

Evaluating “The Best”

*Exploring the Relationship between Tom Brady’s True and Observed
Talent*

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Tom Brady's recently reinstated four game suspension has invigorated questions of his moral character as well as his talent on the field. The NFL ranks quarterbacks in many ways, but gives most value to EPA: clutch-weighted expected points added on plays with pass attempts. But this rating is broad and doesn't provide descriptive analysis of isolated skills. Even when evaluating observed statistics of distinct skills like pass completion or interception rate, what role does luck play in Brady's successes and failures? This paper looks to see if Brady's observed statistics are more impressive than his true talent, which subtracts the role of luck from a player's performance. We explore the question: *Do Tom Brady's observed passing statistics reflect his true talent?* The following report analyzes observed quarterback statistics from the 2015 NFL season in four variables--completed pass percentage, interception percentage, touchdown pass percentage, and sacks per attempted passes. We discuss how we arrive at our findings that Tom Brady's observed statistics are negligibly more impressive than his true talent ratings.

1. Methodology

For each case, we calculated the league average true talent by performing regression to the mean. We first use the statistic of the ratio of successes (here, completed pass, interception, touchdown pass, or sack) to the number of attempts (attempted passes for all cases). We use this statistic to calculate regression to the mean, using the following formula:

$$\sigma_T^2 = \frac{\sum_{i=1}^n \frac{(S_i - \mu_T)^2 - (\sigma_L^2)_i}{2(\sigma_T^2 + (\sigma_L^2)_i)^2}}{\sum_{i=1}^n \frac{1}{2(\sigma_T^2 + (\sigma_L^2)_i)^2}}$$

With the regression, we take into account the variance due to luck with the formula below, choosing a variance formula for binomial variables because each statistic is a binomial percentage.

$$\sigma_L^2 = \frac{1}{n} \mu_T (1 - \mu_T)$$

Data

The data used for this analysis are passing statistics for all quarterbacks in the NFL during the 2015 season, accessed for free at Pro-Football-Reference.com.¹ In order to use the data in R, the rows must be edited to remove extraneous headings that

¹ <http://www.pro-football-reference.com/years/2015/passing.htm>

reappear throughout the dataset. The columns of variables we analyzed are Pass Completion Rate, Intercepted Passes, Passing Touchdown Percentage (meaning the percentage of touchdowns made when attempting a pass), and Sacked Percentage (percentage of times sacked when attempting a pass). For each, we calculate Tom Brady's true talent against the observed statistic. Since we are using a large pool of attempts-624 attempted passes-we can hope to minimize the role of luck in our true talent rating. We use the same method to arrive at the league average true talent and its standard deviation. Standard deviation is useful in signifying where the majority of quarterbacks fit; 68% of the quarterbacks will have results within one standard deviation, and 95% will fall within two standard deviations of the league average following an approximation to normal distribution. Due to a low number of attempted passes, some quarterbacks listed have 100% pass completion rates, for example, which is why the variance due to luck is so valuable as it accounts for the number of instances being tested. The results are then visualized into plots and analyzed.

2. Results and Interpretation

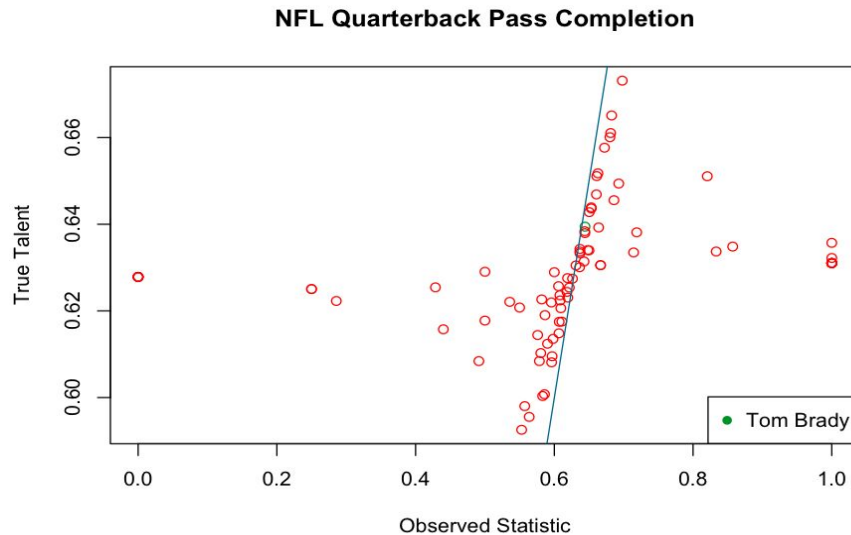
The following section provides the results for the four variables. Within each variable, we interpret the findings to determine to what extent the observed statistic reflects true talent.

