Applied Economics, 2011, **43**, 3037–3049

Routledge
Taylor & Francis Group

The effect of wage dispersion on team outcome and the way team outcome is produced

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The impact of intra-team pay dispersion on team productivity is a highly discussed issue. On the one hand, wage differentials provide incentives for higher employee effort. On the other hand, pay inequality may reduce team cohesiveness and increase feelings of relative deprivation leading to lower performance. Analysing nonlinear effects of wage dispersion in professional soccer, we find empirical evidence that team performance is strongest when there is either very high or very low wage inequality. Medium levels produce the weakest team performance. In addition, we show that the pay structure affects the team's playing style even after controlling for team and coach heterogeneity. We discuss the theoretical and managerial implications as well as the limits of generalization.

I. Introduction

There are basically two competing hypotheses about the influence of wage dispersion on team productivity. Firstly, wage dispersion allows the creation of a positive pay–performance link, which induces higher future performance and attracts talent (Milgrom and Roberts, 1992). On the other hand, large pay differentials reduce team cohesiveness (Levine, 1991) and increase relative deprivation, which may decrease team performance (Akerlof and Yellen, 1990). Since individuals tend to judge their own salary in relation to the income of other team-mates, the intra-team compensation structure is a highly strategic issue, particularly in teams in which workers affect the productivity of their co-workers.

The existing empirical literature on the link between wage dispersion and team performance largely concentrates on linear effects (see Section III).[1] However, given the competing hypotheses the relationship between intra-team wage differentials and team performance is unlikely to be linear (Grund and Westergaard-Nielsen, 2005). Thus, it is not very surprising that the empirical evidence of studies analysing linear effects has not been conclusive so far. Using comprehensive panel data of professional German soccer, this article adds to the existing literature not only by analysing nonlinear effects in the special context of performance teams, but also by examining the impact of the team's pay structure on the playing style. In doing so, we are able to explore the theoretical predictions of Lazear (1989) who argues that a hierarchical pay structure fosters individualism and selfish behaviour, whereas a compressed wage structure encourages cooperative behaviour.

Controlling for the team's wage expenditure, roster size, team composition effects and unobserved team

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[1] Exceptions are Winter-Ebmer and Zweimüller (1999), Bingley and Eriksson (2001), Brown *et al*. (2003), Grund and Westergaard-Nielsen (2008), which include a squared term of wage dispersion in their econometrical models.

Applied Economics ISSN 0003–6846 print/ISSN 1466–4283 online © 2011 Taylor & Francis
http://www.informaworld.com
DOI: 10.1080/00036840903427224

heterogeneity, we find evidence for a U-formed relationship between wage dispersion and sporting performance. In addition, we show that players of high-inequality soccer teams play more individualistically (i.e. have more dribblings and runs) than players of teams with a compressed wage structure. Thus, our results suggest that wage dispersion does not only affect the team's outcome but also the way this outcome is achieved.

II. Theoretical Foundations

Individuals often assess the adequacy of their rewards through a process of social comparison (Festinger, 1954). Since social referents are important for anchoring judgments about pay, not only the level of an individual's salary but also the distribution of rewards across other team members is crucial. The influence of wage dispersion on productivity is controversial as the following two hypotheses indicate.

Under the hierarchical pay hypothesis, the intra-team wage structure is considered as an incentive system that attracts talent and stimulates individual effort. In order to keep highly talented star players, it is often inevitable to introduce significant wage differentials (Milgrom and Roberts, 1992). In addition, wage dispersion allows creating a meritocracy in which rewards are expected to increase with worker performance (Bloom, 1999). Such a positive pay–performance link increases the returns for higher performance and thereby induces higher future performance (Milgrom and Roberts, 1992).

Ramaswamy and Rowthorn (1991) offer a second argument in favour of high pay dispersion. They argue that differentiated labour introduces different levels of 'damage potential' for the efficient firm (team) production. Workers with greater damage potential should be paid higher wages in order to mitigate their motivation to inflict damage on the team's productivity. Workers who are less prone to disruption are paid less. The model of Ramaswamy and Rowthorn (1991) implies that wage dispersion should have a positive impact on team productivity.

The wage compression hypothesis, however, predicts that team performance reacts negatively to wage dispersion increases. Levine (1991) argues that an egalitarian pay structure sustains and stimulates cohesiveness, which enhances the team's total productivity given a participatory team. Similar arguments are advanced by Martin (1981) who conjectures that workers tend to experience feelings of relative deprivation if wages are unequal. The notion 'relative deprivation' goes back to Stouffer *et al.* (1949) who found out that in the military police, where the promotions were infrequent, job satisfaction was greater than in the air corps, where most survivors could anticipate rapid promotions. The level of social discontent is largely determined by the relative comparison of one's own social and economic conditions with the perceived conditions enjoyed by some specific reference group, in teams typically other team-mates. Akerlof and Yellen (1990) explain that deprived workers are not only less satisfied but tend to withdraw effort as well. Field evidence of the behavioural consequences of relative deprivation, however, is scarce. Drago and Garvey (1998) analysed helping effort in workgroups based on questionnaires distributed among Australian companies. They find that cooperation is reduced when promotion incentives are large. Mas (2006) shows that police performance is negatively affected by the gaps between the actual wage and the requested wage in arbitration. After winning arbitration, arrest rates are 12% higher than when arbitration is lost.

