# Applying Economics to the Game of Baseball: A Study on Baseball Player Salary Determination

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## Introduction

Baseball is referred to as “America's pastime,” and is watched live, on television, listened to over the radio, and streamed over the internet by millions of fans each season. In addition to ticket sales, Major League Baseball (MLB) franchises earn millions of dollars in advertising and licensing revenue each year. Although each franchise employs hundreds of support staff, from groundskeepers to concession workers to athletic trainers, the employees that are directly responsible for the money made by a franchise are the twenty-five to forty players the franchise puts on its roster.

With its vast array of individual performance statistics and evolution of player contracts, baseball is a natural choice to study labor economics. Baseball is one of few areas where an individual’s contribution to revenue can be reasonably estimated, so baseball is often used to study monopsony. Also, Major League Baseball has been integrated since Jackie Robinson first played with the Brooklyn Dodgers in 1947. The availability of statistics and salary data allows economists to test, in the small labor market of baseball, for the existence and extent of racial discrimination on player salary.

This study will combine an overview of some of the seminal baseball research in the field of labor economics, and provide original econometric research on the relationship between player statistics and salary.

**The Search for Exploitation and the Beginning of Statistic-Based Salary Studies**

Although research has expanded to include topics in public economics such as the impact of stadia on regional economies, one of the earliest areas where economic theory was applied to baseball was in the field of labor economics. Among the most thorough early studies on the labor market of baseball players was conducted by economist Simon Rottenberg (1956). At the time Rottenberg wrote, a player who had yet to sign a contract with any team was considered a “free agent”. As its name implies, free agents were free to sign with whatever team they wished for the highest salary they were bid. The free agent thus existed in a competitive labor market. However, once a free agent signed his first contract with a team, he never saw a competitive market for his services again. The contract signed, called the *uniform contract*, was a renewable contract of one year duration used for all players, and contained the *reserve clause*. Through the reserve clause, the team essentially controlled the player, gaining the right to his services to the exclusion of other teams. The team could do nearly whatever it wanted with the contract: renew it at any salary at least 75% of the previous season’s salary, sell the contract to another team, or choose not to renew the contract. The player, on the other hand, only had two options: to sign the contract presented by his team, or hold out hoping for a better offer from the team. The reserve rule, according to Rottenberg, “gives a *prima facie* appearance of monopsony to the market” (1956, p. 252). Once signed, a player only had one buyer for his services, and the team had a potentially limitless pool of players from which to buy services.

Since a player’s only choices were to play for the team owning his contract or to hold out and not play at all, according to monopsony theory a profit-maximizing team should pay each player an amount “just about necessary to prevent them from withdrawing their services” (Rottenberg, 1956, p. 252). Rottenberg found, however, that in the Major Leagues teams seemed to pay more than this bottom value, but less than the player’s worth to the team (1956, p. 252). Thus, exploitation existed, but not to the full extent that could be expected in a monopsonistic labor market. Rottenberg theorized that salary did not fall to the level at which a player would withdraw his services because the player held some market power in his ability to hold out, and in his ability to control the amount of effort he exerts. Writes Rottenberg, “a player who is unhappy about his salary will perhaps not play as well as one who is not” (1956, p. 253).

Almost immediately after its inception in the 1880s, players decried the reserve clause for its limitations on player freedom. Owners, on the other hand, claimed the reserve clause was necessary to keep small market, poorer teams competitive with large market teams. Without the reserve clause, the argument ran, rich teams would buy all of the good players, making games uncompetitive and leading to a loss of fans and revenue that would be bad for all teams. Rottenberg argued against the owner’s contention, claiming that the law of diminishing returns would keep this situation from occurring. Since fans would not pay to see uncompetitive games, it would not make sense for teams to monopolize talent above a level at which games are still competitive (1956, p. 254). The unraveling of the uniform contract that was about to begin would prove Rottenberg correct.

Beginning in the mid-1950s, small changes to the uniform contract began to occur. In 1954, the players created a bargaining unit called the Major League Baseball Players’ Association (MLBPA), which was able to raise the minimum Major League salary and finance a player pension fund. By 1968, the MLBPA was able to secure arbitration rights for Major League players unhappy with their salary, although the arbitrator in any salary grievance case under the 1968 agreement was the Commissioner of Major League Baseball, a position appointed by the owners of MLB franchises (Zimbalist, 1992, p. 17-18).

