

## Differences in wages, team performance, and measures of dispersion

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### Abstract.

The effects of wage dispersion on performance is an often-discussed topic in compensation research. Debates over the influence of differences in wages on performance are ongoing. The majority of the literature uses only one measure of disparity. With the indicators, the distribution of wages is measured. One study reports differing findings, using more than one measure for the differences in wages.

This conference paper focuses on the most popular measures for wage dispersion. Substantial literature favors a few indicators to measure differences in wages. This paper will measure wage dispersion with three dimensions: the Coefficient of variation, the Gini coefficient, and Theil's measure.

Many researchers use a sports data set when investigating the effects of wage dispersion. Because professional sports offers multiple advantages, as performance is relatively easy to measure, published in detail, and wages are often publicly disclosed. This paper will also make use of data from a sports setting. The data stems from the 2. Bundesliga, the second-highest league in German football.

A proven team performance model was taken from the literature, and with a standard OLS regression (ordinary least squares), the paper investigates if differences in the outcome appear with different measures of dispersion. Regression output shows that all used measures of dispersion show a significant positive influence of wage dispersion on team performance.

**Keywords:** wage dispersion, performance, compensation

### 1. Introduction

Authors like Gupta and Shaw perfectly summarize why every company should focus on their compensation scheme. "In virtually every aspect of organizational functioning, compensation can shape employee behavior and organizational effectiveness." (Gupta & Shaw, 2014, p. 1). This reasoning also explains the interest in research for the influences of wage dispersion. In the organizational and management literature, wage dispersion is a topic of great interest (Shaw, 2014; Trevor, Reilly, & Gerhart, 2012). Research results differ in their conclusions about the effects of differences in wages on performance. "Despite an increasing number of studies, research evidence on the effects of pay dispersion has not yet been consistent." (Downes & Choi, 2014, p. 53).

This paper will not discuss the corresponding theories regarding whether wage dispersion is beneficial or detrimental to performance. Frequently stated are theories like equity theory (Adams, 1963) or tournament theory (Lazear & Rosen, 1981). The latter is seen to support a positive relationship between wage dispersion and performance, whereas equity theory stands

# 4th INTERNATIONAL CONFERENCE ON MANAGEMENT, ECONOMICS & FINANCE

10-12 September, 2021

for the contrary effect. Tournament theory suggests a dispersed and equity theory a compressed wage structure to be beneficial for the working effort of employees.

Furthermore, researchers differentiate between two levels of wage dispersion. Firstly, horizontal or lateral wage dispersion which is based on wage differences between individuals of the same job family or hierarchical level. Secondly, vertical wage dispersion which is referring to wage differences between individuals of different job families or hierarchical levels (Shaw, 2014). Due to the research setting, this paper focuses on the effects of horizontal wage dispersion.

The focal point of this paper lies not on the question of whether the effects are positive or negative. The main question of this paper is if different measures of dispersion will lead to differences in the interpretation. In their research, Coates et al. (2016) reported that they only found the Coefficient of variation to be statistically significant, whereas wage dispersion measured with the Gini coefficient had no significant influence on performance.

Therefore the following hypothesis will be tested:

- H1: Wage dispersion has a statistically significant influence on team performance regardless of the used disparity measure.

## 1.1 Measures of dispersion

Researchers use a variety of scales to measure the concentration of pay which is also displayed in Table 1. Table 1 gives a small overview of eight studies estimating the influence of wage dispersion on team performance in a sportive setting. In this small overview of eight influential papers, four different measures were used. Bloom and Michel describe which conclusions can be drawn from these scales: "More dispersed pay structures concentrate pay among fewer employees at the top of the pay structure, thereby providing relatively rich rewards for these employees and relatively poor rewards for the rest" (Bloom & Michel, 2002, p. 33).

Allison (1978) suggests using the Coefficient of variation (CV), the Gini coefficient (Gini), or Theil's measure (Theil) when the measure should be invariant to proportionate changes and transfers between individuals change the resulting inequality. This paper follows the suggestion of Allison and uses all three indicators for the hypothesis tests. The suggested measures for inequality in pay CV and Gini are also the most common in wage dispersion research (Trevor et al., 2012).

