THE INTERPLAY OF MLB PAYROLL AND PERFORMANCE

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This study examines how payroll investments, attendance, and market size impact MLB team performance and financial success. Regression analysis shows that previous year payroll, payroll, and attendance significantly influence winning percentage and revenue, highlighting the importance of strategic financial planning and fan engagement. These findings offer guidance for team owners in order to enhance team success.

Baseball Payroll and Performance Review

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Each season in professional sports a captivating display of talent unfolds, drawing fans into a world where the pursuit of victory on the field or court intersects with financial exploits off the playing field, forming dynamic and intricate relationships between the two. Central to this pastime is the investment in player salaries, also known as team payroll. The allocation of financial resources to player compensation not only influences the competitive landscape but is also an important component of a franchise's financial strategy. This paper aims to understand how does payroll investments, attendance, and market size influence MLB teams' on-field performance and financial success. More specifically we examine the effects of the payroll on multiple variables such as revenue and winning percentages. The importance of this question for team owners and executives lies in the understanding that payroll decisions directly impact both performance and financial health, essential for strategic decision-making and budget allocation. For fans and analysts, insights into these dynamics offer a deeper understanding of the factors influencing a team's success and longevity. Additionally, as sports leagues evolve with salary caps and financial regulations, analyzing how payroll influences performance and financial outcomes remains crucial.

Literature Review - Overall effects on team performance:

Throughout the decades the MLB's average payroll per team has seen a significant increase from about 24 million in the 1980s to 66 million in the 2000s (Jane,2010). Jane, 2010 focused on salary dispersion and total MLB salary payment to investigate the causal relationship between salary and team performance in Major League Baseball. This study used data from *USA Today Salaries Databases* and the official MLB website. The findings revealed unidirectional causality only salary disparity affects team performance and not the other way around. A bidirectional causality existed between payroll and team performance. These findings are consistent with tournament theory and equity theory, emphasizing the effect of salary or payroll on team performance. An interesting detail to note is the fact that although the models indicate a bidirectional causality, strategies like the Yankees' salary-raise policy may not consistently produce predictable results. However, this

unpredictability keeps professional baseball interesting, as consistent purchasing of wins would diminish the sport's appeal. However, in more recent years the correlation between winning and a team's payroll seems to have gone down. Eastman (2014) used data from 2006 to 2013 for 30 teams, payroll emerged as a significant variable impacting winning percentage, with strong effects not only revenue, but also with home and total attendance. Surprisingly and contradicting the models from the previous decades, winning percentage exhibited only weak correlations with revenue and payroll, with slightly stronger correlations with home and total attendance. The data that did have a stronger correlation was the previous year's payroll and winning percentage, which correlated just as strongly or more strongly with revenue as the current year's payroll and winning percentage.

Moving on to the NBA, Van Sluytman, (2016) finds a statistically significant correlation between team payroll and performance. Team's win-loss percentage increases by 7.7 percentage points for every standard deviation of payroll investment. Study also doesn't find statistically significant correlation between the 2011–12 collective bargaining agreement change and a team's ability to "buy wins". The collective bargaining agreement affects the amount of tax paid by teams after breaking the luxury tax. It shifted from a flat tax to a progressive tax. However, because it is now less advantageous to surpass the luxury tax threshold, this shift in CBAs results in fewer outlier teams aka teams willing to surpass the regulations set in place. Something interesting to note is that in order to account for the possible detrimental effects of multiple high-paid players on team chemistry and ball movement, the study also recommended adding a quadratic term to the payroll-team performance relationship although they did not do so in said study.

Shiorin (2017) looks at the relationship between team payroll and regular season performance in the NFL in order to investigate whether the same effect discovered above is active in the NFL. It illustrates this association by demonstrating that clubs with larger spending tend to have higher winning percentages throughout the regular season. Using Ordinary Least Squares (OLS) regression, the study finds statistically significant coefficients for the payroll z-score variable, showing that better winning percentages in all leagues are correlated with higher spending. An increase of one standard deviation in payroll, for example, is associated with roughly 0.4 extra victories in the NFL season.