The breakthrough that started the chain of events that seriously altered the uniform contract was the suit filed by player Curt Flood in January 1970. Flood, a twelve year veteran, had his contract sold by the St. Louis Cardinals to the Philadelphia Phillies; however, Flood did not wish to move to Philadelphia and sued for free agency. Although Flood lost his case, his plight led the MLBPA to bargain for and gain impartial arbitration for players with two or more years in Major League Baseball in 1973 and, three years later, free agency for players with six or more seasons in Major League Baseball (Zimbalist, 1992, p. 18-22).

## The Level of Exploitation and the Development of Measurements for Player Worth

While he theorized that exploitation existed in professional baseball, Rottenberg did not go so far as to measure the levels of exploitation. To do this, processes had to be developed to calculate the Marginal Revenue Product (MRP) that a player adds to a team.

Perhaps the most popular method for determining a player's MRP that came out of the 1970s battle over the uniform contract coming from the Flood case is Gerald Scully's two-step method. The major premise of Scully's method is that the major bearing on team revenue over which a team has some control is the number of games that a team wins. Teams win by batting and pitching. A player's contribution to a team's revenue can thus be measured by discovering first the impact that team hitting and pitching statistics have on team winning percentage, and the impact on team revenue had by team winning percentage. The player's MRP can then be estimated with a second step of estimating the player's individual contribution to team hitting and pitching. Using his method, Scully found that nearly all Major League players earned salaries below their MRP (Scully, 1974, 923).

Modifying Scully's method for his 1992 book *Baseball and Billions*, Andrew Zimbalist estimated MRP's for Major League players from 1986 through 1989. The major factor in salary and exploitation by that time, Zimbalist found, was the number of years a player had spent in the Major Leagues. A major reason for this was the modification in baseball contracts beginning in 1976. As discussed earlier, from nearly the beginning of the National League in the late 1800s, player contracts operated with a uniform contract containing the reserve clause. New players could sign with the highest bidding team before their rookie season; however, once signing a contract, the team owned the player's services until the end of his career, or until trading his rights to another team. The contract, and thus the player's services, became the property of the owner, and could be sold to another owner. The player could not negotiate with other teams, and if a player quit and tried to resign with another team, he could not do so.

When Zimbalist wrote his book, the uniform contract system had been changed, as described above, to a system with three tiers of players under different contract stipulations. "Apprentices" are the lowest level of player, and play under a contract similar to the old contract. They have no salary arbitration, and are bound to their team and contract. After two full years in the Major Leagues, an apprentice becomes a "Journeyman", eligible for independent arbitration of salary. The arbitrator weighs the evidence given by both sides and decides on either the salary amount offered by the team or asked for by the player, and not a number in between the two. With each side standing to lose significantly if contract negotiations go all the way to arbitration, most negotiations are settled at a number between the team bid and the player ask before progressing to arbitration. "Masters," with six or more years in the Major Leagues, are no longer affected by the reserve clause and have nearly full freedom of contract.

Zimbalist found that exploitation had more to do with years of service in the Major Leagues than it had with player MRP, measured by the hitting statistic On-base plus slugging (OPS, described in detail later). Those with less than six years in the Majors, or those still under some form of the reserve clause, were exploited in the years 1986-1989. Apprentices, Zimbalist found, were paid only about 25 percent of their MRP, and Journeymen, with the benefit of salary arbitration and approaching the years of service required for free agency, made about half of their MRP. Masters, on the other hand, made an average of about 25 percent to 40 percent above their MRP over the years 1986-1989 (Zimbalist, 1992, p. 90).

While it makes sense that firms with market power, in the case of baseball the team when negotiating with an apprentice or journeyman, would pay a player less than his MRP, Zimbalist could only speculate why teams would pay more than MRP for masters level players. In *Baseball and Billions*, Zimbalist gives four ideas why this phenomenon occurs.

1. By hiring a player, a team not only gains the services of that player, but

also ensures that competitors will not obtain the player's services. Writes Zimbalist, "Our measure considers the player's value only in what he adds to his team, not what he takes away from the opposing team" (1992, p. 94).

