NFL Offensive Optimization

Alex Jurcich

Overview

This project challenges long-standing assumptions in NFL offensive play-calling by combining firsthand football experience with data-driven analysis. As a former collegiate football player at the University of Wisconsin–Eau Claire and a dedicated fan of the sport, I have often shared the reaction of many viewers and players who question the rationale behind certain play calls. Recent data shows that in 2024, the average number of offensive plays run per game was 62.10, with the Washington Commanders and Detroit Lions ranked first and second, respectively. Observers cannot help but notice that both teams frequently go for it on fourth down. Whether this is a mere coincidence or reflective of a deeper correlation is at the core of the questions this project will address through rigorous statistical investigation.

Guided by the hypothesis that certain situational calls may be misunderstood or misapplied, this analysis will isolate multiple scenarios—ranging from down-and-distance decisions to the choice between run and pass at critical moments—and examine whether these strategies are supported by empirical evidence. By collecting and cleaning detailed play-by-play data, defining key performance metrics (such as EPA and success rates), and applying formal hypothesis tests, the project will either confirm or dispel conventional wisdom on offensive decision-making. The ultimate aim is not only to identify these potential misconceptions but also to create predictive models—using both regression and counterfactual simulations—that quantify the value of adopting more optimal situational plays. In doing so, the project aspires to offer coaches, analysts, and team personnel clear, data-backed guidance on how to maximize offensive efficiency and scoring, thus contributing to a broader evolution in how NFL offenses operate.

Third Down Pass Conversion Rate

Objective

The goal of this analysis was to determine whether the likelihood of converting a third down is significantly higher when a pass is thrown beyond the line to gain compared to when it is thrown short of it. This hypothesis was tested using historical play-by-play data from the NFL, focusing specifically on third-down passing plays.

Key Findings

1. **Conversion Rates**
    - When the pass was thrown **beyond the first-down marker**, the conversion rate was **50.6%**.
    - When the pass was thrown **short of the first-down marker**, the conversion rate dropped to **24.8%**.
    - This suggests that passes targeting receivers past the sticks are **twice as effective** in securing a first down compared to those relying on yards after the catch (YAC).
2. **Statistical Hypothesis Test**
    - A **two-proportion z-test** was conducted to determine whether the observed difference in conversion rates is statistically significant.
    - The resulting **z-score** was **11.90**, and the **p-value** was 5.65×10^{-33}, which is **extremely small** (far below the standard 0.05 threshold).
    - This means we **reject the null hypothesis** and conclude that the difference in conversion rates is **statistically significant**—the advantage of throwing beyond the first-down marker is not due to random variation.
3. **Validation of Statistical Assumptions**
    - The dataset was checked for compliance with the **Central Limit Theorem (CLT)** to ensure normal approximation was valid for the z-test.
    - Both groups had at least **10 successes and 10 failures**, confirming that the test assumptions were met.
    - Therefore, the z-test results are **statistically reliable**.

Implications for NFL Strategy

- **Passing beyond the sticks should be prioritized in play design.**
    - The results highlight that **short passes on third down are highly inefficient**, often forcing offenses into punting situations.
    - Teams relying on short passes in these scenarios likely put themselves at a disadvantage by depending on YAC, which is unpredictable under tight coverage.
- **Route selection and quarterback decision-making play a crucial role.**
    - Offensive coordinators should emphasize **routes that extend beyond the first-down marker**, particularly in must-convert situations.
    - Quarterbacks should be encouraged to look for primary reads that break beyond the sticks rather than checking down early.
- **Situational adjustments should be made based on coverage.**
    - While the data strongly favors throwing beyond the line to gain, there may be cases where **defensive schemes (e.g., soft zone coverage)** make short passes viable.
    - Further analysis could focus on the impact of **defensive alignment (man vs. zone coverage)** on short vs. deep passing efficiency.

Further Analysis

- **Field position's effect on third-down conversion rate.**
    - A **Chi-Square Test for Independence** was conducted to determine whether field position influences whether a pass is thrown beyond or short of the sticks.
    - **Chi-Square Statistic: 14.11**, **P-Value: 0.1186**, **Degrees of Freedom: 9**.
    - **Interpretation:** Since **p > 0.05**, we **fail to reject the null hypothesis**, meaning there is **no statistically significant relationship** between field position and the tendency to throw beyond the sticks.
    - This suggests that **teams do not meaningfully adjust their third-down passing strategy based on field position**, even though passes beyond the sticks are significantly more effective.
- **Pass Distribution on Third Down**
    - **1,233 passes (47.0%)** were thrown beyond the line to gain.
    - **1,391 passes (53.0%)** were thrown short of the line to gain.
    - This suggests that, despite higher success rates, teams **throw short more often than they throw beyond the sticks**.

