# Risk & NFL Play Calling

By
Benjamin Alamar, PhD
Menlo College

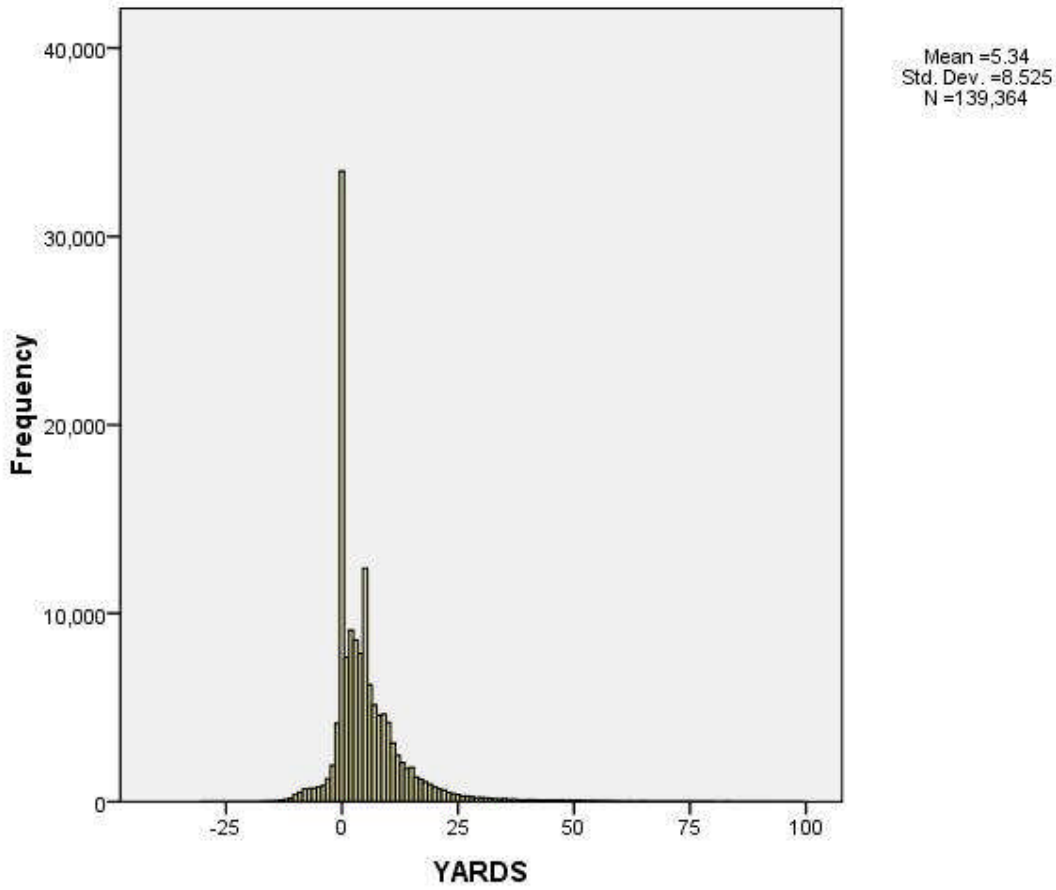
New England Symposium on Statistics in Sports
September 26, 2009

# Play Calling

- Previous work examining play calling behavior in the NFL has noted to possibility of irrational behavior (Alamar 2006, Romer 2002, Winston 2009, Rockerbie 2008).
- Most analysis suggests, based on various measures of payoff, that teams run too much.
- The increased payoff could in theory be attributed to higher risk, therefore, given the risk reward tradeoff, teams may be rational by not passing more.

# But what is risk?

- Rockerbie defines risk as the variance in yards gained/lost on a play of a given type (run or pass).
- But as the distribution of yards is not normal, higher variance is actually desirable.
- Given two plays of equal mean payoff, a coach should choose the play with a higher variance



# Play Context

- To understand risk, we first have to put the outcome in the proper context:
  - 5 yards on 2 and 5 is great, and but on 3 and 6 it likely results in punt.
- Down, distance, yardline all effect how “good” the outcome of a play is.
- Expected points (known as expected runs in baseball work) provides context and a way to measure the value of each play.

