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Team performance and within-team salary disparity: an analysis of nippon professional baseball

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Abstract

Using data from Nippon Professional Baseball, which is the Japanese professional baseball league, we examine the relationship between within-team salary disparity and team performance. We find that greater salary disparity tends to result in better team performance, which is the opposite of what prior studies have observed for Major League Baseball. Our results suggest that even within the same sport, the relationship may be partly affected by different institutional settings

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1. Introduction

Economic theories of the firm predict that the distribution of salaries across employees within an organization may influence its performance. Predictions, however, differ greatly between competing theories. One strand of the literature (e.g., Akerlof and Yellen 1988, 1990; Levine 1991) predicts that a compressed salary structure creates harmony and cohesion among employees, resulting in high productivity. In contrast, the rank-order tournament model (Lazear and Rosen 1981) predicts that greater salary disparities within an organization can increase productivity by inducing greater effort from employees.

The differing views have been subject to empirical analysis. Partly because data is relatively easy to obtain from professional team sports, a number of studies analyzed the relationship between within-team salary disparity and team performance. For example, no significant association is found between within-team salary disparities and season winning percentages in the National Hockey League (NHL) or the National Football League (NFL) (Frick et al. 2003). With regard to the National Basketball Association (NBA), salary disparity is found to have a positive association, if any, with team performance (Frick et al. 2003; Berri and Jewell 2004; Katayama and Nuch 2011). In contrast, a negative association is found in Major League Baseball (MLB) (Annala and Winfree 2011; Bloom 1999; Frick et al. 2003; Debrock et al. 2004; Depken 2000; Jane 2010; Richards and Guell 1998).

From these findings, one might be tempted to conclude that the relationship between within-team salary disparity and team performance depends on the type of sport. Such a conclusion, however, may be somewhat hasty, because all but a few studies in the literature (e.g., Bucciol and Piovesan 2012; Yamamura 2013) examined sporting leagues in the U.S. and, as a result, evidence for sporting leagues outside the U.S. is rather scarce. If, for example, the relationship is partly affected by differences in institutional settings, it may vary across countries even if the same sport is considered. To explore this possibility, we examine Nippon (i.e. Japanese) Professional Baseball (hereafter referred to as NPB). NPB allows us to make a comparison with MLB for which there is ample and robust evidence in the literature. It is hoped, therefore, that our results will shed some light on potential heterogeneity between countries in this relationship.

We attempt to control for potential bias resulting from feedback between team performance, total salary and salary disparity. As team performance in the current season is likely to affect total salary and salary disparity in the next season, these salary variables may not be strictly exogenous. If that is the case, while used in most prior studies, as mentioned in Katayama and Nuch (2011) and Yamamura (2013), the fixed effects estimators will be inconsistent and hence fail to will unveil the causal relationship between salary disparity and team performance. Because economic theories predict causation rather than correlation, it is crucial to examine causation from salary disparity to team performance (Jane 2010). For this reason, we relax the strict exogeneity assumption and apply the Arellano and Bond difference GMM estimator (Arellano and Bond 1991).

The rest of this study is organized as follows. The next section explains our estimation approach. Section 3 briefly discusses the data used in this study. Estimation results are presented in Section 4. Section 5 concludes.

2. Estimation Approach

Following previous studies on MLB (e.g., Depken 2000), we assume that team performance can be measured by season winning percentage. Salary disparity can be measured using the Herfindahl–Hirschman Index (HHI), that is, the squared sum of the share (expressed in percentage) of a player's salary to the team's total salary. The season winning percentage of team i in season t (swp_{it}) is assumed to depend on the salary disparity (hhi_{it}), the total salary expenditure ($totsal_{it}$) and other observable factors (x_{it}) in the following manner: for $i = 1, 2,\ldots, N$ and $t = 1, 2,\ldots, T_i$,

$$\ln(swp_{it}) = \alpha_0 + \alpha_1 \ln(hhi_{it}) + \alpha_2 \ln(totsal_{it}) + x_{it}\delta + \mu_i + u_{it} \quad (1)$$

where μ_i is the fixed effect of team i, u_{it} an idiosyncratic error, and (α_0, α_1, α_2, δ) a set of parameters.

