

## The factors affecting team performance in the NFL: does off-field conduct matter?

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### *Abstract*

This paper contains a statistical analysis of the factors that contribute to team wins in the NFL. The variables examined are divided into offensive, defensive, and special teams categories. In addition, net turnovers, penalties, and off-field conduct, as measured by team arrests, are also included as independent variables. The results show that the quarterback rating has the largest impact on team wins followed by field goal percentage, opponent's passing yards per game, and opponent's rushing yards per game. Team arrests were not found to have a statistically significant impact on team performance.

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## 1. Introduction

The Major League baseball spending philosophy based on Sabermetrics was initially espoused by Billy Bean, the general manager of the Oakland Athletics, in the book *Moneyball: The Art of Winning an Unfair Game*. That philosophy says statistical analysis of the factors that affect winning in Major League Baseball is the foundation for practical spending. Theo Epstein, the general manager of the Boston Red Sox, is a proponent of this method of determining appropriate spending patterns. The implications of this analysis are obvious. The Oakland A's have remained a competitive baseball team in spite of a very low team payroll. The Red Sox have used this technique to lay the foundation for a team that has won two out of the last four World Series championships. Surprisingly there is a dearth of this type of analysis in published literature for the NFL. This article attempts to model the on-field and off-field factors that affect winning in the NFL. A model like this could initiate a statistical analysis and resulting spending philosophy in the NFL that has become popular in Major League Baseball.

The on-field factors that determine team wins in the NFL can be generally categorized as variables measuring the performance of the team's offense, defense, and special teams; penalties per game; and net turnovers. One other factor that might influence team wins in the NFL is the players' off-field conduct. The arrest records of several NFL players are recently front-page news. Some teams assiduously avoid drafting or signing players with a history of criminal behavior. The 2008 Dallas Cowboys, on the other hand, seem determined to collect as many miscreants as possible. During 2008, they signed Tank Johnson and Pacman Jones, both of whom had been arrested multiple times prior to signing with the Cowboys. Similarly, during their glory days, the Oakland Raiders were well known for their collection of players with less than stellar off-field personal conduct.

What are the factors that are correlated with team wins in the NFL? Are there some positions that are particularly important in assembling a winning team? Does off-field conduct that leads to arrests influence a team's on-field wins? This paper explores these questions.

## 2. Literature Review

There is surprisingly little scholarly research examining the determinants of winning percentages of National Football League teams. In a *Wall Street Journal* article, Barra (1999) examines data for all NFL games from 1960 through 1998 and finds that yards per pass is the statistic that is most highly correlated with winning. In another *WSJ* article, St. John (2004) argues (without statistical analysis) for a "Give-N-Take differential" —interception differential plus "adjusted fumbles"—as a key determinant of the likelihood of winning. Haugen (2006) developed a model to try to show which position most influences wins. Given the NFL salary cap, efficient spending is essential for a winning team. He found salary dollars spent on kickers and tight ends most influenced a team's win total.

## 3. Data

This model uses regular season data for 15 variables covering all 32 teams in the National Football League from the years 2003 – 2007. The number of wins, quarterback rating, games

played by the number one quarterback on the depth chart, sacks allowed, rushing yards per game, receiving yards per game, sacks, opponent's passing yards per game, opponent's rushing yards per game, percentage of punts inside of the twenty yard line, field goal percentage, average kickoff return yards, and penalties were all found at the National Football League's official website. Net turnovers were found on ESPN's official website. The number of arrests per team was found at the San Diego Union Tribune's official website.

#### **4. Model and Expected Results**

This paper regresses wins in the NFL on several team performance variables including arrests. The dependent variable is the number of wins in a single regular season. The independent variables can be loosely grouped as variables indicating the performance of the team's offense, defense, special teams, penalties, and arrests. The variables included in the model which are indicative of offensive performance are: (1) the quarterback rating of the number one quarterback on the depth chart at the end of the season (QBR); (2) games played by the number one quarterback on the depth chart (GPQB); (3) sacks allowed per season (SA); (4) rushing yards per game (RYG); and (5) receiving yards per game (RCYG). The variables related to the team's defensive performance are: (1) sacks per season (SAC); (2) opponents passing yards per game (OPYG); (3) opponents rushing yards per game (ORYG). The variables which measure the team's special team performance are: (1) the percentage of punts inside the opponent's 20 yard line (PIT); (2) field goal percentage (FGP); (3) average yards per kickoff return (YKR). Other variables measure the net turnovers (NT), on-field malfeasance as measured by the number of team penalties per season (PEN), and off-field conduct as measured by the number of arrests per team (ARR). The following is a brief explanation of each of the independent variables and their expected signs.