Pass Completion

Pass completion is when a quarterback's pass is successfully caught by a receiver on his team, generally resulting in gained yardage. Regression to the mean on all quarterbacks in the dataset resulted in an estimate league average true talent for pass completion: $\mu_T = 0.629$ or about **63%**. The standard deviation in underlying true talent for this statistic is **2.7%**, meaning most quarterbacks have a relatively similar true talent pass completion rate.

With an estimated 0.6394446 or **63.9%** true talent for pass completion rate, Tom Brady is slightly above the league average in true talent and is within one standard deviation. His observed pass completion percentage is 0.644, which estimates to **64.4%**, making his true talent only slightly below his observed talent. The influence of luck on his observed statistic is low. He has the 15th highest true talent ranking in the league, which indicates that other factors of his skill contribute to his rank as third overall quarterback according to Pro-Football-Reference.

Player	Observed Pass Completion	True Talent Pass Completion	League Average True Talent Pass Completion	Standard Deviation of League Averages
Tom Brady	64.4%	63.9%	63%	2.7%

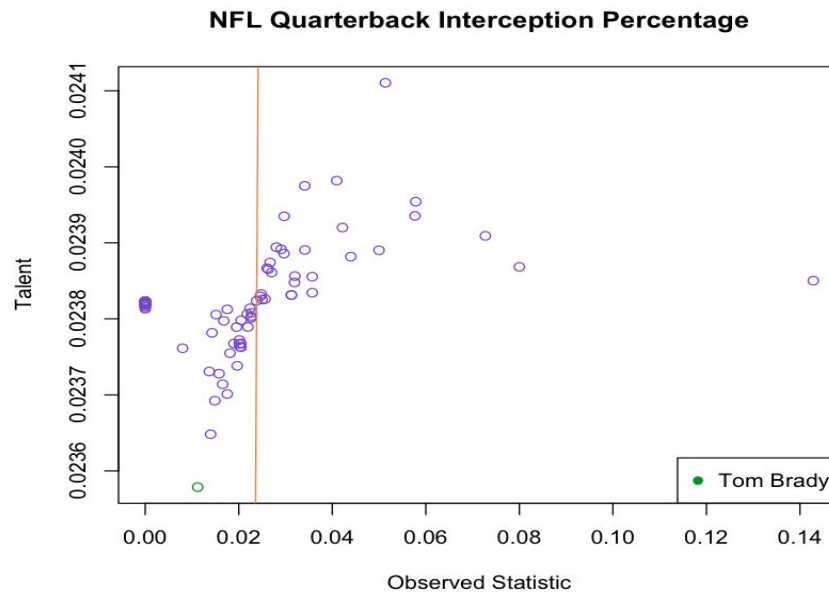


The plot above shows that most quarterbacks have a true talent rating that is relatively close to their observed statistic. The closer the data points align with the line: $y = x$, the closer the value of the two statistics. Data points on the right side of the line have true talent that is lower than their observed statistic; the role of luck is much greater in data on their performance. Data points on the left side of the line have true talent ratings that are higher than their observed statistic, making their skill higher than what is seen in the observed statistics in terms of pass completion. Marked in green, Tom Brady's observed statistic is only slightly higher than his true talent rating.