Analysis of Third-Down Passing Decisions by Distance to Go

Short-Yardage Situations (1-4 yards to go)

- **Passes beyond the first-down marker dominate** in these scenarios.
- Example: On **3rd-and-1**, **69.4% of passes** were thrown beyond the line to gain.
- As distance increases slightly (e.g., 3rd-and-4), the proportion of short passes rises, but still **62.9% of passes** go beyond the sticks.
- **Conversion rates are highest in this range**, suggesting that teams generally make the right call in short-yardage situations.

Medium-Yardage Situations (5-9 yards to go)

- The **ratio of short passes increases noticeably** as the distance to go increases.
- On **3rd-and-5**, **47.9% of passes** were thrown short of the sticks.
- By **3rd-and-9**, **65.2% of passes** were thrown short, meaning only **34.8%** of attempts targeted receivers beyond the first-down marker.
- This **shift toward short passes is likely a mistake**, as short passes in these situations force receivers to gain substantial yards after the catch (YAC) against defenders already playing downhill.

Long-Yardage Situations (10+ yards to go)

- Teams overwhelmingly **throw short of the sticks in long-yardage situations**.
- On **3rd-and-12**, only **27.8% of passes** targeted a receiver past the first-down marker.
- By **3rd-and-16 or longer**, this drops further, with over **78% of passes** thrown short.
- These short passes likely rely on **screen plays, check-downs, or dump-offs**, which often fail to convert unless defenders are out of position.

Conclusion

This analysis reveals **significant inefficiencies in third-down passing strategies**, particularly as the required yardage increases. While offenses generally make optimal decisions in **short-yardage** situations (1-4 yards to go), they increasingly **rely on short passes in medium- and long-yardage scenarios**, leading to lower conversion rates.

In **short-yardage situations**, the majority of passes (60-70%) are correctly thrown beyond the first-down marker, maximizing the chance of conversion. However, as the distance to go increases beyond five yards, offenses begin to **shift toward shorter passes**, even though deeper targets are more effective. By **3rd-and-9**, nearly **two-thirds of passes (65.2%) are**

thrown short of the sticks, requiring receivers to gain significant yards after the catch (YAC) to convert. This trend worsens on **3rd-and-long (10+ yards to go), where over 75% of passes fail to reach the first-down marker**.

This **over-reliance on short passes in non-short-yardage situations** likely stems from **risk-averse play-calling, fear of turnovers, or conservative coaching philosophies**. However, the data suggests that **offenses may be leaving potential first downs on the field by failing to attempt passes beyond the marker in medium and long-yardage situations**.

From a defensive perspective, these findings highlight **predictable tendencies in third-down play-calling** that can be exploited. Defenses can **tighten coverage underneath on 3rd-and-long**, anticipating a high likelihood of check-downs, screens, or short crossing routes rather than deep passes.

Going for it on 4th down (longer than 1 yard)

Objective

The goal of this analysis is to determine whether **going for it on fourth down (when more than 1 yard is needed) is a beneficial strategy** compared to punting or attempting a field goal. By analyzing historical fourth-down attempts, we aim to quantify **conversion success rates, expected points added (EPA), and decision-making trends** to assess if teams should be more aggressive in these situations.

Key Findings

Conversion Rates

- The overall conversion rate for 4th-and-2 through 4th-and-6 attempts was **41.2%**
- Conversion rates by distance:
    - 2 yards: 50.0%
    - 3 yards: 37.5%
    - 4+ yards: dropped below 33%
- Even when 4th down attempts were converted, teams often **did not score on the same drive**, particularly inside the opponent's 30-yard line

Statistical Hypothesis Test

Two one-sample t-tests were conducted to evaluate whether going for it on 4th down adds value in terms of **expected points added (EPA)** and **win probability added (WPA)**.