A complementary theory promoting wage compression has been offered by Milgrom (1988) and Milgrom and Roberts (1992). They argue that workers are more likely to engage in costly rent-seeking instead of productive work if high wage differentials create much potential for redistribution at the discretion of the supervisor.

As the following parameterization shows, the overall impact of wage dispersion on team productivity is very unlikely to be linear: let team performance (TP) be a function of the team's wage dispersion (x) measured by the intra-team Gini coefficient (thus $0 < x < 1$).[2] The hierarchical pay hypothesis can be formalized as $TP_{HP}(x) = ax^r$, where $a > 0$ and $r > 0$ indicate the magnitude and slope of the positive impact of wage inequality on productivity. The wage compression hypothesis, however, predicts that wage dispersion decreases team performance. We denote this negative relationship as $TP_{WC}(x) = -bx^t$, where both b and t are positive. The overall effect of wage dispersion on team performance can be characterized as the sum of the two components including a positive intercept α

$$TP(x) = \alpha + TP_{HP}(x) - TP_{WC}(x) = \alpha + ax^r - bx^t \quad (1)$$

The shape of this function depends on the particular values of the parameters a, b, r and t. It is U-shaped for $r > t$ with a local minimum at

[2] The following parameterization builds on the parameterization proposed by Grund and Westergaard-Nielsen (2005).

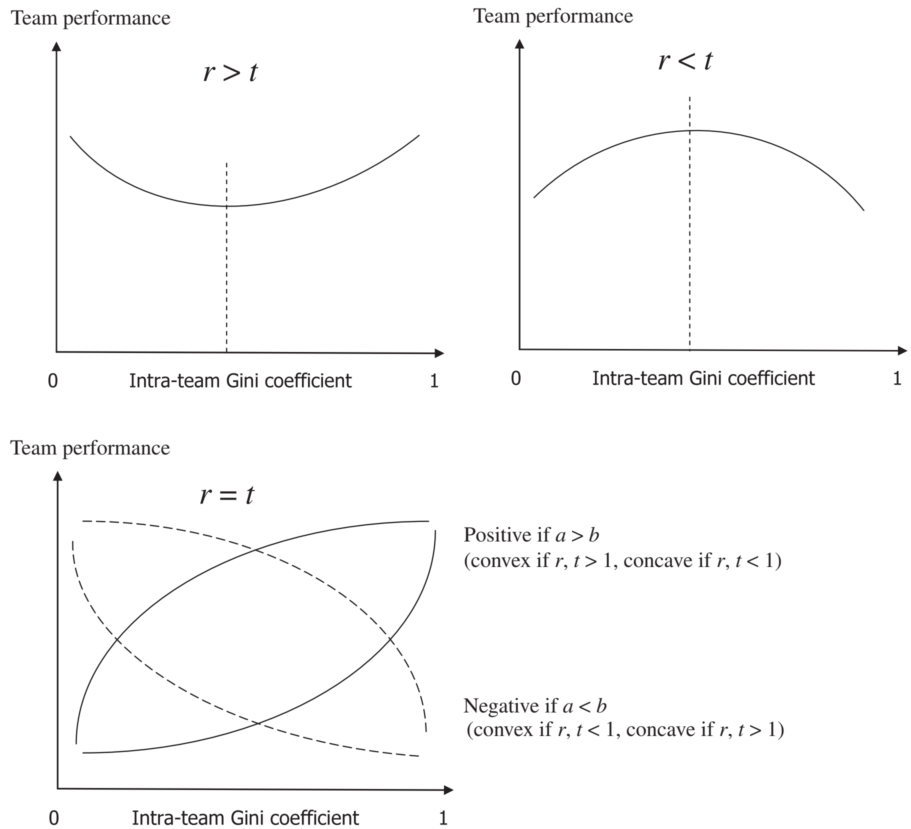

Fig. 1. The relationship between wage dispersion and team performance

$(bt/ar)^{1/(r-t)}$ and inversely U-formed for $r < t$ with a local maximum at $(ar/bt)^{1/(t-r)}$. If $r = t$, the effect of wage dispersion on team performance is strictly positive for $a > b$ and strictly negative if the opposite is true (Fig. 1). The relationship between team performance and wage dispersion is nonlinear unless $r = t = 1$.

Since theory does not provide arguments in favour of only one of the illustrations, the nature of the relationship between wage dispersion and team performance remains an empirical question. But before explaining the empirical procedure of the present study, we want to give a short overview on the existing (empirical) literature.

III. Previous Results

Given the fact that most empirical studies examine linear effects it is perhaps not surprising that the results vary considerably. In the following we start with the clear minority of articles that allow for potential nonlinearity either by including a squared term of wage dispersion or by computing interaction effects.

