Unpacking Rushing Efficiency: Insights from NFL Yards Per Carry Analysis

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I Overview

Understanding rushing efficiency in football is essential for optimizing offensive strategy. This analysis examines how environmental conditions, field segments, and team-specific traits influence yards per carry (YPC). Using NFL play-by-play data from the 2021-2023 seasons, key insights were identified regarding the impact of factors such as temperature, roof type, playing surface, and offensive line rank on rushing performance.

II Introduction

Rushing efficiency is a critical component of offensive success in the NFL. Traditional metrics often fail to capture the contextual nuances of rushing performance. This study focuses on YPC as a measure of rushing success, integrating variables such as environmental conditions, field segments, and offensive line performance. The goal is to provide actionable insights for improving rushing strategy and game planning.

III Data and Methods

A. Data Collection

Play-by-play data from the 2021, 2022, and 2023 NFL seasons was retrieved using the nfl_data_py library. Once pulled, the dataset was filtered to include only running plays in neutral game script situations (score differential ≤ 16).

B. Variables Examined

- Environmental Factors: Temperature, roof type (open/closed), and surface type (grass/turf).
- Field Position: Segmented into 20-yard chunks (inside own 20, own 20-40, midfield, opponent 40-20, red zone).
- Team and Play Context: Offensive line rank (PFF), run gap, shotgun vs. under-center formations, and drive metrics.
- Run Gap: Numbered run gap system corresponding to a gap in between/outside of offensive linemen personnel with the number increasing as the gap gets further from the center; and left/right direction of run, with odd numbers indicating a run to the left and even indicating the inverse.
    - Gaps:
        - 0 - directly behind the center (qb sneaks/goal line/hb dive)
        - 1 / 2 - left/right side of the center
        - 3 / 4 - left/right between guard and tackle
        - 5 / 6 - left/right outside of tackle