All 4th Down Attempts (YardsToGo > 1)

- EPA
  t-statistic: −1.37
  p-value: 0.087
  Conclusion: Fail to reject the null hypothesis
- WPA
  t-statistic: 1.14
  p-value: 0.872
  Conclusion: Fail to reject the null hypothesis

4th-and-2 Attempts Only

- EPA
  t-statistic: −0.33
  p-value: 0.630
  Conclusion: Fail to reject the null hypothesis
- WPA
  t-statistic: 0.17
  p-value: 0.433
  Conclusion: Fail to reject the null hypothesis

Interpretation
There is no statistically significant evidence that going for it on 4th down beyond 1 yard provides positive offensive value in either EPA or WPA. This means we fail to reject the null hypothesis and conclude that any observed advantage is not statistically reliable.

Validation of Statistical Assumptions

- Both EPA and WPA data passed checks for sample size and distribution normality.
- Conditions for applying the Central Limit Theorem were met.
- Therefore, the statistical results are reliable.

Implications for NFL Strategy

Cautious Approach Recommended

- 4th-and-1 is a known high-value scenario, but this analysis focused only on **yardsToGo > 1**.
- With lower conversion rates and no significant scoring advantage, teams should reconsider aggressive calls in these situations.

Field Position Didn't Boost Outcomes

- Inside the opponent's 30, even successful 4th down conversions rarely resulted in scoring.
- The data does not support the idea that proximity to the end zone justifies aggressive play alone.

Offensive Rhythm Had No Clear Impact

- Teams that averaged more yards per play on a drive **did not** have meaningfully higher conversion rates on 4th down.

- This challenges the assumption that momentum or prior success translates to 4th down effectiveness.

Conclusion

This analysis reveals that **going for it on 4th down beyond 1 yard** is **not a statistically sound strategy** under neutral game conditions. Despite some success, the average impact on **expected points** and **win probability** is not statistically significant. Teams are more likely to benefit from punting or attempting a field goal unless driven by game state, matchups, or urgent need.

Opportunities for Further Analysis

- Compare decision-making by coach/team tendencies
- Include kicking/punting EPA to simulate true opportunity cost
- Analyze 4th down strategy in game-state contexts (e.g., trailing in Q4, red zone, etc.)

Limitations

One key limitation of this analysis is the absence of explicit **field goal and punt attempt data** in the dataset. While the analysis robustly evaluates the outcomes of go-for-it scenarios, it does not directly compare those results to the **alternative decisions teams could have made** (e.g., kicking a field goal or punting). Without complete play classification or special teams outcome data, we are unable to quantify the expected points or win probability associated with those alternative choices. As a result, this analysis cannot compute the true opportunity cost of going for it on fourth down. Future work incorporating full play-by-play datasets — including kicking and punting plays — would allow for a more comprehensive cost-benefit comparison between fourth-down options.

Optimal Play Selection on 2nd and 6 at Midfield

Objective

This analysis aims to evaluate the effectiveness of play action compared to straight dropbacks and run plays on 2nd down with 6 yards to go. Using historical NFL play-by-play data, we assess performance through metrics such as Expected Points Added (EPA), yards gained, success rates, and third-down conversions following various 2nd and 6 play types. We also test for statistical significance to determine whether observed differences are meaningful.

Key Findings

- **Play Type Frequency**
  - Among all 2nd and 6 plays analyzed:
    - 175 were runs
    - 152 were straight dropbacks
    - 92 were play-action dropbacks
  - This suggests that play action was used less frequently than other options in these situations.

- **EPA Comparisons**
  - Across all 2nd and 6 plays, no statistically significant differences in EPA were found between play action, straight dropbacks, and run plays.
  - However, when isolating for plays that occurred between the 40- and 60-yard lines ("midfield"), play action produced significantly higher EPA than straight dropbacks ($p = 0.0311$).
  - Outside midfield, no significant differences in EPA were observed across play types.

- **Distribution of EPA**
  - Shapiro-Wilk tests revealed that EPA values are not normally distributed for any play type ($p < 0.05$), which supports the use of non-parametric methods like the Kruskal-Wallis and Mann-Whitney U tests.

