Maximizing Timeout Value: A Data-Driven Evaluation of Timeout Usage in Second Halves of NFL Games

1. Introduction

Timeouts are among the most valuable — and least explored — assets in football. As a longtime fan with an interest clock management, I've often found myself instinctively reacting to teams burning second-half timeouts and thinking: *"They're going to regret that later when they need that timeout to stop the clock."* But were those gut reactions rooted in fact — or just bias from remembering the few games where poor timeout management directly impacted the outcome?

This project began with that question and evolved into a full-scale evaluation of timeout value in second-half scenarios. Specifically, I focused on understanding when it is better for an offense to take an intentional 5-yard penalty versus using a timeout — especially considering how that timeout might later help the team stop the clock on defense and give their offense another chance to win.

The broader goal was twofold:

1. Quantify the strategic tradeoff between burning a timeout early versus preserving it for late-game defensive use.
2. Learn Python from the ground up through a project I was passionate about.

Every model, idea, and decision point in this analysis was developed independently, with ChatGPT serving as a teaching assistant and coding partner along the way.

Project Github: https://github.com/maeisen15/NFL_coding

2. Key Takeaways for Gameday Decision-Making

Timeouts are valuable assets — and in the right situations, it's smarter to take a **5-yard penalty** than to burn one. This analysis identifies when that tradeoff makes sense:

1. **Taking Penalties Can Be the Better Option — About a Quarter of the Time:** Teams should take the penalty instead of calling a timeout on nearly **one in four second-half plays**. When they do, the average win probability gain is often **0.5–1%** — not massive, but meaningful over time.

2. **There are Three Situations Where Taking the Penalty Usually Makes Sense**

   a. **Long-Yardage (13+):** Low conversion odds make the penalty less costly.
   b. **Down 2+ scores:** Timeouts are critical for mounting a comeback.
   c. **Own side of the field:** A timeout is often more valuable than five yards.

3. **The First Timeout Is the Most Valuable:** Going from **3 to 2 timeouts** costs more win probability than any other timeout. Be especially cautious about using the first one.

Timeout management is nuanced and situation-specific, but these guidelines can help teams make faster, more analytically sound decisions in real time.

3. Modeling Approach

The core modeling question was simple: *Is it better to call a timeout or take a penalty?* But answering that required several layers of prediction and simulation.

At every play in the second half of every NFL game from 2002–2024, I simulated:

- **The expected win probability lost from taking a 5-yard penalty**
- **The marginal value of preserving a timeout — conditional on later needing it to stop the clock**
- **The probability the team would eventually need that timeout in a late-game defensive stop scenario (i.e., trailing by one score with ≤5 minutes left)**

By combining these components, I was able to estimate the breakeven point: if the cost of the penalty exceeded the expected value of saving the timeout (B × C), then it was optimal to use the timeout. Otherwise, take the penalty.

4. The Models

Model #1: Marginal Value of a Timeout in Late Game Situations

To quantify the value of each timeout in late-game situations, I used a causal modeling framework. I compared drives where teams had 3, 2, 1, or 0 timeouts remaining and measured how those differences affected win probability outcomes— specifically the team's win probability when the defense either got the ball back or lost the game.

Key Takeaways:

