Sports Market Capacity, Frequency of Movements, and Age in the NBA Players Salary Determination

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Abstract

This study examines pay and performance in the NBA for 1991-2008. In addition to customary on-court productivity, we account for the variations in players' compensation by controlling local sports labor market's capacity to accommodate other competing professional sports teams, the frequency of a player's movements in the league, and players' learning effects. The main findings indicate that players' compensation is negatively correlated with the number of competing teams in given local sports market and with the frequency of moves while it is positively correlated with both athletic and non-athletic learning effects of players.

Keywords: *Salary Determination, Fixed-Effects, Learning Effects*
JEL Classification: *J3, J44*

I. INTRODUCTION

For several decades economists have examined and refined the understanding of salary determination in professional sports labor markets in various perspectives such as on-court productivity, race, characteristics of contracts between owners and players, and asymmetric informational structure. Basic assumptions of the competitive market such as costless entry/exit have been challenged and tools such as game theory and principal-agents model have been applied to the labor contracts between players and team owners. Since the seminal study by Scully (1974) of pay and performance in major league baseball, the vast amount of the literature in sports economics has examined the hierarchy of salaries and the fairness in salary determination in professional sports. In the case of professional basketball, Mogull (1981) analyzed professional basketball players' salaries with an emphasis to race discrimination by controlling for a set of on-court performance indicators such as points per game, percent of field goal attempts made, percent of free throws made, rebounds per game, assists per game, experience, and minutes per game. In a similar study, Dey (1997) investigated salary differentials attributed to race using professional basketball players' salary observations in the time period of 1987-1993. While finding no statistically significant evidence of discrimination, he suggested that the overall variations in salary be examined not just by players' productivity but also by exogenous factors such as long-term television contracts, agents' enhanced services, and more powerful presence of the players' union. In another study of pay and performance in professional basketball, Scully (1995) sought to explain the impact on salary determination of player mobility while controlling players' past performance measures such as last year's points, assists, and rebounds along with career minutes and career minutes squared. He used a slope dummy variable for the years 1973-1975 to note the greater freedom of player mobility due to players' unions in the National Basketball Association (NBA) and American Basketball Association (ABA) and their effects in blocking the proposed merger.

On the other hand, several studies focused on the types of salary discriminations (Kahn and Sherer, 1988; Brown, Spiro, and Keenan, 1991; Hamilton, 1997; Groothuis and Hill, 2004; Burdekin, Hossfeld, and Smith, 2005; Kahn and Shah, 2005). For instance, in an effort to analyze the effects on players' salaries of the market power between team owners and players, Kahn and Shah (2005) employed a model of discriminating monopsony and examined pay differentials among the NBA players who were neither the first round draftees nor free agents, suggesting that individual teams in the NBA had exercised greater market power in the contracts with the players of the particular category. Finally, some recent studies focused on a problem of asymmetric information between players and team owners. For instance, Berri and Jewell (2004) examined the effects of pay inequalities among players on the team productivity in the NBA with a conclusion that pay disparity was negatively correlated with team productivity. In a similar perspective, Berri and Krautmann (2006) investigated the relationship between professional basketball players' incentives for opportunistic behavior (shirking) and their long-term contracts by fitting the estimation of player productivity on the length of contracts and salaries.

One of the main difficulties in the study of pay and performance in professional sports is constructing a general measure of on-court player productivity (performances). For instance, in NBA player salary estimations, a cross-section time series model may be fitted by accounting for players' points, rebounds, assists, blocks, minutes played, percent of field goal or free throw attempts made, steals, turnovers, and perhaps personal fouls. Then the adequacy of the statistical specification of the fitted model depends on how well the model incorporates into its specification different skills emphasized by different positions such as point guard, scoring guard, power forward, scoring forward, and center. Such controversy over which measures accurately reflects players' performance dates back to Scully (1974). He argued "Disagreements about performance may partly depend on which aspect of the game is thought more important (Scully, 1974, p. 924)."

