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The Causality between Salary Structures and Team Performance in Korean Professional Baseball League

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Abstract

Using the salary payment data from Korean Professional Baseball League (KPBL), this paper conducts Panel Granger tests to investigate the causality between pay and performance. Our empirical results show that the causality only runs from the dispersion of salary payment to team performance, but not vice versa. Moreover, the evidence also shows that total salary does not cause team performance, and vice versa. Therefore, payrolls cannot buy wins, and wins cannot bring payrolls in the KPBL.
Key-words: Equity Theory, Korean Professional Baseball League, Panel Granger Causality Test, Salary Regulation, Tournament Theory.

1. Introduction

The enormous salaries earned by successful professional sports players frequently attract attention in the media. However, it is also well-known that less successful players, although highly paid relative to many other professionals, earn vastly less than the star players. [1] A natural question for economists is how the amount and disparity in pay between players on a team affects the players' performances, and through them, team performance.

[1] This is certainly the case in Major League Baseball (MLB). In 2011 Alex Rodriguez was the highest paid player, earning 32 million dollars whilst the MLB players in the first few years of their careers earn 414 thousand dollars for the league minimum.

Economists usually pay more attention to the relationship, rather than the direction, of the linkage between salary structures and team performance. Studies on professional baseball teams (Depken, 2000; DeBrock et al. 2004; Wiseman and Chatterjee, 2003; Scully, 1974; Sommers and Quinton, 1982), soccer teams (Garcia-del-Barrio and Pujol, 2007; Lucifora and Simmons, 2003), and hockey teams (Idson and Kahane, 2000; Jones and Walsh, 1988) normally treat team performance as the dependent variable, and then search for relevant factors that shape it. However, the direction of the linkage, i.e. the causality between salary structures and the subsequent performance of an organization, has rarely been rigorously investigated in the literature. Hall et al. (2002) stressed that such a link "plays a central role in the theory of team sports but is seldom investigated empirically." This paper is one of the few research studies focused on the direction of the linkage.

Both total salary payment and the dispersion of salary are important for us to understand the relationship as well as the causality between salary structures and team performance in labor market theory. Since the total salary for a sports team is more likely to be affected by its talented players, the causality test between the total salary payment and team performance across teams will enable us to understand whether expenditure on playing talent will translate effectively into a team's performance (or success).

The arrangement of the remaining sections of this paper is as follows. Section 2 provides a short overview of the relevant literature, and Section 3 describes the data of the Korean Professional Baseball League (hereafter, KPBL) and a short introduction of the KPBL. Then, we present the empirical model that we used to deal with the problem of heterogeneity when using panel data to perform a Granger Causality Test. Section 4 presents the empirical results and also provides a related discussion on professional baseball in Korea. Finally, we summarize our main findings and conclusions in Section 5.

2. Literature Review

For the effect of total payroll, a few studies suggest that there is a loose association between team payroll and its performance in North American sports (Fort, 2003, pp.157; Quirk and Fort, 1999, pp.83-87; Sanderson and Siegfried, 1997; Scully, 1995, pp.94; Zimbalist, 1992, pp.96). Quirk and Fort (1999) examined correlations between team payrolls and winning percentages by using average measures from regular seasons for four major North American leagues over the period 1990-96. They found that the rank correlations between payrolls and the team's winning percentages were significant in the National Hockey League and the National Basketball Association, but not in the National Football League or MLB. Also, the correlation between team pay and performance are significant in English soccer leagues (Szymanski and Kuypers, 1999), and a strong team salary-performance relationship is found for the leagues in England and Italy (Forrest and Simmons, 2002).