2. Long-term contracts, which grew in popularity after 1976, move a player's compensation determination to more of a career statistics-based salary level than one year contracts, which were prevalent when the reserve clause covered all players.
3. Owners today are often business leaders or businesses themselves, and the owners may operate the team not to maximize team profit, but to maximize joint profit of the team and other businesses. A better team, even if it is had by paying more for players than would be done by maximizing team profit, may better promote the other businesses run by the owner of the team than if the team itself maximized profit.
4. There is a level of "star power" that goes above and beyond a player's statistics. This star power is an ability to draw fans to the gate, and to buy team merchandise, that cause a player to contribute more to team revenue than can be measured by statistics alone.

**Regression of the Effect of Hitting Statistics and other Factors on Salary[1]**

While much has been written on what players are worth to their teams and what their value would be to other teams, less work has been done to test the factors that

[1] I would like to thank Professor William Boal of Drake University for his assistance with the following regression analysis.

actually lead to the salary a player is paid. To test this, ordinary least squares regressions were run comparing 2008 hitter salaries, as reported by *USA Today*, to 2007 statistics reported by *ESPN.com*. In addition, F-tests were run to determine if a player's team and position were contributing factors to his salary independent of hitting statistics.

The following hitting statistics were used to measure hitter performance. On-base plus slugging (OPS) is the sum of on-base average and slugging average. On-base average is the sum of hits, walks, and hit-by-pitches recorded by a player divided by the sum of his number of at bats, walks, hit-by-pitches, and sacrifice flies. Slugging average is the sum of the bases a hitter gains by singles, doubles, triples, and home runs divided by his number of at bats. For instance, a player with one single and one home run in five at bats would have an on-base average of two hits divided by five at bats, or .400, and a total of five bases divided by five at bats, for a slugging average of 1.000. His OPS would thus be 1.400. OPS was chosen as a regressor because it is a favorite tool of statisticians to study a player's worth to his team. Also, OPS was used by Zimbalist (1992) to measure the productivity of hitters to determine their worth to their team and the presence and extent of exploitation.

While many statisticians decry its usefulness as a measure of skill, batting average was selected as a regressor since many still see batting average as perhaps the most important hitting statistic, as evidenced by its presence, along with home runs and runs batted in, in the triple crown of hitting. Although many statisticians see batting average as a tool of little value, there is no reason to believe that all team owners and managers, who determine player salary, feel the same way.

Runs were chosen because they are the measure by which teams win or lose, and the more runs a player makes the more he helps his team. Strike outs were included because they are the worst possible outcome in most at bats. If a player puts his bat on the ball, even for an easy grounder or pop fly, there always is a chance that the player will reach base by a fielding error. When a player strikes out, the only way he can get on base is if the catcher drops the third strike and the hitter makes it to first base before getting tagged out or thrown out at first base, a very rare occurrence at the professional level. Stolen bases were included as a measure of speed, to see the effects, if any, speed has on salary over and above the extent to which speed is an effect on the number of runs scored by a player. Finally, team and position dummy variables were included to see what effect a player's team and position have on salary, independent of the player's statistics. Salary, as the dependent variable, was put into logarithmic form, so that the effects of the regressors could be seen as a percentage change in salary.

The regressions showed some interesting results, shown in tables 1 and 2. The coefficient for OPS is -.317, with a P-value of .613, and batting average has a coefficient of -.855, with a P-value of .678. These two numbers make little sense, since having a better season at the plate should not have a negative effect on salary. The results of these two regressors show that, in the way this experiment was designed, OPS and batting average do not have an accurately measureable impact. In fact, the only factors measured significant to ten percent were runs, stolen bases, team, and position.

As the measure that determines whether a team wins or loses, it makes sense that runs have a positive correlation to player salary, significant to one percent.

However, stolen bases had a negative coefficient, significant to one percent. It is hard to believe that, all else equal, a player's ability to steal bases has a detrimental effect on his salary. It is more likely that the effect that stolen bases may have on salary is already contained in the runs statistic. After all, the purpose of stealing a base is to put the player in a better position to score a run.