Following Scully (1974), this study recognizes basketball as an offensive and defensive team sport while considering each individual player rather than individual teams as the unit of observation. And thus no team-level effects such as number of team wins are considered in this study. While this study follows a conventional way of economic reasoning addressed in the literature, it departs from other studies in two ways as follows. First, in addition to the customary measures of player productivity, this study explicitly examines the effects on the salary determination of the capacity of local sports markets to accommodate other professional sports franchises. Second, in order to account for a player's unquantifiable attributes and his value to a team, this study controls for the frequency of players' movements from one team to another and their ages. Furthermore, to examine causal relationship between salary differentials and different aspects of the basketball game, a regression model is fitted not only for the entire sample observations but also for back court (point guard and scoring guard) group and for front court (scoring forward, power forward, and center) group, respectively, with a priori belief that different performance and skills are expected between the two groups of players.

II. DATA AND THEORETICAL FRAMEWORK

The sample data used in this study were collected from several professional sports websites. First, a total of 2,262 salary observations of 378 NBA players for the time period 1991-2008 is from http://www.basketball-reference.com (from the 1990-1991 season to the 2006-2007 season) and http://hoopshype.com/salaries.htm (2007-2008 season). The data on the number of competing professional sports teams other than basketball teams in local sports markets were gathered from http://www.baseball-reference.com, http://www.football-reference.com, and http://www.hockey-reference.com.

With the presumption that a predominant factor in a player's salary determination is his on-court performance, this study first accounts for the variations in NBA players' salaries (SAL) by controlling customary performance measures such as points per game (PPG), minutes played per game (MINS), rebounds per game (REB), blocks per game (BLOCK), assists per game (ASST), steals per game (STEAL), percent of field goals made (FG%), percent of free throws made (FT%), personal fouls per game (FOULS), and turnovers per game (TOVER). However, as shown in Table 1, some of the key productivity indicators are highly correlated with others. For instance, the correlation coefficient between points per game and minutes played per game is greater than 0.89. Points per game are also correlated with turnovers per game as high as 0.85. Furthermore, rebounds per game are correlated with blocks per game and personal fouls per game as high as 0.73 and 0.71, respectively. Also, among the standard performance measures for the back court players (point guard and scoring guard), the correlation coefficient between assists per game and steals per game is greater than 0.71.

Table 1
Correlation Coefficients among Key Performance Indicators per Game

	PPG	REB	ASST	BLOCK	STEAL	MINS	FOULS	TOVER
PPG	1.00							
REB	0.597	1.00						
ASST	0.609	0.126	1.00					
BLOCK	0.279	0.729	-0.112	1.00				
STEAL	0.666	0.327	0.714	0.056	1.00			
MINS	0.892	0.666	0.657	0.329	0.739	1.00		
FOULS	0.529	0.709	0.195	0.515	0.379	0.660	1.00	
TOVER	0.853	0.530	0.747	0.262	0.689	0.834	0.543	1.00

Although multicollinearity does not pose a problem in terms of goodness-of-fit in ordinary least square estimations, a couple of problems arise. First, *p*-values of individual regressors can be estimated too high when they are important and even the sign of estimated coefficients could change. Second, the confidence intervals on the estimated coefficients of individual regressors tend to be wide. In general, the problem associated with multicollinearity can be mitigated by increasing the number of observations. However, considering that the correlation coefficients reported in Table 1 were estimated from as many as 2,262 salary observations, we control for the following select performance indicators in our estimations: points per game (PPG), rebounds per game (REB), and assists per game (ASST).

In addition to the standard on-court productivity measures, we control for the number of other competing professional sports teams (COMP) in a given local sports market. Although it is true that a larger sports market has a greater population, a broader fan base, and thus a greater economic capacity to accommodate more professional sports franchises, it is presumed that, ceteris paribus, the number of professional sports franchises that share and compete for given fan base has a negative impact on the players' compensation. As of 2008, there is only one professional sports team in Memphis while the combined sports market in New York and New Jersey is currently accommodating as many as nine professional sports teams.

This study also controls for the frequency of movements (MOVES) of a player from one team to another in a season. The variable is not necessarily a direct measure of a player's performance with a specific skill, yet it is expected to be indicative of the degree of importance to a team of a player. The reasoning behind this is that top performers or reliable players are more likely to be retained by a team and thus are less likely to move from one team to another. We expect the variable to be negatively correlated with a player's salary.

