Redefining the Penalty Kick: Does the Punishment Fit the Crime?

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Abstract: In soccer, the practice of awarding a penalty kick to a player fouled near the goal has been a long-standing method attempting to keep the game as fair as possible. Recently, watching games play out and stats accumulate has indicated that penalty kicks are converted to goals at a rate much higher than shots are scored during regular play. Previous studies have shown many inconsistencies in how and when fouls are called and the potentially monumental impact a penalty kick can have on the outcome of a match. This identified a need for the redefinition of the current penalty kick to create a scoring opportunity more comparable to the opportunity players would have had in the absence of the foul. Using StatsBomb open data at the event level for the 2018 Men's World Cup, we used a general additive model approach to predict expected goals for different distances and angles to the goal. The goal was to change the location of the penalty kick, so the chances of scoring were closer to the chances during regular play. We proposed replacing the current penalty kick spot with a penalty kick arc. The format of the arc would position the kick-taker based on where the foul occurred within the box as well as extending the distance from which the kick is taken. We believe this new method of penalty kicks will allow for a fairer experience while keeping the traditional aspects of the game fairly constant.

Men's World Cup 2018 Scoring Percentages

Penalty Kick Scoring

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Number of PKs	29
PK Goals Scored	22
Scoring Percentage	75.86%

Regular Play Scoring within the Box

Shots within the 18	940
Goals Scored	111
Scoring Percentage	11.81%

Challenge

- Shots within the PK box are scored at a disproportional rate in comparison to penalty kicks.
- A redefinition of the penalty kick could solve this problem.

Methods

- General Additive Model
  - Beta family, logit link
  - Response: Statsbomb Expected Goals
  - Predictors
    - Distance to closest defender, k = 9
    - Angle to goal, k = 9
    - Distance to goal, k = 9
    - Defenders Behind Ball, k= 3
- Prediction for Current PK:
  - 74%

Observed vs Predicted Values
General Additive Model
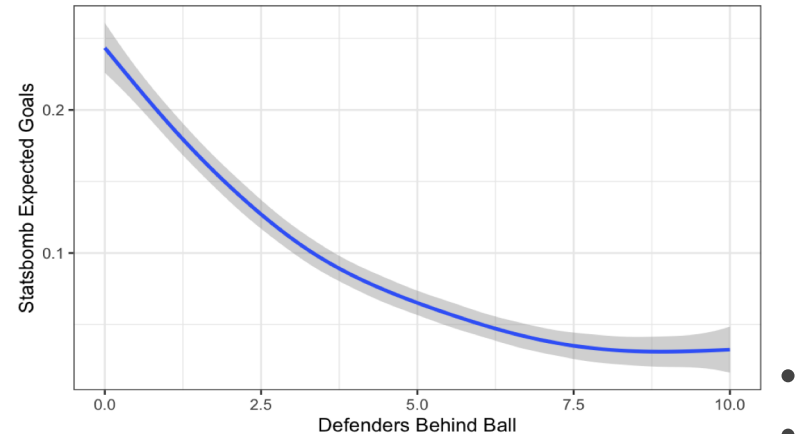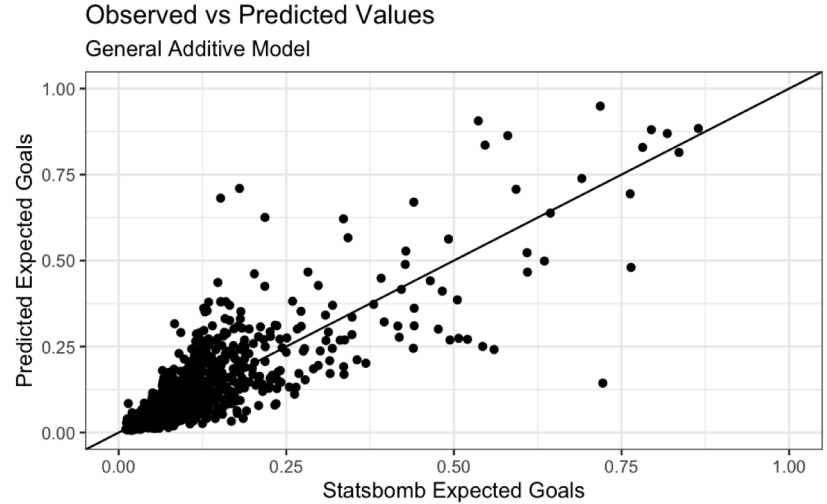
Conclusion: The Penalty Arc

- Hold constant defenders behind ball and distance to closest defender
- Adjust angle and distance to goal to come to a more reasonable PK location

- Final Recommendation:
- Arc 18 yards from goal, outside marks at 50°
- If fouled outside arc, brought into closest mark
- If fouled in arc, placed on arc at horizontal location of the foul
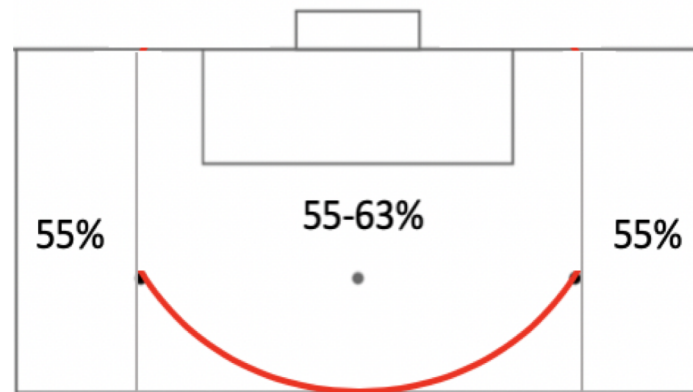
*Percentages represent expected goals from each area, with 63% being the center of the arc