The results of my regression analysis fall in line with the results found by Zimbalist (1992). As discussed above, Zimbalist found that the number of years spent in the Major Leagues, instead of previous year statistics, to be the most accurate measure of a player's exploitation. Indeed, Zimbalist did not find the relationship between a player's 1989 salary and marginal revenue product, based on individual worth to his team measured by OPS, to be statistically significant (1992, p. 92-93).

Perhaps the most interesting result shown by the regressions is the relationship of salaries across teams. An F-test for joint significance by team showed that the team on which a player plays has an effect on salary significantly different than zero at a significance level as low as one percent, with a P-value of 0.00622. This result shows that the team on which a player plays makes a difference in his salary over and above his hitting statistics. Using the New York Yankees as a high-revenue team and the Florida Marlins as a low-revenue team, regressions were run to test differences among player salary due to the team they played on, holding for the regressors shown above. The results with the Yankees as the index team are shown in table 1, and the results with the Marlins as the index team are shown in table 2.

The regression results with the New York Yankees as the index team show that every team but the New York Mets had a negative coefficient, meaning that a player on the Yankees would make more than a player with identical offensive statistics playing on any other team but the Mets. Of these results, ten of the twenty-nine are statistically significant to 10 percent. For instance, the estimated coefficient for the Oakland A's is -0.990, with a p-value of 0.02. Looking at the percent change column of table 1, we see that this coefficient means that an Oakland A's player with identical measured hitting statistics as a New York Yankee makes approximately 62.8% less than the Yankee. Put differently, an Oakland A's player makes approximately 2.69 times less than a Yankee with identical measured hitting statistics.

On the other side of the team revenue spectrum are the Florida Marlins, a team that perennially has one of the lowest payrolls in baseball. According to the regression results with the Marlins as the index team, every team had a positive coefficient, and for every team but two, the Milwaukee Brewers and Atlanta Braves, the results were statistically significant at a significance level of 10 percent. The results show that, for instance, a player for the Cincinnati Reds makes a salary approximately 186% more than the salary of a Marlin with identical measured hitting statistics. Put differently, a Cincinnati Red makes approximately 2.85 times more than a Marlin with identical hitting statistics.

What accounts for the differences among teams? The regressions run for this study only take into account one year of hitting statistics. While 2007 statistics are likely to be representative of a player's ability, they are nowhere near perfect. For instance, one year of statistics does not accurately measure the ability of a player that was injured for more than the average number of games in the season from which statistics were taken. While OPS and batting average, as averages, would still be accurate for such a player, runs, stolen bases, and strike outs would be lower than if the player had played the entire year. Lastly, especially today with the prevalence of long-term contracts, managers look at a player's entire career when deciding salary.

Another factor that likely has a significant effect on salary is the number of years a player has been in the Major Leagues. As discussed above, a player earns the right to independent salary arbitration after two years in the Major Leagues, and earns free agency after six years. Thus, it is likely that the number of years a player has been in the league, or the player's status as an apprentice, journeyman, or master as discussed above, has an effect on player salary.

Lastly, and as Zimbalist (1992) pointed out, there is likely a level of "star power" that is correlated to but yet goes beyond a player's statistics. The amount to which this star power draws fans to the gate is immeasurable using statistics alone.

## Conclusion

Baseball economics is a vast and growing field, and with growing technology and knowledge, the application of economic theory to baseball will only continue to expand. Like it has in other areas, such as public policy, the application of economic theory to baseball continues to shape the face of the game. In addition to giving a brief overview of major studies in the field of professional baseball labor economics, this study has contributed to the field of baseball economics by displaying that the team on which a Major League Baseball player plays has a significant impact on the player's salary independent of five major hitting statistics. We do not yet know the entire reason for this impact; however, the difference is real, and an area for further study.