Intercepted Pass Percentage

Interceptions occur when a player from the opposing team catches the quarterback's pass instead of the intended receiver and result in a turnover of the ball to the opposing team. The lower the rate of interceptions per attempted passes, the higher the assumed passing skill of the quarterback. The estimate of true talent level for intercepted pass percentage is: $\mu_T = 0.0238$ or about **2.38%**. The standard deviation in the underlying true talent is **0.09%**. In 2015, Brady's observed interception percentage was **1.1%**, the lowest in the league. However, Brady's true talent interception percentage is **2.36%**, over double the value of his observed interception percentage. We can conclude that in regards to his intercepted pass percentage, the role of luck in Brady's data is more significant. However, his true talent still beats the league average.

Player	Observed Interception Percentage	True Talent Interception Percentage	League Average True Talent Interception Percentage	Standard Deviation of League Averages
Tom Brady	1.1%	2.36%	2.38%	0.09%

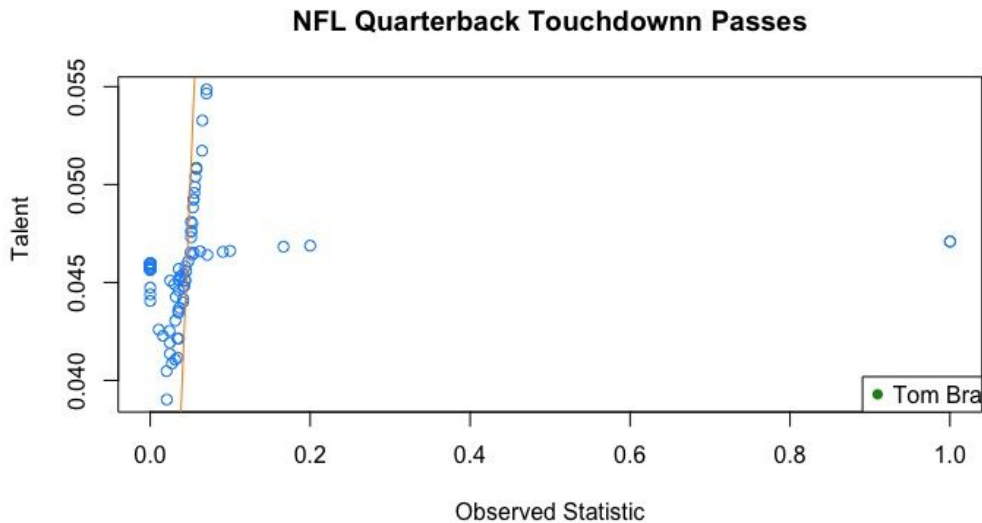


The plot above shows more variance in the relationship between true talent rating and observed statistics. Tom Brady, marked in green, has an observed statistic that is much less than his true talent interception percentage.

Touchdown Pass Percentage

A touchdown pass is worth six points and gives the offense the opportunity to score an additional point with a field goal or attempt a two-point conversion. Most touchdown passes are thrown by the quarterback. The estimate of the league average true talent level for touchdown passes is: $\mu_T = 0.046$ or about **4.6%**. This is low percentage makes sense because most passes do not result in touchdowns. The standard deviation in underlying true talent for this statistic is **.7%**, which is also low, meaning most quarterbacks have a relatively similar true talent rate. With an estimated **5.09%** true talent for touchdown pass percentage, Brady excels above the average quarterback at throwing these passes. Brady is still within one standard deviation, but he is certainly one of the best in the league with the **5th highest true talent ranking** in this statistic. While he is in the top of the league for touchdown passes, his observed statistic, **5.77%**, is slightly more inflated than his true talent.

Player	Observed Touchdown Pass Percentage	True Talent Touchdown Pass Percentage	League Average True Talent Passing Touchdown Percentage	Standard Deviation of League Averages
Tom Brady	5.77%	5.09%	4.6%	0.7%



The plot of touchdown passes shows that there is small variance between true talent ratings and observed statistics. Brady, shown in green, is close to the line of regression.