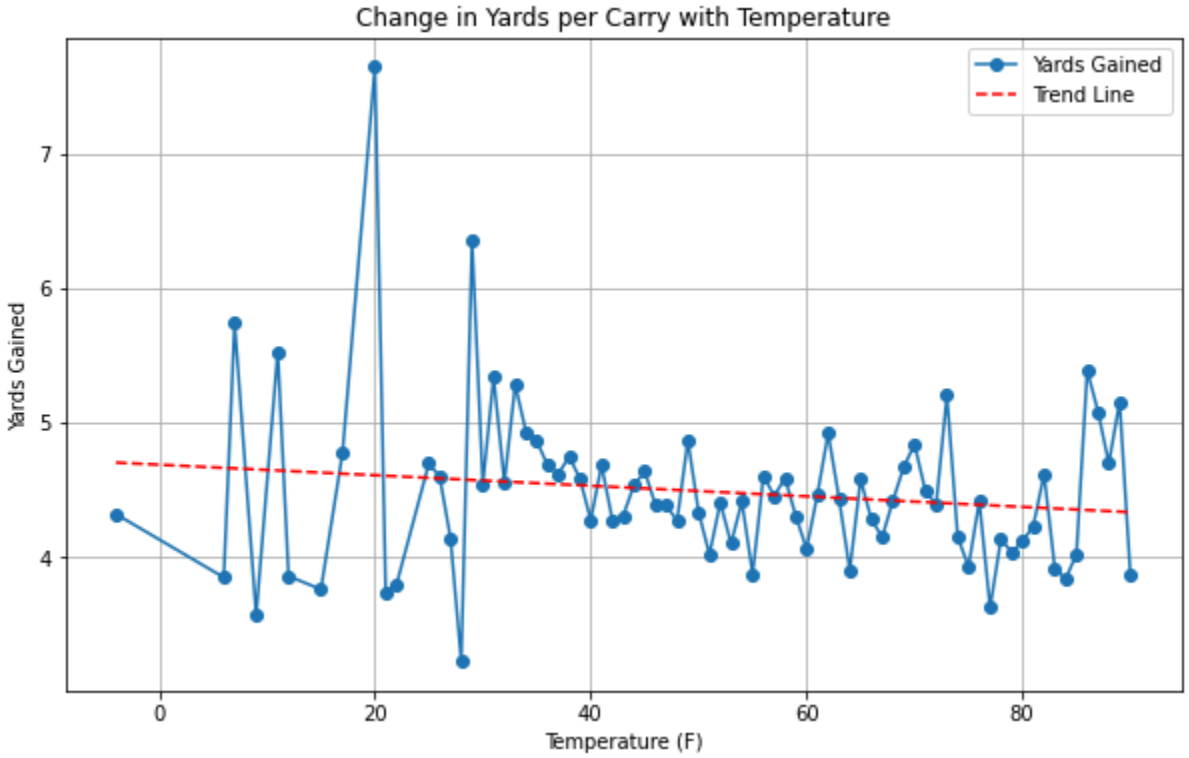
C. Analysis

Using the play-by-play dataset, exploratory visualizations were created to examine trends in YPC by temperature, roof type, surface type, and other contextual variables. Statistical modeling included linear

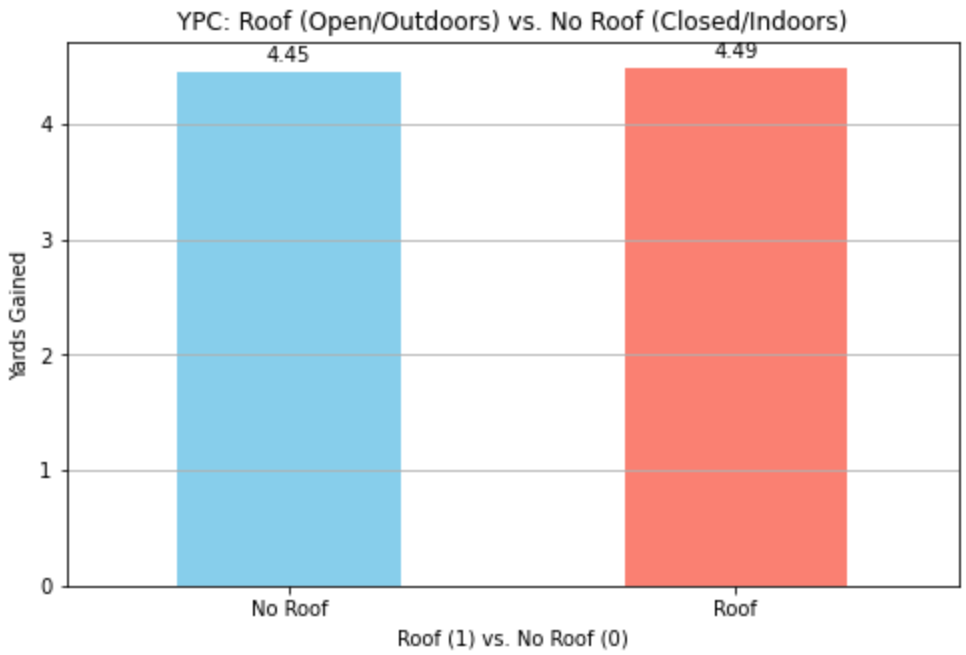
regression and Random Forest regression to assess the significance of features and their contributions to YPC.