Finally, we explicitly take into account a player's age (AGE) in the regression, reflecting a growing league-wide concern that the age limit should be increased so that more mature players could better represent both individual teams and the entire league. Although age is not an accurate measure of a player's career time span in the NBA, the variable is expected to reflect both athletic and non-athletic learning effects. The variable AGE is expected to lead to salary increase, but an increase in age toward the end of a player's career may show a drop-off. Thus we control for a quadratic term of the variable (AGE^2) as well. Table 2 summarizes descriptive statistics of the sample data used in this study.

Table 2
Descriptive Statistics for the Sample Observations

Variable	Mean	Std. Dev.	Min	Max	Observations
SAL†	4.0211	4.2023	0.0195	28	2262
PPG	10.2286	6.6291	0	35.4	2262
REB	4.3153	2.7526	0	15.4247	2262
ASST	2.2400	2.0098	0	11.6316	2262
COMP	3.5548	1.9990	1	9	2262
MOVES	0.2057	0.4140	0	2	2261
Age	25.5385	3.7258	18	41	2262
Age^2	666.0884	200.0678	324	1681	2262

†Salaries are measured in million dollars.

III. EMPIRICAL SPECIFICATION AND RESULTS

For 2,262 sample salary observations from 378 NBA players for the time period 1991-2008, the fixed-effects panel data model is fitted as follows:

$$y_{it} = \boldsymbol{x}_{it}\boldsymbol{\beta} + \boldsymbol{z}_i\boldsymbol{\delta} + u_i + \varepsilon_{it}.$$

In the specification above, $\boldsymbol{x}_{it}$ is a vector of the regressors discussed in the previous section and $\boldsymbol{z}_i$ is a vector of time-invariant characteristics that vary only over individuals. u_i is the individual-level effect and ε_{it} is the disturbance term. The time-invariant characteristics ($\boldsymbol{z}_i$) include not only observable but time-invariant attributes of players such as race and their draft choices but also unobservable attributes of players such as leadership and presence on a team. With the specification of the fixed-effects panel data model, it is assumed that the individual-level effect (u_i) is correlated with the regressors ($\boldsymbol{x}_{it}$). Under the assumption which is to be tested, we obtain consistent estimates of $\boldsymbol{\beta}$ on the within-transformed data as follows:

$$y_{it} - \bar{y}_i = (\boldsymbol{x}_{it} - \bar{\boldsymbol{x}}_i)\,\boldsymbol{\beta} + (\boldsymbol{z}_i - \boldsymbol{z}_i)\,\boldsymbol{\delta} + (u_i - u_i) + (\varepsilon_{it} - \varepsilon_i)$$
$$= (\boldsymbol{x}_{it} - \bar{\boldsymbol{x}}_i)\boldsymbol{\beta} + (\varepsilon_{it} - \varepsilon_i).$$

Note that the current specification of a fixed-effects model incurs some informational loss as we lose two time-invariant observations such as race and draft choice on each player.

The results of the fixed-effects regression are summarized in Table 3. First, in Regression (1), we fitted the model using the whole sample data. The Hausman test statistic is estimated to be $\chi^2(7)$=823.13, and the test statistic soundly rejects the null hypothesis that the individual-level effect (u_i) is uncorrelated with the regressors ($\boldsymbol{x}_{it}$), supporting the current specification of the fixed-effects model. The estimated *F*-statistics also rejects the null hypothesis that all individual effects are zero.

Among the estimated coefficients of the on-court performance indicators in Regression (1), points per game (PPG) and rebounds per game (REB) are statistically significant and the signs are positive as expected. The estimated coefficient of the variable, assists per game (ASST), is positive as expected but statistically insignificant. Considering that the number of the front court players (scoring forward, power forward, and center) in the sample data is 219 out of 378 players and their salary observations account for nearly 60 percent of the whole sample observations, this necessitates separate estimations of the fixed-effects model for the back court players and the front court players, respectively.