Sacking Percentage

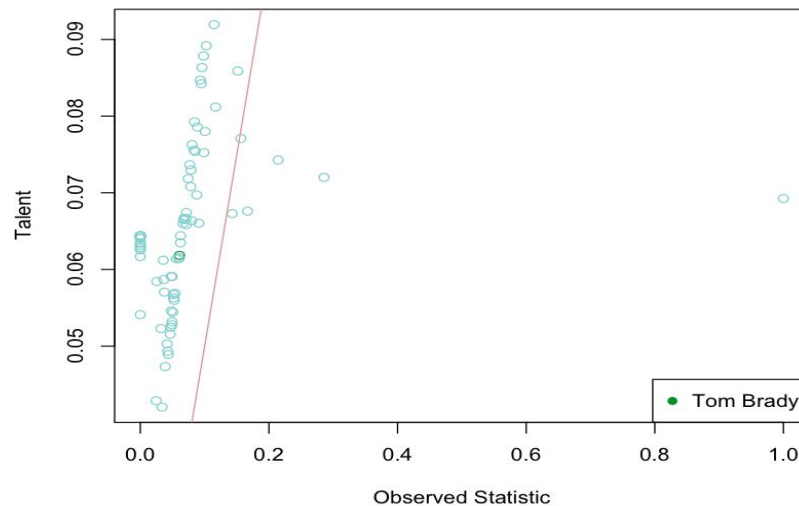
A quarterback is sacked when an opposing team’s defense is able to ground him before he has the opportunity to make a pass or hand-off. Sacks almost always result in a loss of yardage, can incur quarterback injury, and we can assume from casual observation of player-reactions, can severely impact the morale of the offensive team. Data on quarterback sacks are typically used to measure the skill of defensive players or the preventative skill of a quarterback’s defensive line. While other positions have the primary role in plays that result in a sack, this data can be used to assess important and specific quarterback skills. If a quarterback can consistently avoid sacks, we can assume he is agile, has a strong ability to find receivers under pressure, and helps the offensive team avoid plays that result in negative yardage.

The following analyses were derived from regressing to the mean the statistic of times a quarterback is sacked while attempting a pass against the number of attempted

passes. The lower the percentage, the higher the skill of the quarterback and his defensive line in avoiding being sacked during attempted passes. The league average true talent for sacked percentage is **6.5%** with a standard deviation of **1.7%**. Tom Brady's true talent is slightly below the league average, having a **6.2%** true talent for sacks. Being slightly below, but within a single standard deviation indicates that Brady and the team that supports him, is slightly better at avoiding sacks than other NFL quarterbacks and their supporting players. This true talent rating is only negligibly lower than his observed statistic of **6.1%**. The role of luck is only minimal in his observed statistic.

Player	Observed Sacked Percentage	True Talent Sacked Percentage	League Average True Talent Sacked Percentage	Standard Deviation of League Averages
Tom Brady	6.1%	6.2%	6.5%	1.7%

NFL Quarterback Sacked While Attempting Pass Percentage



The graph above shows Tom Brady, colored in green, with a true talent rating slightly above the observed sacked rating, showing the small role of chance in enhancing how Brady appears to be performing. The majority of quarterbacks also have true talent ratings that are higher than their observed statistics.

3. Limitations

We acknowledge that our analysis of a quarterback's true talent has various limitations. Most significantly, a quarterback's talent is a combination of his skills and those of his teammates and competition. This paper only looks at four components of passing

although quarterbacks are valuable for a number of other tasks such as hand-offs and running the ball. Football is a team sport, and much of the success of the quarterback depends on the skill of the other players on the team. A quarterback with talented receivers will have an easier time completing passes, possibly inflating this quarterback's true talent level for pass completion rate. A quarterback with a strong defensive line has a higher likelihood of avoiding sacks and making valuable plays. Additionally, the models do not account for the talent of competition i.e. the ability of the opposing team to sack, make interceptions, or allow complete passes and touchdowns.