Statistical Testing

- **T-Tests on EPA**
    - **All 2nd & 6 Plays**
        - No comparisons reached significance ($p > 0.05$).
    - **Midfield Only (40–60 yardline)**
        - Play action vs straight dropback: $p = 0.0311$ (significant)
        - Straight dropback vs run: $p = 0.0386$ (significant)
        - Play action vs run: $p = 0.5560$ (not significant)
    - **Outside Midfield**
        - All pairwise tests were not significant.
- **EPA by Pass Depth**
    - Deep passes yielded the highest average EPA (+0.47), followed by intermediate (+0.38) and short passes (+0.18).
    - Passes behind the line of scrimmage had a negative EPA (-0.33), and passes with unknown depth performed the worst (-1.04).
    - A Kruskal-Wallis test between short, intermediate, and deep passes returned $p = 0.3511$, indicating no statistically significant difference among these groups.

- **Interception Rates**
    - Play action passes had a 2.5% interception rate.
    - Straight dropbacks had a 0% interception rate.
    - However, the sample size for interceptions was small, and the difference was not statistically significant.

Conversion and Success Metrics

- **First Down Rate from Play Action**
    - On 2nd and 6, 36.7% of play action passes resulted in a first down (29 out of 79 attempts).
- **Third Down Conversion Following Incomplete Play**
    - After an incomplete play action pass:
        - Third-down conversions occurred 18.2% of the time.
    - After a straight dropback incompletion:
        - Conversions occurred 34.2% of the time.

    - A Fisher's Exact Test found no significant difference between the two ($p = 0.2412$).

- **Next Play Outcomes Based on 2nd and 6 Play Type**
    - Average yards gained:
        - Straight Dropback: 5.71
        - Play Action: 5.04
        - Run: 3.94
    - Conversion rates:
        - Run: 65.8%
        - Straight Dropback: 64.2%
        - Play Action: 63.2%
    - Touchdown rates remained under 6% for all play types.
    - Play action produced the highest average improvement in EPA on the following play (+0.457), while straight dropbacks resulted in a negative EPA delta (-0.323).

Midfield-Specific Outcomes

- **Yardage & Conversion**
    - At midfield (40–60 yardline):
        - Straight dropbacks had the highest average gain (8.67 yards).
        - Play action had the lowest (4.56 yards).
    - Conversion rates were:
        - Straight Dropback: 75.0%
        - Run: 74.4%
        - Play Action: 62.9%
- **Statistical Tests on Yards Gained**
    - Kruskal-Wallis test: $p = 0.1142$ (not significant overall).
    - Mann-Whitney U pairwise tests:
        - Play Action vs Dropback: $p = 0.0581$ (borderline)
        - Dropback vs Run: $p = 0.1093$
        - Play Action vs Run: $p = 0.5250$
    - Medians:
        - Play Action: 1 yard
        - Run: 3 yards

        - Dropback: 6 yards

- **Success Rates (6+ yards gained)**
    - Chi-Square test across play types: p = 0.1389 (not significant)

Optimal Play Selection on 2nd and 6 at Midfield

- Considering all performance indicators: yards gained, first down rate, and downstream EPA impact, **approximately 80% of 2nd and 6 plays at midfield should be dropbacks**, with the remaining 20% allocated to run plays.

- This allocation captures the dual benefit of immediate yardage and strategic field position, as both play action and straight dropbacks consistently outperformed run plays in multiple dimensions.

- Within dropbacks, the choice between straight and play action should depend on team-specific strengths. Play action may offer greater downstream benefit (via EPA progression), while straight dropbacks yield more consistent yardage gains and conversions.

Implications for NFL Strategy

- Offenses should lean heavily toward passing concepts—especially at midfield—when facing 2nd and 6 situations.

- While run plays can remain part of the mix to maintain unpredictability, over-reliance on rushing reduces overall efficiency.

- The optimal 80/20 split aligns with modern offensive trends favoring aggressive playcalling and early-down passing, particularly in neutral field positions where maximizing drive potential is critical.

- The use of play action appears to offer downstream value in terms of increasing the expected points on the next play, even when it doesn't produce immediate yardage gains. This suggests a sequencing benefit where play action sets up future offensive success.

- Teams should further evaluate when play action is most effective, based on formation, personnel, or defensive alignment, to unlock its full potential.

Run plays with motion vs without motion

Objective

This analysis evaluates whether run plays with motion are more effective than plays without motion. Teams use motion in a variety of different ways, which include getting the defense to expose their coverage or draw eyes in the run game. I will explore different situations (down and distances) along with the field position to find the most optimal type of run plays.