Using panel data of Austrian firms, Winter-Ebmer and Zweimüller (1999) find a humped-shaped relationship between intra-firm wage dispersion and firm productivity. Since the authors did not have data on the financial performance of the firms, they constructed two standardized earnings indicators as dependent variables. Bingley and Eriksson (2001) also find an inversely U-formed relationship between the pay spread and skewness and total factor productivity of Danish firms. However, this effect applies only to white-collar workers. Using another linked employer–employee data set of Danish firms, Grund and Westergaard-Nielsen (2008) test nonlinear effects of the dispersion regarding both wage levels and wage increases. Whereas the first does not significantly affect the value added per employee, wage increase dispersion clearly impacts on the firm's performance, namely in a U-formed way. Brown *et al.* (2003) analyse efficiency effects of pay dispersion in the US health care industry. Their study shows that high wage dispersion enhances the average length of stay, which indicates a decrease in resource efficiency. The coefficient of the nonlinear term of pay inequality though is low and only weakly significant.

Three other studies use moderators to account for potential nonlinearity due to different situational contingencies. Shaw *et al.* (2002) show that wage dispersion will be associated with higher levels of workforce performance if accompanied by formal individual incentive systems and independent work. Conversely, dispersion is likely to be ineffective in the context of high work interdependence. Beaumont and Harris (2003) examine the relationship between the internal wage structure and firm productivity using UK manufacturing micro-data in five industrial sectors. Whereas the wage compression hypothesis holds in the pharmaceutical sector, it does not hold in the sectors of electronic data processing, motor vehicles and engines, aerospace or miscellaneous foods. They additionally find that plant size and ownership differences moderate the influence of wage dispersion on productivity: while a compressed wage structure increases firm performance in small domestic firms, it has a negative productivity effect regarding large, foreign-owned plants. Jirjahn and Kraft (2007) show that compared to the benchmark, wage dispersion exerts a substantially higher positive impact on productivity if the establishment pays piece rates and does neither have a works council nor a collective bargaining agreement.

A first strand of the broad literature examining linear effects provides evidence in favour of the 'wage compression hypothesis'. Cowherd and Levine (1992) find empirical evidence that wage compression is positively related with business-unit product quality. Pfeffer and Langton (1993) show that the greater the degree of wage dispersion within academic departments the lower is the individual member's satisfaction and research productivity and the less likely it is that faculty members will collaborate on research.

Another strand of the empirical literature finds support for the 'hierarchical pay hypothesis'. Main *et al.* (1993) and Eriksson (1999) find evidence that the coefficient of variation of the top executive team members' salaries is positively associated with the firm's performance. Analysing the pay structure within entire organizations, Lallemand *et al.* (2004) support this finding for Belgian firms and Heyman (2005) for Swedish corporations. Yet, other studies find no relationship between the wage structure and firm performance (Leonard, 1990; Hibbs and Locking, 2000).

We are – to the best of our knowledge – the first to analyse nonlinear effects of wage dispersion within teams. As interaction and interdependence within work groups is likely to be higher than in large organizations, the influence of wage dispersion on performance may be different. Moreover, we are the first to investigate the impact of pay inequality on the way team output is produced, as we have access to precise field performance measures like the number of passes, crosses, dribblings or runs of professional German soccer players.

So far, empirical studies analysing the relationship between wage dispersion and team performance have concentrated on linear effects and on sports teams of US Major Leagues, with a clear dominance of Major League Baseball (MLB). Richards and Guell (1998) find that the variance of the team's salary distribution reduces the winning percentage in MLB controlling for lagged winning percentage and total payroll. Depken (2000) replicates this finding using a team fixed-effects model. The results of Bloom (1999) indicate that pay dispersion does not only reduce group performance, but also the individual performance of baseball players. Jewell and Molina (2004) place the discussion of MLB payroll inequality and team success in a stochastic production frontier framework, and DeBrock *et al.* (2004) additionally analyse the impact of estimated salary differentials due to different levels of individual lagged performance, experience and other player specific controls. Both studies also find a negative relationship between the intra-team wage dispersion and team performance in MLB. Sommers (1998) discovers a (weakly significant) negative impact of the team's Gini coefficient on the points achieved in the National Hockey League (NHL) holding the team's wage expenditures constant, while Gomez (2002) finds no effect of salary inequality on the winning percentage in the NHL based on his fixed-effects estimation. Using data from all four major North American sports leagues (i.e. baseball, basketball, football and hockey) Frick *et al.* (2003) show that a higher degree of pay inequality enhances the performance of basketball and hockey teams but decreases the winning percentage of football and baseball teams. Berri and Jewell (2004), however, do not find a significant correlation between wage dispersion and team productivity in the NBA.