IV Results

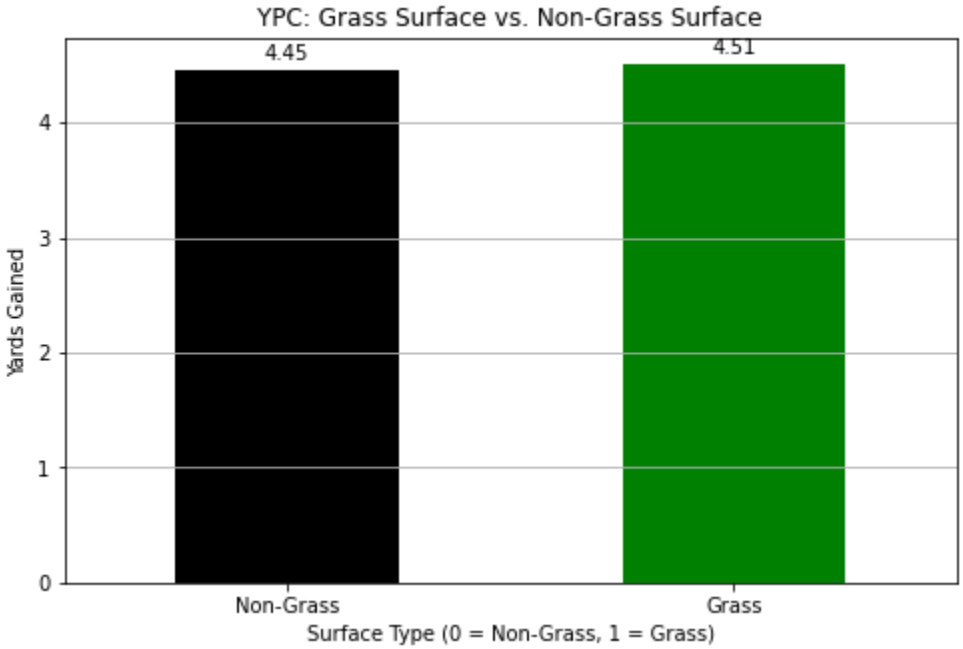
Environmental Factors



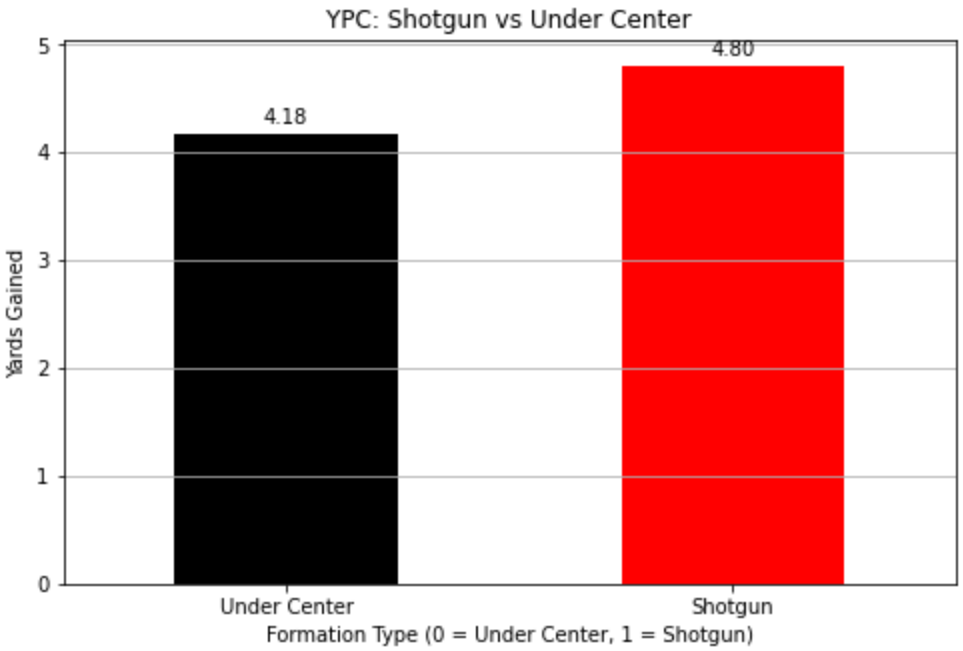
- **Temperature**: A negative correlation was found between temperature and YPC.



- **Roof Type**: Open-roof games averaged slightly higher YPC than closed-roof games.

