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Joshua Congdon-Hohman

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Jonathan A. Lanning

May 2017

COLLEGE OF THE HOLY CROSS, DEPARTMENT OF ECONOMICS
FACULTY RESEARCH SERIES, PAPER NO. 17-02*

Department of Economics
College of the Holy Cross
Box 45A
Worcester, Massachusetts 01610
(508) 793-3362 (phone)
(508) 793-3708 (fax)

https://www.holycross.edu/academics/programs/economics-and-accounting

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Beyond Moneyball: Changing Compensation in MLB

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Joshua Congdon-Hohman[†]
College of the Holy Cross

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Jonathan A. Lanning[††]
College of the Holy Cross

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Abstract

This study examines the changes in player compensation in Major League Baseball during the last three decades. Specifically, we examine the extent to which recently documented changes in players' compensation structure based on certain types of productivity fits in with the longer term trends in compensation, and identify the value of specific output activities in different time periods. We examine free agent contracts in three-year periods across three decades and find changes to which players' performance measures are significantly rewarded in free agency. We find evidence that the compensation strategies of baseball teams increased the rewards to "power" statistics like home runs and doubles in the 1990s when compared to a model that focused on successfully reaching base with a batted ball without a significant regard for the number of bases reached. Similarly, we confirm and expand upon the increased financial return to bases-on-balls in the late 2000s as found in previous research.

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JEL Classification Codes: J24, J31, L83, Z22

Keywords: Compensation, incentives, labor markets, baseball

*Thanks to Jeffery Paadre and Ryan Ghizzoni for their excellent research assistance, and to Victor Matheson and Kurt Rotthoff for their helpful suggestions. Congdon-Hohman also thanks the May and Stanley Smith Charitable Trust for partially funding his work. All errors and omissions are our own

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[†] Department of Economics and Accounting, Box 72A, College of the Holy Cross, Worcester, MA 01610-2395, 508-793-3673 (phone), 508-793-3708 (fax), jcongdon@holycross.edu

[††] Consumer Financial Protection Bureau

1. Introduction

Though professional baseball dates back to the late 1860s, baseball's labor market and the analytic tools brought to bear on its production processes have changed dramatically. In this paper, we examine the changing compensation incentives in Major League Baseball in recent decades as team-building strategies have evolved to emphasize different types of player production when batting. To identify distinct compensation regimes, we will focus on periods that we believe to be relatively stable in terms of labor market structure, performance-enhancing drug policy, and output rewards. We then explore data from one "transition period" between these stable eras to better understand the evolution of rewards between compensation regimes.

Our results are highly consistent with the hypothesis that teams adjusted their compensation strategies in response to the contemporary understanding of baseball's production process. Specifically, we find that the salary returns to power statistics increased dramatically for free agents between the late 1980s and the late 1990s. This is consistent with the increased emphasis on the power game during the 1990s. Additionally, our wage regressions show that the salary returns to on-base percentage and unintentional base-on-balls became significant predictors of a free agent's salary in the 2000s. This finding is consistent with a shift in the value of reaching base following the success of the Oakland Athletics early in the 2000s and the publication of Michael Lewis' book Moneyball in 2003. These results may have further implications for future work exploring the principle agent problem using sports data.

Section 2 provides some background on previous research in this area, as well as information about the free agent market in professional baseball. We then identify the data used, and present some summary statistics, in Section 3. In Section 4, we present the hedonic model

we will use to identify the marginal valuations of various statistics. Section 5 presents our results, and Section 6 concludes.

2. Background

The labor market in professional sports offers a particularly strong opportunity to examine issues of compensation and productivity, due to the meticulously kept measures of individual and team output available to both players and management at the time of contract negotiation (see Kahn (2000) and Fort (2003) for a more thorough discussion). Baseball is especially well-situated for an analysis of individual production and financial rewards as it can be seen as a series of largely independent individual contests (e.g. plate appearances) that aggregate to a team's production (e.g. wins), which stands in slight contrast to some other sports where individual achievement is often a function of collective effort (e.g. a running back's yards from scrimmage in American football is highly dependent on his offensive line's blocking).