- Having 3 timeouts instead of 2 adds **3–5% win probability in late game situations** — a massive margin in close games.
- Surprisingly, the second timeout (having 2 timeouts instead of 1) had a very low marginal value, even before the 2-minute warning.
- Timeout value unsurpisingly drops off sharply as time runs out — but the first timeout still retains value very late in games.
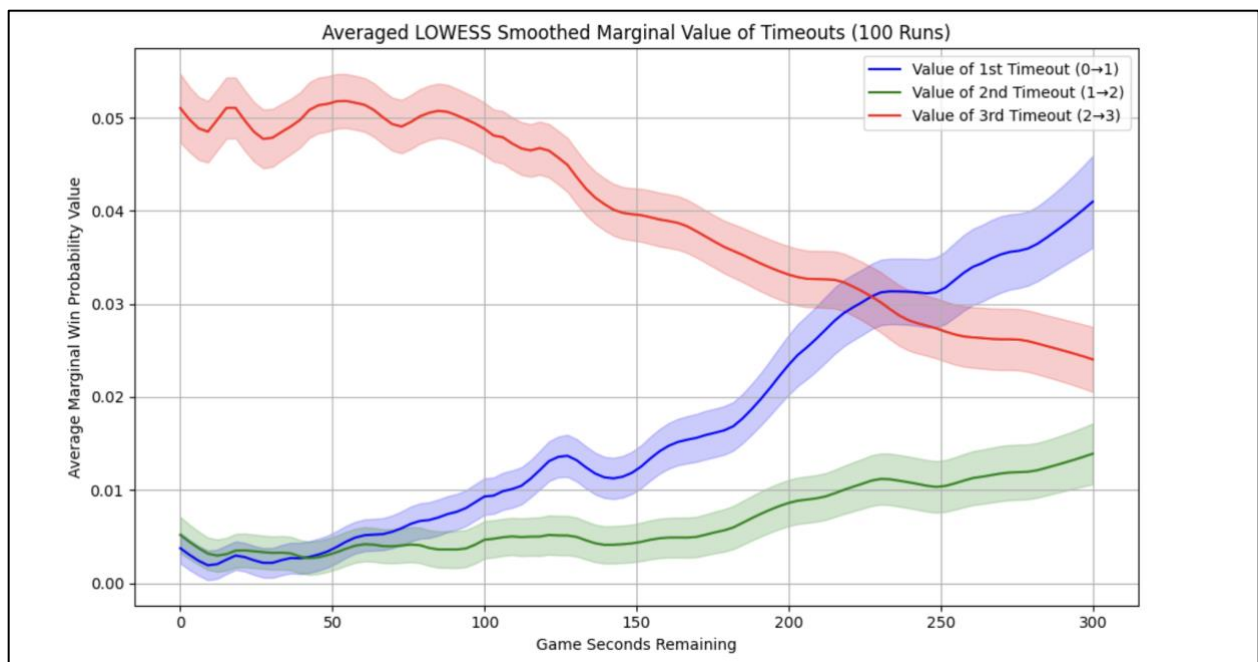
Model #2: Probability of Reaching a Late-Game Defensive Stop Situation

Not every team will get a chance to use their timeouts late. To discount the theoretical value of timeouts appropriately, I trained an XGBoost classifier to predict the likelihood that a team would find itself trailing by one score with ≤5 minutes remaining on defense.

Probability the Team on Offense Will Need a Late Game Defensive Stop

Time of Game	Down 2+ Scores	Down 1 Score	Tied	Up 1 Score	Up 2+ Scores
Early Q3	26%	34%	22%	17%	5%
Mid Q3	27%	35%	23%	16%	3%
Late Q3	27%	37%	23%	15%	2%
Early Q4	27%	41%	23%	12%	1%
Mid Q4	27%	47%	23%	10%	1%
Late Q4	22%	45%	9%	4%	0%

Model #3: Win Probability Loss from Penalty

To assess the cost of a 5-yard penalty, I recreated the NFL FastR win probability model using replicated features and coefficients. Then, I simulated the effect of moving each offense 5 yards backward (or half-the-distance when applicable) and re-estimated their win probability.

Key Takeaways:

- Penalties are 3-6X more costly when games are close, often making them more detrimental than losing a timeout despite those being the situations where a timeout could be most useful late in the game.
- Penalties in long-yardage situations hurt nearly 50% less than all other occasions — making them by far the easiest situations to take a penalty to preserve a timeout.

Average Win Percentage Loss from Taking a Penalty

Down	Distance	Down 2+ Scores	Down 1 Score	Tied	Up 1 Score	Up 2+ Scores
1st Down	Short (1-3 yds)	-1.30%	-4.20%	-3.00%	-1.60%	-0.30%
	Medium (4-7 yds)	-0.60%	-2.30%	-1.80%	-0.90%	-0.20%
	Long (8-12 yds)	-0.60%	-2.80%	-3.20%	-1.80%	-0.40%
	Very Long (13+ yds)	-0.30%	-1.40%	-1.60%	-0.90%	-0.20%
2nd Down	Short (1-3 yds)	-0.80%	-3.10%	-3.10%	-1.90%	-0.50%
	Medium (4-7 yds)	-0.60%	-2.40%	-2.50%	-1.60%	-0.30%
	Long (8-12 yds)	-0.60%	-2.80%	-3.20%	-1.80%	-0.40%
	Very Long (13+ yds)	-0.30%	-1.40%	-1.70%	-1.00%	-0.20%
3rd Down	Short (1-3 yds)	-0.70%	-2.90%	-3.30%	-1.90%	-0.50%
	Medium (4-7 yds)	-0.60%	-2.50%	-2.90%	-1.60%	-0.30%
	Long (8-12 yds)	-0.50%	-2.60%	-3.20%	-1.90%	-0.40%
	Very Long (13+ yds)	-0.30%	-1.40%	-1.70%	-1.10%	-0.20%
4th Down	Short (1-3 yds)	-0.50%	-2.50%	-3.30%	-1.90%	-0.40%
	Medium (4-7 yds)	-0.40%	-2.00%	-2.60%	-1.50%	-0.30%
	Long (8-12 yds)	-0.40%	-2.30%	-3.20%	-2.10%	-0.40%
	Very Long (13+ yds)	-0.20%	-1.20%	-1.70%	-1.30%	-0.30%