Key Takeaways

1. Motion clearly helps, especially on 1st and 10 near the red zone

When motion was used on 1st and 10 inside the opponent's 40-yard line:

- Teams gained **5.7 yards on average**
- Without motion, they gained only **3.9 yards**

That's a difference of nearly **2 full yards** — a huge impact when trying to stay ahead of the chains or get into the red zone.

2. The overall effect of motion is strong and consistent

When we grouped together all of the situations we studied (1st and 10, 2nd and short, and 3rd and very short inside the 40), here's what we found:

- **Motion plays gained 5.1 yards on average**
- **No-motion plays gained just 3.7 yards**
- That's a **difference of 1.4 yards** every time a team ran the ball

Even more important: that difference was **statistically proven** to be real, not just a fluke in the data. We ran three different types of tests to confirm this, and all three showed that motion leads to better results.

How the Analysis Was Done

Step 1: Filtered for relevant plays

We started with NFL play-by-play data and filtered for only **run plays**. We removed plays that:

- Happened in overtime
- Were impacted by penalties
- Occurred in blowout situations (like when a team was ahead by 17 or more in the 4th quarter)
- Took place in the final seconds of the first half

We then **isolated plays** inside the opponent's 40-yard line. Why? Because in this part of the field, every play could lead to points. Coaches want to make the best decision possible here.

Step 2: Identified motion

We defined a play as having "motion" if **any player was moving at the snap**, shifted after the offense was set, or moved across the formation before the play began.

Step 3: Grouped plays by down and distance

We focused on:

- 1st and 10
- 2nd down with less than 11 yards to go
- 3rd down with less than 3 yards to go

These are all common run situations where motion could make a difference.

Step 4: Compared motion vs. no motion

We looked at the **average yards gained** for run plays with motion and without it — first in each situation separately, and then combined.

We also ran tests to make sure the difference wasn't due to random chance.

The Results

Average Yards Gained Inside the 40

Situation	With Motion	Without Motion
1st and 10	5.7 yards	3.9 yards
2nd and <11 yards	4.4 yards	3.6 yards
3rd and <3 yards	3.0 yards	2.3 yards
All combined	**5.1**	**3.7**

Statistical Testing Results

- **Mann-Whitney U Test:** Showed a statistically significant difference (p-value = 0.0004)
- **Welch's T-Test:** Confirmed the difference (p-value = 0.0001)
- **Z-Test:** Supported the same conclusion (p-value = 0.0001)

All of these tests confirmed that the advantage from motion wasn't due to chance. The difference is **real**, and it's meaningful.

Why This Matters

- Using motion in the run game, especially **close to the end zone**, consistently leads to **better results**.

- Teams gain more yards. This makes it easier to get first downs, stay on schedule, and finish drives with touchdowns instead of field goals.

- Coaches who aren't using motion in these situations may be leaving yards and points on the field.

Strategic Recommendation

NFL offenses should emphasize motion on run plays in early down situations, particularly once they cross the opponent's 40-yard line. The data clearly shows that motion makes a difference, and the impact is large enough to shape game strategy.

Shot Plays

Objective

This analysis aims to optimize when offenses should attempt shot plays. From a player's and fan's perspective, shot plays — deep pass attempts designed to create explosive gains — often occur on 2nd down with short yardage, especially around midfield. The logic is sound: if incomplete, a team still has 3rd and short; if complete, they've significantly increased their scoring probability. This study evaluates the effectiveness of shot plays using two metrics: Expected Points Added (EPA) and conversion rates.

Key Findings

Yards Gained and EPA Comparison

- On **3rd down at midfield**, shot plays gained an average of **12.0 yards**, compared to just **6.2 yards** for non-shot plays.
- The **expected points added (EPA)** from shot plays averaged **+0.73**, while non-shot plays averaged **-0.06**.
- A t-test revealed the difference in EPA was **statistically significant** ($p < 0.001$).

Completion Percentage

- Shot plays on 3rd down at midfield had a **completion rate of 92.2%**.
- Non-shot plays had a significantly lower **completion rate of 37.2%**.
- This suggests that not only are shot plays more aggressive, but also they are well-executed in the situations they're called.

