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# Compensation and performance in Major League Baseball: Evidence from salary dispersion and team performance

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ABSTRACT

This study examines the relation between compensation and performance in Major League Baseball (MLB), focusing on salary dispersion and team performance based on 1985–2013 MLB data. We examine whether the tournament theory or the team-cohesiveness hypothesis dominates the relationship. We also use the relative position of team payroll as one of the control variables and compare our findings with the results based on the absolute level of team payroll. This study applies a dynamic panel estimation approach. Our evidence overall supports the team-cohesiveness hypothesis over the tournament theory. We find that greater wage disparity is negatively related to team performance. Our findings also suggest that salary structure is not a robust incentive design for team performance in MLB. A different treatment of payroll variables alters the role of salary dispersion. When we take the payroll level as a control variable, salary dispersion shows a negatively significant effect on team performance, while it has an insignificant effect on team performance when the payroll's relative position is used as a control variable.



## 1. Introduction

As a small number of people who earn substantial amounts of money and take on a dominant role in society, superstars have become an increasingly important phenomenon in modern society (Rosen, 1981). On the back of escalating salary dispersion within an organization, intra-organization salary disparity may undermine group cohesion by creating feelings of inequity, thus generating destructive reactions that can impair team performance. Both the equity pay theory (Lazear, 1989) and the team-cohesiveness hypothesis (Levine, 1991) suggest that narrow wage differentials can reduce dissonance among employees, thereby improving cohesiveness and productivity in an organization. On the other hand, the tournament theory (Lazear & Rosen, 1981) proposes that employees' efforts are induced by the spread between the earnings of each position. The tournament theory predicts that salary dispersion is positively related to performance.[3]

The contradictory predictions of the theory regarding the relation between salary dispersion and performance have led to growth in the empirical literature on this issue. Empirical studies, however, provide mixed evidence. Quite a few empirical studies support the team-cohesiveness hypothesis for the on-field performance measure (Bloom, 1999; Breunig, Garrett-Rumba, Jardin, & Rocaboy, 2014; Debrock, Hendricks, & Koenker, 2004; Depken, 2000; Jane, 2010; Mondello & Maxcy, 2009; Richards & Guell,

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[3] In addition to these two lines of literature, there are alternative theories explaining this relationship. For example, Breunig et al. (2014) "develop a general theoretical model of the effect of wage dispersion on team performance which nests two possibilities: wage inequality may have either negative or positive effects on team performance.", Mohan (2014), and Wang and Cheng (2014).

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1998; Wiseman & Chatterjee, 2003), whereas some studies support the view that more differentiated rewards produce positive effects on team performance (Marchand, Smeeding, & Torrey, 2006), which is consistent with the implication derived from the tournament theory. Still other studies find no evidence to relate wage dispersion to team performance (Avrutin & Sommers, 2007; Berri & Jewell, 2004 and Katayama & Nuch, 2011), while some find mixed evidence (Frick, Prinz, & Winkelmann, 2003).[4] Franck and Nüesch (2011) find negative effects of salary dispersion, but the negative relationship decreases at an increasing rate.

Given the mixed evidence in the literature, it is worthwhile to further explore the effect of salary dispersion on team performance. Meanwhile, we notice that the expression of payroll in the literature is not consistent. Some studies express payroll in absolute terms (Bloom, 1999; Debrock et al., 2004; Depken, 2000; Frick et al., 2003; Jane, 2010; Richards & Guell, 1998). Some research executes a data transformation for payroll (Berri & Jewell, 2004; Katayama & Nuch, 2011; Mondello & Maxcy, 2009).[5] Marchand et al. (2006) do not include payroll. Teams with the same payroll level in different years may have quite different payroll positions relative to the average team payroll. For example, both the 1998 Montreal Expos and the 1986 Oakland Athletics had approximately the same level of average team payroll (US$371,240 and US$376,776, respectively), but their ratios of team payroll to the average MLB team payroll in those corresponding years are quite different for the two teams, being 0.23 and 0.81, respectively. Consequently, implications from the relative payroll position and the payroll level may be quite different.

The purpose of this study is to provide further evidence in order to clarify whether the tournament theory or the team-cohesiveness hypothesis dominates the relationship between salary dispersion and team performance. In this study, we use the payroll level as one of the control variables and then replace the level variable with a team's relative payroll position within MLB as one of the control variables to examine the effect of salary dispersion. We compare the results based on the payroll at the absolute level and at the relative level. In addition, we also consider a time effect (in terms of a lagged dependent variable) on the relation between compensation and team performance.

The remainder of the paper proceeds as follows. Section 2 describes the data and empirical methodology used in this research. Section 3 presents results and discussion. The final section provides conclusions.