##### **4.1. Offensive Performance Variables**

1) Quarterback rating (QBR): The quarterback rating is an official NFL statistic which incorporates a quarterback's attempts, completions, passing yards, touchdowns, and interceptions. This variable is the quarterback rating of the quarterback listed first on the depth chart at the end of the season. As the quarterback rating increases, so should the team's wins. Therefore the anticipated sign of this variable is positive.

2) Games played by the number one quarterback on the depth chart (GPQB): Injuries are commonplace in the NFL. This variable represents games played by the quarterback who is first on the depth chart at the end of the season. This variable is designed to capture the impact of any injuries which cause the best quarterback to miss games during the season. The expected sign on this variable is positive. As games played by the best quarterback increase, so should team wins.

3) Sacks allowed (SA): This variable is the number of sacks allowed by the team's offensive line. The hypothesized sign on this variable is negative. As sacks allowed increase, wins should decrease

4) Rushing yards per game (RYG): This variable is the number of rushing yards per game by the team's offense. Team wins should increase as the offensive rushing yards per game

increase. Therefore the expected sign of this variable is positive.

5) Receiving yards per game (RCYG): This variable represents offensive receiving yards per game. It is expected to have a positive sign. As receiving yards by the team's offense increase so should wins.

#### **4.2. Defensive Performance Variables**

1) Sacks (SAC): This variable represents sacks of the opponent's quarterback by the defense. As the sacks of the opponents quarterback by the defense increase, so should wins. Therefore, the expected sign on this variable is positive.

2) Opponent's passing yards per game (OPYG): This variable is passing yards per game allowed by the team's defense. The anticipated sign of this variable is negative. As the opponents passing yards increase, team wins should decrease.

3) Opponent's rushing yards per game (ORYG): This variable is rushing yards per game allowed by a team's defense. The expected sign of this variable is negative. As the opponents rushing yards increase, team wins should decrease.

#### **4.3. Special Team Performance Variables**

1) The percentage of punts inside the twenty (PIT): This is the percentage of team punts that end up inside the opponent's twenty yard line. As the percentage of these punts increase, the opponent's offense must drive farther for a touchdown. As the percentage of punts inside the twenty increases, so should team wins. Therefore, the anticipated sign of this variable is positive.

2) Field goal percentage (FGP): This variable represents the percentage of field goal attempts which are successful. As this percentage increases, so should team wins. Therefore, the expected sign on this variable is positive.

3) Average yards per kickoff return (YKR): This variable represents average yards per kickoff return gained by the special teams. The anticipated sign of this variable is positive. As average yards per kickoff return increase, so should the team's field position. Therefore, wins should also rise.

#### **4.4. Other Variables**

Net turnovers per season (NT): This variable represents takeaways minus giveaways. The expected sign on this variable is positive. If the team takes the ball from its opponent more than it gives it away with interceptions and fumbles, wins should increase.

Penalties per game (PEN): This variable represents the number of penalties against a team per game. The expected sign on this variable is negative. Penalties result in loss of yardage and the cancellation of otherwise effective plays. Therefore, as team penalties per game

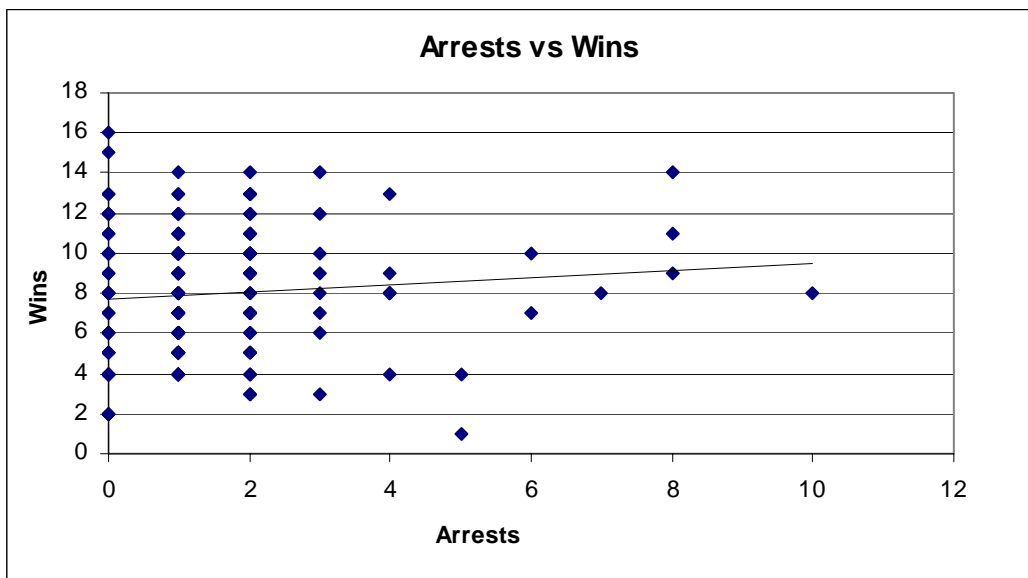
increase, team wins should decrease.