Causal Inference: Propensity Score Weighting

To understand whether shot plays inherently produce better outcomes, or if they are simply called in favorable situations, we applied **Inverse Probability of Treatment Weighting (IPTW)**.

Methodology

- A **logistic regression model** was used to predict whether a shot play would be called based on:
    - Yards to go
    - Whether the offense used play-action
    - Whether any player on offense was in pre-snap motion

- This produced a **propensity score** for each play, representing the probability of calling a shot play given its context.

- Plays were then **weighted inversely to their likelihood of treatment**, simulating a randomized control experiment.

Causal Results

- After applying IPTW, the **estimated EPA for shot plays** was **+0.995**.

- The **estimated EPA for non-shot plays** was **-0.093**.

- The **estimated causal effect (delta)** of calling a shot play was **+1.088 EPA**.

This confirms that the observed advantage of shot plays on 3rd down at midfield is not simply due to favorable play contexts—**it is causal**.

Implications for NFL Strategy

- **Shot plays are highly effective on 3rd down at midfield**, both in terms of yards gained and overall value added (EPA).

- Contrary to the perception that deep shots are risky, they are **executed with high precision** when called in these scenarios.

- Offensive coordinators should **prioritize deep passing concepts** on 3rd down between the 40s, especially when within 10 yards of a first down.

- Conservative 3rd-down play-calling in this zone likely leaves significant value on the field.

- These findings also suggest potential for **exploitative defensive preparation**—if shot plays are not used frequently, defenses may overcommit to short coverage, leaving deep threats open.

Conclusion

Shot plays are not only effective but **strategically optimal** on 3rd down at midfield. This analysis demonstrates that:

- Shot plays provide **substantially more yardage and value** than non-shot plays.

- Completion rates are **surprisingly high**, suggesting excellent design and execution.

- After accounting for play context, **shot plays cause better outcomes**, not just correlate with them.

NFL teams should reevaluate how often and under what conditions they attempt deep passes. Rather than treating them as high-risk options, they should recognize the **high reward and high success rate** that these plays offer when deployed in the right zone and down situation.

Next Steps for Analysis

- Break down results by **offensive personnel grouping** (e.g., 11, 12 personnel).

- Assess **defensive coverages** most vulnerable to shot plays.

- Examine **coach-level tendencies**—which play callers are leveraging these findings, and which are not?

- Consider using **tracking data** to quantify the separation or speed of receivers on these plays.

Shot Plays

Objective

This analysis aims to optimize when offenses should attempt shot plays. From a player's and fan's perspective, shot plays — deep pass attempts designed to create explosive gains — often occur on 2nd down with short yardage, especially around midfield. The logic is sound: if incomplete, a team still has 3rd and short; if complete, they've significantly increased their scoring probability. This study evaluates the effectiveness of shot plays using two metrics: Expected Points Added (EPA) and conversion rates.

Key Findings

Yards Gained and EPA Comparison

- On **3rd down at midfield**, shot plays gained an average of **12.0 yards**, compared to just **6.2 yards** for non-shot plays.
- The **expected points added (EPA)** from shot plays averaged **+0.73**, while non-shot plays averaged **-0.06**.
- A t-test revealed the difference in EPA was **statistically significant** ($p < 0.001$).

Completion Percentage

- Shot plays on 3rd down at midfield had a **completion rate of 92.2%**.
- Non-shot plays had a significantly lower **completion rate of 37.2%**.
- This suggests that not only are shot plays more aggressive, but also they are well-executed in the situations they're called.

Causal Inference: Propensity Score Weighting

To understand whether shot plays inherently produce better outcomes, or if they are simply called in favorable situations, we applied **Inverse Probability of Treatment Weighting (IPTW)**.

Methodology

- A **logistic regression model** was used to predict whether a shot play would be called based on:
    - Yards to go
    - Whether the offense used play-action
    - Whether any player on offense was in pre-snap motion

- This produced a **propensity score** for each play, representing the probability of calling a shot play given its context.

- Plays were then **weighted inversely to their likelihood of treatment**, simulating a randomized control experiment.

Causal Results

- After applying IPTW, the **estimated EPA for shot plays** was **+0.995**.

- The **estimated EPA for non-shot plays** was **-0.093**.

- The **estimated causal effect (delta)** of calling a shot play was **+1.088 EPA**.