Table 1: Used dispersion measures

Study	Dataset	Dispersion measure
Coates et al., 2016	Football; North America	Gini coefficient and Coefficient of variation

# 4th INTERNATIONAL CONFERENCE ON MANAGEMENT, ECONOMICS & FINANCE

10-12 September, 2021

Franck & Nüesch, 2011	Football; Germany	Gini coefficient and Coefficient of variation
Mondello & Maxcy, 2009	American Football; North America	Coefficient of variation
Debrock, Hendricks, & Koenker, 2004	Baseball; North America	Herfindahl-Hirschman Index
Simmons & Berri, 2011	Basketball; North America	Gini coefficient
Trevor et al., 2012	Ice hockey; North America	Pay variance
Frick, Prinz, & Winkelmann, 2003	Ice hockey, Basketball, American football and Baseball; North America	Gini coefficient
Bloom, 1999	Baseball; North America	Gini coefficient

The following equation gives the Gini coefficient:

$$G = \frac{\frac{1}{n^2} \sum_{i=1}^n \sum_{j=1}^n |x_i - x_j|}{2\mu}$$

The equation can be expressed in several ways (Pyatt, 1976), but the given expression clarifies that the Gini is a dispersion measure divided by twice the mean  $\mu$ . Harrison and Klein (2007) suppose that researchers favor the Gini over the variation coefficient because it follows a standard metric. The Gini coefficient varies from 0 -illustrating equally distributed wages- to (nearly) 1 -illustrating unequal distributed wages.

Whereas the Coefficient of variation is given by the standard deviation  $\sigma$  divided by the mean  $\mu$ :

$$CV = \frac{\sigma}{\mu}$$

The CV value is large if the wages concentrate on a few persons at the top and more at the bottom. The maximum value of both the Gini and the Coefficient of variation depends on the sample size  $n$ , but it should be less of a limiting factor in the case of the Gini. "Because the maximum CV is sensitive to sample size, highly dispersed units with fewer members likely would be regarded as having less disparity than those with more members." (Harrison & Klein, 2007, p. 1212). Nevertheless, both measures are scale-invariant, which means that they decline if a positive constant to every wage is added.

Allison also suggests the use of Theil's measure because it would be especially desirable for measuring inequality of income. To the best of the author's knowledge, Theil's measure was not used to investigate the effects of wage dispersion in a regression model so far.

$$T = \frac{\frac{1}{n} \sum_{i=1}^n x_i \log x_i - \mu \log \mu}{\mu}$$

# 4th INTERNATIONAL CONFERENCE ON MANAGEMENT, ECONOMICS & FINANCE

10-12 September, 2021

The displayed formula reveals that  $T$  is a measure of dispersion divided by the mean. The Theil index can take on values between zero and infinity; a value of zero would stand for equal distribution, and the higher the values, the higher the levels of inequality

## 1.2 Data set and model

Various researchers chose to investigate their research question with a secondary data set taken from professional sports. Such a setting offers multiple advantages compared to a corporate research setting. Kahn perfectly describes the main benefits: "There is no research setting other than sports where we know the name, face, and life history of every production worker and supervisor in the industry. Total compensation packages and performance statistics for each individual are widely available, and we have a complete data set of worker-employer matches over the career of each production worker and supervisor in the industry." (Kahn, 2000, p. 75).

The data of this paper was collected from two internet sources, the web pages [transfermarkt.de](http://transfermarkt.de) and [kicker.de](http://kicker.de). Kicker is a German football magazine that is released on a weekly basis. Transfermarkt is an online community with journalistic content and a broad data source of football statistics. In its forums, registered users can discuss and recommend the market values of football players.

The market value from [transfermarkt](http://transfermarkt.de) was taken as a wage proxy. Prockl and Frick (2018) performed a correlation test for ten consecutive seasons (2006-2015) between the publicly disclosed wages of North American football players and the market values from [transfermarkt](http://transfermarkt.de). For the seasons 2006-2010, their data shows a statistically significant positive correlation between the market value and the base wage ( $r = 0.71$ ), which supports the use of the market value as a wage proxy.

On the other hand, team performance was taken from the [kicker](http://kicker.de)-homepage. In this paper, the team performance is given by the winning percentage. The variable is calculated by dividing the gathered points of each team through the number of games played. A win in the regular season is awarded with three, a draw with one, and a loss with zero points.

Data from three consecutive seasons of the 2. Bundesliga was collected (2018/2019-2020/2021). The 2. Bundesliga is the second-highest league in German professional football. This leads to a total number of 54 observations for team performance, eighteen for each year.

