly *et al.* (1988), who also finds a negative relationship. A positive association between the number of contestants and managerial pay spread is presented in Main *et al.* (1993) and Eriksson (1999).

The negative relationship between the number of firm managers and managerial wage dispersion is consistent with wage-setting theories stressing the importance of fairness and/or cohesiveness (see the references given in Section 2). If, for instance, department managers compare their wage to that of the CEO and

perceive the relative wage as unfair, they may put less effort into their work and, hence become less productive. In this case, a compressed wage structure in firms with a large number of managers is productivity enhancing. A similar argument can be based on the risk for uncooperative behavior, if managerial wages are very dispersed (see Lazear (1989)).

Finally, drawing conclusions on the effect of the number of contestants on the wage spread, it is important to keep in mind that the theoretical prediction of a positive relationship hinges on the assumption of contestants' risk behavior. McLaughlin (1988) shows that in the case of risk-averse contestants, the effect on the wage spread is ambiguous; the optimal wage spread going to zero in the limit.

5.4 The Effect of Market Demand Volatility on Pay

Various versions of tournament models show that the greater is the importance of variability in demand, the lower is the optimal effort level. This means that in markets with a large stochastic output component, the wage gap must be sufficiently high to counterbalance the negative effect on effort from the random component. Empirically, this implies that we will observe large wage spreads in markets characterized by a high degree of demand and output uncertainty. Results from tests on this aspect of tournament theory are presented in Table 7.

The dependent variable in column 1 is the pay gap between the CEO and the average pay for other managers. Consistent with tournament theory, the coefficient for the coefficient of variation in firm sales is positive and significant, implying higher wage dispersion in firms operating in volatile markets. The results are robust for including control for variation in human capital among firms (column 2). The point-estimates in columns 1 and 2 are very similar, suggesting that firm-differences in observable human

Table 7. The effect of market demand volatility on wage dispersion for managers. Firm-size WLS estimations. Standard errors in parentheses.

	1	2	3	4	5	6
	Wage gap			Coefficient of variation		
CV of Sales/Employee	.242***	.327***	.242***	.008***	.007***	.007***
	(.079)	(.086)	(.073)	(.002)	(.002)	(.002)
Log firm size	.040***	.012	.117	.001***	.001***	.002***
	(.014)	(.017)	(.019)	(.000)	(.000)	(.000)
Number of managers/100			-.113***			-.001***
			(.014)			(.000)
Human Capital	NO	YES	YES	NO	YES	YES
Industry	YES	YES	YES	YES	YES	YES
R^2 (overall)	0.30	0.39	0.57	0.19	0.27	0.29
No. of employees	56 021	56 021	56 021	87 456	87 456	87 441
No. of firms	184	184	184	560	560	559

Notes: *** indicate significance at the 1%-level. Human capital corresponds to control for workers' experience, seniority, gender, age, blue-collar workers and birth origin. The industry classification corresponds to 14 industries. The dependent variable in columns 1-3 is the wage gap between the CEO and other managers and in column 4-6, the coefficient of variation for log executive pay. F-tests for the joint insignificance of the human-capital variables are rejected in equations (2), (3), (5) and (6). The same applies to F-tests for the joint insignificance of the industry dummies in all equations.

capital do not influence the results. The result on the effect of market demand volatility is also robust for including the number of contestants (see column 3).

To make the results comparable to Eriksson (1999), Table 7 also shows results when the coefficient of variation in executive compensation is used as a dependent variable. As can be seen from columns 4-6, results on the effect of noisy business environment on wage dispersion remain qualitatively unchanged. Quantitatively, the coefficient implies that a one standard deviation increase in the variable for firm sales uncertainty is associated

with a 6-11 percent increase in the pay spread for managers. This effect is higher than what is found in Eriksson (1999). He reports that an increase in the coefficient of variation in firm sales by 1 standard deviation increases the coefficient of variation in pay by 3 percentage points.

6 Summary and Conclusions

This paper uses a large matched employer-employee data set for Sweden to test several predictions from tournament theory. First of all, the relationship between within-firm pay inequality and firm performance is studied. In addition, three more specific implications from tournament models are tested. The analysis is carried out for both white-collar workers and managers, using different measures of intra-firm wage dispersion.

For white-collar workers, results show a positive effect of intra-firm pay spread on firm performance for both 1991 and 1995. This applies to different measures of wage dispersion, capturing both raw differences as well as differences corrected for part of the wage spread being due to differences in human capital accumulation. Using detailed information on individual characteristics, all equations include controls for firm differences in the human capital of the work force, for industry affiliation and for firm size. To take unobserved firm heterogeneity and the possible endogeneity of wage dispersion into account, difference equations and IV-equations are estimated on a panel of firms present in both 1991 and 1995. Once more, consistent with tournament theory, results yield a positive and significant effect of wage dispersion on profits.