The features identified above have led to baseball performance and salary data being used extensively to analyzing the principal-agent problem. In addition to using this data to identify the value of players' marginal revenue product in analysis such as Scully (1974) and Bradbury (2007), research over the last 25 years has used single performance measures chosen based on the current conventional wisdom at the time of their studies to look for evidence of shirking following new contracts. For example, Krautmann (1990), Scoggins (1993), Maxcy et al. (2002) focus heavily on slugging percentage ("SLG" -- total bases divided by at bats); Sommers (1993) uses slugging percentage and batting average (hits divided by at bats); Woolway (1997) and Krautmann and Donley (2009) use estimates of players' marginal revenue product (found using statistics such as batting average, stolen bases, slugging percentage, and on-base percentage -- number of times a batter reaches base divided by his plate appearances, "OBP"); and Krautmann

and Solow (2009) uses a variant of OPS (on-base percentage plus slugging percentage adjusted for league and ballpark effects). These output measures are likely to reflect both the conventional wisdom of the time and the basis for which players were rewarded. In this paper, we look to empirically show that these measures, along with other aggregate and individual output measures, were indeed rewarded at various times in the last three decades and identify how the value of the rewards for these measures have changed over time.

On a more limited basis, Hakes and Sauer (2006) have looked into how financial rewards respond to changes in baseball's "conventional wisdom" by examining the financial rewards to on-base percentage from 2000 through 2003, following the publication of Moneyball (Lewis 2003). We hope to broaden the literature by identifying which of a broad range of production indicators are rewarded in the free agency market in various time periods. Specifically, we look at the returns to aggregate or "rate" statistics like OPS, slugging percentage, and on-base percentage, and also "counting" statistics like home runs, bases-on-balls and doubles. The use of counting statistics in addition to aggregate statistics will be important because aggregate values can be reached in a number of different ways. For example, a player's slugging percentage will be the same if a player has two singles or one double in two at bats and his on-base percentage will be the same whether a player walks or singles, but his method of reaching these aggregate values could lead to different expected salary offers.

3. Data

Professional baseball provides excellent data with both meticulously kept, detailed measures of productivity and transparent wages (as salaries are widely reported in the popular press and regularly published by the players' union). Our primary analysis focuses on the statistics and salaries of players reaching "free agency" in three sets of three-year periods: 1988

through 1990, 1998 through 2000, and 2008 through 2010.[1] Free agency is the common term used for the period between seasons after a contract expires when an eligible player is free to negotiate with all potential employers (teams). In order to be eligible, a player must first accumulate 6 years of service for Major League Baseball teams.[2] Prior to six years, a player's current team has monopsony power over the player's services, and can set a player's salary unilaterally for the first three years (subject to a league minimum), and then at an arbitration-determined level for the next three years. Because of these market limitations, free agency is best to identify the market price for a player's labor.

We chose the above sets of years for three important reasons. First, allowing for a separation in time for the market to "evolve" is useful for separating temporal variation in compensation practices regarding which statistics are rewarded in free agency. Second, these periods exhibit relative stability for labor relations, league size, and performance-enhancing drug testing policies.[3] Third, these years follow periods of generally agreed upon shifts in the measures of performance which were emphasized by talent evaluators and analysts. For example, the number of league-wide home runs increased dramatically in the early-to-mid 1990s, and there was a shift of focus from batting average to on-base performance in the early-to-mid 2000s. To allows us to comment on the evolution of incentives, we will take a look at one

[1] We identify a player's "free agency year" by the year they are last under their previous contract (i.e. a player that is a free agent between the 1988 and 1989 seasons is identified as being part of the 1988 free agent class). Free agents are identified by annual lists published each year by the *Associated Press* immediately following the deadline for eligible players to register as free agents.

[2] Free agency has been included in all collective bargaining agreements since 1976. The terms of the collective bargaining agreements can be found both on the Major League Baseball website (mlb.com) and on a website devoted to the business of baseball, bizofbaseball.com.

[3] This is actually in stark contrast to many adjacent years. For example: prior to the 1985 collective bargaining agreement, there were restrictions on which teams could negotiate with a free agent (determined by a draft process) and how many free agent players a team could add in a particular year; collusion amongst teams inhibited the movement and salaries of free agents from (at least) 1985-87; a labor strike disrupted play in the 1994 season; the number of teams expanded by two prior to both the 1993 and 1998 seasons; new performance-enhancing drug testing policies were implemented in stages between 2003 and 2006; etc.

transition period using data from 2002 through 2007. This intervening period is of particular interest given the work of Hakes and Sauer (2006), but also introduces the risk of confounding changes to the policies prohibiting and policing the use of performance-enhancing drugs.

