2024 Run/Pass Variability on 3rd/4th and 2 in the NFL: Why Teams Should Look to Increase Variation for First Down Success Rate

By Peter Chapman

Research Study Overview

- 2024 NFL season analysis using Pro Football Focus
- Situation: 3rd or 4th and 2 on offense
- Total attempts and 1st down successes tracked for each team
- Play type (run or pass) marked for each attempt
- Variation in play type calculated for each NFL team
- **Research Question**: Does variability in playcalling between running and passing on 3rd or 4th and 2 have a relationship with 1st down conversion percentage?

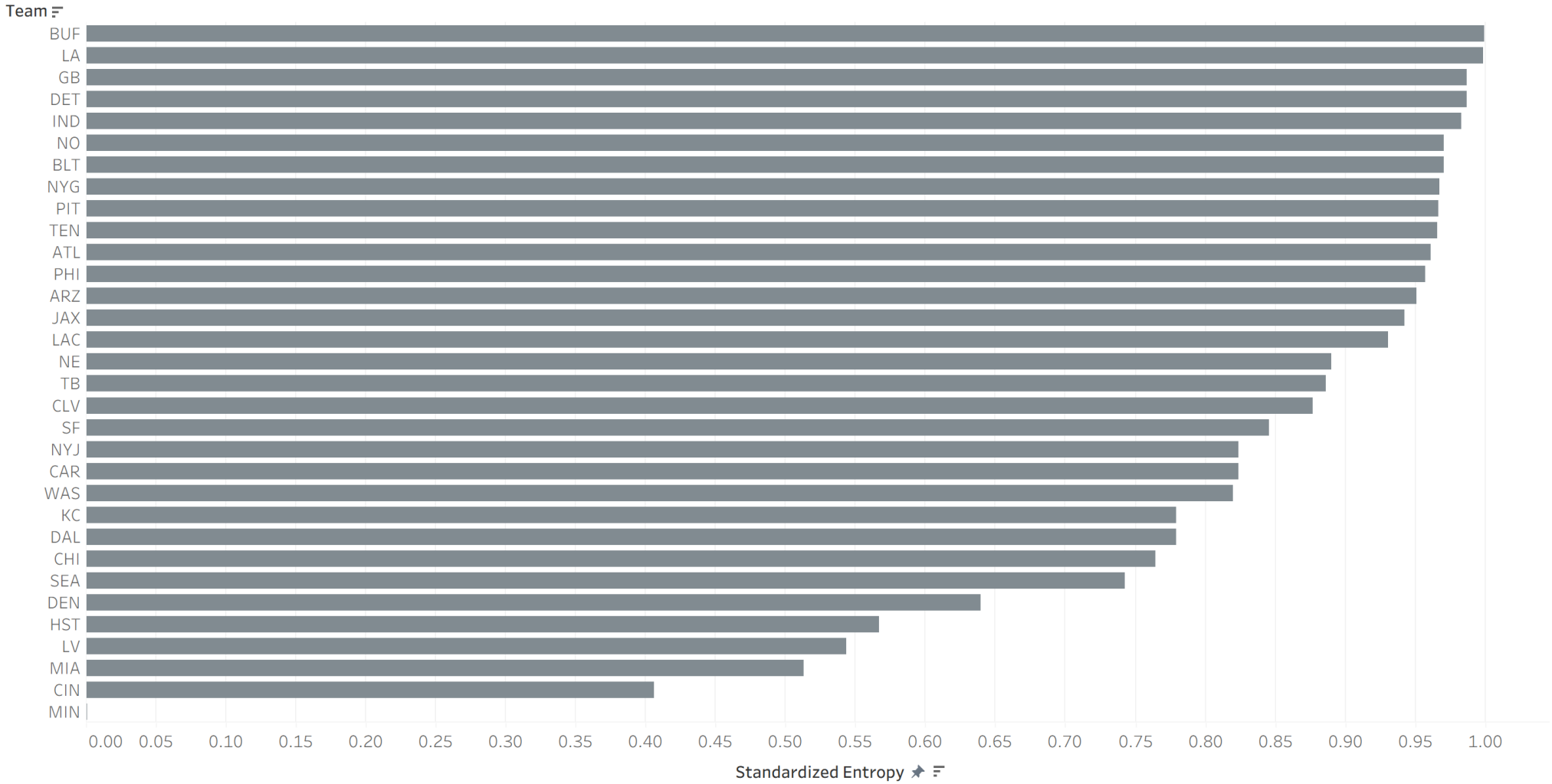
Run/Pass Entropy and Standardized Entropy