Quantitatively, an increase in the coefficient of variation in wages by one standard deviation increases firm profits by approximately 20 percent, evaluated at the mean of profits. Results from Hausman tests show that exogeneity of the wage dispersion variable cannot be rejected. Hence, there seems to be a causal effect of pay spread on firm performance, both in cross-section

and first-difference estimations.

The results for managers are based on information on approximately 10,000 managers in 560 firms. For various measures of wage dispersion and specifications, a positive and significant association between managerial pay and profits is found. Based on the data on managers, several other hypotheses from tournament theory are also tested. These are (i) a convex relationship between pay and job levels for managers, (ii) a positive relationship between the number of executives (contestants) and wage dispersion for managers and (iii) a positive association between market demand uncertainty and managerial pay spread.

Regarding the first of these predictions, results show that wages increase as one moves up the corporate hierarchy. There also seems to exist a particularly high wage gap at the very top. However, data do not reveal a convex pay structure for managers.

No support is found for the hypothesis of a positive relationship between the number of managers (contestants) and wage spread. Instead, results show a negative and significant effect of the number of executives on pay spread among managers, a result consistent with wage-setting theories stressing the importance of fairness and cooperation.

Finally, consistent with tournament theory, a higher wage dispersion is found in firms operating in volatile product markets, characterized by a high degree of output uncertainty.

Most studies that empirically test aspects of tournament models have used US data on executive compensation. The present paper is the first to test predictions from tournament theory on Swedish data. Given the large differences between US and Swedish labor markets, this study adds to the empirical literature on the effects of wage dispersion within firms. Despite differences in wage-setting institutions and the distribution of wages, results are similar to those in previous studies.

References

Akerlof, G. A. and Yellen, J. L. (1986). *Efficiency Wage Models of the Labor Market*, Cambridge: Cambridge University Press.

Akerlof, G. A. and Yellen, J. L. (1990). "The Fair-Wage Hypothesis and Unemployment", *Quarterly Journal of Economics* 105, 255-283.

Ang, J. S., Hauser, S. and Lauterbach, B. (1998). "Contestability and Pay Differential in the Executive Suites", *European Financial Management* 4, 335-360.

Arai, M. (1999). "Wages, Profits and Capital Intensity: Evidence from Matched Worker Firm Data", Working Paper, no. 3, Department of Economics, Stockholm University, forthcoming in *Journal of Labor Economics* 2003.

Baker, G., Gibbs, M. and Holmström, B. (1994). "The Internal Economics of the Firm", *Quarterly Journal of Economics* 109, 881-919.

Bingley, P. and Eriksson, T. (2001). "Pay Spread and Skewness, Employee Effort and Firm Productivity", Working Paper, no. 2, Department of Economics, Aarhus School of Business.

Cowherd, D. and Levine, D. (1992). "Product Quality and Pay Equity between Lower-Level Employees and Top Management", *Administrative Science Quarterly* 37, 302-330.

Eriksson, T. (1999). "Executive Compensation and Tournament Theory: Empirical Tests on Danish Data", *Journal of Labor Economics* 17, 224-242.

le Grand. C., Szulkin, R. and Tåhlin, T. (eds.) (1996). *Sveriges arbetsplatser - Organisation, personalutveckling, styrning*, Stockholm: SNS förlag.

Hibbs, D. and Locking, H. (2000). "Wage Dispersion and Productive Efficiency: Evidence for Sweden", *Journal of Labor Economics* 12, 775-782.

Lazear, E. (1989). "Pay Inequality and Industrial Politics", *Journal of Political Economy* 87, 1261-1284.

Lazear, E. (1992). "The Job as a Concept", In *Performance Measurement, Evaluation, and Incentives*, ed. by William Burns, Boston: Harvard Business School Press.

Lazear, E. and Rosen, S. (1981). "Rank-Order Tournaments as Optimum Labor Contracts", *Journal of Political Economy* 89, 841-864.

Leonard, J. (1990). "Executive Pay and Firm Performance", *Industrial and Labor Relations Review* 43, 13-29.

Levine, D. (1991). "Cohesiveness, Productivity and Wage Dispersion", *Journal of Economic Behavior and Organisation* 15, 237-255.

Main, B., O'Reilly, C. A. and Wade, J. (1993). "Top Executive Pay: Tournament or Teamwork?", *Journal of Labor Economics* 11, 606-628.

McLaughlin, K. (1988). "Aspects of Tournament Models: A Survey", *Journal of Labor Economics* 15, 403-430.