## 2. Data and empirical methodology

### *2.1. Data*

Data from MLB are particularly appealing for testing the relation between salary dispersion and team performance. First of all, as MLB games attract a large number of spectators and a television audience, the measurement code for performance is prone to be set up strictly, and MLB performance records are highly accurately preserved. Consequently, player and team productivities are objectively and comprehensively defined. Second, most MLB players' salary information has been revealed through the media since 1985, which helps test hypotheses related to the effects of intra-team salary disparity on team performances. Third, whereas panel data are rare in organizational research, such data are widely available on MLB. The availability of MLB panel data allows us to apply the dynamic panel estimation approach to examine the role of salary dispersion on team performances, with a better control on team specific heterogeneity.

This study's sample covers the period from 1985 to 2013. During this time, two expansion teams were established in 1993 (Colorado Rockies and Florida Marlins) and another two expansion teams were set up in 1998 (Arizona Diamondbacks and Tampa Bay Rays).[6] Specifically, there are 26 teams between 1985 and 1992, 28 teams between 1993 and 1997, and 30 teams between 1998 and 2013.[7] All the teams have complete data for the period since 1985 or since their established year, except for the Texas Rangers whose 1987 data we exclude from analysis, because only 4 players' salary information was revealed in that year.

This study measures salary dispersion by the Gini coefficient as in Bloom (1999). For comparison, we also follow Depken (2000) by using the Herfindahl-Hirschman index (HHI) to measure salary dispersion. We collect team performance data and individual players' salary data from Sean Lahman's baseball database.[8] Team history data are mainly collected from the official website of each MLB team and supplemented by ballparks' websites.[9] We use metropolitan population to represent the market size of each MLB team. For teams in the U.S., we adopt the metropolitan statistical area's (MSA) population, collected from Texas A&M University's Real Estate Center website.[10] For Canada's Toronto Blue Jays and Montreal Expos, we adopt Census

[4] Frick et al. find no consistent relationship between wage dispersion and team performance across the four North American major sports leagues.

[5] Berri and Jewell (2004) use the difference in a team's payroll between two seasons as a control variable. Katayama and Nuch (2011) look at the salary ratio between two opposing teams in a game. Mondello and Maxcy (2009) use the ratio of each team's annual payroll to the league salary cap in that year.

[6] Tampa Bay Devil Rays (1998–2007) and Tampa Bay Rays (2008-present) are treated as the same team, as are Montreal Expos (1969–2004) and Washington Nationals (2005-present).

[7] The team number information is shown in the following time line.

| number of years | | 8 | | 5 | | 16 | |
|---|---|---|---|---|---|---|---|
| year | 1985 | | 1993 | | 1998 | | 2013 |
| number of teams | | 26 | | 28 | | 30 | |

[8] http://www.seanlahman.com

[9] http://mlb.mlb.com and http://www.ballparks.com/baseball, separately.

[10] http://recenter.tamu.edu/data

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**Table 1**
Descriptive statistics.

| Variable | Obs | Mean | SD | Min | Max |
|---|---|---|---|---|---|
| Team winning percentage | 827 | 0.4999 | 0.0694 | 0.2654 | 0.7160 |
| Team average salary[a] | 827 | 2,131,677 | 1,532,669 | 234,940 | 9,157,818 |
| Relative position of team payroll | 827 | 0.9998 | 0.3609 | 0.1915 | 2.8848 |
| Team Gini coefficient | 827 | 0.5254 | 0.0769 | 0.2755 | 0.7450 |
| Team HHI | 827 | 0.0897 | 0.0238 | 0.0493 | 0.2307 |
| National League | 827 | 0.5091 | 0.5002 | 0 | 1 |
| Manager quality | 827 | 0.5002 | 0.0388 | 0.3148 | 0.5824 |
| Market size[b] | 827 | 5,435,183 | 4,416,154 | 1,389,361 | 19,300,000 |
| Team's top 3 paid pitchers' ERA | 827 | 4.3093 | 1.3094 | 2.1000 | 23.1950 |
| Team's top 3 paid batters' RBI | 827 | 198.3204 | 63.6898 | 42[c] | 389 |
| City tenure[d] | 827 | 56.5393 | 37.4136 | 1[d] | 131[d] |
| Major League average salary[a] | 827 | 2,132,440 | 1,168,110 | 465,636 | 4,036,263 |
| National League average salary[a] | 421 | 2,102,374 | 1,095,370 | 455,825 | 3,971,051 |
| American League average salary[a] | 406 | 2,163,645 | 1,254,490 | 446,308 | 4,106,361 |

[a] The unit of salary is US dollar. We calculate Major League average salary by averaging the total salaries of all MLB players of the same year in the sample. Similarly, National League average salary is calculated by averaging the total salary of all players of the same year in the National League. We calculate American League average salary based on the same method.

[b] The unit of market size is person.