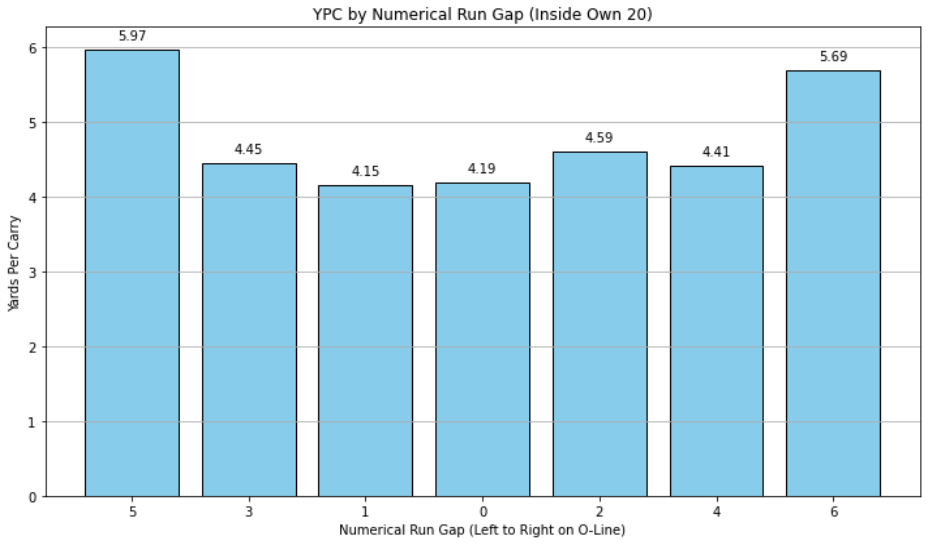


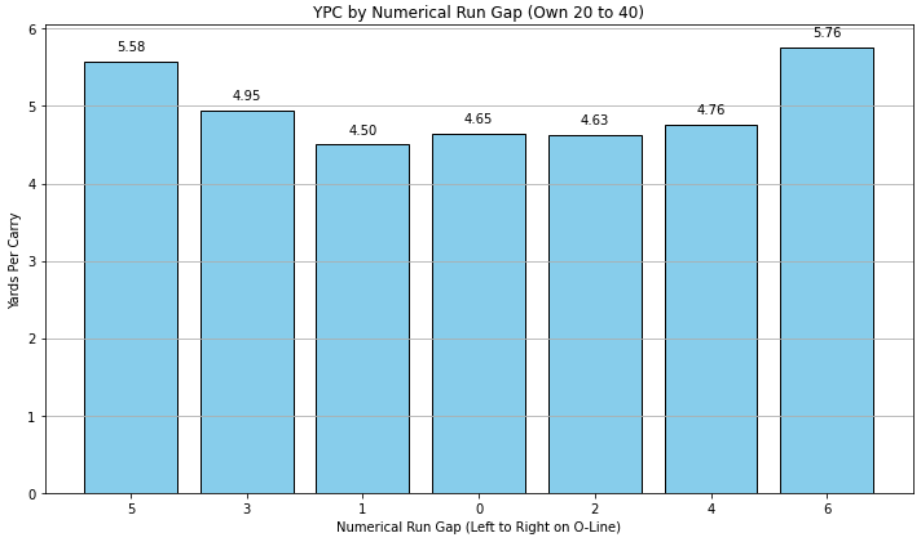
- **Surface Type**: Grass surfaces showed a minimal advantage over turf (+0.06 YPC).