Besides total salary payment, salary disparities and organizational performance have long been an important topic of economic research. There are two strands of literature with opposing predictions. One strand of this literature focuses on incentives and establishes a positive link between salary dispersion and firm performance. Workers will work harder if there is more money to be earned. An example of this is the Tournament Theory as put forward by Lazear and Rosen (1981), wherein greater salary dispersion induces better performance. The second strand of literature focuses on equity and fairness, e.g., the Fair Wage-effort Hypothesis of Akerlof and Yellen (1990). In this, a dramatic increase in salary dispersions within an organization may cause a breakdown of team cohesiveness and performance. As advocated by Levine (1991), the Pay Equality Hypothesis predicts that greater salary disparity causes jealousy and mistrust among players in teams and possible reduction in overall team performance. While the possible relationships between salary dispersion and organizational performance have been investigated for decades, few of the studies in the literature focused on the issue of the direction of causality between salary dispersion and organizational performance.

The developments in econometric methodology in recent years have enabled Granger (1969) time-series causality tests to deal with panel data. The Panel Granger Causality (PGC) test has been employed to deal with several different economic issues in recent research. For example, Hurlin and Venet (2008) analyzed financial development and economic growth. Their results provide support for a robust causality relationship from economic growth to the financial development. Erdil and Yetkiner

(2008) provided evidence on income-health causality by employing a large micro panel data set with a VAR representation. They indicated that one-way causality generally runs from income to health in low and middle-income countries, whereas the reverse holds for high-income countries. Hoffmann et al. (2005), and Bhaduri and Durai (2006) applied the above econometric method on the analysis of the FDI and pollution, and the relationship between dividends and investment decisions.

In this paper, the PGC test is employed for two reasons. First, by using the panel data we can more broadly examine the possible causality across teams within a professional sport. Secondly, the robustness of the possible causality between salary payment and performance can be examined more rigorously, and the possible direction of causality can serve as a valuable reference in the literature on the sports industry.

3. Data Description and Empirical Model

South Korea entered its professional baseball era in 1982. It is the second country in Asia, after Japan, to form a baseball league. In the establishing period, there were six baseball teams, and there are eight teams in 2012. Generally speaking, the system of KPBL is similar to that of MLB, for example, the salary system is annual payment with signing bonus. KPBL started to import foreign players from 1998. The current (2012) common annual salary for foreign players is above USD 200,000, but not exceeding USD 300,000. There is no upper limit for domestic player's salary, however. South Korea Professional Baseball Players' Association (KPBPA) was founded in 2000.

There is also a Free Agency in the KPBL. A player with seniority of 9 years (those who do not have a four-year college degree) or 8 years (those who graduated from college) can apply for a free agent status. After staying in the professional team after seven years, a player can pursue the career overseas with the consent of the original team. During 2004-2012, seven players have left KPBL to play in Japan's professional baseball teams.

Due to the data requirement in the panel causality tests, the data have to be a balanced panel. In this paper, the size of sample as well as time span is mainly determined by the availability of salary structures and team performance. We collected the balanced panel data of salary for 775 players on 8 teams over a ten-year period from 2001 to 2010.[2]

An expanded model of the standard Granger (1969) causality test was set up based on a balanced panel data model with fixed coefficients as proposed by Hurlin and Venet (2001). The advantage of using panel data is that we can fully utilize the cross-sectional and time-series information without losing any degree of freedom. Therefore, the efficiency of the Granger Causality Test can be improved when we perform it with panel-data analysis. However, in any context individuals are heterogeneous. In order to fix the heterogeneity across individuals, a panel data model with fixed coefficients is applied to determine whether or not causality between a team's performance and its salary structure in fact exists.[3]