[c] It happened in 2008 when the top three paid non-pitchers of Washington Nationals were Nick Johnson, Paul LoDuca and Dmitri Young. They earned 20, 12, and 10 RBI, respectively.

[d] The unit of city tenure is year. The city tenure of 1 is observed for 5 observations, including 4 newly established team in 1993 and 1998, respectively; and Washington Nationals in 2005, which moved to Washington D.C. in 2005. The city tenure of 131 is observed for Philadelphia Phillies in 2013 since it was established in Philadelphia in 1883 (2013–1883 + 1 = 131).

Metropolitan Area's (CMA) population of Toronto and Montreal, collected from Statistics Canada.[11] Table 1 reports the data's descriptive statistics.

Our data show that the average MLB team payroll is about $2.13 million over the period 1985–2013. The average team payroll is marginally higher in the American League (AL) ($2.16 million) versus that in the National League (NL) ($2.10 million). The average team payroll grew about 8.38 times over this period, from $0.48 million in 1985 to $4.02 million in 2013. The growth in the average AL team payroll is also higher (from $0.46 million in 1985 to $4.07 million in 2013) than in the NL (from $0.50 million in 1985 to $3.96 million in 2013). With respect to salary dispersion, the average MLB team Gini is about 0.53 in 1985–2013, with 0.52 for the AL and 0.53 for the NL, and grew about 1.50 times over this period, from 0.36 in 1985 to 0.54 in 2013. The average AL team Gini rose from 0.34 in 1985 to 0.53 in 2013, with the NL team Gini rising from 0.38 to 0.56.

### *2.2. Team performance equation*

The majority of studies in the existing literature follow the conceptual framework developed by Levine (1991) to construct their empirical model. We thus follow this line to define a team's performance based on the following panel data model, which controls for the effects of unobserved individual team heterogeneity, such as teams' culture, and observed team-specific characteristics, such as manager quality.

$$\text{TWP}_{jt} = \gamma_0 + \gamma_1 \text{TWP}_{jt-1} + \gamma_2 \text{Dispersion}_{jt} + \gamma_3 \text{Payroll}_{jt} + X'_{jt}\beta + \gamma_j + \varepsilon_{jt}, \quad (1)$$

where $\text{TWP}_{jt}$ is team performance. $\text{Dispersion}_{jt}$ measures intra-team salary disparity. Based on Levine (1991), we assume team cohesiveness decreases as intra-team salary disparity increases. $\text{Payroll}_{jt}$ symbolizes player payroll expenditure, which stands for a team's production function following Depken (2000). Moreover, $X_{jt}$ is a set of control variables indicating other factors that may affect team performance, and $\text{TWP}_{jt-1}$ represents a team's winning percentage in the previous year, which denotes a team's potential ability for the current year's team performance. $\gamma_j$ represents unobserved individual team heterogeneity. $\varepsilon_{jt}$ denotes random error term. For a comparison, we also present Depken's (2000) equation, which adopts the $\text{Year}_t$ variable to control for the payroll trend over the year.

#### *2.2.1. Team performance, salary dispersion, and payroll measures*

Most studies in the literature use team winning percentage (TWP) in the regular season to examine team performance. We thus use $\text{TWP}_{jt}$ to measure team performance. The tournament theory suggests that individual players are encouraged by large wage dispersions, and team performance should benefit from the joint efforts of teammates. A positive coefficient for wage dispersion is expected on $\text{TWP}_{jt}$. The team-cohesiveness hypothesis implies that individual players feel discouraged by large wage dispersions due to feelings of inequity. Thus, a negative coefficient for wage dispersion is expected on $TWP_{jt}$.

[11] http://www12.statcan.gc.ca/census

Gini coefficients in Bloom (1999) and HHI in Depken (2000) are two commonly used measures for salary dispersion. We adopt Gini coefficients to measure intra-team salary disparity in this study.[12] However, we also present estimation results based on the HHI measure for comparison.[13] The Gini coefficient ranges from 0 to 1. A value of 0 represents complete equality of the salary distribution, while a value of 1 represents complete inequality. Gini coefficients in previous studies were calculated on the basis of salaries either for all players listed or for the top-25 paid players on a team if more than 25 players' salary information is available. This paper follows Wiseman and Chatterjee (2003) by using only the salaries of the 25 highest paid players on each team in the Lahman database (not every team in each year has 25 players) in order to correspond to a roster of 25 players from April to August in the regular season. The mean Gini coefficient of the sample is 0.53 with a standard deviation of 0.08. The most unequal salary structure occurs in 1998 for the Marlins (0.75), while the least unequal salary structure happens in 1985 for the Angels (0.28). It is interesting to note that the Yankees have an intermediate Gini coefficient with an average of 0.48 over the 29 years of our sample period, which goes against the common notion that with several talented players the Yankees should be associated with a relatively high Gini coefficient.