# The Expected Points Framework

- Issue of context addressed by utilizing an expected points framework.
- Expected points are the points a team scores on average given their current situation.
- Net expected points is the change in expected points that a play generates.
- Utilized in football previously (Winston 2009, Carroll et al 1989, Romer 2002)

# Expected Points Formula

$$\text{Expected Points}_t = F(Down_t, YardsToGo_t, Yardline_t)$$

$$NEP_t = \text{Expected Points}_{t+1} - \text{Expected Points}_t + \text{Points Scored}_t$$

- Could easily be expanded to include effects of “next drive” or rest of game or half
- For this work, the post play EP on turnovers is the negative of the expected points given the new game context.

# Data

- Data used to estimate the equations is NFL play by play data from the 2005 to 2008 regular seasons (as provided my Football Outsiders)
- There are 220,326 plays in the data set
- Each play includes a variable for play type (run or pass) as well as the down, yards to go for a first, distance from the end zone, team on offense, team on defense and several other play descriptors.

# Data (cont)

- From the play by play data a points on drive variable was created that calculates the total points scored on the drive
- An additional variable was calculated for the number of plays on the drive.

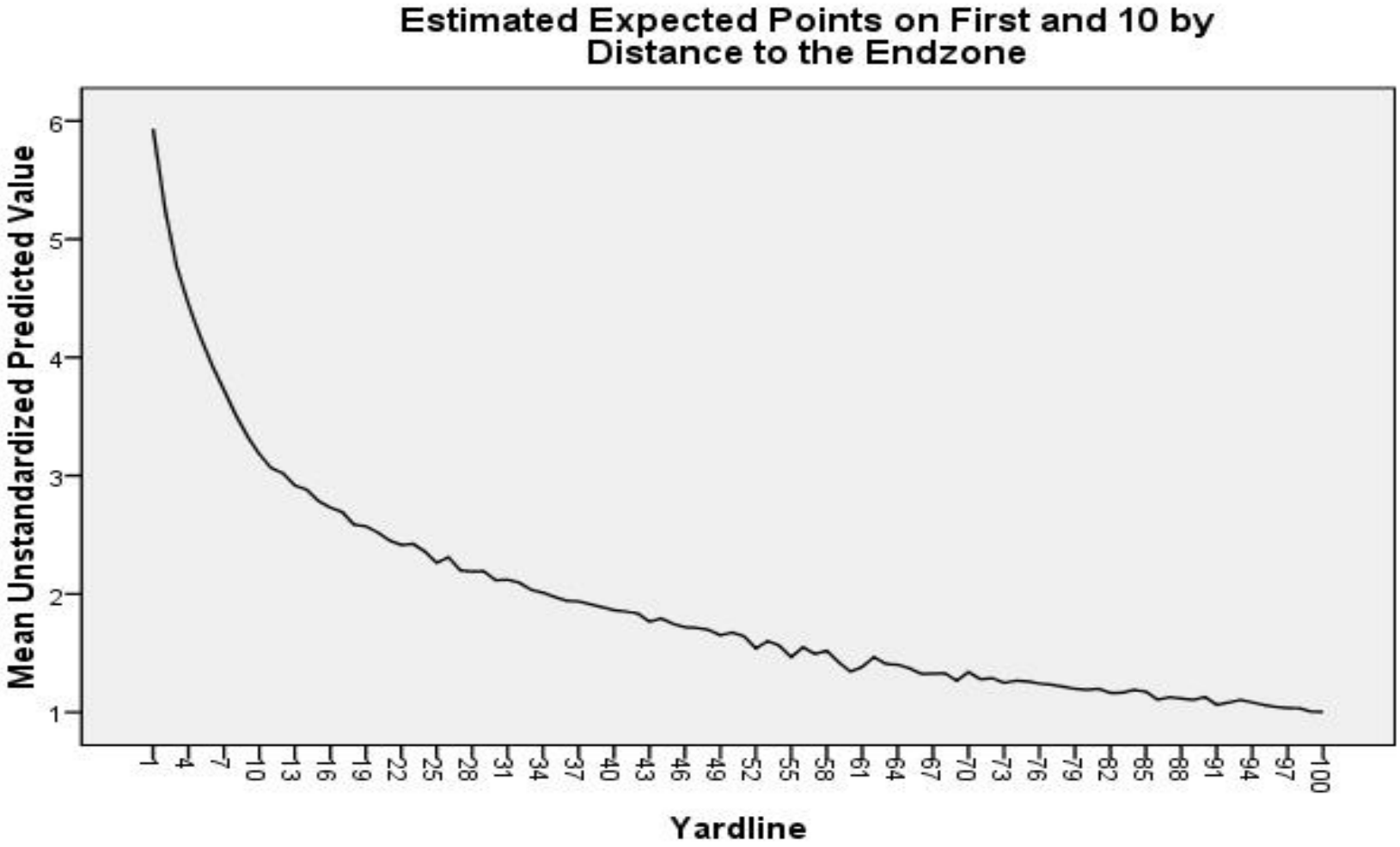
# Estimation

- The expected points equation is estimated using a weighted least squares approach (weighted by # of plays on a drive).
- Fixed effects for each team year were included (ie: 49ers2005, 49ers2006, 49ers2007 & 49ers2008).
- Statistically significant results were obtained for all control variables with a weighted $R^2$ of 0.37.

# Results of Estimation

| Results of Expected Points Weighted Least Squares Regression | | | |
|---|---|---|---|
| Variable | Estimate | Std Error | t-value |
| Constant | 6.38 | 0.09 | 73.38 |
| Down | -0.49 | 0.01 | -41.57 |
| Yards to Go | -0.07 | 0.00 | -26.83 |
| Q1 | -0.29 | 0.03 | -8.71 |
| Q2 | 0.07 | 0.03 | 2.31 |
| Q3 | -0.37 | 0.03 | -11.22 |
| Distance to Goal | -1.18 | 0.01 | -90.31 |
| Note: All estimates are significant at the 99% confidence level expect Q2 which is significant at the 95% level. Distance to goal is entered in natural log form. | | | |

# Expected Points By Distance



# Net Expected Points

- Using the estimated expected points for each play, Net Expected Points (NEP) were calculated for each play.