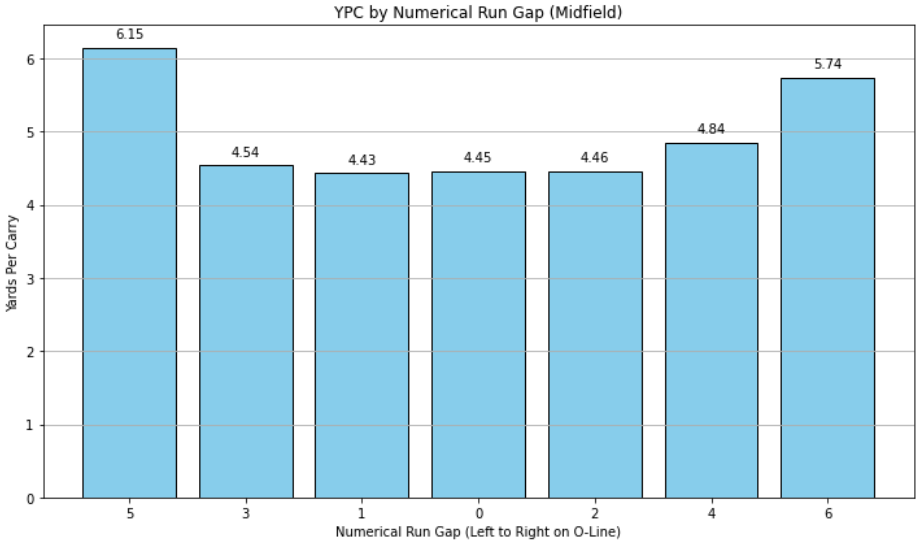


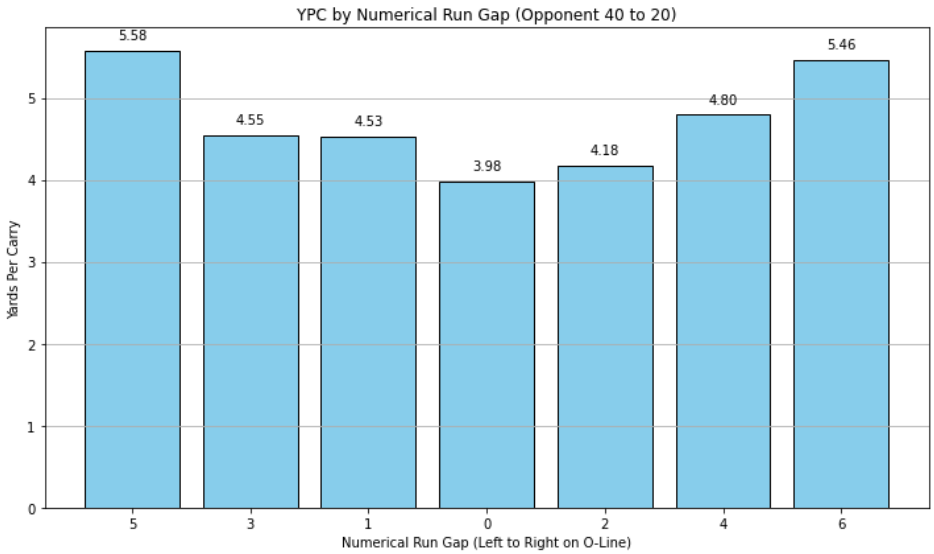
- **Formation**: Shotgun formations averaged 4.8 YPC, outperforming under-center formations (4.18 YPC).

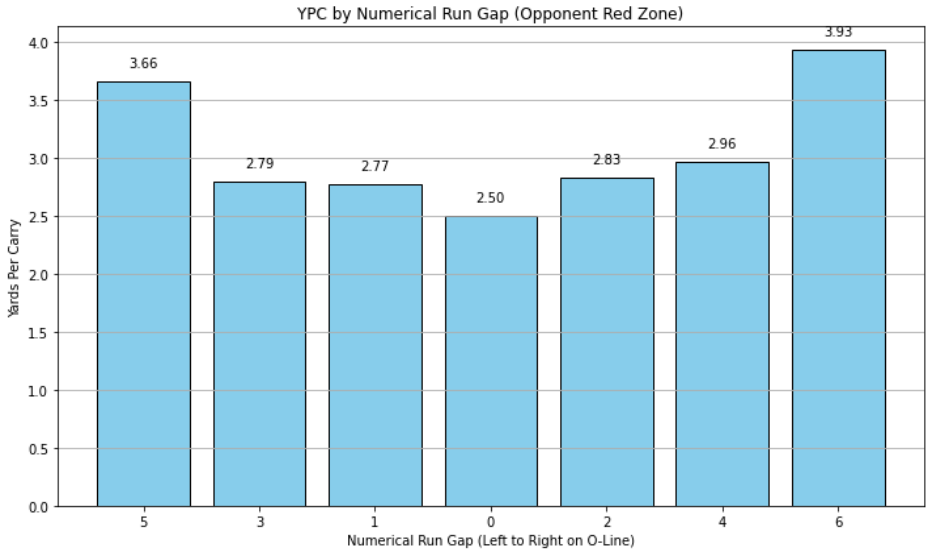
Field Segments




YPC by Numerical Run Gap (Own 20 to 40)
Yards Per Carry
Numerical Run Gap (Left to Right on O-Line)
5.58
4.95
4.50
4.65
4.63
4.76
5.76
5
3
1
0
2
4
6