Following the panel Granger causality model, we now suppose that, for each team $i \in [1, N]$ and time period $t \in [1, T]$, the specification of the auto-regressive model is represented as follows:

$$y_{i,t} = \gamma y_{i,t-1} + \beta_1 x_{1i,t-1} + \beta_2 x_{2i,t-1} + \nu_{i,t}, \quad (1)$$

$$x_{ji,t} = \alpha x_{ji,t-1} + \eta_j x_{ji,t-1} + e_{ji,t}, \ j = 1,2. \quad (2)$$

with $\nu_{i,t} = \psi_i + \varepsilon_{i,t}$ and $e_{ji,t} = \varphi_{ji} + \xi_{ji,t}$, where individual effects of ψ_i and φ_{ji} (j=1, 2) are assumed to be fixed with each team. $\varepsilon_{i,t}$ and $\xi_{ji,t}$ (j=1, 2) are error terms, and they are assumed i.i.d. $(0, \sigma_\varepsilon^2)$ and i.i.d. $(0, \sigma_\xi^2)$ respectively. y is the team's performance, as measured by the percentage of wins (WinP) or the total

[2] In 2008, Nexen Heroes bought Hyundai Unicorns. Two teams are treated as the same one in our sample because it is only the ownership/sponsorship changing between corporations.

[3] Different from the traditional literature on Granger Casualty Tests in time series, the PGC test model proposed by Hurlin and Venet (2001) proposes two types of processes to deal with the heterogeneity among individual cross-sectional units. One way is via the process of distinctive intercepts and another is via the variances of variable' slopes. The former one is simple and intuitive way, and is used in this paper.

number of wins (Wins) in each year. $X_{1i,t}$ and $X_{2i,t}$ are different specifications of the salary structure, namely, total salary bills and the dispersion of salaries within a team. In the regression, total salary bills which deflated by consumer price index (CPI) is defined as the team's annual total expenditures on players' salaries (RealPay). The salary dispersion of a team is measured by Herfindahl index (HHI) or correlation of variation (CV). Judson and Owen (1999) provide Monte Carlo evidence to show that the bias of fixed effects estimator developed by Kiviet (1995) generally outperforms other estimators for balanced panels, even when T is small. For this reason, the estimation of equations (1) and (2) above will rely on the fixed effects estimator (Kiviet, 1995; Bruno, 2005).

In terms of the direction of causality from salary structures to team performance, there are four possible hypotheses within two categories, as shown in Table 1.

Table-1. Hypotheses of Granger Causality Test

	Salary structure➔ Team performance	**Team performance➔ Salary structure**
SDE	H_{10}: $\beta_1 = 0$	$H_{30}: \eta_1 = 0$
	H_{11}: $\beta_1 \neq 0$	$H_{31}: \eta_1 \neq 0$
TSE	H_{20}: $\beta_2 = 0$	$H_{40}: \eta_2 = 0$
	H_{21}: $\beta_2 \neq 0$	$H_{41}: \eta_2 \neq 0$

In the first category, we would like to test the salary dispersion effect (SDE), i.e., whether the slopes of the salary dispersion (β_1) are statistically significant when the total salary payment is controlled. If the null hypothesis H_{10} is rejected, there is an evidence of the Granger causality relationship from salary dispersion to team performance, and such causal relationship exists in at least one team on the panel.

The second category of the test is the total salary effect (TSE), i.e., the Granger-causality test from total salary to team performance by controlling the salary dispersion while H_{20} is tested. Likewise, the possible reverse causality from team performance to salary structure can also be examined one-on-one by H_{30} and H_{40}. By the same inference, the Granger causality relationship from team performance to salary dispersion (or total salary) exists if the null hypothesis is rejected. The statistic for the tests can be computed by means of the following equation:

$$F = \frac{(RSS_2 - RSS_1)/N}{RSS_1/[TN - 2N - 1]}, \qquad (3)$$

where RSS_2 denotes the restricted sum of squared residuals obtained under the null hypothesis. RSS_1 is the unrestricted residual sum of squares of the model and TN is the total number of observations. The statistic has a Fisher distribution with N and TN-2N-1 degree of freedom, under the null hypothesis.