Tallinn (2018) conducts basic regression analysis using lagged wins and payrolls as variables, the study investigates the link between NFL club payroll and performance. Z-scores,

which indicate the departure from the mean and have positive values denoting amounts above and negative values below the mean, are used to normalize the payroll data for each league. The dataset which covered 20 years in the NFL, the results show a strong relationship between victories and salary. A one standard deviation increase in salary is roughly equivalent to a gain of 0.5 wins over the season. This is a noteworthy discovery considering how closely league rankings are contested.

These findings highlight the relationship between payroll investment and team success across Major League Baseball, the NFL, and the NBA, revealing both league-specific trends and broader insights for management strategies. While higher payroll generally correlates with improved performance, the impact varies by league and is influenced by factors such as salary distribution and position-specific investments. Recent research suggests a weakening link between payroll and winning percentages, indicating that success may depend more on strategic allocation than sheer spending alone. This evolution invites further analysis, especially as payroll strategies and league regulations continue to change.

Impact of specific payroll allocation to positions on performance

Payroll distribution to individual positions is a critical component of sports management, especially in baseball, where the division of resources between hitting and pitching positions has long been a source of contention and strategic analysis. A number of studies investigate the effects of payroll distribution on hitting and pitching positions in baseball teams' performance. This section explores the implications, and possible benefits of assigning payroll resources to these crucial aspects of the game by examining a number of studies and analyses.

Lu, etal (2018), for example, shows that an increase in pitcher payroll of $1 million is associated with an average increase in team winning % of 1.01 percentage points, while the same model implies an improvement of 0.79 percentage points per $1 million increase in hitter payroll Additionally, calculations determine the inflection points, and the best investment point for pitcher payroll is roughly $47.13 million, while the inflection point for hitter payroll is roughly $45.79 million. Its simplicity in player categorization and potential limitations in capturing the true nature of the payroll-performance relationship are notable weaknesses. This study also found a nonlinear

effect of payroll increase. Initially, an increase in team payrolls corresponds to improved performance, mirroring the trend observed in previous analyses. However, once surpassing a certain threshold, further increases in team payrolls start showing a diminishing effect on winning percentage. This u-shaped relationship persists across both pitcher and hitter payrolls.

Killins, (2017) using data from Baseball Reference found that all positional locations have positive coefficients in relation to winning percentage. This suggests that increasing payroll for any of these positions positively correlates with increased team success, as measured by each team's winning percentage. The catching position has the highest coefficient, implying that teams that allocate more payroll to this position may achieve more efficient spending, leading to improved team performance. A 1% increase in catching payroll allocation corresponds to higher winning percentage, more runs scored, and fewer runs allowed. However, the study suggests that outfielders are overpaid, as increased payroll allocation to outfielders has no significant impact on a team's winning percentage (Killins, R. 2017).

Spending more money on pitching staff correlates with better performance, but not as strongly as expected, according to Roebber (2021). A significant increase in spending may only marginally improve a team's chances of winning. What most teams seem to do is focus a significant amount of payroll on a star player in either an offensive or defensive position. However Roebber, (2021) suggests that focusing on a single superstar pitcher may not be the best strategy. Spreading the money among multiple, less expensive pitchers may increase the likelihood of at least one of them performing well. Despite this notion, the reality in MLB is quite different. As MLB teams' budgets increase, they tend to focus their spending on a few star pitchers rather than diversifying their pitching staff.