Moene, K-O. and Wallerstein, M. (1997). "Pay Inequality", *Journal of Labor Economics* 15, 403-430.

OECD (1996). *Employment Outlook*, Paris.

O'Reilly, C., Main, B. and Crystal, G. (1989). "CEO Compensation as Tournament and Social Comparison: A Tale of Two Theories", *Administrative Science Quarterly* 33, 257-274.

Prendergast, C. (1996). "What Happens within Firms? A Survey of Empirical Evidence on Compensation Policies", Working Paper, no. 5802, National Bureau of Economic Research, Cambridge, MA.

Rosen, S. (1986). "Prizes and Incentives in Elimination Tournaments", *American Economic Review* 76, 701-715.

Winter-Ebmer, R. and Zweimuller, J. (1999). "Intra-firm Wage Dispersion and Firm Performance", *Kyklos* 52, 555-572.

Appendix: Data Description

Definition of variables

Individual outcome variables:
Wages: Monthly pre-tax full-time equivalent wages in 1990 prices (using CPI) based on Swedish Trade Union Confederation (*LO*) and the Swedish Employers' Confederation (*SAF*) wage data and completed with the income registers from Statistics Sweden (*SCB*).

Demography variables:
Gender, Age and Birth Origin are from SCB's Population Census (*Registret över totalbefolkningen*).

Human Capital variables:
Education level dummies are based on 2 digit level of the Swedish Education Nomenclature (SUN-codes) from the Swedish Education Register (*Utbildningsregistret*). These are *Compulsory School* (less than 9 years), *Comprehensive School* (9 years), *Upper Secondary School* (2 years at most), *Upper Secondary School* (3 years), *Long Upper Secondary School* (more than 4 years), *College* (Shorter University Education) and *University*.
Experience is number of years on the labor market according to the Employment Register (*Sysselsättningsregistret*).
Seniority is number of years at the establishment based on tracing the individual back to 1986 in the Employment Register (*Sysselsättningsregistret*). The variable is left censored at 5.5 years. Individuals with more than 6 years of seniority are given the mean seniority in Sweden according to the Level of Living Survey, i.e. 16 years.

Industry and Occupational Groups:
Industry dummies based on the 2-digit SIC (*SNI69* and *SNI92*). Own classification of 14 industries.

Blue- and White-collar worker according to the Population and Housing Census of 1990 (*FoB90*). These refer to the occupation classification in 1990 and not necessarily to the current employment.
Managerial classification according to ISCO-88. Available for 1995 from Statistics Sweden. Four levels: Level 1=Directors and chief executives, Level 2=Production and operations managers, Level 3=Other departmental managers, Level 4=Lower level decision makers.

Balance sheet information:
Profits (Swedish kronor) are defined as annual profits after capital depreciation. Available for the period 1987-95 (MM Partners).
Number of employees refer to average number of employees. Available for the period 1987-95 (MM Partners).

Table A.1. Sample Means.

	White-collar workers						Managers		
	1991			1995			1995		
	N	Mean	SD	N	Mean	SD	N	Mean	SD
Female	63 862	.30		97 900	.34		10 198	.11	
Experience	63 862	20	9.17	97 900	21	9.70	10 198	26	8.04
Seniority	63 862	8	6.68	97 900	10	7.00	10 198	11	6.56
Education level:									
Compulsory School < 9	63 767	.06		97 789	.04		10 198	.08	
Comprehensive School $=9$	63 767	.06		97 789	.06		10 198	.06	
Upper Secondary School < 3	63 767	.20		97 789	.26		10 198	.22	
Upper Secondary School 3	63 767	.24		97 789	.21		10 198	.24	
Upper Secondary School > 3	63 767	.21		97 789	.22		10 198	.17	
College < 3	63 767	.22		97 789	.20		10 198	.22	
University	63 767	.01		97 789	.01		10 198	.02	
Log monthly wage:	63 862	9.63	.31	97 900	9.65	.32	10 198	9.93	.37
Level 1 managers							517	10.64	.34
Level 2 managers							3 175	10.12	.30
Level 3 managers							2 112	9.99	.32
Level 4 managers							4 394	9.67	.17
Residual inequality	63 798	.04	.01	97 746	.05	.02			
White/blue collar ratio	53 699	1.02	.02	75 212	1.03	.01			
90-10th percentile ratio	63 862	1.08	.01	97 900	1.07	.02			
Coefficient of variation in wages	63 862	.03	.004	97 900	.03	.01	10 198	.03	.01
CEO-other managers wage diff.							10 198	.78	.29
CEO-other managers wage ratio							10 198	1.08	.03
Coeff. of variation of Sales/Empl.							10 195	.26	.25
Profits/Employee, 100.000 SEK	63 862	.29	.42	97 900	.45	1.04	10 198	.47	.97
Log firm size	63 862	7.75	1.49	97 900	7.62	1.80	10 198	7.23	1.69

Working Paper Series/Arbetsrapport

FIEF Working Paper Series was initiated in 1985. A complete list is available from FIEF upon request. Information about the series is also available at our website: http://www.fief.se/Publications/WP.html.