Arrests per team (ARR): This variable represents the arrests accumulated by the team members during the calendar year of the season. The expected sign of this variable is unknown. It is possible that arrests, a measure of off-field conduct, will negatively impact the performance of a team in the National Football League. A team with a large number of arrests may have a large number of players unable to participate in games due to suspensions and penalties from these arrests. It is also logical to assume that a team with a large number of arrests will have low team morale. Arrests bring negative media attention to teams and players, which could lead to poor team performance.

However, it is also possible that a team with more arrests may perform better than a team with fewer arrests. Arrests are associated with aggression. Players must be aggressive in order to perform well. A team that has a large number of arrests most likely has a large number of aggressive players and, therefore, may perform better than a team with fewer arrests.

The following scattergram illustrates the relationship between the number of arrests and wins for 2003 through 2007 for all 32 teams. Many of these observations overlap which makes the appearance of this scattergram somewhat deceiving. For example, there were seven teams over this five year period which had no team arrests and eight wins for the season. At first glance, there is no obvious correlation between the number of arrests and the number of wins. However, the fitted trend line for this data, which considers all observations including the coincidental ones, shows a slight positive correlation.

Figure 1



## 5. Preliminary Analysis

An examination of the correlation coefficients between the independent variables revealed that there was a high correlation between quarterback rating and receiving yards per

game. Therefore, in order to avoid multicollinearity, receiving yards per game was eliminated from the model.

Arrests were not found to be significantly correlated with the other independent variables. It seems logical that a team with a large number of players arrested would also have a large number of in-game penalties. However, the correlation coefficient between arrests per team and team penalties was found to be a very insignificant -.0901.

During the regular season in the National Football League, the maximum number of games that a team can win is sixteen. Therefore, it would seem logical to use a multiplicative functional form for this regression. However, a linear functional form was found to yield a higher R-squared. Therefore, the results of the linear functional form are reported below.

## 6. Regression Results

The estimated equation with the t-statistics in parenthesis is:

$$\begin{aligned} \text{WINS} = & .5703 + .0703 \text{ QBR} + .1329 \text{ GPQB} - .0411 \text{ SA} + .0212 \text{ RYG} + .0690 \text{ SAC} - \\ & (5.0809) \quad (2.5698) \quad (-3.1808) \quad (3.3276) \quad (3.5743) \\ & .0163 \text{ OPYG} - .0272 \text{ ORYG} + .0219 \text{ PIT} + .0504 \text{ FGP} - .0503 \text{ YKR} - .0042 \text{ PEN} - .1121 \text{ ARR} + \\ & (-2.9395) \quad (-3.6874) \quad (1.0878) \quad (2.9800) \quad (-.7036) \quad (-.6973) \quad (-1.5113) \\ & + .0927 \text{ NT} \\ & (5.7844) \end{aligned}$$

Adjusted R<sup>2</sup>: .7591

The Adjusted R<sup>2</sup> value indicates that 75.91% of the variation in WINS is explained by the variation in the independent variables.

### 6.1. Offensive Performance Variables

The estimated parameter of QBR is positive, as expected, and significant at the 99% confidence interval. This variable has the largest t-statistic in the model. This indicates, as expected, that a greater quarterback rating for the quarterback listed as number one on the depth chart at season's end leads to more wins.

The coefficient on GPQB is positive, as expected, and significant at the 95% level. This indicates that as the number of games played by the starting quarterback increases, the number of wins for that team increases.

The estimated parameter of SA is negative, as predicted, and significant at the 99% confidence level. This indicates that fewer sacks allowed by the team's offensive line is correlated with more wins.

The coefficient on the variable RYG is positive and significant at the 99% confidence

level. This variable has the second highest t-statistic among the independent variables. This indicates that the greater the number of rushing yards by the offense, the greater the number of wins.