In the analysis that follows, we will focus on the relationship between the salary that players receive following free agency and a broad range of aggregate and counted statistics which were all collected from Baseball-Reference (http://baseball-reference.com).[4] We will examine the aggregate statistics used in previous literature as well as more traditional "counting stats" (those stats that are naturally measured in totals, and not rates). Amongst counting stats, we will be examining totals for offensive events that are accumulated over the course of a season. We will focus on plate appearances, hits, home runs, doubles, unintentional walks, triples, stolen bases, runs scored, runs batted in (RBI), and strikeouts.[5] Since counted stats will be highly correlated with the number of plate appearances, we will estimate the value of plate appearances as a level and convert all other counting stats to rates.[6] We project all stats to the level they would be for a "standard" season, which we set to 502 plate appearances.[7]

Table 1 displays a summary of the data, and illustrates some clear differences across cohorts. First, the number of free agents has increased over time, and those free agents have seen significant increases in their annual salary in the year following free agency. The increase in the

[4] A player's salary annual salary from their first year of a new contract will be used in this analysis. Using more detailed contract data that includes length and total value gives consistent results to those presented below.
[5] A base-on-balls, or walk, occurs when the pitcher throws four pitches outside of the strike-zone and can be intentional or unintentional. An intentional base-on-balls occurs when a pitcher purposefully walks a player for strategic reasons, often due to the batter's hitting skills. An unintentional base-on-balls is often a measure of a batter's "plate discipline" in allowing pitches outside the strike-zone to pass without offering a swing. Unintentional base-on-balls are calculated by subtracting intentional base-on-balls from the total base-on-balls. We believe intentional walks serve as a proxy for power and unintentional walks better isolate the skill of plate discipline.
[6] Note that plate appearances may also have productivity implications as well, as increased plate appearances imply greater durability and total production for a given level of rate statistics.
[7] This number represents the minimum number of plate appearances necessary to qualify for the annual batting title, or 3.1 plate appearances in each of the 162 games scheduled in Major League Baseball's regular season.

number of free agents is likely due partially to an expansion of the league, and partially due to a much higher rate of one-year contracts (which includes those receiving minor league contracts), going from 34 percent of contracts in the 1980s cohort to almost 75 percent in the 2000s cohort. We can also see that offensive statistics have skewed towards a more power-based game after the 1980s cohort. The on-base plus slugging percentage (OPS) and slugging percentage (SLG) both showed large increases between the 1980s cohort and the 1990s cohort, which continued into the 2000s cohort.[8] This change can also be seen in the cohorts' doubles and home run rates (measured in per 502 plate appearance levels, holding plate appearances constant). While power numbers have gone up among free agents, on-base percentage (OBP) has stayed relatively level over the three cohorts, which reflects a similar trend in the hit and walk rates. Finally, stolen bases have steadily fallen across the cohorts while strikeouts (SO) have steadily increased.

The remaining statistics in Table 1 are presented to show the make-up of the free agent cohorts. The percentage of players playing any games at defensive positions that we consider "premium" (catchers, second basemen, and shortstops) has increased over the cohorts.[9] The addition of four National League teams in the 1990s led to the decreased percentage of American League games for the later cohorts and likely contributed to the increase in the age of free agents when combined to the added supply caused by the decrease in the number of multi-year contracts. Finally, the distribution of free agents by year within each cohort is relatively even with no year making up more than 40.4 percent of a cohort.

[8] The values for these statistics are consistent with the league-wide averages and therefore suggests that there is not a high degree of selection in the free agent pool, even after the move to more one-year contracts. Specifically, the league-wide OBP/SLG/OPS splits were 0.321/0.379/0.700 in the 1988 through 1990 seasons, 0.342/0.430/0.772 in the 1998 through 2000 seasons, and 0.330/0.412/0.743 in the 2008 through 2010 seasons (based on authors' calculations).

