

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

Bria Cratty & Jack de la Parra

01

THE PROBLEM



Men's World Cup 2018 Scoring Percentages

Penalty Kick Scoring

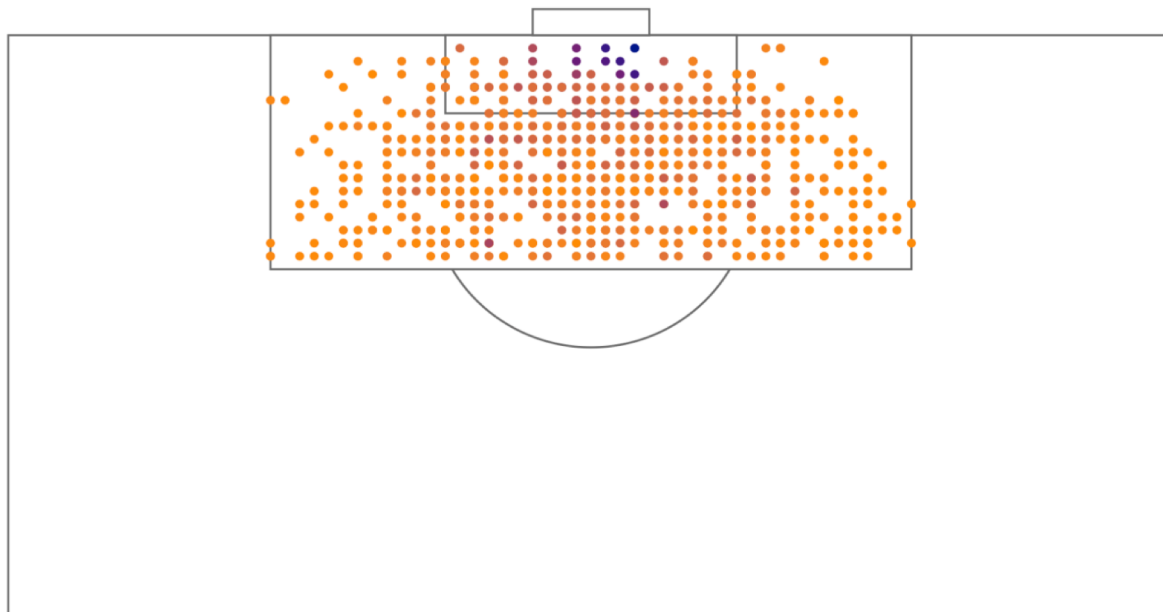
Number of PKs	29
PK Goals Scored	22
Scoring Percentage	75.86%

Regular Play Scoring within the Box

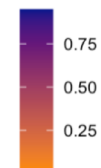
Shots Taken within the 18	940
Goals Scored	111
Scoring Percentage	11.81%

Expected Goals for Open Play Shots

Men's World Cup 2018



Statsbomb Expected Goals





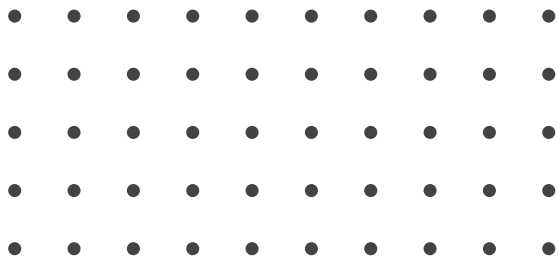
Goal:

- Re-configure the penalty kick to make for a more fair penalty kick opportunity
 - Reshape or move the location of the kick



02

BUILDING THE MODEL



Model Objectives

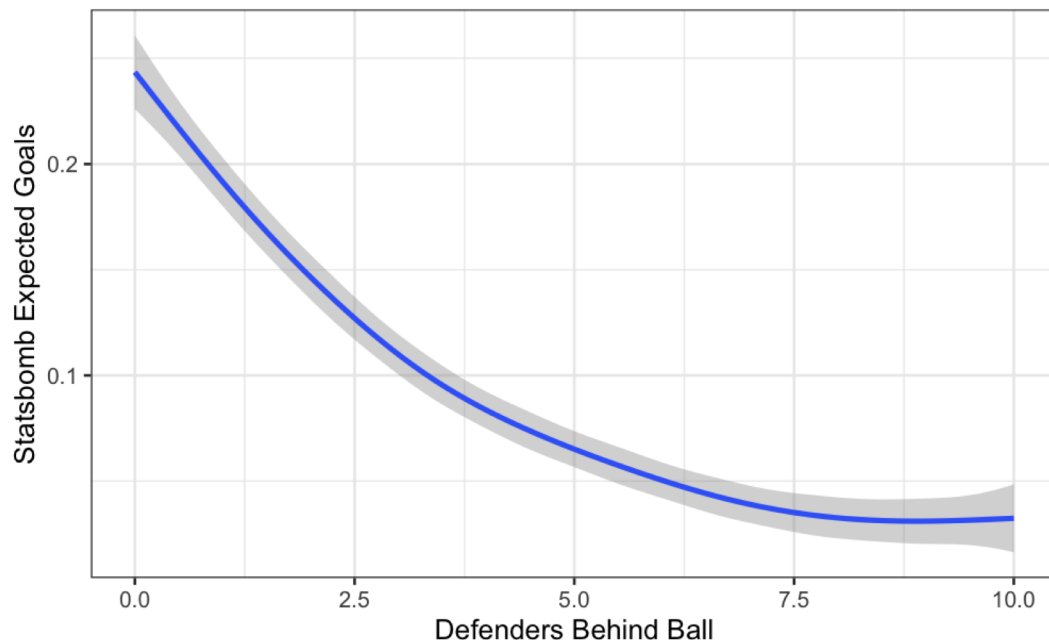
- No change in box shape
- Model for how expected goals change at different penalty kick distances and angles
 - Calibrate model to ~75% for current penalty kick distance and angle
- Find a new location and angle with reduced expected goals