## **6.2. Defensive Performance Variables**

The estimated parameter of SAC is positive and significant at the 99% confidence interval. This indicates, as expected, that a greater number of sacks by the team's defense leads to more wins.

OPYG is significant at the 99% level of confidence. The coefficient on the variable OPYG is negative, as expected. This means that an increase in the number of receiving yards of the opposing team will decrease the number of wins for a team.

The estimated parameter of ORYG is negative and significant at the 99% level of confidence. This indicates, as expected, that an increase in the number of rushing yards for the opposing team will decrease the number of wins for a team.

## **6.3. Special Team Performance Variables**

The estimated parameter on PIT is positive as expected, but not significant. This indicates that the percentage of punts inside the opponent's twenty-yard line does not significantly affect wins.

The estimated parameter of FGP is positive and significant at the 99% level of confidence. This means that the better a team's field goal percentage, the more wins a team has.

The coefficient on YKR is negative, which is unexpected. However, this variable is not significant. This means that the number of yards per kickoff return is insignificant in determining team wins.

## **6.4 Other Variables**

The estimated parameter of NT is positive and significant at the 99% level of confidence. This indicates, as expected, that an increase in the number of net turnovers will increase the number of wins for a team.

As expected, the estimated parameter on PEN is negative. This coefficient, however, is insignificant. This means that the number of penalties a team has in one season does not have a significant affect on the number of wins the team has in that season.

The coefficient on the number of arrests per team is negative, but turns out to be insignificant. This indicates that the number of arrests per team does not have a significant effect on the number of wins for the team.

## 7. Elasticities

The following elasticities were computed using the estimated equation and the average values as indicated in Table I. These results indicate that a one percent increase in quarterback rating has the largest estimated impact on team wins.

Table I: Elasticities

Variable	Average Value	Elasticity
QBR	80	.7045
GPQB	15	.2495
SA	30	-.1543
RYG	115	.3049
SAC	35	.3021
OPYG	200	-.4089
ORYG	115	-.3917
PIT	30	.0823
FGP	80	.5047
YKR	20	-.1259
NT	1	.0001
PEN	100	-.0531
ARR	1	-.0140

## 8. Conclusions

All of the independent variables are statistically significant at the 95% confidence level except punts inside the twenty, yards per kickoff return, penalties, and arrests. Not only does the number of arrests not significantly affect wins, but they are not significantly correlated with any other aspect of the game either, including penalties. While the number of arrests a team has may cause negative publicity for the team and individuals, this model suggests no significant correlation between the performance of a team and the number of arrests of team members.

The independent variables with the highest elasticities have the greatest impact on wins for a one percent change in those variables. Therefore this analysis suggests the general managers in the NFL should draft or attempt to attract free agents associated with the factors with the greatest absolute magnitude of elasticity. Quarterback rating has the highest elasticity at .70. This means that a one percent increase in quarterback rating causes a .70 percent increase in wins. A ten percent increase in quarterback rating would cause an approximate 7.0 percent increase in wins. Since the NFL season is sixteen games, one game represents 6.25 percent of the total number of games played. Therefore a ten percent increase in quarterback rating should result in more than one additional win.

Field goal percentage has the second highest elasticity at .50. This indicates that a ten percent increase in field goal percentage would result in a 5.0 percent increase in wins or a little less than one game. This indicates that having an accurate field goal kicker should be one of a team's top priorities. In the past field goal kickers have not been drafted in the early rounds as a rule. These results may suggest a change in drafting strategy in the future.



The next highest elasticities in terms of absolute magnitude are opponent's passing yards per game and opponent's rushing yards per game at -.41 and -.39 respectively. These numbers indicate that a ten percent increase in opponent's passing yards reduces wins by 4.1 percent. These numbers also suggest that a ten percent increase in opponent's rushing yards per game reduces wins by 3.9 percent. Therefore, other than the quarterback and the placekicker, the team defense has the greatest potential impact on victories in the NFL. This suggests that defensive players should also have high draft priority.

More research needs to be completed about how team performance variables including arrests affect team victories in the NFL. In a lot of ways the NFL has surpassed Major League Baseball as America's favorite sport. The surprising lack of prior statistical analysis is one area where the NFL still falls short of Major League Baseball. This should change rapidly in the future as the popularity of the NFL continues to increase. There are a myriad of research opportunities concerning NFL performance and payrolls. This research base should continue to grow as more economists earn PhDs from this generation that is much more fascinated with the NFL than Major League Baseball.

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