[9] We have tested the robustness of the results that follow to other definitions of premium defensive positions, including: identifying only players that played fifty percent of their games at one or more of these positions, the inclusion of third basemen or centerfielders, and adding individual dummy variables for key positions. None of these alternative definitions led to substantive differences in the results we report below.

4. Empirical Methodology

To estimate the financial returns to particular statistics, we use a Rosen (1974) hedonic price model to examine the wage components of the free agent classes in each cohort. The coefficients found in the hedonic model represent the marginal impact of each performance measure on market wages and will reflect both the supply and demand for that output type. As described earlier, Table 1 provides a rough estimate of how the supply of each output is different across cohorts among the available free agents. As Hakes and Sauer (2006) found with on-base percentages between 2000 and 2004, we expect that the valuation of individual statistics will change between examination periods. As such, we estimate the salary returns to our productivity statistics separately for each era. Specifically, we will estimate the following model using ordinary least squares:

$$\log(W_{it}) = \theta_0 + \beta X_{i,t-1} + \theta_1 Age_{i,t-1} + \theta_2 Age_{i,t-1}^2 + \theta_3 Premium_{i,t-1} + \theta_4 AL_{i,t-1} + \varepsilon_i \quad (1)$$

In Specification 1, $\log(W_{it})$ represents the log of the salary player i receives in the year following free agency (*t*), $X_{i,t-1}$ represents a vector of the player's output statistics in the year prior to free agency (*t-1*), $Age_{i,t-1}$ and $Age_{i,t-1}^2$ represents the age of player i and its squared value, $Premium_{i,t-1}$ represents an identifier for whether player i has played a premium defensive position, and $AL_{i,t-1}$ represents the share of player i's games that were played for an American League team.[10] Though market-size has been shown to impact the marginal-revenue product of each team win (Burger and Walters (2003) and Brown and Link (2008)) and to impact salary offers (Krautmann 2009)), we do not include such a measure in our model. However,

[10] The share of American League games will be valued at either 0 or 1if a player stays in the same league for the full season and will have a fractional value if he is traded to a team in a different league within the season.

including dummy variables indicating whether a signing team is in the top 5 or top 10 in payroll in the previous year does not have a substantive effect on the results reported below.[11]

The X_i variables are a subset of those statistics discussed in Section 3. In all specifications, plate appearances are included to capture the role of a player as a regular, regular substitute, or infrequent contributor. We then move through a number of specifications that progress from a single aggregate measure of performance to multiple, less aggregated measures. We will also show that the results presented below are similar if deviations from each year's league averages are used in place of the levels and rates discussed above.

5. Empirical Results

We start with aggregate stats in our analysis to test whether players' power statistics where indeed more financially rewarded in the 1990s than in the 1980s and whether the ability to get on base became a rewarded activity in the 2000s, as the "conventional wisdom" of each period might suggest. Table 2 presents the results of Specification 1 for each free agent cohort, first using OPS to capture overall performance and then including OPS's two components to separately measure the impact of power outputs (slugging percentage -- SLG) and reaching base safely (on-base percentage -- OBP). In the case of OPS (columns 1 through 3), this measure of output is significant in all eras. That said, the increase in the size of the valuation from the 1980s to the 1990s and 2000s cohorts is itself statistically significant at the 5 percent level, but the change between the 1990s and the 2000s cohort is not statistically significant. Also, the significance of OPS in the 1980's cohort is likely being driven by the importance of batting

[11] The results for the aggregate statistics when payroll rank indicators are used confirm that there is a large market premium in the latter two cohorts, but the addition of this control does not impact the results of our analysis.

average in that period.[12] It should also be noted that plate appearances have a significantly positive impact implying an increase in wages per plate appearance between .3 and .4 percent in all of the specifications that follow, though the impact of this measure seems to diminish with each era, as other included measures rise in relative prominence.

When OPS is broken up into its two components, we see a slightly different story. Neither component has a statistically significant impact on log wages in the 1980s cohort. When we look at the 1990s cohort, slugging percentage is a highly significant contributor to log wages while on-base percentage is not. The change in the valuation of SLG between the 1980s and 1990s is significant at the 1 percent level. This finding reflects the increased focus on home runs in what is often referred to as the "steroid era" of baseball, so named due to the surge in league-wide home runs and the later revelations of wide-spread use of performance-enhancing drugs. Since this period is prior to the "Moneyball revolution" in baseball, the insignificance of on-base percentage is not surprising and consistent with the findings of Hakes and Sauer (2006).