NBA managers usually direct a large amount of their team's payroll toward a small group of star players, usually those who perform exceptionally well in their roles. The idea that these players will dramatically improve their team's chances of making the playoffs and winning championships is frequently the justification for this large amount of spending. But given their success on the court, how often do these highly paid athletes really provide positive returns on investment? In order to investigate this question, Williams, (2019) looked at the playoff experiences and championship victories of the five highest-paid players in each position: centers, shooting guards, small forwards, power forwards, and point guards. The results, which covered the years 1999–2000 to 2008–09 and

2009–10 to 2018–19, show a significant positive relationship between player pay and team performance. At first, from 1999–2000 to 2008–09, small forwards and centers were the most deserving of large payroll since they had a lot of playoff experience and championship victories. But as the NBA changed, with a focus on three-point shooting and a more diffused approach to gameplay, it began to emphasize power forwards, point guards, and small forwards as the key players to success. Indicating that those positions are more likely to make it to the playoffs and win championships in the modern NBA.

The findings of Williams (2018) indicate that franchise owners who want to win championships nowadays would be better off making investments into small forwards, power forwards, and point guards rather than shooting guards and centers, who win championships less frequently. Moreover, a review done within the study of player payroll total across positions over the previous 20 years revealed a significant change in general managers' valuation, with a shift towards prioritizing investments in the previously mentioned positions a clear correlation with the patterns of playoff and championship success that have been observed.

Zimmer (2016) investigates how the NFL pay cap concentration affects club performance. Teams who spend as much as possible above the maximum salary ceiling often have a better chance of winning; teams that spend less than this amount, have less opportunities to succeed this season. Furthermore, it has been demonstrated that the concentration of incomes within a team is a non-linear factor affecting team performance. Salary concentration is measured by the Herfindahl-Hirschman Index (HHI), which shows varying effects on various performance indicators. Although it initially has a negative impact on winning percentage and margin of victory, it improves the team's offensive ranking. But once you go over a certain point, more focus improves team performance. Team performance is positively impacted by demographic parameters like population size, which suggests that larger markets are better able to draw in better players. On the other hand, in every model, position-specific factors like the ratio of quarterbacks to running backs had no discernible effect on the performance of the team. These results highlight the intricate relationship that exists in the NFL between talent salary, financial investment, and club success. They also imply that performance depends on striking a careful balance between strategic spending on positions of importance such as the quarterback and salary concentration.

Impact of team payroll on financial operations:

The allocation of team payroll within Major League Baseball (MLB) significantly shapes not only individual and team performance but it also has an effect on a team's financial performance as well. Eastman (2014), observes the complex relationship between payroll investment, market size, and their effects on franchise revenues. Using Forbes' MLB financial data of team performance history, market size estimates, attendance numbers, stadium information, and inflation figures, the author put all the information into a data set that ranges from 2006 to 2013. The findings suggest that there is a positive relationship between team payroll and franchise valuation. The strengths and weaknesses of the article are evident in its empirical approach, reliance on statistical analysis, and the inclusion of various independent variables. However, it does have the weakness of using estimates given by its data source (Forbes), potentially omitting more complex variables, as well as only providing data for a rather short period from 2006 to 2012. The results of both payroll from the studies current year and payroll from the previous year were highly statistically significant in all three tests of all three regression models, indicating that payroll appears to be highly predictive of a team's revenue (Eastman, 2014).

Nelson (2015) finds a complex relationship between a team's payroll and its revenue, profitability, and performance. While higher player salaries are associated with increased team revenue, this relationship is not a true one-to-one positive relationship. The estimate on player salaries suggests that team revenues increase by a smaller proportion than the increase in player salaries. This points to a decrease in a profit margin, indicating that spending more on player salaries might not lead to a proportional increase in profits. It is important to note that player salaries still show a positive and statistically significant relationship with team revenue and performance, even if the impact is somewhat minor. For every dollar increase in salaries, team revenue increases by 15.3 cents and gross profit margin decreases by .9 percent. With this, increases in player salaries appear to be greater than the marginal revenue product associated with said pay increase. However, there is no statistical significance in their fixed-effects models for the relationship between team operating income and player salaries, as well as the relationship between team operating profit margin and player salaries. Therefore, the role of player salaries in affecting team profit is negligible once other team expenses are taken into account.