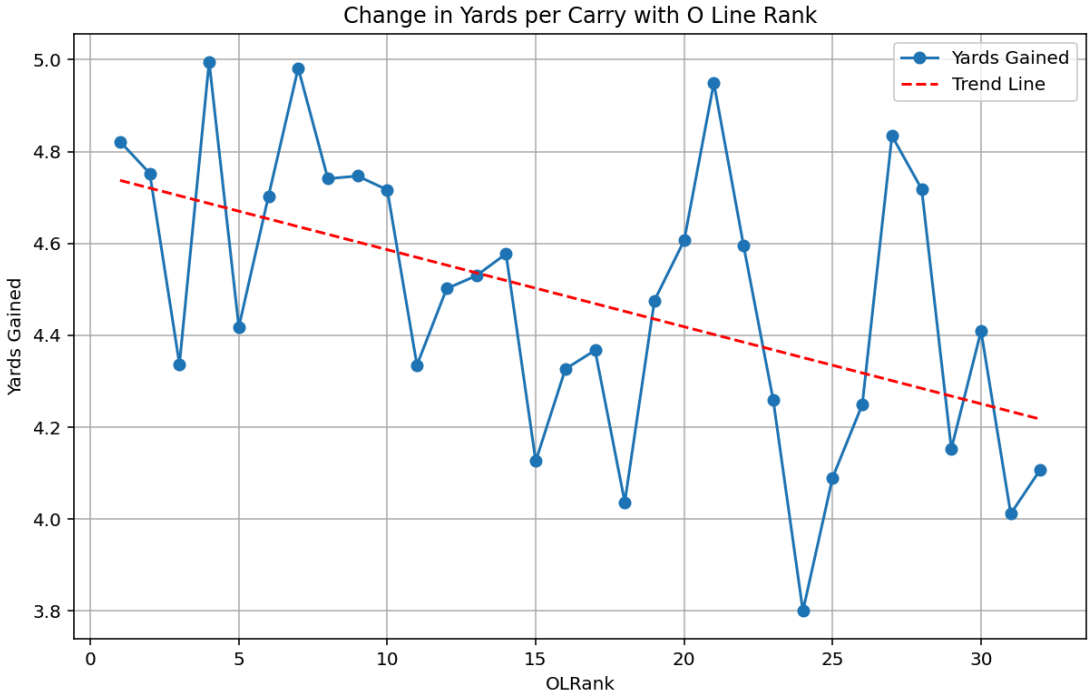

YPC by Numerical Run Gap (Midfield)
Yards Per Carry
Numerical Run Gap (Left to Right on O-Line)
6.15
4.54
4.43
4.45
4.46
4.84
5.74
5
3
1
0
2
4
6


YPC by Numerical Run Gap (Opponent 40 to 20)
Yards Per Carry
Numerical Run Gap (Left to Right on O-Line)
5.58
4.55
4.53
3.98
4.18
4.80
5.46
5
3
1
0
2
4
6



- **Opponent Red Zone**: Lowest average YPC (2.8), attributed to conservative play calling, compacted defensive formations, and relative short distance to go.
- **Own 20 to 40**: Highest average YPC (4.5), likely driven by creative run concepts looking to create momentum for drive sustenance.

Offensive Line and Formation



- **Offensive Line Rank**: Teams with top-10 offensive lines averaged 4.7 YPC, compared to 4.3 YPC for bottom-10 lines.

Discussion

The analysis demonstrates that environmental conditions, field position, and team traits significantly affect rushing efficiency. Teams with elite offensive lines consistently perform better in rushing situations, and shotgun formations provide a measurable advantage. Additionally, environmental factors such as temperature and surface type, though secondary, should not be overlooked in game planning.

Conclusion

This study highlights key variables influencing rushing performance in the NFL. By leveraging insights from environmental conditions, field segments, and offensive line performance, teams can refine their strategies to maximize rushing efficiency. Future work should integrate player tracking data and defensive alignments for a more granular understanding of rushing success.