The increased emphasis on plate discipline in the 2000s is reflected by the fact that OBP is rewarded more significantly and substantially through free agency. On-base percentage in the 2000s is not only a significant predictor of log wages, it has a larger estimated coefficient than slugging percentage which implies a similar impact on log wages.[13] In terms of the change in SLG and OBP between the 1990 and 2000s cohorts, the decrease in the coefficient on SLG is statistically significant at the one percent level while the increase in the coefficient of OBP is not

[12] Batting average was excluded from this analysis because it is an important component of OBP, SLG, and therefore OPS. If batting average is included and the other measures are adjusted to exclude the batting average component, OPS in the 1980's cohort is no longer statistically significant. The results for the other two cohorts are generally unchanged with this inclusion. These results can be found in Appendix Table 1.

[13] Using deviations from league averages result in similar conclusions and show that the effect of SLG and OBP is similar in the 2000 cohort with a one percent deviation from the league average resulting in a 1.2 to 1.3 percent increase in salary, respectively, and can be found in Appendix Table 2. Similarly, the same results are found if the average salary is used for multiyear contracts. Finally, analysis with multiple years of performance statistics show that the final year is indeed the most significant to determining post-free agency's salary.

statistically significant at traditional levels. That said, the fact that the valuation of OBP has risen so sharply as to be statistically significantly different from zero suggests that a small potentially positive factor has moved to a clearly meaningful wage determinant, which reflects an important change in the compensation process and the incentives that the process implies.

While these composite productivity indicators simplify the analysis by representing overall performance in a compact manner, they may mask more subtle adjustments players might make to change individual components that impact the aggregate measures. The results when omitting composite statistics and adding individual counting stats (measured as rates and projected to 502 plate appearances) in Specification 1 can be found in Table 3. In the 1980s cohort (column 1), only hits and RBI per 502 plate appearances have statistically significant impacts on log wages. Hits are not a surprise, but the case of RBI is moderately surprising given the statistic's dependence on teammates and situations that the player finds himself in. This is another case where generational differences may be important, as more emphasis has been put on non-team based statistics in more recent decades. Not surprisingly, RBI are not statistically significant in the latter two cohorts.

The increase in the emphasis on power in the late 1990s is reflected in column 2 of Table 3. Hits, doubles, and home runs are all statistically significant in salary determination in the corresponding cohort. The impact of doubles further supports the increased importance of slugging percentage in this era, despite the fact that home runs captured much of the public's attention. In fact, the increase in the marginal valuation of doubles between the 1980s and 1990s cohorts is statistically significant at the one percent level while the increase in the valuation of each home run is not significant at traditional levels.

The results for the 2000s cohort in column 3 of Table 3 reflect the increased importance of patience at the plate. Unintentional base-on-balls in this period are rewarded with a statistically significant increase in expected salary, while doubles and home runs see a somewhat reduced emphasis. As with OBP in this period, the doubling of the return to unintentional walks brings the total valuation to a statistically significant level but the increase itself is not statistically significant at traditional levels when compared to the earlier cohorts. As before, this does not change the interpretation that this type of output has risen to a level that is likely to reflect an important role in management and player decision-making. Surprisingly, runs (a team dependent statistic) is a significant predictor of log wages in this cohort, but this could simply reflect the increased focus on reaching base, as reaching base at higher rates necessarily increases a player's opportunity to score more runs.[14]

The analysis of this study has focused on distinct time periods where the evaluation of baseball players in free agency is thought to be relatively stable. If we did look at the transition periods, we might expect to find results that lie between the two bookend cohorts. To examine this question, we gathered additional performance and salary data for players who reached free agency between 2002 (the year examined in *Moneyball*) and 2007. The results from this period can be found in Table 4. In terms of rewarded performance, the results for aggregate statistics are much more similar to the 1998 through 2000 cohort results. Similarly, the coefficient values for unintentional walks and home runs are more similar to the 1990s cohort results than those for the 2000s cohort, though the results are estimated with more precision.[15] The higher coefficient

[14] It is interesting to note that players were not rewarded for stolen bases or penalized for strikeouts in any cohort, as this is in mild contrast to the "conventional wisdom" that these are indicators of "good baseball."