The formulas also do not consider several variables that impact player performance. The analysis does not weigh certain plays over others or consider the variables of score differential, time remaining in the game, placement on the field, yards gained, and whether or not the result of the game has an impact on play-off standings. It considers the four variables as mutually exclusive and looks at each equally, as opposed to weighing more valuable plays like touchdown passes over more common pass completions. This data also looks only at one season and ignores the other 16 years of playing with the Patriots that have influenced Brady's celebrity status, notoriety, rankings, and perhaps performance. In the following section, we provide suggestions for addressing some of these limitations.

4. Implications and Recommendations

To confront these problems, we recommend an analysis that incorporates other players into the true talent evaluation to eliminate the bias of the quarterback's star position. One way to improve this method is to perform regression to the mean within other positions and players on the field, such as receivers, running backs, or any other players that Brady directly engages with. To hone in on specific players, one might also change the dataset and use in-game statistics rather than season totals. The inherent disadvantage of the season totals is aggregation, which causes information loss about individual games.

Another method of evaluating the quarterback's talent in relation to the talent of the opposing defense would be fitting a Rasch model to the dataset and tapping into the depth of play-by-play data. In addition, a Bradley-Terry model using game results would be particularly helpful in determining the home field advantage, which also factors into player performance, especially for Brady and players on the New England Patriots. In Boston, Tom Brady is worshipped beyond even his usual celebrity throughout the United States, and we would guess that playing at home affects his games, most likely for the better. Home field factors into practical considerations of skill as well since Brady, more so than Ryan Tannehill of the Miami Dolphins, for example, is more accustomed to playing in the snow and cold weather.

The potential issues with using these models, however, might be the very extent of Brady's stardom -- he plays every down of the season. This would make it difficult to distinguish between the impact of his talent and the talent of his receivers because no other quarterbacks throw to those receivers. Again, one could overcome these issues by looking at more data. By including multiple seasons of data, one could create more quarterback-receiver combinations.

Our results raise questions regarding the commercial and the voyeuristic side of the sports industry. Certainly coaches, team-owners, and bettors should be aware that a top player's stats might not reflect his true talent due to the role of luck. But could the inflation of a player's talent work to the team's advantage? Should a team want to acquire an overhyped player? Could the celebrity of Tom Brady -- his strong effect on his fans and big-money gamblers -- be useful in the game? Might Brady's stardom significantly impress or demoralize the other teams he faces? Might that give his team an advantage on the field?

5. Conclusion

This paper used regression to the mean to compare Tom Brady's true talent performance against his observed statistical ratings in four variables--pass completion, interceptions, touchdown passes, and sacks--for the 2015 NFL season. We found that Brady's true talent rating was slightly below the observed statistic for pass completion and touchdown passes and slightly above the observed statistic for interceptions and sacks. The most significant absolute value between true and observed talent percentages was Brady's interception rate, with a difference of 1.26%.

Overall, the variance due to luck somewhat enhances Tom Brady's observed statistics. This result makes sense because Tom Brady outperforms most quarterbacks in sacked percentage, interception percentage, passing completion rate, and touchdown pass percentage. The format of the model, which tends to push higher outliers closer to the league average during regression to the mean, could also explain why his true talent is rated lower than his observed statistics so often. We emphasize the suggestion for further research to include considerations of Brady's teammates, competition, home field performance, position on the field, and time left in the game among other variables that influence player performance and talent rankings. Ultimately, Brady's true talent is above the league average for all four statistics measured; his skill still makes him exceptional and validates why he is one of the highest rated quarterbacks in the league.

Appendix: R Code

```

I. Complete Passes
data = read.csv('passingdata.csv')
hist(data$Att)
sum(data$Att)

makes = data$Cmp
attempts = data$Att
names(makes) = names(attempts) = data$Name

S = makes/attempts
muT = sum(makes) / sum(attempts)
print(muT)

sigma2L = muT*(1-muT)/attempts
sigma2T = 0

for (i in 1:100000) {
  weight = 1/(2*(sigma2T + sigma2L)^2)
  sigma2T = sum(weight*((S - muT)^2 - sigma2L))/sum(weight)
}
print(sigma2T)
sqrt(sigma2T)

talent = (muT/sigma2T + S/sigma2L)/(1/sigma2T + 1/sigma2L)
head(sort(talent, decreasing = TRUE))
tail(sort(talent, decreasing = TRUE))

talent[data$Name == "Tom Brady*"]

tb = data$Name == 'Tom Brady*'
plot(S, talent, col = ifelse(tb, 'forestgreen', 'firebrick2'), xlab =
"Observed Statistic", ylab = "True
  Talent", main = "NFL Quarterback Pass Completion")
abline(0, 1, col = 'deepskyblue4')
legend('bottomright', 'Tom Brady', pch = 16, col = 'forestgreen')