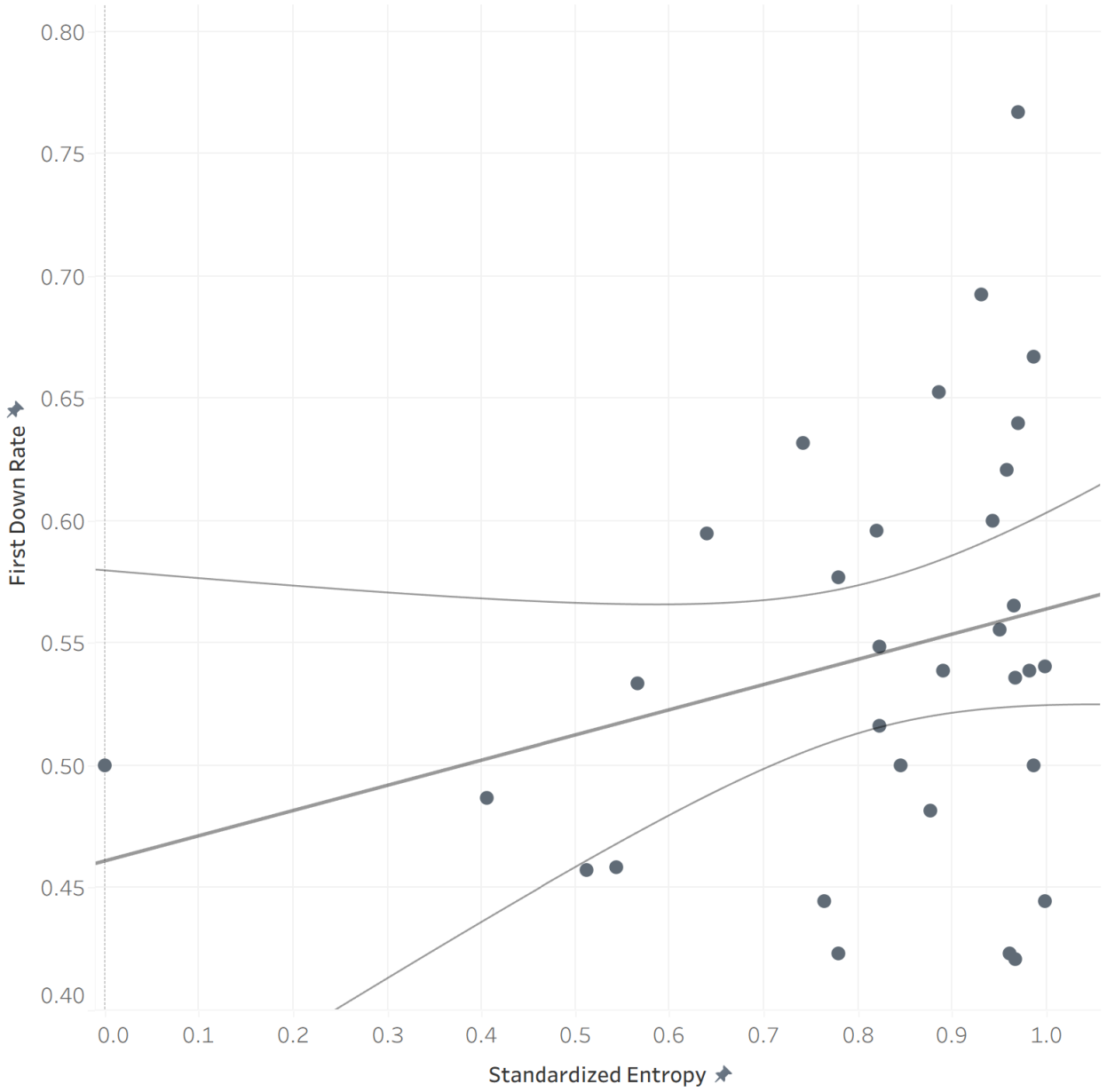
$$\text{Entropy}_{\text{Team}} = \text{ABS}[(\text{RunPercentage}_{\text{Team}} * \ln(\text{RunPercentage}_{\text{Team}})) + (\text{PassPercentage}_{\text{Team}} * \ln(\text{PassPercentage}_{\text{Team}}))]$$

$$\text{StandardizedEntropy}_{\text{Team}} = \frac{\text{Entropy}_{\text{Team}}}{\ln(2)}$$

Perfect Variability → Standardized Entropy of 100%

Distribution of Standardized Entropy





Simple Linear Regression Between Standardized Entropy and 1st Down Rate

$$\widehat{FirstDownRate}_{Team} = 0.102944 * \widehat{StandardizedEntropy}_{Team} + 0.460856$$

R-Squared: 6.98%
P-Value: 0.143906

Controlling for Team Offensive Grades

- Is playcalling variation on its own truly correlated with 1st down rate?
- **Lurking variables**: Other variables not included in the regression that also have an impact on the dependent variable
- Solution: Control for certain team offensive metrics
  - Pass Grade
  - Pass Block Grade
  - Receiving Grade
  - Rush Grade
  - Rush Block Grade
- With controls, true effect of variability on 1st down rate can be determined
- Relevant predictors will be kept in the model

Multiple Linear Regression with Controls

$$\widehat{FirstDownRate}_{Team} = 0.177177 * \widehat{StandardizedEntropy}_{Team} + 0.004003 * \widehat{PassGrade}_{Team} + 0.001790 * \widehat{ReceivingGrade}_{Team} - 0.001320 * \widehat{PassBlockGrade}_{Team} - 0.003032 * \widehat{RushGrade}_{Team} + 0.002813 * \widehat{RunBlockGrade}_{Team} + 0.074973$$

- New R-Squared: 38.7375%
- New P-Value for Standardized Entropy: 0.02046
- Relevant Predictors: Pass Grade, Run Block Grade, Standardized Entropy
- Predictors to Remove: Receiving Grade, Pass Block Grade, Rush Grade
- Conclusions
  - Multiple linear regression removed some lurking variable bias
  - Estimate for standardized entropy grew → strong relationship with 1st down percentage
  - Variability can be beneficial for converting on 3rd or 4th and 2