IV. Empirical Framework

Our empirical analysis is based on panel data of all teams appearing in the first German soccer league during twelve seasons (from 1995/96 until 2006/07). Professional sports offer some important advantages for empirical studies of organizational and personnel issues (Kahn, 2000): First, in most sports a large panel data set is available due to the frequency and regularity of athletic events. Second, performance is clearly observable and measured with great accuracy. Third, hypotheses may be tested in relatively controlled field environments. The athletes face the same rules and restrictions. Thus, when analysing the connection between wage dispersion and team performance, a lot of other influencing factors can be controlled for (Wolfe *et al.*, 2005). However, the same properties which make the sports context an advantageous area of research – published salaries, clear performance measures, controlled environment – also limit the generalizability of sport studies (Harder, 1992).

Dependent and explanatory variables

Soccer success is measured by the *winning percentage* and the *league standing* at the end of the season. The *winning percentage* variable is calculated by dividing the achieved points at the end of the season through the maximum possible points. The second dependent variable *league standing* is given by the formula: $-\ln[position/(n+1-position)]$, whereas n denotes the number of clubs in the league (in our case 18). Thus, the *league standing* variable varies between $+2.89$ (club winning the championship) and -2.89 (least successful club).

We use two alternative measures of pay dispersion as explanatory variables. The first, the Gini coefficient, is a common metric employed in economic research to measure the degree of inequality in income distributions. As a second alternative measure, we use the coefficient of variation.[3] The Gini index and the coefficient of variation are computed for each team and each season separately using 5316 individual salary proxies provided by *Kicker*, the most prominent soccer magazine in Germany. Since the salary proxies are estimated in a systematic manner for several years by almost the same editorial staff, they are likely to be consistent (Torgler and Schmidt, 2007), especially when using the Gini coefficient or the coefficient of variation for which only relative proportions matter. In order to explore the reliability of our data, we compared it with the market value estimates provided by a second independent source regarding the season 2005/06, namely the team independent institution *Online-Pro* that runs the webpage *www.transfermarkt.de*. The two estimations are strongly correlated (correlation is 0.89), which indicates high reliability.[4] Both data sources have been widely used for empirical studies in the past (Forrest and Simmons, 2002; Torgler *et al.*, 2006; Torgler and Schmidt, 2007; Lehmann and Schulze, 2008).

Estimated at the beginning of each season our salary proxies do not incorporate current performance bonuses, which weakens potential simultaneity between wage dispersion and team performance.[5] The issue of simultaneity matters whenever it is plausible that successful teams pay higher performance bonuses, which in turn leads to more wage inequality.[6] On the other hand, it is plausible that performance is a function of both the base salary structure *and* the bonus packages. Unfortunately, valid information about individual incentive contracts is not available. However, we believe that potential omitted variable bias is limited as first, bonuses that are proportional to the base salary do not alter our wage dispersion measures because both the Gini coefficient and the coefficient of variation are scale invariant (Allison, 1978), and second, time-constant deviations from proportional bonus payments are incorporated in the team fixed-effects. To capture the predicted nonlinearity, we also include the squared values of the Gini index and the coefficient of variation.

Following Depken (2000) we use the logarithm of wage expenditures as control variable for the team's playing talent.[7] Forrest and Simmons (2002) show that in European soccer high wage expenditures clearly increase field success. In order to account for team composition effects that are likely to affect both wage dispersion and team productivity, we include a proxy for intra-team talent heterogeneity in our model. In German soccer every match performance of a player who plays more than half an hour is individually and consistently evaluated and marked by sports experts. These evaluations are published in the *Kicker* soccer magazine. Since it is plausible to assume that playing talent is uniformly distributed over the different tactical positions, the mean values of the expert evaluations should be the same for

[3] Allison (1978) discusses several measures of inequality and finds that both the Gini index and the coefficient of variation are advantageous in many respects. Harrison and Klein (2007) also recommend the same two measures to capture the effects of pay disparity. We did not use the Herfindahl index as measure of a team's wage dispersion because the potential range of the Herfindahl index is affected by the team's roster size.

[4] Regarding the reliability of the *Kicker* salary proxies, see also Frick (2007) and Torgler and Schmidt (2007).

[5] However, this does not contradict our hierarchical pay hypothesis. Even players, whose market values are at the low end of the distribution in a given season, may be motivated by greater pay dispersion to display better field performances in order to receive a higher base salary next season.

[6] Bingley and Eriksson (2001), Lallemand *et al.* (2004) and Heyman (2005) address the issue of simultaneity by using income tax information excluding bonuses or lagged predetermined values of wage dispersion as instruments of the current pay inequality.

[7] Wage expenditures are expressed in 2003 Euro and adjusted for inflation.