Prior to estimation, it is necessary to check for stationarity related to the variables included in the dynamic panel data model. Fort and Lee (2006) provided a schematic of a general process applicable to the investigation of the nonstationary behavior of sports for attendance analysis in MLB. Following their standard procedure, the panel unit root test proposed by Im et al. (2003) is applied. For this approach, the null hypothesis is rejected and there is evidence to support the variable's stationarity when the value of the statistic significantly exceeds a critical value at a specific level. Im et al. (2003) is based on the well-known Dickey-Fuller procedure, and it begins by specifying a separate ADF regression for each cross-section with individual effects and no time trend:

$$\Delta z_{i,t} = a_i + \gamma_i z_{i,t-1} + b_i t + \sum_{j=1}^{p_i} \beta_{ij} \Delta z_{i,t-j} + \varepsilon_{it},\ i=1,2,\ldots, N,\ t=1, 2,\ldots, T. \qquad (5)$$

where z_{it} could be WinP, Wins, or RealPay. The statistic for the panel unit root test is derived by performing separate tests for each equation to obtain the statistic for the individual ADF test and taking the sample mean of the statistic for all individual time-series tests. The null hypothesis of the unit root test states that all of the series have unit roots, and the alternative one assumes that some series are stationary. The average statistic is that shown in the following equation:

$$z_{tbar} = \frac{\sqrt{N[\bar{t} - E(\bar{t})]}}{\sqrt{Var(\bar{t})}}, \quad \bar{t} = (1/N)\sum_{i=1}^{N} t_i \, p_i \beta_i, \qquad (6)$$

where t_i represent the statistics for the unit root tests for the individual tests. $E(\bar{t})$ and $Var(\bar{t})$ denote the theoretical mean and variance of $\bar{t}$, and $\bar{t}$ has a specific distribution. z_{tbar} has an asymptotic standardized normal distribution. The critical values are those computed by Im et al. (2003). When the value of the statistic significantly exceeds a critical value at the specific level, the null hypothesis is rejected and there is evidence to support the variable's stationarity. The summary statistics for the variables used in this study are shown in Table 2.

Table-2. Basic Statistics

Variable	Mean	S. D.	Observation
WinP	.489	.080	80
Wins	63.6	10.533	80
CV	1.658	.723	80
HHI	.116	.091	80
Totsal (KRW$)*	648061.8	405735.4	80
CPI	101.3565	22.6334	80

* Totsal is defined as the team's annual total expenditures on players' salaries. The unit is a thousand Won, and the average exchange rate during our data period (2001-2010) was roughly 1US$= 1087.2 KRW$.

4. Empirical Results and Discussion

The results for checking the stationarity of the variables are presented in Table 3. In terms of the variables for team performance, i.e., WinP and Wins, our model specification includes a constant term and a time trend together with a number of lag-orders, i.e., 1 and 2 lags are tested separately.[4] Table 3 shows that the values of the statistics for WinP, Wins, CV, and HHI are statistically significant and they are stationary. However, by using the same method, RealPay is insignificant and therefore non-stationary. It is necessary to apply the first difference operator on RealPay. Then, the null hypothesis of the unit roots test is rejected and it is found to be stationary.

Table-3. Results of the Panel Unit Roots (IPS) Test for Heterogeneous Individuals

Variable	Lags	IPS test[a] (Constant)	IPS test (Const.+Trend)	1st Differences (Constant)	1st Differences (Const.+Trend)
WinP	1	-1.428	-2.878**	-	-
		(0.560)	(0.049)		
	2	-1.267	-2.821**	-	-
		(0.549)	(0.022)		
Wins	1	-1.410	-2.871*	-	-
		(0.578)	(0.051)		
	2	-1.289	-2.773**	-	-
		(0.528)	(0.028)		
RealPay	1	-1.396	-1.837	-2.623***	-2.930**
		(0.592)	(0.785)	(0.002)	(0.038)
	2	-0.736	-1.130	-1.046	-1.230
		(0.917)	(0.959)	(0.742)	(0.935)
CV	1	-2.756***	-2.815*	-	-
		(0.001)	(0.066)		

[4] Because this test for panel unit roots allows a different number of lag lengths for each equation, a lag-order, for example 2, refers to the average of the lag lengths included in this test.