2000

158. **Antelius, Jesper**, "Sheepskin Effects in the Returns to Education: Evidence on Swedish Data", 17 pp.

159**. Erixon, Lennart**, "The 'Third Way' Revisited. A Revaluation of the Swedish Model in the Light of Modern Economics", 97 pp.

160**. Lundborg, Per**, "Taxes, Risk Aversion and Unemployment Insurance as Causes for Wage Rigidity", 16 pp.

161. **Antelius, Jesper** and **Lundberg, Lars**, "Competition, Market Structure and Job Turnover", 27 pp.

162. **Johansson, Sten** och **Sélen, Jan**, "Arbetslöshetsförsäkringen och arbetslösheten – En reanalys av IFAUs studie", 46 s.

163. **Edin, Per-Anders, Fredriksson, Peter and Lundborg, Per,** "Trade, Earnings, and Mobility – Swedish Evidence", 28 pp.

164. **Strauss, Tove**, "Economic Reforms and the Poor", 25 pp.

165. **Strauss, Tove**, "Structural Reforms, Uncertainty, and Private Investment", 31 pp.

2001

166. **Hansson, Pär**, "Skill Upgrading and Production Transfer within Swedish Multinationals in the 1990s", 27 pp.

167. **Arai, Mahmood** and **Skogman Thoursie, Peter**, "Incentives and Selection in Cyclical Absenteeism", 15 pp.

168. **Hansen, Sten and Persson, Joakim,** "Direkta undanträngningseffekter av arbetsmarknadspolitiska åtgärder", 27 pp.

169. **Arai, Mahmood** and **Vilhelmsson, Roger**, "Immigrants' and Natives' Unemployment-risk: Productivity Differentials or Discrimination?", 27 pp.

170. **Johansson, Sten** och **Selén, Jan**, "Arbetslöshetsförsäkringen och arbetslösheten (2). Reformeffekt vid 1993 års sänkning av ersättningsgraden i arbetslöshetsförsäkringen?", 39 pp.

171. **Johansson, Sten**, ”Conceptualizing and Measuring Quality of Life for National Policy”, 18 pp.

172. **Arai, Mahmood** and **Heyman, Fredrik**, “Wages, Profits and Individual Unemployment Risk: Evidence from Matched Worker-Firm Data”, 27 pp.

173. **Lundborg, Per** and **Sacklén, Hans**, “Is There a Long Run Unemployment- Inflation Trade-off in Sweden?”, 29 pp.

174. **Alexius, Annika** and **Carlsson, Mikael**, “Measures of Technology and the Business Cycle: Evidence from Sweden and the U.S.”, 47 pp.

175. **Alexius, Annika**, “How to Beat the Random Walk”, 21 pp.

2002

176. **Gustavsson, Patrik**, “The Dynamics of European Industrial Structure”, 41 pp.

177. **Selén, Jan**, “Taxable Income Responses to Tax Changes – A Panel Analysis of the 1990/91 Swedish Reform”, 30 pp.

178. **Eriksson, Clas** and **Persson, Joakim**, “Economic Growth, Inequality, Democratization, and the Environment”, 21 pp.

179. **Granqvist, Lena, Selén, Jan** and **Ståhlberg, Ann-Charlotte**, “Mandatory Earnings-Related Insurance Rights, Human Capital and the Gender Earnings Gap in Sweden”, 21 pp.

180. **Larsson, Anna**, “The Swedish Real Exchange Rate under Different Currency Regimes”, 22 pp.

181. **Heyman, Fredrik**, “Wage Dispersion and Job Turnover: Evidence from Sweden”, 28 pp.

182. **Nekby, Lena**, “Gender Differences in Recent Sharing and its Implications for the Gender Wage Gap”, 22 pp.

183. **Johansson, Sten** and **Selén, Jan**, “Coping with Heterogeneities in the Difference in Differences Design”, 13 pp.

184. **Pekkarinen, Tuomas** and **Vartiainen, Juhana**, “Gender Differences in Job Assignment and Promotion in a Complexity Ladder of Jobs”, 27 pp.

185. **Nekby, Lena**, “How Long Does it Take to Integrate? Employment Convergence of Immigrants and Natives in Sweden”, 33 pp.

186. **Heyman, Fredrik**, “Pay Inequality and Firm Performance: Evidence from Matched Employer-Employee Data”, 38 pp.