### 1.2.1 Model

Frick et al. (2003) established the following model to estimate the influence of wage dispersion on team performance.

$$WP = \alpha + \alpha WD + \alpha LNWS + \alpha NOP + \alpha TD + \alpha YD$$

Where  $WP$  is the winning percentage of a team (points/games played);  $WD$  stands for the wage dispersion measure (Gini, Theil, and CV);  $LNWS$  is the natural logarithm of the team's total wage sum;  $NOP$  is the number of players on the roster;  $TD$  is used for the team dummies; and  $YD$  for the year dummies.

# 4th INTERNATIONAL CONFERENCE ON MANAGEMENT, ECONOMICS & FINANCE

10-12 September, 2021

The same proven model will be used in this paper to test for the influences of wage dispersion on team performance. As well as the question whether different measures of dispersion lead to differences in the interpretation of the effects of wage dispersion on team performance.

## 2. Results

The regression output for the standard OLS-Regressions is displayed in the following tables 2-4. With the Gini as a dispersion measure (Table 2), the estimation shows a significant positive influence of wage dispersion on team performance. The more dispersed the wages are, the higher the team performance, which would support theories like the already mentioned tournament theory. Simplified, an employer who wants to improve work performance, therefore, should allow differences in wages.

Table 2: Regression 1 (Gini)

	Estimate	Significance
Constant	69.742	
Gini	2.196	***
LNWS	-0.008	*
NOP	-0.020	*
YD	-0.034	
R2	0.84	

‘\*\*\*’  $p < 0.001$ ; ‘\*\*’  $p < 0.01$  ‘\*’  $p < 0.05$

The regression results also promote a significant positive influence of wage dispersion on team performance with the other two dispersion measures Theil’s measure and CV (see Table 2 and 3). As all three measures are showing a significant positive influence, the established hypothesis would not be rejected even if the level of significance is the highest with the Gini index.

Table 3: Regression 2 (Theil)

	Estimate	Significance
Constant	51.963	
Theil	1.223	**

# 4th INTERNATIONAL CONFERENCE ON MANAGEMENT, ECONOMICS & FINANCE

10-12 September, 2021

LNWS	-0.007	
NOP	-0.017	
YD	-0.025	
R2	0.80	

‘\*\*\*’  $p < 0.001$ ; ‘\*\*’  $p < 0.01$  ‘\*’  $p < 0.05$

The most apparent difference between the regression models is the significance of other variables. Only with the Gini coefficient does the total wage sum and the roster size seem to influence team performance significantly. Simplified, the higher the total wage sum of a team, the poorer is the team performance, which could be interpreted as a contradiction to theories like efficiency wage theory. Paying wages above the market-clearing wage seem not to lead to better performance of employees. The same occurs for the number of players in the team. This effect could be explained with coordination approaches; the bigger the team, the harder it is to coordinate the work efficiently.

Table 4: Regression 3 (CV)

	Estimate	Significance
Constant	54.897	
CV	0.480	**
LNWS	-0.040	
NOP	-0.017	
YD	-0.026	
R2	0.78	

‘\*\*\*’  $p < 0.001$ ; ‘\*\*’  $p < 0.01$  ‘\*’  $p < 0.05$

### 3. Discussion

In total, the hypothesis could be confirmed with the collected data. Wage dispersion has a statistically significant influence on team performance regardless of the disparity measure.

These results would suggest that bigger differences in wages in a team do not harm the team performance. Nevertheless, the influence of wage dispersion on team performance has to be examined in a more nuanced way. "A broad-brush approach will only add ambiguity and confusion. But when the theoretical underpinnings are logically derived, and the operationalization and measurement specifically dovetails with the theoretical rationale, there are vast possibilities for great enhancements in understanding." (Gupta, Conroy, & Delery,

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10-12 September, 2021

2012, p. 113). This paper did neither investigate a non-linear relationship between wage dispersion and team performance nor was a conditional wage part of the investigation of this paper.

However, researchers should include more than one measure of dispersion to confirm their findings. The Gini coefficient, Theil's measure, and the Coefficient of variation were tested and showed a statistically significant positive relationship between wage dispersion and team performance. Unlike the findings of Coates et al. (2016), where only one of the used measures showed a statistically significant influence.

## **Acknowledgment**

This paper is an output of the doctoral studies of the author. In his thesis, the author is investigating the influence of wage dispersion on performance in teams, the individual level, and the team level.

# 4th INTERNATIONAL CONFERENCE ON MANAGEMENT, ECONOMICS & FINANCE

10-12 September, 2021

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# 4th INTERNATIONAL CONFERENCE ON MANAGEMENT, ECONOMICS & FINANCE

10-12 September, 2021

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