We measure team payroll by the absolute level ($ln\_TavgPay_{jt}$) and the relative position of team payroll ($Tm\_mlb\_ratio_{jt}$), respectively. Previous studies have used an absolute measure of team payroll ($ln\_TavgPay_{jt}$) to explain the relation between payroll and team performance. Even though those studies control for the increasing payroll trend through a variable representing the time effect or current year league payroll variable, they were not always able to distinguish whether payroll explains a team's relative position within a league across time. We define a team's relative position as the ratio of team payroll to current MLB team payroll ($Tm\_mlb\_ratio_{jt}$), to measure this team-specific payroll relation. This measure can also solve the problem of an increasing trend in a team's payroll level and also implies the payroll rank of the MLB team. Payroll rank denotes inter-team payroll disparity, which has been a concern for a long time.[14] As teams with a higher payroll level or high payroll rank are capable of recruiting more talented players to induce better team performance, both coefficients are expected to be positively related to a team's winning percentage. Since the number of players varies for each team in each year in the sample, rather than include total payroll, we instead use average payroll. The highest average team payroll is US$9.16 million (Yankees, 2013) versus the lowest at US$0.23 million (Pirates, 1988).

### 2.2.2. Control variables

$X_{jt}$ is a set of control variables including talented players' performance ($Top3era_{jt}$, $Top3rbi_{jt}$), manager quality ($Mgr_{jt}$), dummy variable of the two leagues ($League_{jt}$), average pay of the two leagues ($\ln\_LeaguePay_{jt}$), and two local variables: market size ($Market_{jt}$) and city tenure ($Cityten_{jt}$). $Top3era_{jt}$ and $Top3rbi_{jt}$ measure the statistics of key players' performances. A common notion suggests that ballplayer talent is more important to a team winning, and team performance drops when talented players underperform or are absent. We thus introduce these two variables to reflect the role of top paid players' performances in order to rule out any adverse impact that may be brought up by these key players. $Top3era_{jt}$ is a weighted average of the *ERA* of the top 3 paid pitchers on a team in the Lahman data set. $Top3rbi_{jt}$ is the total *RBI* of the top 3 paid hitters.

Manager quality ($Mgr_{jt}$) is the average career winning percentage of a team manager. Kahn (1993) finds that a new manager with better coaching quality significantly raises a player's performance and a team's performance. We thus use manager quality as one of the inputs in the production function. We expect the coefficients of $Mgr_{jt}$ to be positively significant. The average pay of the two leagues (NL and AL) controls for the increasing trend in MLB salaries; the two leagues' salaries have grown about 7.92 times and 8.85 times, respectively, over the study's time period. This variable is excluded if average team payroll is replaced by the relative position of team payroll ($Tm\_mlb\_ratio_{jt}$).

The $Market_{jt}$ variable controls for the market size. Some studies relate $Market_{jt}$ to team performance, for example, Bloom (1999). A larger $Market_{jt}$ is expected to help the home team have higher revenues. Thus, larger market teams are expected to be capable of offering higher salaries than smaller market teams, which tend to increase overall team production. City tenure ($Cityten_{jt}$) represents the number of years a team resides in its current city. Since MLB teams sometimes move to other cities, we do not use team age (the number of years after a team has been established) as the control variable. Similar to market size, city tenure is commonly used in studies to represent attendance, showing the affection a city's residents have towards their own MLB team. The more years a team remains in the host city, the more fans the team accumulates, and thus the stronger atmosphere there is for the fans to help spur the home team to win a game. We include both market size and city tenure in our model as control variables.

### 2.3. Empirical methodology

We apply the Blundell-Bond (1998) methodology to estimate our dynamic model. Since prior season performance controls for serial dependence (Bloom, 1999), a positive relation is expected, other things being equal. Furthermore, even though its coefficient is not the focus of interest, Bond (2002) proposes that allowing for a dynamic relationship might be critical for recovering consistent estimates of other parameters. Since thirty MLB teams are observed over a twenty-five year dimension in this study, the Arellano and Bover/Blundell and Bond system (1995/1998) (hereafter, Blundell-Bond) is suitable to solve problems caused by a lagged dependent variable among the regressors. The estimator follows the practice of Anderson and Hsiao (1981) and

[12] Gini-coefficient $= 1 + \frac{1}{N} - \frac{2}{N^2 \bar{S}}(S_1 + 2S_2 + \ldots\ldots + NS_N)$. Here, $S_1 \cdots S_N$ is the individual player salary on a given team arranged in order of decreasing salary, $\bar{S}$ is the mean salary of this team, and $N$ is the number of players on this team. We compute a separate Gini coefficient for each team in each year.

[13] HHI $= \sum_{i=1}^{N} (SHARE_i)^2$, where $SHARE_i$ is the $i$th player's share of a team's total salary expenditure.