However, this model does not definitively show causation but only correlation like mentioned above. While the models account for some of the fixed variables, I believe not all of them have been analyzed. The data sources used in these studies include Forbes Valuations for team revenues and operating income, MLB Salary Database for team payrolls, and baseball-reference.com for winning percentages. The usage of reputable and comprehensive data sources mentioned above adds credibility to the study. To go into more specifics, these studies do not consider the impact of a team's specific management, front office, coaching strategies, and player development on performance and financial sustainability. While these studies provide valuable insights into the relationship between team payroll and performance, they also have limitations in fully capturing the complex dynamics of team success and therefore cannot establish a causation.

The assessment of financial success is of utmost significance in the context of this research question. In order to further our research into our hypothesis it is important to not only look at the MLB but also take a look at other professional sports. Professional sports are a multi-billion-dollar industry, and MLB teams' management and decision-making are heavily influenced by financial considerations. For an in-depth analysis of these other sports franchises' financial health, financial indicators like annual revenues, and operating income Shiorin (2017). The analysis concentrates on operational income, a term that takes both revenues and costs into account, in order to better understand the financial dynamics of MLB and other sports leagues. This study (Shorin,2017) shows a comparison of operational income and team payroll z-scores for the years 1995 to 2015. More specifically it found that while higher team payrolls as often correlated with increased operational income, the strength of this relationship varied over the 1995-2015 period. Teams with payroll z-scores significantly above the league average generally saw higher operational income, indicating a positive return on player investments.

Hunter (2009) which examines the relationship between a team's operating income, which serves as a proxy for financial performance, and the overall cost of player compensation. According to the null hypothesis, player compensation costs and team financial success are positively correlated. Operating income is the dependent variable and player wage cost is the independent variable in the regression study. In addition, operating income, operating income as a percentage of player salary cost, and total player salary cost across NBA franchises from 1998 to 2007 are analyzed to look for trends and patterns. The findings show that operating income and player pay cost were

negatively correlated for the majority of the tested years, with statistical significance equal to .05 noted in both the combined model of all 10 years and the six individual years. This suggests that excessive payroll may not always result in returns that are favorable for a franchise. Despite the fact that this study is limited to NBA data, its implications demand more research into comparable correlations in other sports leagues.

Data and Methodology:

The data for this research was collected from three sources, spanning all 30 Major League Baseball teams over 20 seasons. Revenue data recorded in millions of dollars was obtained from Statista, attendance figures were sourced from Baseball Reference, team payroll, previous year payroll, and team winning percentages were obtained from The Baseball Cube. The market size was calculated using population data from census.gov. This dataset provides a comprehensive view of the financial and performance related aspects of professional baseball teams. The primary variables included are revenue in millions of dollars, which is the dependent variable of this study representing the total earnings of each team in a given year; team payroll, which captures the total payroll expenses for a team's players during the season; win percentage, representing the proportion of games won by a team in a season as a measure of on-field performance; attendance, indicating the total number of fans who attended games throughout the season; market size, a categorical variable that captures the size of the market the team operates in using the average population as a separating factor ; and last year's payroll, reflecting the payroll for the same team in the previous season. To explore the determinants of team revenue and winning percentage, multiple linear regressions analysis were conducted using Microsoft Excel. The dependent variables in the analysis were revenue and winning percentage, while the independent variables were team payroll, win percentage, attendance, market size, and last year's payroll. The regression aimed to identify the strength and direction of relationships between revenue and these variables.

The first regression model is represented as:

1).Revenue=$\beta 0+\beta 1$(Team Payroll)+$\beta 2$(Win Percentage)+$\beta 3$(Attendance)+$\beta 4$(Market Size) +$\beta 5$(Last Year Payroll)+ϵ

- $\beta 0$: The intercept, indicating the base revenue when all independent variables are zero.

- β1: Indicates the change in revenue with a one unit increase in team payroll, holding all other variables constant.
- β2: Indicates the change in revenue for a one unit increase in win percentage, assuming all other variables remain constant.
- β3: Indicates the change in revenue from a one unit increase in attendance, assuming all other variables remain constant.
- β4: Indicates the change in revenue associated with being in a larger market.
- β5: Indicates the change in revenue from a one unit increase in the previous year's payroll on current-year revenue, assuming all other variables are constant.
- ϵ: accounting for variability not explained by the model.