	2	-2.508*** (0.002)	-5.364*** (0.000)	-	-
HHI	1	-3.299*** (0.000)	-2.878** (0.049)	-	-
	2	-3.819*** (0.000)	-48.349*** (0.000)	-	-

Notes:
(a) Im et al.'s (2003) t-bar statistics for the panel unit root. (N, T) = (8, 10).
(b) ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.
(c) Based on the mean of the individual Dickey-Fuller t-statistics of each unit in the panel, the IPS test assumes that all series are non-stationary under the null hypothesis.

The results of PGC test are divided into two parts and reported in Table 4. [5] The upper part includes regressing the RealPay or salary dispersion (measured by HHI or CV) on team performance individually, and is a one-to-one regression. The lower part involves a two-to-one regression where the payroll (salary dispersion) is regressed on team performance when salary dispersion (payroll) is controlled for. Team performance is measured by winning percentage and wins.

For the non-causality tests with a time trend or a year dummy involving one-to-one regression of the growth rate of total salary expenditure (ΔRealPay) on team performance (WinP or Wins), all F values imply that the null hypothesis can not be rejected at 5% significance level. As to the non-causality tests with a time trend or a year dummy involving two-to-one regression of the salary dispersion on team performance, the Granger non-causality hypothesis for the relationship between salary dispersion on team performance is rejected. The rejection of the null hypothesis suggests that, for at least one team in the KPBL, the past values of salary dispersion is relevant when it comes to forecasting team performance. One-way causality running from salary dispersion to team performance is confirmed. In terms of the non-causality tests from the ΔRealPay to team performance (WinP or Wins), all the PGC tests are insignificant whether salary dispersion is controlled or not.

Table-4. Results of Granger Causality Test

Direction of Granger Causality (One to One)				
Salary Structure	H_1 [a]	Team Performance	WinP	Wins
With Time Trend				
ΔRealPay	=>	WinP/Wins	0.14	0.69
	<=		0.09	0.08
HHI	=>	WinP/Wins	0.60	0.02
	<=		0.94	0.79
CV	=>	WinP/Wins	0.24	0.21
	<=		1.71	1.14
With Year Dummy				
ΔRealPay	=>	WinP/Wins	0.00	0.00
	<=		0.00	0.00
HHI	=>	WinP/Wins	0.87	0.84
	<=		0.09	0.08
CV	=>	WinP/Wins	1.59	1.56
	<=		0.21	0.21
Direction of Granger Causality (Two to One)				
Salary Structures	H_1 [a]	Team	WinP	Wins

[5] We used the Akaike Information Criterion (AIC) to determine the optimal-lag length. In order to save the loss of degree of freedom, we followed Justesen (2008) and included lag-length up to two for y_{it}, x_{1it} and x_{2it} in the estimated equation.

Performance				
With Time Trend				
ΔRealPay	=>	WinP/Wins	1.42	1.78
HHI			8.58**	3.85*
With Year Dummy				
ΔRealPay	=>	WinP/Wins	0.47	0.53
HHI			7.41**	7.75**
With Time Trend				
ΔRealPay	=>	WinP/Wins	1.05	0.82
CV			1.68	0.37
With Year Dummy				
ΔRealPay	=>	WinP/Wins	0.72	0.82
CV			7.35**	7.78**

Notes: (a) *** denotes significance at the 1% level, ** denotes significance at the 5% level, and * denotes significance at the 10% level. The critical values simulated by Huilin and Venet (2001) are 4.315 and 6.937 for the 5% and 1% significance levels, respectively.
(b) The optimal lag-length for each equation is determined by the Akaike Information Criterion (AIC).