Table 1. Variables and descriptive statistics

Variables	Description	Mean	SD
Dependent variables			
Winning percentage	Ratio of achieved points divided by the maximum possible points at the end of the season	0.46	0.12
League standing	Modified league standing at the end of the season ($-\ln(\text{rank}/(n+1-\text{rank}))$)	0.00	1.48
Explanatory variables			
Wage dispersion variables			
Gini	Gini coefficient of the wage distribution at the beginning of the season	0.37	0.08
Gini square	Square of the Gini coefficient	0.15	0.06
CV	Coefficient of variation of the wage distribution at the beginning of the season	0.70	0.17
CV square	Square of the coefficient of variation	0.51	0.24
Control variables			
Talent heterogeneity	SD of the average individual match evaluations within a team. Individual match evaluations are divided by the mean for the player's tactical position in a given season.	0.12	0.03
Log wage expenditures	Logarithm of the wage expenditures in terms of Euro 2003 at the beginning of the season	17.23	0.49
Roster size	Number of players within a team	24.83	3.16

Note: The model also includes season dummies that are not reported.

goalkeepers, defenders, midfielders and attackers. Franck and Nüesch (2008), however, show that goalkeepers tend to receive better evaluations than midfield players even though they receive the lowest salaries. Thus, in order to eliminate any bias stemming from the tactical position of a player, we divide the average expert evaluation of a player by the mean value of the player's respective tactical position in a given season. The variable *talent heterogeneity* is then determined by the SD of the centred average match evaluations of the players within a team in a given season.[8] In addition, we control for the roster size and use seasonal dummies to account for time-effects (Table 1).

Estimation approach

It is well known that panel data requires special econometric modelling, either pooled regression, random or fixed-effects modelling. An F test following a fixed-effects regression indicates that there are significant team-level effects (F-statistics are between 1.87 and 2.17) implying that pooled Ordinary Least Squares (OLS) would be inappropriate. In order to decide whether the team-level effects are random or fixed, we performed the Hausman specification test (Hausman, 1978) that compares the fixed-effects model with the random-effects model. Whereas the fixed-effects model allows the team-level effects to be correlated with the regressors, the random-effects model assumes strict orthogonality. The Hausman test clearly rejects this assumption in all cases at the 1% significance level (chi-square statistics between 48 and 98), which suggests that team-level effects are inadequately modelled by a random-effects model. An additional aspect supporting the use of a fixed-effects approach lies in the nature of our data set. Due to promotion and relegation in European soccer, we have an unbalanced panel as some teams do not always play in the first German soccer league. The reason why a team gets promoted or relegated (called attrition) is not random. Instead, it is likely to be correlated with unobserved team playing strength, which may cause

[8] An anonymous referee correctly noted that the expert evaluations may be endogenous. Since we measure both individual playing talent and team performance on the same time interval, we cannot exclude the possibility that the expert evaluations are shaped by team productivity rather than *vice versa*. However, two points are worth making. First, match-specific analyses show that whereas the *average* of expert evaluations strongly depends on the game's result, the SD of individual expert evaluations is very similar for the winning and the losing teams. Thus, there is no significant relation between talent heterogeneity and team performance on a match-level basis. Second, due to the longitudinal nature of our data set, we can test whether *current* team performance affects the *future* talent heterogeneity of a team. The assumption of strict exogeneity of talent heterogeneity is not rejected (see next section).

biased estimators due to resulting sample selection. Through our choice of a fixed-effects model, this problem is moderated because fixed-effects analysis allows for the attrition to be correlated with the constant unobserved effect (Wooldridge, 2003).[9]

Following Wooldridge (2002, p. 285), we specify the following regression equation as a test of strict exogeneity:

$$y_{it} = x'_{it}\beta + w'_{i,t+1}\delta + v_t\gamma + c_i + \varepsilon_{it} \tag{2}$$

where x'_{it} is the vector of explanatory variables, $w'_{i,t+1}$ denotes a subset of x'_{it} for club i in the subsequent year $t+1$, v_t is the time effect, c_i the unobserved team effect and ε_{it} the remaining error term. A test of the null hypothesis of strict exogeneity is equivalent to testing $H_0: \delta = 0$. First, we have to choose the relevant elements of $w'_{i,t+1}$. Here, it is crucial to consider for which regressors future values might be correlated with ε_{it}. As it seems plausible that a shock in the current dependent variable may affect all our explanatory variables, we include future values of all our regressors. Based on the specification in Equation 2, we clearly reject the null hypothesis regarding future wage expenditures. However, we did not find that a shock in the current dependent variable significantly influences the team's wage dispersion, talent heterogeneity or roster size in the next season.[10] The results of the Wooldridge test of strict exogeneity suggest that current sporting success increases the team's future budgets. In European soccer some financial rewards are largely determined by relative field performance. Successful clubs do not only receive a higher share of the broadcasting revenues, they are also more likely to qualify for the very lucrative UEFA Champions League that provides significant extra-money in the following season.[11]

The use of instrumental variables is a common approach to the endogeneity problem. We consider the league standing and the home attendance in the preceding season as a good instrument for the current wage expenditures.[12] The following reduced form of the first-stage equation,

$$\begin{aligned}&\textit{Log wage expenditures}_t\\ &\quad = \underset{(0.99)}{1.79} + \underset{(0.01)}{0.10}\ \textit{league standing}_{t-1}\\ &\qquad + \underset{(0.07)}{0.13}\ \textit{log home attendance}_{t-1}\end{aligned}$$

shows that the chosen instruments are highly correlated with the endogenous variable. As suggested by Bound *et al.* (1995), we report the F-statistics for joint significance of the instruments in the first-stage equation as a diagnostic in Table 2.[13] The second requirement for adequate instruments, namely that instrumental variables must not be correlated with the equation's disturbance process, is tested by the Sargan test for overidentifying restrictions. The null hypothesis that the instruments are uncorrelated with the error term is not rejected in all model specifications. The Breusch–Pagan test does not signal any problem of heteroskedasticity.

