Parameters 2015-2020 model 12

Rates for the home and away goals

$$\ln \lambda_k(t) = \ln \alpha_i + \ln \beta_j + \ln \gamma_h + \mathbb{I}\{\text{half} = 2\} \ln \tau + \omega_{\text{goal}}(x(t) - y(t)) + \omega_{\text{player}}(y^*(t) - x^*(t)) + \omega_{\text{value}}(v_i - v_j)$$

$$\ln \mu_k(t) = \ln \alpha_j + \ln \beta_i + \mathbb{I}\{\text{half} = 2\} \ln \tau + \omega_{\text{goal}}(y(t) - x(t)) + \omega_{\text{player}}(x^*(t) - y^*(t)) + \omega_{\text{value}}(v_j - v_i)$$

- i: home team index;
- j: away team index;
- α: attack strength parameter;
- $1/\beta$: defense strength parameter;
- γ_h: home advantage parameter;
- τ: second half parameter;
- $x(t)$: the number of goals of the home team until minute t;
- $y(t)$: the number of goals of the away team until minute t;
- $x^*(t)$: the number of red cards of the home team until minute t;
- $y^*(t)$: the number of red cards of the away team until minute t;
- v_i: log of the value of the home team's starting roster in euros;
- v_j: log of the value of the away team's starting roster in euros;
- ω_{goal}: parameter that measure the impact of leading in the score in the rates;
- ω_{player}: parameter that measure the impact of having extra players on the field;
- ω_{value}: parameter that measure the impact of the difference in value of the starting rosters.

Rates for the home and away red cards

$$\lambda_k^*(t) = A_\lambda \left(t + 45^{\mathbb{I}\{\text{half} = 2\}} \right)$$

$$\mu_k^*(t) = A_\mu \left(t + 45^{\mathbb{I}\{\text{half} = 2\}} \right)$$

Stoppage time

The stoppage time for the first half, U^1, and the second half, U^2, are modeled as:

$$U^1 \sim \text{Poisson}(\eta_1 + \rho_1 r^1)$$

$$U^2 \sim \text{Poisson}(\eta_2 + \rho_2 r^2 + \kappa c)$$

- r^t is the amount of red cards received in half t until minute 45;

- $c = \begin{cases} 1, & \text{if } |x - y| \leq 1 \text{ at minute 45 of the second half;} \\ 0, & \text{otherwise.} \end{cases}$

Constraint

The constraint for identificability is

$$\sum_i^n \log(\alpha_i) = \sum_i^n \log(\beta_i).$$

```r
options(knitr.kable.NA = "-")
options(scipen = 999)

library(dplyr)
library(knitr)

load("data/input.RData")
load("data/mod_12.RData")
```

```r
alphas_betas = tibble(Team = times$Time,
                alpha = exp(mod_12$alpha),
                beta = exp(mod_12$beta))
kable(alphas_betas, digits = 4, caption = "Alphas and betas",
      col.names = c("Team", "$\\alpha$", "$\\beta$"))
```

Table 1: Alphas and betas

Team	α	β
América-MG	0.0629	0.0949
Athletico-PR	0.0965	0.0748
Atlético-GO	0.0948	0.0871
Atlético-MG	0.1154	0.1015
Avaí	0.0700	0.0983
Bahia	0.1019	0.0900
Botafogo	0.0861	0.0861
Ceará	0.0980	0.0743
Chapecoense	0.0883	0.0947
Corinthians	0.0960	0.0774
Coritiba	0.0844	0.0851
Cruzeiro	0.0804	0.0861
Csa	0.0565	0.1029
Figueirense	0.0751	0.0938

Team	α	β
Flamengo	0.1137	0.0898
Fluminense	0.0905	0.0946
Fortaleza	0.1029	0.0797
Goiás	0.0992	0.1045
Grêmio	0.1025	0.0778
Internacional	0.0937	0.0747
Joinville	0.0650	0.0838
Palmeiras	0.1169	0.0814
Paraná	0.0456	0.0967
Ponte Preta	0.0961	0.0905
Red Bull Bragantino	0.1117	0.0734
Santa Cruz	0.1083	0.1275
Santos	0.1069	0.0812
São Paulo	0.0941	0.0862
Sport	0.0944	0.1003
Vasco da Gama	0.0820	0.0951
Vitória	0.1018	0.1117

```r
Parameter = c("$\\gamma_h$", "$\\tau$",
              "$\\omega_{{\\text{goal}}}$",
              "$\\omega_{{\\text{player}}}$",
              "$\\omega_{\\text{value}}$")
goals = tibble(Parameter,
               Estimative = c(exp(mod_12$gamma),
                              exp(mod_12$tau),
                              mod_12$omega))
kable(goals, digits = 4, caption = "Goal rate parameters")
```

Table 2: Goal rate parameters

Parameter	Estimative
γ_h	1.5425
τ	1.2248
ω_{goal}	-0.0984
ω_{player}	0.3316
ω_{value}	0.1608

```r
Parameter = c("$A_\\lambda$", "$A_\\mu$")
reds = tibble(Parameter, Estimative = exp(mod_12$a))
kable(reds, digits = 8, caption = "Red card rate parameters")
```

Table 3: Red card rate parameters

Parameter	Estimative
A_λ	0.00001973
A_μ	0.00003190

```r
Parameter = c("$\\eta_1$", "$\\eta_2$", "$\\rho_1$", "$\\rho_2$", "$\\kappa$")
st = tibble(Parameter,
            Estimative = c(mod_12$eta, mod_12$rho, mod_12$kappa))
kable(st, digits = 4, caption = "Stoppage time parameters")
```

Table 4: Stoppage time parameters

Parameter	Estimative
η_1	2.4359
η_2	3.7394
ρ_1	1.1400
ρ_2	0.2267
κ	1.0101

```r
mod_12$loglik
```

```
## [1] -25850.64
```