

Do Cowardly Punts Lose games?

There is a growing consensus in professional football that punting is a poor play analytically. In 2002, economist David Romer analyzed punts and discovered that, “Even on its 10-yard line – 90 yards from a score – a team within 3 yards of a first down is better off on average going for it.” [Romer(2002)] Punts are also disappointing to watch, as a fan. To quantify this disappointment, blogger Jon Bois developed the Surrender Index [Secret Base(2019)]- a measure of how much a punt feels like the team is giving up.

We decided to see if teams committing cowardly punts makes them more likely to lose the game. To convert this continuous index into a binary event, we define a cowardly punt to be a punt which ranks in the top 10 percentile of all punts, ranked by Surrender Index. To apply Bayes Theorem, we have event L = “Losing a football game” and event B = “Committing a cowardly punt.” Our prior probability in this case would be the probability of losing a game, $P(L)$. Our likelihood is the probability a team committed a cowardly punt given they lost the game, $P(B|L)$. Finally, our posterior probability is the probability of losing a game given that a team committed a cowardly punt, $P(L|B)$.

To calculate these probabilities, we scraped punt play data for every NFL game from 2010-2019 from pro-football-reference.com. We used the yards-to-gain, field position, game clock, and score information to calculate the Surrender Index as detailed in the appendix. We used the first 5 years of data (2010-2014) as a baseline to establish the 90th percentile Surrender Index, and we used the final 5 years of data (2015-2019) to calculate the Bayesian probability of a loss given the team committed a punt that ranks in the top 10 percent of all-time cowardly punts. To do this, we tracked:

- The number of games (2608)
- The number of losses (1297)
- The number of games in which a team commits a cowardly punt (786)
- The number of games in which a losing team commits a cowardly punt (449)

We can use these numbers to calculate our posterior probability of a team losing given that they committed a cowardly punt:

$$\begin{aligned}
P(L|B) &= \frac{P(B|L)P(L)}{P(B)} \\
&= \frac{\frac{\# \text{ games where losing team commits a cowardly punt}}{\# \text{ of losses}} \cdot \frac{\# \text{ of losses}}{\# \text{ of games}}}{\frac{\# \text{ games where any team commits a cowardly punt}}{\# \text{ of games}}} \\
&= \frac{\frac{449}{1297} \cdot \frac{1297}{2608}}{\frac{786}{2608}} \\
&= \frac{0.35 \cdot 0.50}{0.30} \\
&= 0.57
\end{aligned}$$

We have our conclusion: teams that punt with a Surrender Index in the top 10 percentile have a 57% chance of losing. Although the math is complicated, the Surrender Index can easily be calculated ahead of any punt, and coaches can use this information to decide to go for it, rather than punt.

Appendix: Surrender Index Definition

The Surrender Index S is defined as the product of 4 subscores:

$$S = pos \cdot dist \cdot score \cdot time$$

Where pos penalizes punting away from your own endzone. Within a team's own 40 yard line, the score is 1. It goes up 10% per yard from a team's own 40 to the 50 yard line, and then 20% per yard in opposing territory. Let yrd be the distance in yards from your own endzone, then the pos score can be calculated as:

$$pos = \max(1, 1.1^{\min(10, yrd - 40)} \max(1, 1.2^{yrd - 50}))$$

The $dist$ component penalizes punting with a short distance to gain for first down:

$$dist = \begin{cases} 1 & \text{if 4}^{\text{th}} \text{ and 1} \\ 0.8 & \text{if 4}^{\text{th}} \text{ and 2-3} \\ 0.6 & \text{if 4}^{\text{th}} \text{ and 4-6} \\ 0.4 & \text{if 4}^{\text{th}} \text{ and 7-9} \\ 0.2 & \text{if 4}^{\text{th}} \text{ and 10+} \end{cases}$$

$score$ penalizes punting when trailing, and penalizes punting most harshly when down by just 1 score:

$$score = \begin{cases} 1 & \text{if the punting team is in the lead} \\ 2 & \text{if the score is tied} \\ 4 & \text{if the punting team is down by 1 score (1-8 points)} \\ 3 & \text{if the punting team trails by 2+ scores} \end{cases}$$

Finally the *time* only applies to teams who are trailing or tied in the second half. It exponentially increases with the number of seconds, *sec*, since halftime, harshly penalizing late-game punts and overtime punts.

$$\text{time} = 1 + (\text{sec} * 0.001)^3, \text{if trailing or tied only}$$

References

- [Romer(2002)] David Romer. It's Fourth Down and What Does the Bellman Equation Say? A Dynamic Programming Analysis of Football Strategy. Technical Report w9024, National Bureau of Economic Research, Cambridge, MA, June 2002. URL <http://www.nber.org/papers/w9024.pdf>.
- [Secret Base(2019)] Secret Base. The search for the saddest punt in the world | Chart Party, February 2019. URL <https://www.youtube.com/watch?v=F9H9LwGmc-0>.