Table 2 illustrates the results of the Two-Stage-Least-Squares (2SLS) team fixed-effects estimation. Since the wage dispersion variables are measured on a scale that is difficult to interpret, we also listed the beta coefficients that show the change in the dependent variable if a regressor varies by one SD.

We find evidence that sportive success reacts in a U-formed way to intra-team wage dispersion. Hence, our results imply that teams do better by either deciding for a steep hierarchical pay structure or for a rather egalitarian one. However, to be 'stuck in the middle' is detrimental for sporting success. Analyzing the beta coefficients, we see that the effect of wage inequality on team productivity is both statistically and economically significant. Lowest team performance is produced when the Gini is around 0.4 and the coefficient of variation around 0.8. Since the turning points are close to the mean of the Gini index and the coefficient of variation, both the declining and the rising part are relevant in our sample. Around 75% of all team observations are located on the left-hand side of the U whereas for the other 25% the increasing part of the curve is relevant. Since we control for the talent heterogeneity within a team, the significant impact of wage dispersion is not driven by pure team composition effects. The result that a team's wage expenditures do not help to explain team performance is surprising at first view. However, since the financial strength of a club has a high serial correlation (0.78), the team fixed-effects seem to capture the effect of wage expenditures on team success. The significant negative coefficient of the roster size indicates that teams with a smaller

[9] See e.g. Kyriazidou (1997) for a procedure to also account for nonconstant selection effects.
[10] Detailed regression results are available form the authors upon request.
[11] In the season 2004/05 the qualified clubs received in total €414.1 million of broadcasting income and generated substantial extra match day turnover.
[12] We use gate attendance instead of gate revenue as instrument because revenue data is partly not available for precedent seasons.
[13] Since we do not have multiple endogenous variables, we do not need to report the Shea partial R^2 measure that takes the intercorrelations among the instruments into account (Shea, 1997).

Table 2. Test of the effect of wage dispersion on team performance using 2SLS team fixed-effects models

	Dep. var.: winning percentage						Dep. var.: league standing					
Independent variables	Coeff.	SE	Beta	Coeff.	SE	Beta	Coeff.	SE	Beta	Coeff.	SE	Beta
Gini	−1.27*	0.66	−0.80				−21.47***	8.11	−1.12			
Gini square	1.47*	0.88	0.70				25.91**	10.76	1.01			
CV				−0.64**	0.27	−0.88				−9.84***	3.28	−1.12
CV square				0.39**	0.18	0.77				6.16***	2.25	1.00
Talent heterogeneity	0.46*	0.25	0.10	0.47	0.25	0.10	3.71	3.10	0.07	3.69	3.09	0.07
Log wage expenditures	0.06	0.05	0.24	0.07	0.05	0.26	0.46	0.61	0.15	0.52	0.61	0.17
Roster size	−0.01***	0.00	−0.20	−0.01***	0.00	0.20	−0.10***	0.04	−0.22	−0.10***	0.04	−0.22
Seasonal dummies	Yes			Yes			Yes			Yes		
Diagnostics												
R^2 within		0.10			0.11			0.12			0.13	
Number of observations		216			216			216			216	
Turning point/Minimum		0.43			0.82			0.41			0.80	
Percentage of observations located at the declining part of the curve		75%			77%			70%			74%	
Joint-significance of instruments in first-stage regression (*F*-statistics)		52.38***			53.05***			52.38***			53.05***	
Sargan statistic (Chi-square)		0.63			0.55			0.64			0.59	
Breusch–Pagan (*p*-value)		0.81			0.74			0.93			0.92	

Notes: 2SLS estimation with team fixed-effects. Log wage expenditures$_{(t)}$ is instrumented by league standing$_{(t-1)}$ and log home attendance$_{(t-1)}$.
*, ** and *** show significance (two-tailed) at 10, 5 and 1% levels, respectively.

