## Mathematical Appendix

Most of the methodology I used followed closely to David Robinson's, replacing at-bats and hits with shots and goals respectively.

Initial Bayesian Estimates

The initial Bayesian model is estimated using a Beta prior distribution with the following distribution of conversion percentage $c_i$ (values determined through empirical distribution fitting):

$c_i \sim \text{beta}(\alpha_0, \beta_0)$
$\alpha_0=3.26$
$\beta_0=32.5$

This means the prior point estimate for each player is just the mean:

$\mu_0 = \alpha_0/(\alpha_0 + \beta_0) \approx 0.0912$

And the conversion percentage point estimates are derived as such:

$\hat{c}_i = (\text{goals}_i + \alpha_0)/(\text{shots}_i + \alpha_0 + \beta_0)$

Beta-Binomial Regression Estimates

With the Beta-Binomial regression we assume the following two linked distributions:

$c_i \sim \text{beta}(\alpha_0, \beta_0)$
$\text{goals}_i \sim \text{binomial}(\text{shots}_i, c_i)$

We then parameterise using the following approach

$\sigma_0 = 1/(\alpha_0 + \beta_0)$
$\mu_0 = \alpha_0/(\alpha_0 + \beta_0)$

$c_i \sim \text{beta}(\mu_0/\sigma_0, (1- \mu_0)/ \sigma_0)$

Now we can define individual priors for each player (the coefficients are estimated using a logistic regression):

$\mu_i = \mu_0 + \mu_{\text{shots}} \log(\text{shots}_i)$

And individualised alphas and betas:

$\alpha_{0,i} = \mu_i/\sigma_0$
$\beta_{0,i} = (1- \mu_i)/ \sigma_0$

And now the prior distributions for each player are individualised as well and we can use these priors to estimate the conversion percentages in the same Bayesian way as above:

$c_i \sim \text{beta}(\alpha_{0,i}, \beta_{0,i})$
$\text{goals}_i \sim \text{binomial}(\text{shots}_i, c_i)$