[15] Though not shown in Table 4, it should be noted that this transition period did not exhibit a smooth evolution of the value of unintentional walks. Some years in this period show particularly high values for unintentional walks and low values for home runs, which is consistent with the league and its executives transitioning to the new metrics at different rates and with the findings of Hakes and Sauer (2006).

on home runs in this transition period appears to be a response to the stark reduction in supply, likely due to the new drug policies implemented in this period. The average number of league-wide home runs dropped by 5% between the 1990s cohort and this period, from 5428 on average to 5180.

6. Conclusion

In this study, we set out to explore the question of whether the generally recognized shifts in strategic importance of particular outputs in baseball are reflected in the free agent salaries that players receive. While there are certainly limits to our analysis, we have found strong evidence that the answer to this question appears to be "yes" both at the aggregate level and in the detailed individual performance measures. Specifically, we find that salaries evolve to reward those measures of production that are understood to best predict production. This is heartening, as if this had not been true, it might imply that workers' incentives are not optimally aligned with firms' production goals. As it is, our findings are consistent with the hypothesis that baseball strategically (if not necessarily optimally) rewards perceived indicators of productivity.

The 1990s are seen as an era in baseball when power hitting became an extremely important part of the game, both in winning and for drawing fans to the ballpark. The marginal value of power statistics for free agents (as measured by their impact on log salary) increased dramatically between the late 1980s and the late 1990s as baseball executives identified these power statistics as better predictors of productivity than the simple batting average. For example, a home run per 502 plate appearances increased free agent salaries by 2 percent in the 1990s compared to only 0.3 percent in the 1980s. Following the success of the Oakland Athletics in the late 1990s and early 2000s, there was an increased emphasis on drawing walks and driving opposing pitchers to high pitch counts. Again, our wage regressions show that

market incentives reflected this change, as on-base percentage and unintentional base-on-balls became significant predictors of a free agent's salary.

Baseball provides an ideal case-study for exploring incentives and effort, as salaries and numerous individual-level productivity indicators are available for all players. But, as is to be expected in any analysis of worker effort and compensation, there are factors confounding our analysis. Individual contracts are necessarily idiosyncratic, depending on the teams' needs and budgets, other players in the market, general economic fluctuations, and numerous other factors that are specific to each free agent and his class. As such, even general patterns of financial rewards changing in response to a better understanding of baseball's "production process" constitutes strong evidence in support of our question.

The results have important implications for future research in the area of agency theory. As compensation strategies change across time periods, baseball players face different incentives in terms of their statistical production. Future work could use the measurable changes in the rewards structure to identify responses in players' performance as they approach free agency and after signing long-term contracts. The variation in reward structures will allow future research to separate general age or experience performance patterns that are consistent across time with responses to era-specific changes in incentives.

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Table 1
Means for each free agent cohort in year before free agency

	1980's Cohort	1990's Cohort	2000's Cohort
Salary following free agency	$ 922,675	$ 2,438,075	$ 3,185,636
Percent receiving multi-year deals	67.0%	43.9%	25.5%
OPS	0.686	0.764	0.741
OBP	0.321	0.341	0.331
SLG	0.366	0.423	0.410
Plate Appearances	359.3	398.8	393.1
R's per 502 ABs	53.8	62.2	57.6
H's per 502 ABs	112.7	120.5	115.5
2B's per 502 ABs	19.1	24.4	23.7
3B's per 502 ABs	2.1	2.0	1.8
HR's per 502 ABs	9.0	13.2	13.1
RBI's per 502 ABs	49.9	60.3	57.0
SB per 502 ABs	9.9	7.6	5.7
BB's per 502	44.4	45.9	45.1
Unintentional BB's per 502 ABs	40.1	42.9	41.8
SO's per 502 ABs	75.2	80.1	87.0
Premium Position	43.3%	48.1%	51.2%
Percent of Games in AL	57.0%	49.2%	50.1%
Age	31.6	32.9	32.8
Age Squared	1005.9	1091.9	1085.9
1988/1998/2008	34.6%	40.3%	27.3%
1989/1999/2009	32.7%	24.0%	37.6%
1990/2000/2010	32.7%	35.7%	35.1%
Number of Players	104	154	205

Notes: 1980s cohort is made up of free agents following the 1988, 1989, and 1990 seasons. 1990s cohort is made up of free agents following the 1998, 1999, and 2000 seasons. 2000s cohort is made up of free agents following the 2008, 2009, and 2010 seasons.