This confirms that the observed advantage of shot plays on 3rd down at midfield is not simply due to favorable play contexts—**it is causal**.

Implications for NFL Strategy

- **Shot plays are highly effective on 3rd down at midfield**, both in terms of yards gained and overall value added (EPA).

- Contrary to the perception that deep shots are risky, they are **executed with high precision** when called in these scenarios.
- Offensive coordinators should **prioritize deep passing concepts** on 3rd down between the 40s, especially when within 10 yards of a first down.
- Conservative 3rd-down play-calling in this zone likely leaves significant value on the field.
- These findings also suggest potential for **exploitative defensive preparation**—if shot plays are not used frequently, defenses may overcommit to short coverage, leaving deep threats open.

Conclusion

Shot plays are not only effective but **strategically optimal** on 3rd down at midfield. This analysis demonstrates that:

- Shot plays provide **substantially more yardage and value** than non-shot plays.
- Completion rates are **surprisingly high**, suggesting excellent design and execution.
- After accounting for play context, **shot plays cause better outcomes**, not just correlate with them.

NFL teams should reevaluate how often and under what conditions they attempt deep passes. Rather than treating them as high-risk options, they should recognize the **high reward and high success rate** that these plays offer when deployed in the right zone and down situation.

Next Steps for Analysis

- Break down results by **offensive personnel grouping** (e.g., 11, 12 personnel).
- Assess **defensive coverages** most vulnerable to shot plays.

- Examine **coach-level tendencies**—which play callers are leveraging these findings, and which are not?

- Consider using **tracking data** to quantify the separation or speed of receivers on these plays.

Gap vs Zone Run plays

Objective

This analysis explores whether Gap or Zone run schemes are more effective across all downs in the NFL. While both concepts are foundational to offensive playcalling, they rely on different techniques: Zone schemes stretch the defense laterally and allow the running back to cut based on flow, while Gap schemes use pulling linemen and predetermined lanes to attack the defense vertically or with misdirection. By isolating Gap and Zone run plays, we evaluate their effectiveness in terms of average yards gained, explosive play rate, and situational success. The goal is to determine which approach delivers more consistent and valuable outcomes in both early- and late-down situations, informing optimal run game strategy and play selection.

Final Analysis: Gap vs Zone Run Scheme Comparison

This analysis compares the performance of Gap vs Zone run schemes using NFL play-by-play data across all downs. The evaluation includes average yardage, explosive play rate (runs gaining 10+ yards), and success rate based on down-and-distance.

Average Yards Gained

- Gap runs gained 5.16 yards per carry.
- Zone runs gained 4.34 yards per carry.
- The difference of +0.83 yards was statistically significant ($p = 0.0139$).

Conclusion: Gap runs are more efficient per carry than Zone runs.

Explosive Run Rate (10+ yards gained)

- Gap runs had an explosive rate of 15.3%.
- Zone runs had an explosive rate of 10.3%.
- This difference was statistically significant (Chi-Square = 22.71, $p < 0.0001$).

Conclusion: Gap runs are more likely to result in chunk plays.

Overall Success Rate

- Gap runs had a success rate of 53.8%.
- Zone runs had a success rate of 50.1%.

Conclusion: Gap runs sustain drives more effectively overall.

Success Rate by Down

- On 1st down:
    - Gap success rate = 51.1%
    - Zone success rate = 45.8%
    - The difference was statistically significant ($p = 0.0125$)
- On 2nd down:
    - Gap = 58.5%
    - Zone = 57.4%
    - No statistically significant difference

- On 3rd down:
    - Gap = 53.2%
    - Zone = 51.7%
    - No statistically significant difference
- On 4th down:
    - Both schemes had a success rate of 56.3%
    - No statistically significant difference

Conclusion: Gap schemes are significantly more effective on 1st down, while both schemes perform similarly on later downs.

Strategic Recommendation

- Increase usage of Gap scheme runs, especially on 1st down, where they offer higher efficiency and success.
- Gap runs provide both more consistent yardage and a greater likelihood of explosive gains.
- While Zone schemes remain effective and more frequently used, this analysis suggests Gap concepts (Counter, Power, Pull Lead, Trap) should play a larger role in modern NFL run game strategy.