Table 3. Wage dispersion effects over time using 2SLS team fixed-effects models

	Between 1995/96 and 2000/01						Between 2001/02 and 2006/07					
Independent variables	Coeff.	SE	Beta	Coeff.	SE	Beta	Coeff.	SE	Beta	Coeff.	SE	Beta
Gini	−26.94**	12.20	−1.47				−20.95*	11.75	−1.03			
Gini square	36.26**	16.51	1.47				23.10°	15.25	0.86			
CV				−9.86**	4.62	−1.20				−12.73**	5.31	−1.33
CV square				6.75**	3.14	1.18				8.12**	3.59	1.22
Talent heterogeneity	2.54	5.82	0.04	2.38	5.81	0.04	3.72	3.83	0.07	−0.15	7.28	0.00
Log wage expenditures	−0.45	0.91	−0.15	−0.33	0.96	−0.11	−0.79	0.97	−0.21	−0.73	0.96	−0.20
Roster size	−0.07	0.06	−0.15	−0.07	0.06	−0.15	−0.05	0.08	−0.08	−0.05	0.05	−0.10
Seasonal dummies	Yes			Yes			Yes			Yes		
Diagnostics												
R^2 within		0.10			0.10			0.10			0.11	
No. of obs.		108			108			108			108	
Turning point/Minimum		0.37			0.73			0.45			0.78	
Percentage of observations located at the declining part of the curve		53%			63%			85%			72%	
Joint-significance of instruments in first-stage regression (*F*-statistics)		23.83***			23.71***			22.80***			23.72***	
Sargan statistic (Chi-square)		0.04			0.01			0.29			0.23	
Breusch–Pagan (*p*-value)		0.30			0.35			0.98			0.98	

Notes: 2SLS estimation with team fixed-effects. The dependent variable is the modified league standing given by the formula ln(position/$(n+1-\text{position})$). Log wage expenditures$_{(t)}$ is instrumented by league standing$_{(t-1)}$ and log home attendance$_{(t-1)}$.
°, *, ** and *** show significance (two-tailed) at 15, 10, 5 and 1% levels, respectively.

Table 4. Team fixed-effects estimation results of the playing style

	Cooperative plays				Individualistic plays			
Independent variables	Dep. var: passes		Dep. var: crosses		Dep. var.: dribbles		Dep. var.: runs	
Gini	183.9		−109.8		355.6°		499.9**	
	(2088.8)		(248.6)		(278.0)		(216.6)	
CV		−169.7		−44.6		176.6°		244.4**
		(1158.2)		(129.4)		(140.4)		(119.8)
Talent heterogeneity	4760.5	4826.7	−232.2	−224.9	245.9	211.9	129.4	102.7
	(3852.7)	(3892.8)	(356.4)	(375.8)	(467.4)	(459.8)	(514.9)	(508.3)
Log wage expenditure	631.2	652.9	127.8	127.7	112.4	109.8	34.1	38.6
	(1066.3)	(1067.0)	(85.8)	(86.3)	(96.9)	(98.0)	(89.2)	(94.4)
Roster size	−47.7	−45.3	−10.3**	−10.6**	−25.1***	−24.5***	−2.9	−2.3
	(66.6)	(65.5)	(6.0)	(5.8)	(7.8)	(7.8)	(6.9)	(6.6)
Coach fixed effects	Yes***	Yes***	Yes***	Yes***	Yes***	Yes***	Yes***	Yes***
R^2 within	0.58	0.59	0.53	0.53	0.69	0.69	0.48	0.48
No. of obs.	108	108	108.0	108	108	108	90	90

Notes: Team fixed-effects estimation. Robust SEs clustered on teams in parantheses.
°, *, ** and *** show significance (one-tailed) at 15, 10, 5 and 1% levels, respectively.

squad outperform large teams, holding wage expenditures and the other explanatory variables constant.

Professional German soccer experienced a strong commercialization during the time frame covered by our study (1995/96–2006/07). Both club revenues and player wages tripled (Jones, 2007). In order to test whether the effect of wage dispersion has changed as a result thereof, we split the data in an earlier and later half. The results in Table 3, however, show that the U-formed relationship between wage dispersion and team performance is a consistent empirical pattern that is not affected by the wage levels of the players.

Following Lazear (1989) wage dispersion does not only affect the final team output but also the way this output is produced. Particularly, he predicts that members of high inequality teams behave less cooperatively and act more selfishly than members of teams with a compressed wage structure. Having detailed information about various field performance measures like passes, crosses, dribbles and runs for a sub-sample of seasons, we are able to test the postulated hypothesis. We consider the number of passes and crosses – defined as all sideways passes from the sidelines in the opposition half – as playing elements reflecting cooperation and interactivity within a team. As indicators of individualistic or even selfish behaviour, we use the numbers of dribbles and runs. Even though a certain level of both individualistic and interactive plays is necessary to win a game, there are still a lot of situations in which 'selfish' plays like dribblings may be replaced by 'cooperative' plays like passing the ball – or the other way round. In the following, we test the influence of the intra-team Gini coefficient and the coefficient of variation on both 'cooperative' and 'individualistic' plays, controlling for observed and unobserved team heterogeneity, wage expenditures or roster size.[14] Since accurate information of coach instructions is not available, we try to control for coach specific effects including coach dummies. As the results in Table 4 show, coaches truly exert high influence on the team's playing style. But even after holding coach heterogeneity constant we find that the team's wage dispersion significantly increases the number of seasonal dribblings and runs. The hypothesis that teams with a rather egalitarian pay structure play more cooperatively, however, is not supported. Strictly speaking, this result is not (yet) an empirical affirmation of Lazear's hypothesis, since high numbers of individualistic plays do not necessarily have to be bad for the team. Some players may be hired and paid high salaries in particular for their special ability to run and dribble.[15] Nevertheless, we find empirical evidence that the pay distribution affects the team's playing style even after team and coach heterogeneity is controlled for.