[14] "Since 1995 every World Series champion has ranked among the top five clubs in total payroll, and the 10 teams to appear in the World Series since 1995 have each ranked among the top third in total payroll" (Mitchell 2008, Washington Post).

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**Table 2**
Definition and measurement of variables.

| Variables | Definition and measurement |
|---|---|
| **Dependent** | |
| $TWP_{jt}$ | Team *j* winning percentage in current year (= wins/games played) |
| **Independent** | |
| $Gini_{jt}$ | Gini coefficients are calculated on the basis of the salaries of the top 25 paid players on team *j* |
| $HHI_{jt}$ | HHI is calculated on the basis of the salaries of the top 25 paid players on team *j* |
| $\ln\_TavgPay_{jt}$ | Log of team *j* average payroll in current year |
| $Tm\_mlb\_ratio_{jt}$ | Ratio of team *j* average payroll to MLB average payroll in current year |
| $TWP_{jt-1}$ | Team *j* winning percentage the previous 1 year |
| $League_{jt}$ | Dummy variable coded 1 for National League, 0 for American League |
| $Top3era_{jt}$ | A weighted average of earned run average of the top 3 paid pitchers of team *j* in current year in the Lahman data set |
| $Top3rbi_{jt}$ | A total of runs batted in earned by the top 3 paid hitters of team *j* in current year in the Lahman data set |
| $Mgr_{jt}$ | Team *j*'s manager quality in current year measured by an average career winning percentage of the team manager |
| $Market_{jt}$ | Metropolitan area population of a team's hometown |
| $\ln\_LeaguePay_{jt}$ | Log of National League and log of American League average pay in current year, respectively |
| $Cityten_{jt}$ | The period during which a team played its MLB games in the city |
| $Year_t$ | A monotonic time trend is only used in the Depken model |

Arellano and Bond (1991). Anderson and Hsiao (1981) remove an unobserved individual-level effect through the first differencing approach. Arellano and Bond (1991) further improve the model by using lagged values of the dependent variable as additional instruments. Since there are more instruments than parameters to be estimated, a generalized method of moments (GMM) procedure is adopted. This GMM-type moment condition can be introduced into either a fixed or random effect model. Arellano and Bover (1995) extend the GMM framework to include additional instruments based on the original equations in levels, which can accommodate predetermined variables. Blundell and Bond (1998) further improve the weak instrument by using lagged differences of the dependent variable as additional instruments for equations in levels.

We assume average team payroll is a predetermined variable since a previous team performance can influence the current team payroll. For example, when a team plays well in one season, team management may increase the payroll to secure players in the following year. As a result, the team payroll increases. As manager quality is the weighted average of his winning percentage, we assume manager quality is an endogenous variable given that concurrent team winning percentage is included into the calculation. Table 2 reports the definition and measurement of the variables.

## 3. Results

Tables 3 and 4 show the estimation results from the payroll variable in level form ($\ln\_TavgPay_{jt}$) and relative position form ($Tm\_mlb\_ratio_{jt}$), respectively. We report results of Eq. (1) in panel 3 of Tables 3 and 4 (referred to as GMM estimates). To compare results in the current literature, we also list the estimates of the panel static model following Depken (2000) in panel 1 of Tables 3 and 4 (referred to as “Depken” estimates) and the estimates of an autoregressive procedure following Bloom (1999) in panel 2 of Tables 3 and 4 (referred to as “Bloom” estimates).[15] The GMM estimates report the results based on the Blundell-Bond (1998) approach. “Bloom” estimates report the results using the Prais-Winsten regression. The Hausman (1978) specification test is employed to test whether the unobservable individual-team effects are uncorrelated with the regressors or not. In the “Depken” models, the Hausman (1978) test supports the panel random effects model.

We test whether the relationship between salary dispersion and team performance is dominated by the equity pay theory (Lazear, 1989) as well as the team-cohesiveness hypothesis (Levine, 1991), or the tournament theory (Lazear & Rosen, 1981) by examining the sign of the $Dispersion_{jt}$ variables. If the sign is negative, then the equity pay theory (Lazear, 1989) and the team-cohesiveness hypothesis (Levine, 1991) are supported. The tournament theory (Lazear & Rosen, 1981) is supported when the sign of $Dispersion_{jt}$ variables is positive. Our results of the estimated parameters of $Dispersion_{jt}$ variables vary depending on the expression of the payroll variable. $Gini_{jt}$ is negative and significant when team payroll level ($\ln\_TavgPay_{jt}$) is included as a control variable, which supports the equity pay theory (Lazear, 1989) and the team-cohesiveness hypothesis (Levine, 1991). However, the relation is not significant when the payroll level is replaced by the relative position of team payroll ($Tm\_mlb\_ratio_{jt}$). These

[15] In the “Depken” models, we follow Depken (2000) by using $HHI_{jt}$ as the measure of wage dispersion for a comparison.