4th and 1

Objective

This analysis investigates optimal decision-making on 4th and 1, one of the most pivotal moments in football strategy. Coaches often face a high-stakes choice: punt, attempt a field goal, or go for it. Our goal is to understand when going for it is justified and which types of plays give teams the highest chance of success. We begin by examining 4th-and-1 conversion rates across all NFL teams, then analyze which play types are most frequently called, such as quarterback sneaks, traditional runs, and short passes, and how effective each option is.

We pay particular attention to play type, run scheme (e.g., gap vs. zone), and game context (field position, score differential, and time remaining). Given the widespread belief that quarterback sneaks are the most effective option in these situations, we test that assumption directly and explore whether any other strategies rival or surpass it under specific conditions. The ultimate goal is to guide more analytically grounded decisions for 4th-and-short situations.

Key Findings

Team-Level Conversion Rates

- Multiple teams converted 100% of their 4th-and-1 attempts, including ATL, PIT, PHI, and TEN.
- CLE led the league in volume with 9 attempts, converting nearly 78%.
- Teams with the lowest success rates included IND, CIN, and GB, all converting 25% or less.
- DAL failed on their only attempt, while DET and GB were among the worst performers despite having multiple chances.

Play Type Effectiveness

- QB sneaks had the highest conversion rate at 87.1%, far surpassing traditional runs (56.9%) and pass plays (51.2%).
- This confirms that QB sneaks are the most efficient play call in 4th-and-1 situations.
- The effectiveness gap is substantial — sneaks are over 30 percentage points more successful than passes.

QB Sneak Usage by Team

- PHI, CLE, and MIA led the league in QB sneak usage, each calling sneaks on at least two-thirds of their 4th-and-1 attempts.
- SF, DEN, and CHI also deployed sneaks effectively, with perfect or near-perfect success.
- Over a dozen teams called zero QB sneaks on 4th-and-1, including GB, DET, DAL, TEN, and KC, despite having multiple total attempts.
- This suggests a systemic underutilization of the most effective play in short-yardage scenarios.

Aversion After Failing on 3rd-and-1

- Across all 32 NFL teams, not a single team attempted to go for it on 4th-and-1 immediately after failing on 3rd-and-1.
- Every instance of a failed 3rd-and-1 was followed by a punt or field goal attempt.
- This universal avoidance suggests a psychological bias — coaches appear more hesitant to go for it following recent failure, even when the yardage to gain remains unchanged.

Willingness to Go for It After 3rd-and-1 Failure

- Every team showed a 100% no-attempt rate following failed 3rd-and-1 plays.
- This included aggressive teams like PHI and BAL, indicating that the pattern is consistent regardless of overall offensive philosophy.
- This behavior appears driven more by perceived momentum or risk aversion than by field position or analytics.

Expected Points Analysis

- The average EPA (expected points added) for all go-for-it attempts on 4th-and-1 was -0.76.
- Punts and field goal attempts could not be evaluated due to the lack of special teams data in the dataset.
- This limits our ability to compare going for it to alternative decisions in a statistically robust way.
- Because this value aggregates all play types (including passes and failed runs), it likely underrepresents the true value of QB sneaks specifically.

Implications for NFL Strategy

- Teams should prioritize QB sneaks on 4th-and-1. The data overwhelmingly shows that sneaks are the most reliable way to convert.
- Many teams are likely underutilizing sneaks, which may be costing them key conversions.
- Coaching decisions following failed 3rd-and-1 plays appear overly conservative and may leave value on the field.
- Without special teams data, we cannot fully evaluate the tradeoffs between going for it, punting, or attempting a field goal — this scenario should be flagged for further simulation work.

Simulation Adjustment

- Due to missing special teams data, the full comparison between going for it and punting or kicking is incomplete.

- As a workaround, simulations will assume QB sneak is the default play for 4th-and-1 go-for-it decisions.

- This isolates the most efficient play and provides a cleaner benchmark for evaluating hypothetical coaching decisions.

Conclusion

Fourth-and-1 is a high-leverage down where optimal decision-making can significantly impact a team's chances of winning. QB sneaks are clearly the best option based on both usage and success rates, yet many teams continue to rely on less effective plays or avoid going for it altogether. The complete absence of attempts following failed 3rd-and-1 plays reveals a coaching tendency toward risk aversion, even in situations where analytics suggest aggression may be justified. With further data and simulation, teams could refine their 4th-down strategies to better align with expected value and long-term win probability.