A second regression was also run with Win% as the dependent variable:

2).Win%=β0+β1(Team Payroll)+β2(Revenue)+β3(Attendance)+β4(Market Size)+β5(Last Year Payroll)+ϵ

- β0: The intercept, indicating the base revenue when all independent variables are zero.
- β1: Indicates the change in revenue with a one unit increase in team payroll, holding all other variables constant.
- β2: Indicates the change in revenue for a one unit increase in win percentage, assuming all other variables remain constant.
- β3: Indicates the change in revenue from a one unit increase in attendance, assuming all other variables remain constant.
- β4: Indicates the change in revenue associated with being in a larger market.
- β5: Indicates the change in revenue from a one unit increase in the previous year's payroll on current-year revenue, assuming all other variables are constant.
- ϵ: accounting for variability not explained by the model.

Table 1. Summary Statistics

Variable	Mean	Median	Standard Deviation	Minimum	Maximum	Observations
Revenue (Mil $)	253.0	236.0	99.8	102.0	683.0	564.0
Team payroll	108297726.3	96693568.0	49825502.3	14998500.0	334233332.0	564.0
Win%	0.5	0.5	0.1	0.3	0.7	564.0
Last year payroll	113015843.1	100047226.0	51899980.7	14998500.0	334233332.0	564.0
Attendance	2395918.5	2352009.0	707765.2	642617.0	4298655.0	564.0
Market Size	0.6	1.0	0.5	0.0	1.0	564.0

Table 1 above presents the summary statistics for the key variables used in the regression analysis. In total there were 564 observations for each variable. These statistics provide an overview of the dataset's variability. Revenue, the dependent variable in this study, has an average of approximately $253 million, with a median value of $236 million. The standard deviation of $99.8 million indicates the variation across teams and seasons, with a minimum of $102 million and a maximum of $683 million. Team payroll, an independent variable has a mean of $108.3 million and a median of $96.7 million, with a standard deviation of $49.8 million. The range spans from a low of $14.99 million to a high of $334.2 million, showcasing significant disparities in financial investment across teams. Win percentage, a measure of on-field performance, has an average of 0.50, consistent with the expected balance in competitive sports, and a standard deviation of 0.074. The range extends from a minimum of 0.29 to a maximum of 0.685. Last year's payroll, another key financial variable, is similar to the current payroll statistics closely, with a mean of $113 million and a median of $100 million, and a similarly large standard deviation of $51.9 million. The range also extends from $14.99 million to $334.2 million. Attendance averages 2.4 million attendees per season, with a median of 2.35 million. The standard deviation is approximately 707,000, and attendance values range from 642,617 to 4.29 million. Market size has a mean of .6 indicating 60 % of the teams throughout the data are in large markets. These summary statistics provide a foundational understanding of the data and its variation, forming the basis for subsequent regression analysis to explore the determinants of team revenue.

Findings

Table 2. Revenue Regression

Variable	Coefficient	Std. Error	t-Stat	P-value	Lower 95%	Upper 95%
Intercept	99.56	16.61	5.99	0	66.93	132.18
Payroll (thousands $)	0.001***	0.0001	9.56	0	0.0008	0.0012
Win %	9.61	37.38	0.26	0.797	-63.81	83.03
Previous Year Payroll (thousands $)	0.0008***	0.0001	7.47	0	0.0006	0.001
Attendance(thousands)	-0.022***	0.0041	-5.39	0	-0.03	-0.014
Market Size	0.71	5.27	0.13	0.893	-9.65	11.07