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**Table 3**
Estimates of salary dispersion on team performance controlled by the team payroll level.

| Dependent variable: team winning percentage | | | | | | |
|---|---|---|---|---|---|---|
| | Depken estimates | | Bloom estimates | | GMM estimates | |
| Variable | Coefficient | SE | Coefficient | SE | Coefficient | SE |
| $TWP_{jt-1}$ | | | 0.0821** | 0.0333 | 0.0768** | 0.0359 |
| $HHI_{jt}$ | −0.5178*** | 0.1060 | | | | |
| $Gini_{jt}$ | | | −0.0599** | 0.0301 | −0.0699* | 0.0385 |
| $\ln\_TavgPay_{jt}$ | 0.0415*** | 0.0061 | 0.0071 | 0.0067 | 0.0182* | 0.0100 |
| $\ln\_LeaguePay_{jt}$ | | | −0.0008 | 0.0072 | −0.0128 | 0.0116 |
| $Year_t$ | −0.0029*** | 0.0006 | | | | |
| $League_{jt}$ | | | −0.0033 | 0.0037 | 0.0073 | 0.0120 |
| $Top3era_{jt}$ | | | −0.0122*** | 0.0034 | −0.0093*** | 0.0031 |
| $Top3rbi_{jt}$ | | | 0.0003*** | 0.0000 | 0.0003*** | 0.0000 |
| $Mgr_{jt}$ | | | 0.6959*** | 0.0534 | 0.6757*** | 0.1159 |
| $Cityten_{jt}$ | | | −0.0000 | 0.0000 | 0.0001 | 0.0001 |
| $Market_{jt}$ | | | 0.0002 | 0.0004 | 0.0003 | 0.0014 |
| Constant | 5.7450*** | 1.1248 | 0.0474 | 0.0452 | 0.0589 | 0.0725 |
| $N$ | 827 | | 823 | | 823 | |
| $R^2$ | 0.1855 | | 0.4674 | | | |
| *Hausman test* | | | | | | |
| Test statistic | 5.49 | | | | | |
| Prob. > $\chi^2$ | 0.1393 | | | | | |
| *Observations per group* | | | | | | |
| Min | 16 | | | | 15 | |
| Average | 27.6 | | | | 27.43 | |
| Max | 29 | | | | 29 | |
| *Sargan test* | | | | | | |
| Test statistic | | | | | 176.0124 | |
| Prob. > $\chi^2$ | | | | | 0.2644 | |

Both the Depken estimates and the Bloom estimates adopt robust standard errors, and the GMM estimates adopt the Windmeijer robust standard errors. Team average pay and league average pay take a logarithm. Market size is scaled down by million. The Hausman test supports random effects for the Depken estimates. Dynamic estimates assume team average pay as the predetermined variable, and manager quality is endogenous. The null hypothesis of the Sargan test: overidentifying restrictions are valid. Prob. > $\chi^2$ refers to the *p*-value of both the Hausman test and the Sargan test. Although our sample starts from 1985, we use 1984 team winning percentage to avoid losing observations for the models with a lag term. Thus, the sample size for Bloom and GMM is different by only 4 observations from the Depken estimation, which is due to the 4 latest established teams in the 1990s.

*** Sstatistical significance at 1% level.

** Sstatistical significance at 5% level.

* Statistical significance at 10% level.

findings hold in the "Bloom" and GMM estimates, but in the "Depken" estimates we find that $Dispersion_{jt}$ variables in both expressions of payroll variables are significantly negatively related to $TWP_{jt}$.

It is noted that the "Depken" model does not include an autoregressive procedure, whereas both "Bloom" and GMM models adopt one. Bond (2002) proposes that allowing for a dynamic relationship might be critical for recovering consistent estimates of other parameters. We thus conjecture that the lag dependent variable ($TWP_{jt-1}$) may play a crucial role in the results' differences. To verify our speculation, we further include the lag dependent variable ($TWP_{jt-1}$) in the "Depken" model and report the results in Table 5. Similar to the results in the "Bloom" and GMM models, $Dispersion_{jt}$ variables (measured by $HHI_{jt}$) turn out to be insignificant when we transform payroll data from level to rank.

On the part of team payroll, the variable in level form ($\ln\_TavgPay_{jt}$) is strongly significant in the "Depken" estimates, but not in the "Bloom" and GMM estimates. On the other hand, the variable in relative position form ($Tm\_mlb\_ratio_{jt}$) is significantly related to team performance in the "Depken" and GMM estimates. As mentioned earlier, the same team payroll level in different years has quite different payroll positions relative to the average MLB team payroll. The level form problem will worsen in the panel data methodology. Conversely, $Tm\_mlb\_ratio_{jt}$ represents inter-team payroll disparity in the same year, which is a more specific same-year comparison. As expected, the lag team winning percentage variable ($TWP_{jt-1}$) is positively related to $TWP_{jt}$, showing a degree of persistency in team performance in terms of winning percentage. For team characteristics, star athletes ($Top3era_{jt}$, $Top3rbi_{jt}$) and manager quality ($Mgr_{jt}$) are positively related to team performance as expected. However, two local variables, market size ($Market_{jt}$) and city tenure ($Cityten_{jt}$), are not significantly related to team performance measure used in this study.