**Table 1 - Regression results with the New York Yankees as the comparison team**

| Variable | Estimated Coefficient | Percent Change* | Standard Error | T-statistic | P-value |
|---|---|---|---|---|---|
| ON-BASE PLUS SLUGGING | -0.317 | -27.2% | 0.626 | -0.506 | [.613] |
| BATTING AVERAGE | -0.856 | -57.5% | 2.060 | -0.415 | [.678] |
| RUNS | 0.029 | 2.9% | 0.003 | 8.709 | [.000] |
| STRIKE OUTS | -0.001 | -0.1% | 0.002 | -0.534 | [.594] |
| STOLEN BASES | -0.024 | -2.3% | 0.007 | -3.452 | [.001] |
| DIAMONDBACKS | -0.975 | -62.3% | 0.434 | -2.244 | [.025] |
| BRAVES | -0.859 | -57.7% | 0.515 | -1.668 | [.096] |
| ORIOLES | -0.603 | -45.3% | 0.450 | -1.340 | [.181] |
| REDSOX | -0.250 | -22.1% | 0.454 | -0.550 | [.582] |
| CUBS | -0.385 | -31.9% | 0.458 | -0.840 | [.402] |
| WHITESOX | -0.156 | -14.4% | 0.423 | -0.368 | [.713] |
| REDS | -0.557 | -42.7% | 0.410 | -1.357 | [.175] |
| INDIANS | -0.840 | -56.8% | 0.401 | -2.096 | [.037] |
| ROCKIES | -0.856 | -57.5% | 0.421 | -2.034 | [.043] |
| TIGERS | -0.202 | -18.3% | 0.421 | -0.480 | [.632] |
| MARLINS | -1.606 | -79.9% | 0.422 | -3.804 | [.000] |
| ASTROS | -0.367 | -30.7% | 0.406 | -0.903 | [.367] |
| ROYALS | -0.975 | -62.3% | 0.405 | -2.406 | [.017] |
| ANGELS | -0.498 | -39.2% | 0.448 | -1.110 | [.268] |
| DODGERS | -0.602 | -45.2% | 0.461 | -1.305 | [.193] |
| BREWERS | -1.094 | -66.5% | 0.450 | -2.433 | [.015] |
| TWINS | -0.429 | -34.9% | 0.416 | -1.031 | [.303] |
| METS | 0.203 | 22.5% | 0.398 | 0.511 | [.609] |
| A'S | -0.990 | -62.8% | 0.425 | -2.329 | [.020] |
| PHILLIES | -0.605 | -45.4% | 0.406 | -1.493 | [.136] |
| PIRATES | -0.839 | -56.8% | 0.390 | -2.153 | [.032] |
| PADRES | -0.558 | -42.8% | 0.483 | -1.155 | [.249] |
| GIANTS | -0.232 | -20.7% | 0.432 | -0.538 | [.591] |
| MARINERS | -0.103 | -9.8% | 0.399 | -0.258 | [.797] |
| CARDINALS | -0.497 | -39.2% | 0.428 | -1.162 | [.246] |
| DEVILRAYS | -0.981 | -62.5% | 0.422 | -2.324 | [.021] |
| RANGERS | -0.593 | -44.7% | 0.452 | -1.311 | [.191] |
| BLUEJAYS | -0.438 | -35.5% | 0.439 | -0.998 | [.319] |
| NATIONALS | -0.658 | -48.2% | 0.418 | -1.574 | [.116] |

* Found by subtracting one from exponential function of the estimated coefficient, exp(coefficient) - 1. For the statistical regressors, this calculation gives the percent change that a one point increase in the regressor causes to player salary. For the team variables, this calculation gives the percentage of salary more or less that a player of identical hitting statistics makes playing for the selected team than he would playing for the New York Yankees. For example, an Oakland A makes 62.8% less than a player with identical hitting statistics would make playing for the New York Yankees.