```

II. Interceptions

```

makes = data$Int
attempts = data$Att
names(makes) = names(attempts) = data$Name

S = makes/attempts
muT = sum(makes) / sum(attempts)
print(muT)

sigma2L = muT*(1-muT)/attempts
sigma2T = 0

for (i in 1:100000) {
  weight = 1/(2*(sigma2T + sigma2L)^2)
  sigma2T = sum(weight*((S - muT)^2 - sigma2L))/sum(weight)
}
print(sigma2T)
sqrt(sigma2T)

talent = (muT/sigma2T + S/sigma2L)/(1/sigma2T + 1/sigma2L)
head(sort(talent, decreasing = TRUE))
tail(sort(talent, decreasing = TRUE))

talent[data$Name == "Tom Brady*"]

tb = data$Name == 'Tom Brady*'
plot(S, talent, col = ifelse(tb, 'forestgreen', 'firebrick2'), xlab =
"Observed Statistic", ylab = "True
  Talent", main = "NFL Quarterback Interception Percentage")
abline(0, 1, col = 'deepskyblue4')
legend('bottomright', 'Tom Brady', pch = 16, col = 'forestgreen')

```

III. Touchdown Passes

```

makes = data$TD
attempts = data$Att
names(makes) = names(attempts) = data$Name

S = makes/attempts
muT = sum(makes) / sum(attempts)
print(muT)

```

```

sigma2L = muT*(1-muT)/attempts
sigma2T = 0

for (i in 1:100000) {
  weight = 1/(2*(sigma2T + sigma2L)^2)
  sigma2T = sum(weight*((S - muT)^2 - sigma2L))/sum(weight)
}
print(sigma2T)
sqrt(sigma2T)

talent = (muT/sigma2T + S/sigma2L)/(1/sigma2T + 1/sigma2L)
head(sort(talent, decreasing = TRUE))
tail(sort(talent, decreasing = TRUE))

talent[data$Name == "Tom Brady*"]

tb = data$Name == 'Tom Brady*'
plot(S, talent, col = ifelse(tb, 'forestgreen', 'firebrick2'), xlab =
"Observed Statistic", ylab = "True
  Talent", main = "NFL Quarterback Touchdown Pass Percentage")
abline(0, 1, col = 'deepskyblue4')
legend('bottomright', 'Tom Brady', pch = 16, col = 'forestgreen')

```

IV. Sacks

```

makes = data$Sk
attempts = data$Att
names(makes) = names(attempts) = data$Name

S = makes/attempts
muT = sum(makes) / sum(attempts)
print(muT)

sigma2L = muT*(1-muT)/attempts
sigma2T = 0

for (i in 1:100000) {
  weight = 1/(2*(sigma2T + sigma2L)^2)
  sigma2T = sum(weight*((S - muT)^2 - sigma2L))/sum(weight)
}
print(sigma2T)
sqrt(sigma2T)

```

```
talent = (muT/sigma2T + S/sigma2L)/(1/sigma2T + 1/sigma2L)
head(sort(talent, decreasing = TRUE))
tail(sort(talent, decreasing = TRUE))

talent[data$Name == "Tom Brady*"]

tb = data$Name == 'Tom Brady*'
plot(S, talent, col = ifelse(tb, 'forestgreen', 'firebrick2'), xlab =
"Observed Statistic", ylab = "True
    Talent", main = "NFL Quarterback Sacked Percentage")
abline(0, 1, col = 'deepskyblue4')
legend('bottomright', 'Tom Brady', pch = 16, col = 'forestgreen')
```