Although our results of the effect of salary dispersion are mixed, the sign of the relation remains negative in all estimating results. Thus, we may infer that greater wage disparity is negatively related to team performance, which is in favor of supporting the equity pay theory (Lazear, 1989) and the team-cohesiveness hypothesis (Levine, 1991). However, the relation between them is not robust. The significance alters when the expression of payroll changes. The weak relation between the $Dispersion_{jt}$ variables and team performance may be explained by the following two contextual factors. First, the objective measurement and low monitoring cost of individual performances allow individual performances to be observable, motivating athletes to positively affect their future salary when they are concerned over their future careers. They build up their performance reputation ahead of

**Table 4**
Estimates of salary dispersion on team performance controlled by relative position of team payroll.

| Dependent variable: team winning percentage | | | | | | |
|---|---|---|---|---|---|---|
| | Depken estimates | | Bloom estimates | | GMM estimates | |
| Variable | Coefficient | SE | Coefficient | SE | Coefficient | SE |
| $TWP_{jt-1}$ | | | 0.0806** | 0.0330 | 0.0771** | 0.0375 |
| $HHI_{jt}$ | −0.3980*** | 0.1101 | | | | |
| $Gini_{jt}$ | | | −0.0296 | 0.0264 | −0.0405 | 0.0366 |
| $Tm\_mlb\_ratio_{jt}$ | 0.0594*** | 0.0072 | 0.0079 | 0.0069 | 0.0470*** | 0.0142 |
| $Year_t$ | 0.0003 | 0.0003 | | | | |
| $League_{jt}$ | | | −0.0030 | 0.0038 | 0.0052 | 0.0103 |
| $Top3era_{jt}$ | | | −0.0120*** | 0.0034 | −0.0094*** | 0.0030 |
| $Top3rbi_{jt}$ | | | 0.0003*** | 0.0000 | 0.0003*** | 0.0000 |
| $Mgr_{jt}$ | | | 0.6957*** | 0.0538 | 0.6047*** | 0.1229 |
| $Cityten_{jt}$ | | | 0.0000 | 0.0000 | 0.0002 | 0.0001 |
| $Market_{jt}$ | | | 0.0002 | 0.0005 | −0.0009 | 0.0015 |
| Constant | −0.1941 | 0.5715 | 0.1115*** | 0.0315 | 0.1117 | 0.0673 |
| $N$ | 827 | | 823 | | 823 | |
| $R^2$ | 0.1922 | | 0.4616 | | | |
| *Hausman test* | | | | | | |
| Test statistic | 2.93 | | | | | |
| Prob. $> \chi^2$ | 0.4018 | | | | | |
| *Observations per group* | | | | | | |
| Min | 16 | | | | 15 | |
| Average | 27.6 | | | | 27.43 | |
| Max | 29 | | | | 29 | |
| *Sargan test* | | | | | | |
| Test statistic | | | | | 151.2003 | |
| Prob. $> \chi^2$ | | | | | 0.7719 | |

Both the Depken estimates and the Bloom estimates adopt robust standard errors, and the GMM estimates adopt the Windmeijer robust standard errors. Team average pay and league average pay take a logarithm. Market size is scaled down by million. The Hausman test supports random effects for the Depken estimates. GMM estimates assume team payroll ratio as a predetermined variable, and manager quality is endogenous. The null hypothesis of Sargan test: overidentifying restrictions are valid. Prob.$> \chi^2$ refers to the $p$-value of both the Hausman test and the Sargan test. Although our sample starts from 1985, we use 1984 team winning percentage to avoid losing observations for the models with a lag term. Thus, the sample size for Bloom and GMM is different by only 4 observations from the Depken estimation, which is due to the 4 latest established teams in the 1990s.
*** Statistical significance at 1% level.
** Statistical significance at 5% level.