[14] Team level effects are jointly significant in most of the models, implying that a pooled regression is not suitable. The Hausman specification test reveals that the team level effects correlate with the regressors, implying that the fixed-effects approach is appropriate. We do not find evidence for potential nonlinearity.
[15] We are grateful to an anonymous referee for raising this issue.

V. Concluding Remarks

Given the competing hypotheses about the relationship between wage dispersion and team productivity, empirical models have to allow for potential nonlinearity. Using salary and performance data of soccer teams appearing in the first German soccer league, we find evidence for a U-formed relationship between the intra-team wage dispersion and sporting success. Teams that have either an egalitarian or a very differential pay structure are more successful on the field than teams with a medium level of wage dispersion, holding a team's talent heterogeneity constant. Considering the remuneration system as one important element of team culture, our results suggest that soccer teams should either have a strong culture of individualism and personal rewards or a culture of cooperation, teamwork and team based rewards. We find clear evidence that the pay structure affects the team's playing style since teams with a hierarchical pay structure have significantly more runs and dribblings than teams with more compressed wages.

The empirical finding that an increase of pay inequality reduces performance only in rather egalitarian teams and even here with diminishing marginal effects is consistent with newer articles about the relationship between inequality and relative deprivation. While the traditional concept of Yitzhaki (1979), Hey and Lambert (1980) and others assumed that relative deprivation increases proportionally with the Gini coefficient, more recent approaches (Paul, 1991; Podder, 1996; Paul, 1999) abandon the idea of a linear relationship. They rather argue that relative deprivation reacts less than proportionally to the Gini, because individuals usually tend to compare themselves only with nearby referents. Runciman (1972, p. 285) writes: 'Most people's lives are governed more by the resentment of narrow inequalities, the cultivation of modest ambitions and the preservation of small differentials (...)'. Paul (1991) argues that people care much more about income changes of people who are near to them in the income scale than of those who are very far off from them. Thus, an income transfer from a peer who earns slightly more to an already highly earning 'superstar' may even decrease the feelings of relative deprivation despite increasing the team's Gini coefficient. The relevance of fairness considerations declines as inequality increases.

Since remuneration and status are usually highly correlated, our result that increasing wage dispersion above a certain level again enhances team performance also contributes to the literature on status hierarchies and team effectiveness. Overbeck *et al.* (2005) show that teams having clear status hierarchies are more effective than teams with a lot of high status seeking individuals. Groysberg *et al.* (2007) agree that 'too many cooks spoil the broth'. Studying the group effectiveness of Wall Street equity research analysts, they find that the marginal benefit of stars diminishes as the proportion of star analysts in a research group increases. It becomes even negative when the star proportion within a team exceeds a certain threshold level. The authors argue that clear social hierarchies reduce dysfunctional team processes by bringing clarity to social interactions and increasing team effectiveness. As the findings of this article indicate, this applies to pay hierarchies as well, at least regarding high inequality soccer teams.

Of course, the professional sports context is in some ways unique: individual performance during the games is readily observed by thousands of spectators. The salaries are much higher, on average, than in most other occupations and professional sports is a typical context of pay for performance (Harder, 1992). These particularities limit the generalizability of the study. Professional sports teams represent a special type of team, which we have to keep in mind when applying our results. We classify soccer teams along two dimensions: the relation between exploitation and exploration and the degree of interdependence within the team. First, soccer teams are performance-oriented production teams, defined as teams producing the primary product of the organization (Crown, 2000). Unlike research and development teams, production teams are characterized by exploitation rather than exploration. The effect of wage dispersion on team performance may be even stronger in research and development teams and in project teams whose output is less observable and more knowledge-intensive. It is well known that tacit knowledge reacts very sensitively to motivational factors (Osterloh and Frey, 2000). A second distinguishing feature of soccer teams is the high interdependence. Keidel (1987) differentiates between pooled, sequential and reciprocal interdependence illustrating the three cases with the examples of baseball, (American) football and basketball. The intensity of cooperation in soccer teams is most similar to that of basketball teams and much higher than the pooled interdependence of baseball teams. Soccer players continually interact, and coordination is achieved through constant mutual adjustment. Intra-team wage dispersion may have a different impact in teams with less interdependence and, therefore, higher visibility of the individual contributions to the team output.

Against this background, this article suggests that performance teams with reciprocal interdependence are better off if wage inequality is either very high or very low. However, it remains the task of future empirical research to show whether the U-formed relationship between wage dispersion and team performance also stands in other team contexts.

Acknowledgements

We are grateful to David Forrest, Jaume Garcia, Michael Kosfeld, Andrew Oswald, the editor Mark Taylor, three anonymous referees, and to the seminar participants of the Western Economic Association conference 2007 in Seattle, US, of the Scientific Commission Organization 2008 in Munich, and of the 11th Colloquium of Personnel Economics 2008 in Bonn for helpful comments. Nicolai Grüter provided excellent research assistance. Remaining errors, are of course, our own.

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