Table 2
Regression of log player salary on aggregate statistics

Variables	1 1988-90	2 1998-2000	3 2008-2010	4 1988-90	5 1998-2000	6 2008-2010
PA	0.004*** [0.000]	0.003*** [0.000]	0.003*** [0.000]	0.004*** [0.000]	0.003*** [0.000]	0.003*** [0.000]
OPS	1.115*** [0.370]	3.726*** [0.547]	3.163*** [0.606]			
OBP				1.087 [1.334]	0.651 [1.419]	3.726** [1.580]
SLG				1.131 [0.923]	4.842*** [0.637]	2.945*** [0.717]
Premium Position	-0.146 [0.105]	0.082 [0.111]	0.190* [0.108]	-0.145 [0.114]	0.066 [0.110]	0.188* [0.108]
AL games (ratio)	-0.402*** [0.107]	0.04 [0.098]	0.075 [0.092]	-0.402*** [0.109]	0.036 [0.097]	0.078 [0.092]
Age	0.835*** [0.274]	-0.137 [0.276]	-0.179 [0.178]	0.835*** [0.276]	-0.196 [0.276]	-0.172 [0.177]
Age Squared	-0.012*** [0.004]	0.001 [0.004]	0.002 [0.003]	-0.012*** [0.004]	0.002 [0.004]	0.002 [0.003]
Constant	-2.245 [4.514]	13.053*** [4.728]	14.190*** [2.909]	-2.239 [4.538]	14.479*** [4.789]	13.982*** [2.893]
Observations	104	154	205	104	154	205
R-squared	0.749	0.692	0.565	0.749	0.702	0.565

Notes: Robust standard errors in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3
Regression of log player salary on counting statistics

Variables	1 1988-90	2 1998-2000	3 2008-2010
PA	0.003*** [0.000]	0.003*** [0.000]	0.003*** [0.000]
R's per 502 PAs	0.003 [0.004]	0.005 [0.004]	0.009** [0.005]
H's per 502 PAs	0.005*** [0.002]	0.007* [0.004]	0.008* [0.005]
2B's per 502 PAs	-0.005 [0.006]	0.020*** [0.006]	0.013 [0.008]
3B's per 502 PAs	-0.019 [0.016]	0.018 [0.021]	0.023 [0.022]
HR's per 502 PAs	0.003 [0.007]	0.020* [0.010]	0.018* [0.009]
RBI's per 502 PAs	0.012*** [0.004]	0.006 [0.004]	-0.002 [0.004]
SB's per 502 PAs	0.006 [0.005]	0.005 [0.007]	-0.007 [0.007]
UBB's per 502 PAs	0.004 [0.003]	0.005 [0.003]	0.009** [0.003]
SO's per 502 PAs	-0.002 [0.002]	0.000 [0.002]	-0.001 [0.002]
Premium position	0.000 [0.138]	0.089 [0.115]	0.166 [0.114]
AL games (ratio)	-0.469*** [0.117]	0.020 [0.100]	0.055 [0.090]
Age	1.029*** [0.341]	-0.155 [0.297]	-0.268 [0.206]
Age Squared	-0.016*** [0.005]	0.002 [0.004]	0.004 [0.003]
Constant	-5.678 [5.561]	13.483** [5.179]	15.818*** [3.349]
Observations	104	154	205
R-squared	0.783	0.712	0.579

Notes: Robust standard errors in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 4

Regression of log player salary on aggregate and counting statistics, 2002 through 2007

	1	2	3
Variables	2002-07	2002-07	2002-07
OPS	2.449***		
	[0.467]		
OBP		-0.238	
		[1.145]	
SLG		3.840***	
		[0.546]	
R's per 502 PAs			0.005
			[0.003]
H's per 502 PAs			0.003
			[0.003]
2B's per 502 PAs			0.004
			[0.004]
3B's per 502 PAs			0.015
			[0.016]
HR's per 502 PAs			0.025***
			[0.007]
RBI's per 502 PAs			0.005
			[0.003]
SB's per 502 PAs			0.004
			[0.004]
UBB's per 502 PAs			0.004**
			[0.002]
SO's per 502 PAs			-0.004***
			[0.001]
Observations	380	380	380
R-squared	0.67	0.678	0.696

Notes: Robust standard errors in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%. The results for other variables were suppressed for space. PA, Premium Positions, AL game ratio, Age and Age-squared, and year dummies were included in all specifications.