In summary, the direction of the causality from salary dispersion (HHI and CV) to team performance (WinP and Wins) is clearly confirmed. These findings are in line with both tournament theory and equity theory both of which stress that the salary dispersion affects team performance. In addition, our empirical results also confirm that total salary bills cannot cause team performance (WinP or Wins). This implies that even though spending money on human capital is important for a team performance, however, it can still not buy wins. The results from KPBL are different from that of MLB. Using sample of 1998-2007, Jane (2010) show that in MLB, the past total payroll values are relevant when it comes to forecasting team performance, and vice versa. However, salary dispersion enhances team performance in a one-way direction. DeBrock et al. (2004) obtained a similar result from earlier data.

Alternatively, Zimbalist (1992) found that average team salary explained less than 10 percent of the variance in a team's winning percentage for the MLB between 1984 and 1989. He argued that this rather weak correlation between average team salary and team performance may be due to the fact that the team's owners fail to sign top-performing free agents, and that the team also fails to pay players in accordance with their performance. Scully (1995) argued that increased expenditures on players, coaching and managerial talent is a necessary, but not a sufficient, condition for improving a team's winning chances. Following this line of argument, an intuitive way to explain why payroll does not cause team performance in KPBL is the following: If there is explicit or implicit restrictions on the total salary bills, then team managers will have to resort to salary dispersion to improve team performance.

In KPBL, there are some explicit institutional restrictions on the movements of the players. In contrast to England's 'freedom of contract' for football players since 1978, the KPBL is less developed in the sense that there are no definite rules regarding trading of players. As mentioned above, there is a free agency system in KPBL, but the restrictions are much higher than MLB. For example, to become a free agent, a player has to play in the league for at least 8 years. In contrast, the requirement is six years in MLB. Another example is the wage arbitration mechanism. Between 1984 and 2012, there was only one case that was arbitrated by the arbitration committee. The player owned the best batting record in 2002 season, but the team manager planned a wage reduction for the whole team, the applicant included. The player eventually got a pay rise, but his relationship with the team got worse. And two years later, the player retired. Finally, as mention above, there are several foreign players in the KPBL, but there is a wage cap of 300 thousand US dollars on their salary. No wage restrictions exist in MLB.

Besides explicit restriction, it is always possible that there are collusion between team managers, but the evidence is hard to locate. The player's average salary in the data is about $153.89 thousands USD per year, which is much lower than MLB and Japan's professional players. Between 2004 and 2012, seven players in the KPBL were recruited by Japanese Professional Baseball League, the latest

one in 2012 got a two-year contract, and an annual pay of 250 million Japanese Yuan (about 3.12 million US dollars). The above examples suggest that the specific causality between performance and salary in KPBL resulted from institutional restrictions, further studies are needed to clarify the causality effects.

5. Conclusions

In this paper we have examined the possible causal relationship between salary structures and team performance in KPBL. By using the KPBL's panel data, the PGC test results confirmed that the causality runs only from the dispersion of the salary payment to team performance, but not vice versa. Surprisingly, the dispersion of the salary payment created more Granger-cause team performance than the total salary payment when we regressed one variable to team performance by controlling another. The above conclusions were also sustained in the different kinds of robust tests we performed.

The significance of the above results give rise to a twofold conclusion. First, our empirical results of the causality confirm that salary dispersion granger causes to team performance. That is, both Tournament Theory, which stresses the incentive of salary dispersion, and Equity Theory, which represents that salary equity induces good performance, are relevant in enhancing a professional sports team's performance. Possible causality between the total salary payments and the team performance, which emphasizes the importance of the overall stock of human capital within an organization, was not investigated. Therefore, the over-accumulation of talent that is represented by large payrolls in a team may actually lead to significant negative externalities.

Second, the one-way causality results suggest that the teams, under the league with strict restrictions on the mobility of players, must rely more on internal salary policy adjustments, especially on the dispersion of salary payment. Furthermore, by incorporating data into a novel method of the PGC test, more information and individual heterogeneity can be included so as to examine the possible relationship between salary structures and performance in the professional sports industry.

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