We first assume, as in most prior studies, that u_{it} satisfies

$$E(u_{it} \mid hhi_{i1}, totsal_{i1}, x_{i1},\ldots, hhi_{iTi}, totsal_{iTi}, x_{iTi,} \mu_i) = 0. \quad (A1)$$

In other words, *hhi*, *totsal* and x are assumed to be strictly exogenous. Under Assumption (A1), the standard fixed effects estimator is consistent. This assumption, however, may not hold for *hhi* and *totsal*, as the distribution of and the total amount of salaries for a team are likely to depend on the team's performance in the previous year. To account for feedback from swp_{it} to hhi_{is} and $totsal_{is}$ for $s > t$, we assume

$$E(u_{it} \mid hhi_{i1}, totsal_{i1}, x_{i1},\ldots, hhi_{it}, totsal_{it}, x_{it,} x_{it+1},\ldots, x_{iTi}, \mu_i) = 0. \quad (A2)$$

In this case, we use the estimation technique developed by Arellano and Bond (1991). Specifically, we first eliminate the fixed effects by differencing equation (1) and then estimate:

$$\Delta\ln(swp_{it}) = \alpha_1 \Delta\ln(hhi_{it}) + \alpha_2 \Delta\ln(totsal_{it}) + \Delta x_{it}\delta + \Delta u_{it}.$$

Under Assumption (A2), potential instruments for $\Delta\ln(hhi_{it})$ and $\Delta\ln(totsal_{it})$ are $\ln(hhi_{it-j})$ and $\ln(totsal_{it-j})$ ($j \geq 1$). Using these instrument sets, we can efficiently estimate the parameters in the GMM framework. In particular, we use the two-step GMM estimator, which provides the most efficient estimator on the basis of moment conditions available. To compute the standard errors, we use a method introduced by Windmeijer (2005) that corrects for the small-sample downward bias in the computed standard errors in the two-step GMM.

To control (at least partially) for the coach's skills that potentially affect the team's performance, we include the natural logarithm of the coach's years of experience into x_{it}. To deal with the fact that some coaches do not have any experience, we add one to the coach's years of experience before taking the natural logarithm.

3. Data and Descriptive Statistics

Our data cover 12 regular NPB seasons from 1999 to 2010. NPB consists of 12 teams, half of them belonging to the Central League and the other half to the Pacific League. After the 2004 season, one team exited the Pacific League and another joined the league. As a result, we have an unbalanced panel with 13 teams, consisting of 144 team-season observations. Data on season winning percentages are directly extracted from the official website of NPB. Coaches' years of experience are constructed based on information provided by the NPB website. Data on players' salaries are obtained from a private website on NPB statistics collection (http://home.a07.itscom.net/kazoo/pro/pro.htm; "Kochira Pro Yakyu Jinjibu"). Descriptive statistics of the variables used for estimation are presented in Table 1.

Table 1. Descriptive statistics

	Mean	Std. dev.	Max	Min
Season winning percentage	0.500	0.073	0.664	0.281
HHI	466.8	115.7	1065.4	281.0
Total salary (expressed in 10,000 yen)	262389	80576	543596	144250
Coach's years of experience	6.06	6.31	23	0

4. Estimation Results

We provide estimation results in Table 2. Column (1) presents the result of the OLS estimator, where the log of season winning percentage is regressed on the log of HHI. The coefficient is found to be positive and significant at the five percent level, implying that greater salary disparities are associated with higher winning percentages. It becomes insignificant, although it remains positive, when we control for the total salary (see Column (2)) and when we further control for the coach's years of experience (see Column (3)). Column (4) presents the result where we further control for team fixed effects. The coefficient on the log of HHI becomes significant at the five percent level. This result appears to suggest the importance of controlling for team fixed effects; if fixed effects are not adequately controlled for, it might be falsely concluded that salary disparity is not associated with team performance.

Note, however, that these results do not necessarily imply a causation from salary disparity to team performance, as the strict exogeneity assumption (A1) may be violated. We conducted a test to examine whether the strict exogeneity assumption for the salary variables i.e., ln(*hhi*) and ln(*totsal*), holds. The idea of this test is that if ln(*hhi*) is strictly exogenous, leads of ln(*hhi*) (i.e., $\ln(hhi_{it+s})$ for $s \geq 1$) should not matter to the team performance in the current period (i.e., $\ln(swp_{it})$). This is essentially a test for the significance of leads of ln(*hhi*). Adding $\ln(hhi_{it+1})$ and $\ln(hhi_{it+2})$ to the model in Columns (4), we conducted a Wald test for these variables. The null hypothesis is rejected at the ten percent level; ln(*hhi*) does not seem to be strictly exogenous. Similar results are obtained for ln(*totsal*); the null hypothesis is rejected at the five percent level.