The estimated coefficient of the number of competing professional sports teams in a given sports market (COMP) is negative and statistically significant. It suggests that, ceteris paribus, the salary differential for the NBA players is negatively correlated with the number of other professional sports teams that compete for the common fan base in the given local sports market. The estimated coefficient of the variable MOVES is negative and significant, and it is inferred that frequent movements within the league of a player on average result in a decrease in salary. It is noteworthy that the variable MOVES could account for the quality of a player's non-athletic attributes such as comradeship or rapport among team members. Finally, the estimated coefficient of the variable AGE is positive and significant both statistically and economically. In recent years, there has been a growing concern in the league about some detrimental impacts of basketball players' behavior on the images of individual teams and the league. Also, consistent with our presumption, the estimated coefficient of a player's age squared (AGE^2) is statistically significant and negative, confirming that an additional year of learning effect from both athletic and non-athletic experience has a positive impact on a player's salary at a decreasing rate.

Finally, building upon the argument in Scully (1974) that different aspects of the basketball game are more important for different positions, the current specification of the fixed-effects model is estimated again for the back court players and the front court players in Regressions (2) and (3), respectively. First, the estimation results for the two separate groups are highly consistent with the one in Regression (1) for the entire sample data set except for the variable COMP whose estimated coefficients become statistically less significant as the number of sample observations in each estimation decreases. One thing noteworthy in the fitted regression for each group of players is that points per game (PPG) and rebounds per game (REB) are positive and statistically significant factors in the front court players' salaries while points per game (PPG) and assists per game (ASST) are causal in the back court players' salary determination. This observation is consistent with the argument of Scully (1974).

Table 3
Fixed-Effects Estimation Results

Dependent variable: log(SAL)	Regression (1) (All Players)	Regression (2) (Back Court Players)	Regression (3) (Front Court Players)
PPG	0.0331*** (0.0059)	0.0351*** (0.0092)	0.0274*** (0.0082)
REB	0.0332*** (0.0127)	0.0099 (0.0151)	0.0679* (0.0348)
ASST	0.0066 (0.0181)	0.1261*** (0.0368)	-0.0304 (0.0226)
COMP	-0.0169* (0.0087)	-0.0208 (0.0142)	-0.0182* (0.0110)
MOVES	-0.1419*** (0.0324)	-0.1429*** (0.0481)	-0.1358*** (0.0438)
AGE	0.8809*** (0.0491)	0.7721*** (0.0769)	0.9562*** (0.0649)
AGE^2	-0.0129*** (0.0009)	-0.0108*** (0.0014)	-0.0143*** (0.0012)
CONSTANT	0.3351 (0.6343)	1.5954 (1.0127)	-0.4772 (0.8297)
R^2 (within)	0.5764	0.5601	0.5963
F-statistic (H_0: all β_k's=0)	$F(7, 1876)=364.67$	$F(7, 786)=142.96$	$F(7, 1083)=228.49$
F-statistic (H_0: all u_i's=0)	$F(377, 1876)=5.72$	$F(158, 786)=5.02$	$F(218, 1083)=6.09$
Hausman specification test	Chi-sq (7)=823.13		

***, **, and * indicate statistical significance at 1%, 5%, and 10% level, respectively.

IV. CONCLUSIONS

In this study, we investigated the relationship between pay and performance in the NBA by fitting a fixed-effects panel data model. Building upon the line of reasoning in Scully (1974), we not only investigated the controversy of what aspect of the game is more important for each position with different skills, but also accounted for the salary variations among the NBA players by controlling for the capacity of local sports markets to accommodate other competing professional sports teams, the frequency of movements of a player in the league, and players' ages. Our study confirms that a player's scoring ability is a primary athletic factor in players' salary determination, and that different aspects of the basketball game such as rebounds per game and assists per game are valued differently for different positions with different skills. Our finding also supports the presumption that lesser players are more likely to move more often resulting in a lower salary. Furthermore, our finding suggests that, other factors remaining constant, a player's salary is relatively low as his team competes for the common fan base with more of other professional sports teams in a given local sports market.

This study yet leaves much to improve on in the future research of salary determination in professional sports. Incorporating into the analysis non-competitive features of the labor market, the impact of the greater circulation of the salary information, and asymmetric informational structure of the labor contracts in professional basketball may further improve our understanding of the relationship between pay and performance.

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