**Table 2 - Regression results with the Florida Marlins as the comparison team**

| Variable | Estimated Coefficient | Percent Change* | Standard Error | T-statistic | P-value |
|---|---|---|---|---|---|
| ON-BASE PLUS SLUGGING | -0.317 | -27.2% | 0.626 | -0.506 | [.613] |
| BATTING AVERAGE | -0.856 | -57.5% | 2.060 | -0.415 | [.678] |
| RUNS | 0.029 | 2.9% | 0.003 | 8.709 | [.000] |
| STRIKE OUTS | -0.001 | -0.1% | 0.002 | -0.534 | [.594] |
| STOLEN BASES | -0.024 | -2.3% | 0.007 | -3.452 | [.001] |
| DIAMONDBACKS | 0.631 | 88.0% | 0.366 | 1.727 | [.085] |
| BRAVES | 0.747 | 111.0% | 0.455 | 1.640 | [.102] |
| ORIOLES | 1.003 | 172.7% | 0.379 | 2.648 | [.008] |
| REDSOX | 1.357 | 288.3% | 0.405 | 3.353 | [.001] |
| CUBS | 1.222 | 239.2% | 0.392 | 3.114 | [.002] |
| WHITESOX | 1.451 | 326.5% | 0.359 | 4.044 | [.000] |
| REDS | 1.049 | 185.6% | 0.344 | 3.049 | [.002] |
| INDIANS | 0.766 | 115.2% | 0.334 | 2.297 | [.022] |
| ROCKIES | 0.750 | 111.8% | 0.358 | 2.098 | [.037] |
| TIGERS | 1.404 | 307.3% | 0.373 | 3.768 | [.000] |
| ASTROS | 1.240 | 245.4% | 0.340 | 3.648 | [.000] |
| ROYALS | 0.631 | 88.0% | 0.335 | 1.887 | [.060] |
| ANGELS | 1.109 | 203.0% | 0.394 | 2.811 | [.005] |
| DODGERS | 1.005 | 173.1% | 0.397 | 2.533 | [.012] |
| BREWERS | 0.513 | 67.0% | 0.391 | 1.312 | [.190] |
| TWINS | 1.177 | 224.4% | 0.349 | 3.368 | [.001] |
| METS | 1.809 | 510.7% | 0.331 | 5.465 | [.000] |
| YANKEES | 1.606 | 398.4% | 0.422 | 3.804 | [.000] |
| A'S | 0.616 | 85.2% | 0.352 | 1.753 | [.080] |
| PHILLIES | 1.001 | 172.0% | 0.346 | 2.888 | [.004] |
| PIRATES | 0.767 | 115.4% | 0.318 | 2.414 | [.016] |
| PADRES | 1.048 | 185.2% | 0.429 | 2.445 | [.015] |
| GIANTS | 1.374 | 295.1% | 0.368 | 3.733 | [.000] |
| MARINERS | 1.503 | 349.7% | 0.332 | 4.533 | [.000] |
| CARDINALS | 1.109 | 203.1% | 0.364 | 3.050 | [.002] |
| DEVILRAYS | 0.625 | 86.9% | 0.354 | 1.768 | [.078] |
| RANGERS | 1.014 | 175.5% | 0.381 | 2.659 | [.008] |
| BLUEJAYS | 1.168 | 221.7% | 0.391 | 2.991 | [.003] |
| NATIONALS | 0.949 | 158.2% | 0.351 | 2.701 | [.007] |

* Found by subtracting one from exponential function of the estimated coefficient, exp(coefficient) - 1. For the statistical regressors, this calculation gives the percent change that a one point increase in the regressor causes to player salary. For the team variables, this calculation gives the percentage of salary more or less that a player of identical hitting statistics makes playing for the selected team than he would playing for the Florida Marlins. For example, a Cincinnati Red makes 185.6% more than, or 2.856 times, a player with identical hitting statistics would make playing for the Florida Marlins.

**Table 3 - Average 2008 Batter Salary by Team**

| **Team** | **Average 2008 Batter Salary** |
|---|---|
| DIAMONDBACKS | $1,758,190 |
| BRAVES | $2,946,192 |
| ORIOLES | $2,975,851 |
| REDSOX | $6,943,714 |
| CUBS | $4,559,792 |
| WHITESOX | $5,042,976 |
| REDS | $3,042,157 |
| INDIANS | $2,483,612 |
| ROCKIES | $3,540,625 |
| TIGERS | $6,864,550 |
| MARLINS | $462,067 |
| ASTROS | $4,339,172 |
| ROYALS | $2,301,423 |
| ANGELS | $4,756,786 |
| DODGERS | $4,113,787 |
| BREWERS | $1,849,964 |
| TWINS | $3,133,564 |
| METS | $5,467,255 |
| YANKEES | $10,521,390 |
| A'S | $1,730,333 |
| PHILLIES | $3,956,837 |
| PIRATES | $2,234,286 |
| PADRES | $2,927,201 |
| GIANTS | $3,910,692 |
| MARINERS | $5,410,999 |
| CARDINALS | $3,300,889 |
| DEVILRAYS | $1,691,450 |
| RANGERS | $2,322,214 |
| BLUEJAYS | $3,984,614 |
| NATIONALS | $2,463,125 |

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