Appendix Table 1

Regression of log player salary on aggregate statistics with batting average

	1	2	3	4	5	6
VARIABLES	1988-90	1998-2000	2008-2010	1988-90	1998-2000	2008-2010
PA	0.004***	0.003***	0.003***	0.004***	0.003***	0.003***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Batting Average	2.340**	6.491***	6.265***	2.320**	5.348***	6.514***
	[0.959]	[1.617]	[1.878]	[1.015]	[1.646]	[1.990]
Isolated OPS	1.038	4.203***	3.188***			
	[0.705]	[0.645]	[0.694]			
Isolated OBP				0.914	0.848	3.886**
				[1.645]	[1.800]	[1.760]
Isolated SLG				1.091	4.909***	2.997***
				[0.997]	[0.670]	[0.761]
Premium Position	-0.148	0.092	0.192*	-0.146	0.069	0.195*
	[0.108]	[0.111]	[0.114]	[0.115]	[0.112]	[0.115]
AL games (ratio)	-0.402***	0.053	0.075	-0.402***	0.038	0.077
	[0.108]	[0.098]	[0.092]	[0.110]	[0.098]	[0.092]
Age	0.829***	-0.136	-0.178	0.829***	-0.194	-0.168
	[0.288]	[0.280]	[0.182]	[0.288]	[0.278]	[0.182]
Age Squared	-0.012***	0.001	0.002	-0.012***	0.002	0.002
	[0.004]	[0.004]	[0.003]	[0.004]	[0.004]	[0.003]
Constant	-2.155	13.166***	14.182***	-2.15	14.458***	13.929***
	[4.706]	[4.786]	[2.941]	[4.717]	[4.818]	[2.951]
Observations	104	154	205	104	154	205
R-squared	0.749	0.694	0.565	0.749	0.702	0.565

Robust standard errors in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.
"Isolated OPS" equals OPS minus two times the player's batting average, "isolated OBP" equals the OBP minus batting average, and "isolated SLG" equals the SLG minus batting average.

Appendix Table 2

Regressions of log player salary using percent deviation from annual league-wide average

Variables	1 1988-90	2 1998-2000	3 2008-2010
Specification 1			
OPS	0.008*** [0.003]	0.028*** [0.004]	0.024*** [0.004]
Specification 2			
OBP	0.003 [0.004]	0.001 [0.005]	0.013** [0.005]
SLG	0.004 [0.003]	0.021*** [0.003]	0.012*** [0.003]
Specification 3			
R's per 502 PAs	0.001 [0.002]	0.003 [0.003]	0.006** [0.003]
H's per 502 PAs	0.005*** [0.002]	0.009* [0.005]	0.009* [0.005]
2B's per 502 PAs	-0.001 [0.001]	0.004*** [0.002]	0.003* [0.002]
3B's per 502 PAs	-0.001 [0.000]	0.000 [0.001]	0.001 [0.001]
HR's per 502 PAs	0.000 [0.001]	0.003* [0.001]	0.002** [0.001]
RBI's per 502 PAs	0.006*** [0.002]	0.004 [0.003]	-0.001 [0.002]
SB's per 502 PAs	0.001 [0.001]	0.000 [0.001]	-0.001 [0.001]
UBB's per 502 PAs	0.001 [0.001]	0.002 [0.001]	0.004*** [0.001]
SO's per 502 PAs	-0.001 [0.002]	0.000 [0.002]	-0.002 [0.002]
Observations	104	154	205

Notes: Robust standard errors in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%. All variable measured as percentage deviation from MLB average in each year. The results for other variables were suppressed for space. PA, Premium Positions, AL game ratio, Age and Age-squared, and year dummies were included in all specifications.