Generalized Additive Model

- Beta family, logit link
- Used shot data excluding penalty kicks
 - 1638 observations
- Original Model:
 - Used distance to goal, angle to goal and distance to closest defender
 - Not predicting correctly for PK
- Considered adding defenders behind ball variable to the model
 - Decide between linear or smoothed term

Smoothing Spline More Appropriate for Defenders Behind Ball



- Seems to have an exponential relationship
 - Not captured linearly
- K value of 9 not needed

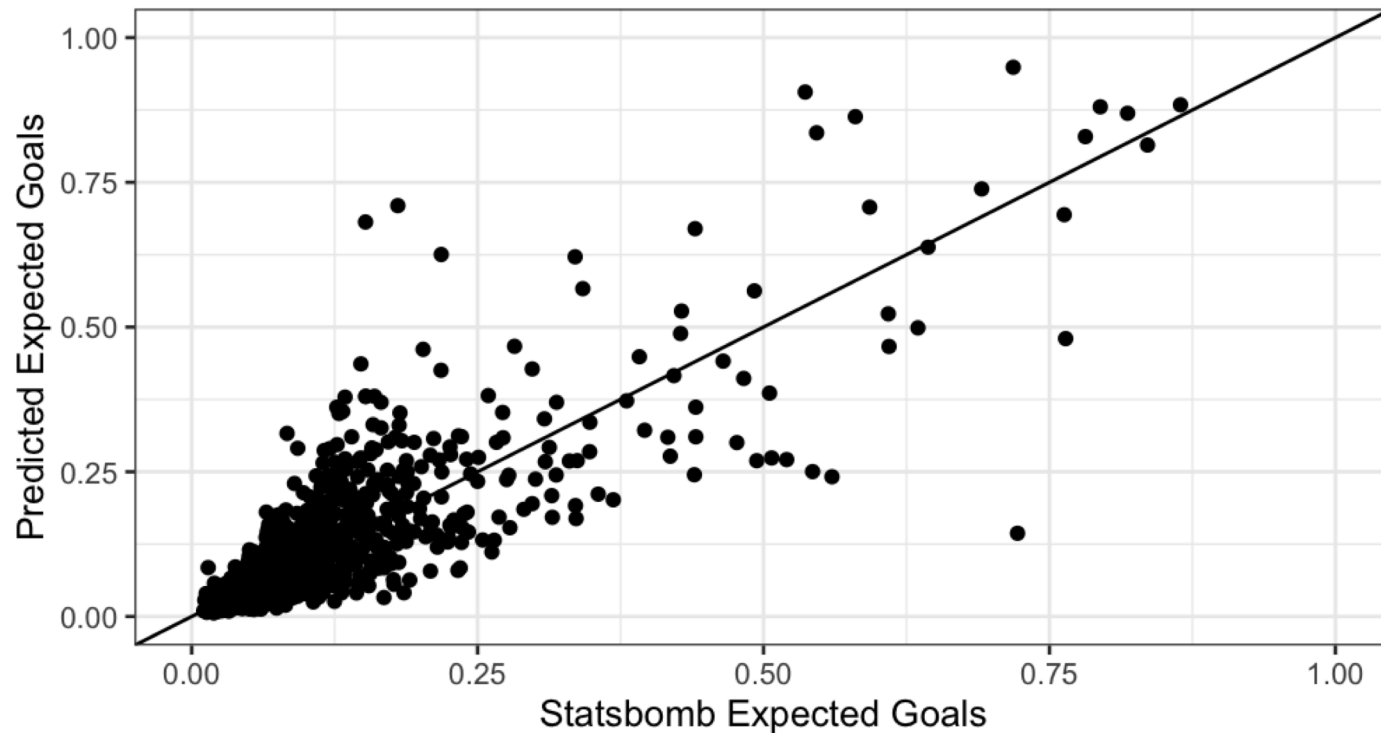


Final Model

- Generalized Additive Model
 - 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



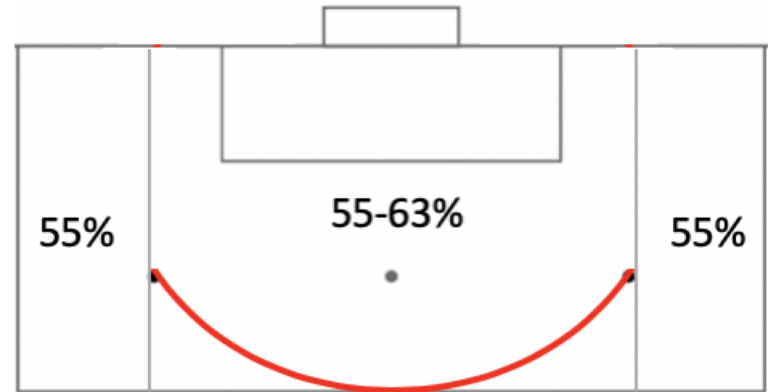
03

CONCLUSIONS



The Penalty Arc

- 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



THANKS &
QUESTIONS?