Given that the strict exogeneity assumption is not satisfied for ln(*hhi*) and ln(*totsal*), we used the Arellano and Bond difference GMM estimator under Assumption (A2). Although potential instruments for $\Delta\ln(hhi_{it})$ and $\Delta\ln(totsal_{it})$ are hhi_{it-j} and $totsal_{it-j}$ for all $j \geq 1$, we limited j up to and including two so that the number of

instruments were not too many relative to the number of teams (*N*). The result, obtained by xtabond2 in STATA (Roodman 2009), is presented in Column (5). According to the Arellano and Bond test for AR(2) in differences, serial correlation of order l is not present in levels. In addition, the Sargan test does not reject the null hypothesis that the over-identifying restrictions are satisfied. Overall, there is no strong evidence against the validity of the instruments.

Table 2. Estimation Results

	(1)	(2)	(3)	(4)	(5)
HHI	0.184*	0.080	0.092	0.180*	0.400*
	(0.064)	(0.055)	(0.057)	(0.076)	(0.160)
Total salary		0.195**	0.202**	0.021	-0.164
		(0.036)	(0.041)	(0.097)	(0.118)
Coach's years of experience			0.032*	0.024	0.024
			(0.014)	(0.011)	(0.042)
Intercept	-1.828**	-3.617**	-3.823**	-2.108	
	(0.391)	(0.433)	(0.533)	(1.036)	
Team fixed effects	No	No	No	Yes	Yes
Estimation Method	OLS	OLS	OLS	FE	GMM
F statistics	8.30*	24.19**	12.21**	3.68*	4.32*
Number of instruments					42
AB test for AR(1)					-2.32*
AB test for AR(2)					1.85
Sargan test					51.81

Note: The dependent variable is the natural logarithm of the season winning percentage. All explanatory variables are logged. OLS, FE and GMM denote the ordinary least squares estimator, the fixed effects estimator and the two-step difference GMM estimator, respectively. Standard errors clustered by team are presented in parentheses. ** and * denote statistical significance at the one and five percent levels, respectively. "AB test" denotes the Arellano and Bond test. "Sargan test" denotes the Sargan test for over-identifying restrictions where the null hypothesis is that over-identifying restrictions are valid.

The coefficient on the log of HHI is found to be positive and significant at the five percent level; the GMM estimate indicates that salary disparity has a positive effect on team performance, similar to the fixed effects estimate. Importantly, however, the size of the effect obtained by the GMM estimator (0.400) is at least twice as large as that obtained by the fixed effect estimator (0.180). This demonstrates the importance of controlling for feedback from the salary variables to team performance; although previous studies often used the fixed effects estimator, their estimates might have been biased.

5. Conclusion

This study examined the relationship between within-team salary disparity and team performance in NPB. We show that higher salary disparities result in better team performance, which is in sharp contrast to previous studies on MLB. Our results, combined with those by previous studies, appear to suggest that the relationship varies across countries.

The fact that evidence is contrasting between MLB and NPB may suggest that each of the competing theories highlights part of the whole picture. In other words, each theory captures part of the two opposing effects of salary disparity; an increase in salary disparity lowers the harmony/cohesion effect among employees (Akerlof and Yellen 1988, 1990; Levine 1991), while strengthening the incentive effect suggested by the rank-order tournament model (Lazear and Rosen 1981). The overall effect of an increase in salary disparity may therefore be either positive or negative, determined by the relative importance of the two effects. The size of each effect may vary. In particular, the size of the first effect may depend on the initial level of cohesion/harmony; if the initial level is relatively high (low), a given increase in salary disparity is associated with a small (large) decline in the level of cohesion/harmony so that the incentive effect (the cohesion/harmony effect) tends to dominate.

This argument can account for the differing results between MLB and NPB, if the initial level of cohesion/harmony is relatively higher in NPB than in MLB. This may be the case due to institutional differences, especially, a difference in the free agent system. A player in MLB is required to have six years of major league experience to become eligible to be a free agent, while the required period in NPB is currently eight years and used to be even longer. Partly due to this difference, the degree of mobility among players is lower in NPB. In line with the idea that low mobility promotes cooperation (Killingback et al., 2006; Janssen and Goldstone 2006), the level of cohesion/harmony may be expected to be relatively higher in NPB. That being said, there may be different reasons for the observed difference. It may be fruitful, therefore, to examine the source of country heterogeneity for future research.

We also found that the strict exogeneity assumption for the salary variables does not hold and hence the fixed effects estimator is not consistent. As feedback from team performance to the salary variables is likely to occur in professional team sporting leagues, future studies in this area should be cautious about the use of the fixed effects estimator.

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