**Table 5**
Dynamic panel estimation results using HHI as salary dispersion variable.

| Dependent variable: team winning percentage | | | | |
|---|---|---|---|---|
| | GMM 1 | | GMM 2 | |
| Variable | Coefficient | SE | Coefficient | SE |
| $TWP_{jt-1}$ | 0.2035*** | 0.0463 | 0.2012*** | 0.0476 |
| $HHI_{jt}$ | −0.3866*** | 0.1046 | −0.1297 | 0.1224 |
| $\ln\_TavgPay_{jt}$ | 0.0308*** | 0.0111 | | |
| $Tm\_mlb\_ratio_{jt}$ | | | 0.0762*** | 0.0149 |
| $Year_t$ | −0.0022** | 0.0009 | −0.0003 | 0.0004 |
| Constant | 4.3333** | 1.7415 | −0.1946 | 0.7267 |
| $N$ | 823 | | 823 | |
| *Observations per group* | | | | |
| Min | 15 | | 15 | |
| Average | 27.43 | | 27.43 | |
| Max | 29 | | 29 | |
| *Sargan test* | | | | |
| Test statistic | 163.2132 | | 146.2413 | |
| Prob. $> \chi^2$ | 0.4806 | | 0.8225 | |

Payroll variables are assumed to be the predetermined. Standard errors adopt Windmeijer robust standard errors for two equations. Team average pay takes a logarithm. The null hypothesis of the Sargan test: overidentifying restrictions are valid. Prob. $> \chi^2$ refers to the $p$-value for the Sargan test.
*** Statistical significance at 1% level.
** Statistical significance at 5% level.

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their next contract negotiation. As a result, the perception of inequity from intra-team salary disparity does not generate destructive reactions that impair team performance. Thus, observable individual performance itself and players' career concerns surpass pay distributions in incentive designs. Consequently, salary structure is not a useful incentive for enhancing team performance. Second, the relative payroll position variable mitigates the negative effects of salary dispersion, as it implies the payroll rank of a team in MLB. Teams with a higher payroll rank are more capable of employing more competitive athletes and therefore are likely to win more games.

Another possible interpretation relates to the composition of wage dispersion. A large wage dispersion for a team may come from a combination of a few talented or superstar-type players with tremendously high salaries while their teammates have comparatively lower pay. This type of team is less likely to win more games as the number of talented or superstar-type players on such a team is not enough to compete with teams having an overall greater number of talented players. As a result, a large wage dispersion may lead to a lower winning percentage for such a team. Other situations of a lower winning percentage for teams with only a few superstar players may be caused by the poor performances of these superstar players or from them missing games due to injuries, therefore creating a negative relation between team performance and salary dispersion. These are some possible scenarios under which a team with a large wage dispersion may show poor team performance.

Our results overall suggest that $Dispersion_{jt}$ variables do not generate a robust relation with team performance. The association between $Dispersion_{jt}$ and team performance is weaker than the relationship between the relative position of team payroll ($Tm\_mlb\_ratio_{jt}$) and team performance. The implication from these two salary variables is that a team with a high payroll is more competitive in team performance, but a larger intra-team salary dispersion may show an adverse effect on team performance. The relationship between the team performances with the two salary variables resembles the findings in the literature (Debrock et al., 2004; Richards & Guell, 1998).

In sum, our evidence tends to support the team-cohesiveness hypothesis over the tournament theory. In terms of wage dispersion, our evidence supports that teams paying considerably more for top talented players are more likely to create disharmony feelings between players and harm team performance rather than inducing players' effort to achieve a better team performance. However, looking at dispersion alone is not enough to predict team performance. Our findings related to team payroll indicate that a team's payroll rank in MLB is a more robust explanatory variable than a salary dispersion variable is. We may infer that inter-team payroll disparity contributes more to team performance than the structure of intra-team salary dispersion does.

## 4. Conclusion

This study attempts to clarify whether the tournament theory or cohesiveness hypothesis dominates in the relation between salary dispersion and team performance. The tournament theory (Lazear & Rosen, 1981) proposes that employees' efforts are induced by the spread between the earnings of each position. The team-cohesiveness hypothesis (Levine, 1991) suggests that narrow wage differentials can improve cohesiveness and productivity in an organization. The current empirical literature regarding the relation between salary dispersion and team performance provides inconclusive evidence. Many of the latest studies use payroll in the level form, while some research executes a data transformation for payroll. We thus explore the issue by comparing the results controlled by the different expressions of payroll. We use the relative position of team payroll as one of the control variables and compare our findings with the results based on the absolute level of team payroll.

Our estimation results based on the dynamic panel method suggest that compensation does play a role in team performance. In terms of salary dispersion, its negative effect on team performance turns somewhat weaker when a team's relative payroll position variable replaces the payroll level variable. Salary dispersion shows a negatively significant effect on team performance when the level of pay is included as a control variable. However, salary dispersion has an insignificant effect on team performance when the relative level of payroll is used as a control variable. Thus, the findings based on the team performance result suggest that the team-cohesiveness hypothesis is supported over the tournament theory, but a team's payroll rank in MLB is a more robust explanatory variable than a salary dispersion variable is. We may infer that inter-team payroll disparity contributes more to team performance than the structure of intra-team salary dispersion does. In the future, we can investigate the effect of salary dispersion on individual players' performance. This further study will allow us to achieve a broader knowledge of the impact of salary dispersion on performance.

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