5. Findings

Timeouts are a critical strategic asset in the second half of games — especially for teams that may later find themselves needing a defensive stop to regain possession. While timeouts are traditionally viewed as a way to prevent delay-of-game penalties or avoid broken plays, this analysis reveals that teams can selectively gain a win probability advantage by taking a penalty instead of calling a timeout, particularly when protecting their first timeout.

Share of Plays a Team Should Take a Penalty Instead of Calling a Timeout						
Team's Current TO's Remaining	Overall	Down 2+ Scores	Down 1 Score	Tied	Up 1 Score	Up 2+ Scores
3TO	37%	88%	24%	3%	3%	26%
2TO	16%	40%	1%	0%	0%	18%
1TO	26%	64%	7%	1%	1%	27%

This chart provides a high-level overview of how often, across all situations, a team would be better off taking a five-yard penalty rather than burning a timeout. While it's not the majority of plays, **around a quarter all second half plays** present situations where taking a penalty is the better choice when the team still has all 3 timeouts.

Notably:

- Teams with **3 timeouts** are in the most critical position: burning the first one eliminates the flexibility and leverage of a full set.
- Teams **down 2+ scores** are especially likely to benefit from saving their timeout — time is scarce, comeback probability often hinges on clock control, and the win probability impact of a penalty is marginal.
- Teams that are **tied or winning** tend to benefit less — they're less likely to need all their timeouts defensively, and the downside of a penalty (e.g. punting, falling out of field goal range) often outweighs the clock tradeoff.

This tells us that while taking a penalty isn't always the right decision, it's common enough — and strategically impactful enough — that coaching staffs should be equipped with general heuristics to identify when it's a better option.

To explore a specific use case, I focused on situations where the offense is **down by 1 score** — a scenario that introduces uncertainty: the team may need the timeout later to get the ball back or may score and flip the game situation entirely.

Key takeaways:

- **Consistency across time**: The decision logic holds steady from early Q3 to mid Q4. Unsurprisingly, the late Q4 bucket shows less frequent recommendations to save the timeout, as teams are approaching "use it or lose it" territory.
- **Very long distance makes it better to take the penalty**: On any down, when teams face 13+ yards to gain, the model consistently favors saving the timeout. The likelihood of

converting is already low, so the 5-yard penalty doesn't meaningfully reduce win probability — but the timeout may matter later.

- **Other plays show moderate value**: In standard down and distances, taking the penalty is recommended ~**25–33%** of the time. These are the marginal decisions that can easily be overlooked but together add up to meaningful win probability shifts over a season.

Share of Plays a Team Should Take a Penalty Instead of Calling their First TO							
Down	Distance	Late Q4	Mid Q4	Early Q4	Late Q3	Mid Q3	Early Q3
1st Down	Short (1-3 yds)	1%	1%	0%	0%	0%	0%
	Medium (4-7 yds)	13%	40%	51%	39%	35%	39%
	Long (8-12 yds)	13%	20%	20%	17%	19%	14%
	Very Long (13+ yds)	39%	72%	74%	68%	83%	74%
2nd Down	Short (1-3 yds)	10%	15%	11%	15%	12%	16%
	Medium (4-7 yds)	16%	24%	24%	24%	28%	27%
	Long (8-12 yds)	16%	22%	22%	20%	20%	18%
	Very Long (13+ yds)	45%	65%	73%	68%	76%	75%
3rd Down	Short (1-3 yds)	15%	17%	18%	16%	17%	18%
	Medium (4-7 yds)	21%	28%	25%	23%	27%	28%
	Long (8-12 yds)	21%	29%	23%	23%	24%	25%
	Very Long (13+ yds)	47%	74%	70%	70%	76%	77%
4th Down	Short (1-3 yds)	20%	35%	30%	33%	24%	29%
	Medium (4-7 yds)	35%	47%	45%	41%	48%	49%
	Long (8-12 yds)	34%	35%	37%	32%	32%	32%
	Very Long (13+ yds)	64%	75%	73%	71%	76%	77%

The next chart shifts the lens to field position, revealing that **location on the field matters just as much as time and distance.**

Key findings:

- **Penalty is better when deep in your own territory**: In "own side of field" situations, taking the penalty is often the better choice — likely because the chances of scoring are lower, and retaining the timeout holds future strategic value.
- **Penalty is worse near scoring position**: As teams cross midfield (into "No-Man's Land," FG range, or red zone), penalties carry a greater cost. Five yards can make the difference between attempting a field goal or being forced to punt. In these spots, calling the timeout becomes more valuable, and taking the penalty is rarely optimal.