******* = Statistically significant

The regression analysis performed above in Table 2 sheds light on the factors that influence MLB team revenues. The intercept of 99.56 represents the baseline when all other variables are set to zero. The coefficient for team payroll is.001, which means that for every additional thousand dollars spent on payroll, team revenue rises by about $1000. The coefficient for win percentage is 9.61, indicating that every 1% increase in win rate results in an additional $9.61 million in revenue. While not statistically significant, this demonstrates the significant benefits of on-field success, as winning teams tend to attract more fans, sponsorships, and media deals. The attendance coefficient is -.022, implying that an increase of 1000 would result in a decrease of 22,000$, indicating that increased attendance does not always contribute positively to revenue. The coefficient for attendance is statistically significant. This could indicate declining marginal returns from attendance or that attendance is correlated with other variables, such as ticket pricing or market conditions, affecting overall revenue. The coefficient for market size is 0.71, emphasizing the revenue benefits of operating in larger markets. Teams in larger markets can benefit from larger fan bases and higher sponsorship values, emphasizing the significance of market conditions in determining financial outcomes. However, this result was not statistically significant. Finally, the coefficient for previous year payroll is.008, indicating that a $1000 increase would result in an approximate revenue increase of $8,000. This variable showed statistical significance. This suggests that consistent investment in team payroll can result in long-term financial benefits.

According to these findings, only payroll, attendance, and previous year payroll were statistically significant, indicating that teams with higher payrolls generate more revenue, most likely due to improved performance and marketable players.

Table 3. Winning Percentage Regression

Variable	Coefficient	Std. Error	t-Stat	P-value	Lower 95%	Upper 95%
Intercept(M)	0.383	0.0107	35.9015	0	0.362	0.4039
Revenue(M)	12.3257	47.9384	0.2571	0.7972	-82	106
Payroll(M)	-0.0006***	0.0001	-4.7422	0	-0.0009	-0.0004
Last Year Payroll(M)	0.0009***	0.0001	7.4382	0	0.0007	0.0011
Attendance(M)	0.0345***	0.0046	7.5729	0	0.0256	0.0435
Market Size	-0.0067	0.006	-1.12	0.2632	-0.0184	0.005

******* = Statistically significant

The regression analysis performed above in Table 3 provides insight into the factors that influence winning percentage as the dependent variable. The intercept of 0.382974 represents the base winning percentage when all other independent variables are set to zero. The revenue coefficient, 12.3257, indicates that every $1 million increase in revenue raises the winning percentage by 12.3257 percentage points. However, the relationship is not statistically significant. Payroll has a coefficient of -0.0006, which means that for every $1 million increase in payroll, the winning percentage drops by 0.0006 points. This is statistically significant, implying that higher payroll does not always result in better performance on the field and may reflect diminishing returns. However, the coefficient for last year payroll, 0.0009, indicates that for every $1 million increase in payroll over the previous year, the winning percentage rises by 0.0009 points. This positive and statistically significant relationship emphasizes the importance of sustained investment. Attendance has a strong positive correlation, with a coefficient of.0345, implying that every 1 million more attendees results in a.0345 point increase in winning percentage. This relationship is statistically significant, demonstrating the importance of fan support. Finally, market size has a coefficient of -0.006680, indicating a slight negative correlation between larger markets and winning percentage. However, the effect is not statistically significant. This analysis reveals that payroll, last year's payroll, and attendance all have a significant impact on a team's winning percentage, with prior investments and fan support being positively associated with success.

Conclusion

Finally, the analysis performed in this study highlighted the importance of multiple variables, such as previous year payroll, payroll, and attendance, in determining a team's on-field and financial performance. Using these findings, teams should allocate resources to specific sections in order to maximize performance and revenue. Teams should also proceed with caution when increasing their payrolls, as the negative relationship between payroll and success indicates that simply spending more is not always effective. Instead, focusing on value-driven player acquisitions and contracts could lead to better outcomes and sustained spending over the course of multiple seasons. This could be further research for a future paper. Furthermore, increasing fan engagement and attendance is important for improving team performance because it is strongly related to winning percentage. Using this information, team owners should invest in strategies to attract new fans. While revenue and market size were not found to be significant predictors of winning percentages in this study, they may influence other aspects of a team's success and should be considered in larger decisions.

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