- As a “reality” check, the average NEP for each team for each season, for both offense and defense, were calculated.
- The top offenses and defenses, based on average NEP, were ranked.

# Top Offenses and Defenses

| Year | Offense | Average NEP | Year | Defense | Average NEP |
|---|---|---|---|---|---|
| 2007 | Patriots | 0.27 | 2008 | Steelers | -0.04 |
| 2006 | Colts | 0.26 | 2006 | Ravens | -0.03 |
| 2007 | Colts | 0.24 | 2008 | Eagles | -0.02 |
| 2008 | Saints | 0.23 | 2006 | Bears | -0.02 |
| 2005 | Bengals | 0.22 | 2008 | Ravens | 0.00 |
| 2005 | Colts | 0.22 | 2008 | Titans | 0.00 |
| 2008 | Chargers | 0.22 | 2006 | Jaguars | 0.02 |
| 2007 | Cowboys | 0.22 | 2006 | Patriots | 0.02 |
| 2005 | Seahawks | 0.21 | 2005 | Bears | 0.03 |
| 2008 | Broncos | 0.20 | 2007 | Buccaneers | 0.03 |

Note: For all teams and all seasons, Offense NEP has a correlation with winning of 0.55 and Defense NEP has a correlation with winning of -0.54.

# Expected Points and the Passing Premium

- Using plays only through the 3rd quarter in which the score difference was less than 11 points, the average NEP for passing plays and running plays was calculated
- The 0.06 difference between running and passing is statistically significant at the 99% confidence level
- Normal mean difference between running and passing results

| Play Type | Mean NEP |
|---|---|
| Run | 0.07 |
| Pass | 0.13 |

# Measuring Risk

- Risk can now be thought of as the probability that a play will produce negative NEP (risk factor – rf)
- Comparing run plays and pass plays demonstrates that passing (rf = 0.57) is less risky than running (rf=0.62) for all plays.
- Looking at specific situations, the risk profile changes. On 1st and 10 running (rf=0.66) has a much higher risk than passing (rf=0.53), while on 2nd and 3 running (rf=0.35) has a lower risk factor than passing (rf=0.44).

# Risk Variation by Play Type

# Conclusion

- The existence of the passing premium is further confirmed by the use of the expected points framework.
- If team's passed more, they would increase their probability of winning by both achieving a higher mean NEP and a lower probability of negative NEP plays.
- Coach's insistence on balancing the run and pass seems to be irrational, as running creates a lower expected outcome with increased risk.