This field-position sensitivity emphasizes that **timeouts should be treated differently depending on where you are** — not just when you are.

Share of Plays a Team Should Take a Penalty Instead of Calling their First TO					
Down	Distance	Redzone	FG Range	No-Man's Land	Own Side of Field
1st Down	Short (1-3 yds)	0%	0%	0%	0%
	Medium (4-7 yds)	31%	20%	13%	50%
	Long (8-12 yds)	16%	6%	11%	20%
	Very Long (13+ yds)	79%	37%	40%	78%
2nd Down	Short (1-3 yds)	3%	5%	8%	21%
	Medium (4-7 yds)	15%	9%	15%	33%
	Long (8-12 yds)	13%	7%	13%	25%
	Very Long (13+ yds)	74%	35%	41%	76%
3rd Down	Short (1-3 yds)	5%	6%	10%	28%
	Medium (4-7 yds)	19%	10%	15%	35%
	Long (8-12 yds)	15%	7%	14%	32%
	Very Long (13+ yds)	65%	35%	47%	77%
4th Down	Short (1-3 yds)	14%	16%	20%	43%
	Medium (4-7 yds)	31%	21%	29%	60%
	Long (8-12 yds)	25%	13%	24%	44%
	Very Long (13+ yds)	70%	43%	50%	81%

Finally, this table shows the **win probability gain** in situations where the model recommends taking a penalty — essentially the **value of making the right call** when you follow the model's recommendation.

Key observations:

- The typical win probability gain is **0.5% to 0.9%** — near the margins that justify some fourth down decisions.
- When teams are **down 2+ scores** (not shown here, but found in the data), the WP improvement is even more pronounced (reaching at or over 1%).
- These numbers may seem small, but the can make an impact when aggregated across a season — and especially in high-leverage games.

Win Percentage Increase from Taking a Penalty v. Calling a Timeout (Recommended Plays Only)					
Down	Down & Distance	Redzone	FG Range	No-Man's Land	Own Side of Field
1st Down	Short (1-3 yds)	0.0%	0.0%	0.0%	0.0%
	Medium (4-7 yds)	0.5%	0.4%	0.7%	0.6%
	Long (8-12 yds)	0.3%	0.4%	0.4%	0.4%
	Very Long (13+ yds)	0.7%	0.7%	0.7%	0.8%
2nd Down	Short (1-3 yds)	0.3%	0.4%	0.4%	0.4%
	Medium (4-7 yds)	0.3%	0.4%	0.4%	0.5%
	Long (8-12 yds)	0.4%	0.4%	0.4%	0.5%
	Very Long (13+ yds)	0.6%	0.5%	0.7%	0.8%
3rd Down	Short (1-3 yds)	0.4%	0.4%	0.4%	0.5%
	Medium (4-7 yds)	0.4%	0.4%	0.5%	0.5%
	Long (8-12 yds)	0.4%	0.4%	0.5%	0.5%
	Very Long (13+ yds)	0.6%	0.6%	0.7%	0.8%
4th Down	Short (1-3 yds)	0.4%	0.4%	0.6%	0.6%
	Medium (4-7 yds)	0.5%	0.6%	0.6%	0.7%
	Long (8-12 yds)	0.5%	0.5%	0.6%	0.6%
	Very Long (13+ yds)	0.6%	0.6%	0.7%	0.9%

6. Next Steps

This project is just the beginning. I plan to extend the analysis in several directions:

- **Build a full Timeout Value Model** that includes:
    - Timeout utility in late-game offensive drives
    - Timeout value as a fallback to avoid later penalties or bad plays
    - The in-play benefit of a timeout (e.g., setting up the right play a high-leverage 3rd down)
- **Improve the existing models** with better feature engineering, modeling techniques, and validation.
- **Explore strategic use of penalties**, such as:
    - Intentionally giving up a short-yardage first down late in games to preserve clock
    - Using penalties creatively between 2 and 5 minutes left in the game (when the clock stops but it's not illegal) to stop the clock when already trailing

7. Conclusion

This project was motivated by a simple, real-world football question: *Are we using timeouts optimally?* By combining data, models, and football intuition, I found evidence that second half timeout management has room for innovation.

With better tools, coaches can make smarter decisions under pressure. This work is a step toward building those tools — and showing how analytics can influence in-game strategy in a meaningful way.