Parameters Série A 2019

Rates for the home and away teams

Model 0

$$\lambda_k = \alpha_i \beta_j \gamma_h$$
$$\mu_k = \alpha_j \beta_i$$

- i: home team index;
- j: away team index;
- α: attack strength parameter;
- $1/\beta$: defense strength parameter;
- γ_h: home advantage parameter.

Model 1

$$\lambda_k(t) = \alpha_i \beta_j \gamma_h$$
$$\mu_k(t) = \alpha_j \beta_i$$

Model 2

$$\lambda_k(t) = \alpha_i \beta_j \gamma_h \tau^{\mathbb{I}\{\text{half} = 2\}}$$
$$\mu_k(t) = \alpha_j \beta_i \tau^{\mathbb{I}\{\text{half} = 2\}}$$

- τ: second half parameter.

Model 3

$$\lambda_k(t) = \alpha_i \beta_j \gamma_h \tau^{\mathbb{I}\{\text{half} = 2\}} \lambda_{xy}$$
$$\mu_k(t) = \alpha_j \beta_i \tau^{\mathbb{I}\{\text{half} = 2\}} \mu_{xy}$$

- $\lambda_{xy} = \begin{cases} 1, \text{ if } x = y; \\ \lambda_{10}, \text{ if } x > y; \\ \lambda_{01}, \text{ if } x < y; \end{cases}$
- $\mu_{xy} = \begin{cases} 1, \text{ if } x = y; \\ \mu_{10}, \text{ if } x > y; \\ \mu_{01}, \text{ if } x < y. \end{cases}$

Stoppage time

For all models except model 0, the stoppage time for the first half, U^1, and the second half, U^2, are modeled as:

$$U^1 \sim \text{Poisson}(\eta_1 + \phi_1 g^1)$$
$$U^2 \sim \text{Poisson}(\eta_2 + \phi_2 g^2 + \kappa c)$$

- g^t is the amount of goals scored in half t until minute 45;
- $c = \begin{cases} 1, & \text{if } |x - y| \leq 1 \text{ at minute 45 of the second half;} \\ 0, & \text{otherwise.} \end{cases}$

```
# options(OutDec = ",")
options(knitr.kable.NA = "-")

library(dplyr)
library(knitr)

load("dados_serie_a_2019.RData")
load("mod_0.RData")
load("mod_1.RData")
load("mod_2.RData")
load("mod_3.RData")
```

```
alphas = tibble(Time = times$Time,
                mod_0 = exp(mod_0$alpha),
                mod_1 = exp(mod_1$alpha),
                mod_2 = exp(mod_2$alpha),
                mod_3 = exp(mod_3$alpha))
kable(alphas, digits = 4, caption = "Alphas")
```

Table 1: Alphas

Time	mod_0	mod_1	mod_2	mod_3
Athletico-PR	1.0000	1.0000	1.0000	1.0000
Atlético-MG	0.9004	0.8942	0.8946	0.8698
Avaí	0.3650	0.3677	0.3676	0.3420
Bahia	0.8739	0.8735	0.8739	0.8485
Botafogo	0.6167	0.6195	0.6189	0.6031
Ceará	0.7130	0.7093	0.7091	0.6789
Chapecoense	0.6219	0.6247	0.6244	0.6093
Corinthians	0.8251	0.8276	0.8272	0.8201
Cruzeiro	0.5376	0.5418	0.5417	0.5130
CSA	0.4846	0.4884	0.4882	0.4592
Flamengo	1.6998	1.7065	1.7071	1.8153
Fluminense	0.7572	0.7557	0.7551	0.7296
Fortaleza	1.0008	1.0046	1.0045	1.0149
Goiás	0.9376	0.9331	0.9330	0.9045
Grêmio	1.2665	1.2769	1.2769	1.2902
Internacional	0.8697	0.8643	0.8645	0.8569
Palmeiras	1.1966	1.1994	1.1991	1.2331

Time	mod_0	mod_1	mod_2	mod_3
Santos	1.1784	1.1883	1.1884	1.2431
São Paulo	0.7625	0.7587	0.7582	0.7633
Vasco da Gama	0.7762	0.7727	0.7720	0.7658

```
betas = tibble(Time = times$Time,
               mod_0 = exp(mod_0$beta),
               mod_1 = exp(mod_1$beta),
               mod_2 = exp(mod_2$beta),
               mod_3 = exp(mod_3$beta))
kable(betas, digits = 4, caption = "Betas")
```

Table 2: Betas

Time	mod_0	mod_1	mod_2	mod_3
Athletico-PR	0.7826	0.0079	0.0071	0.0066
Atlético-MG	1.1911	0.0120	0.0108	0.0103
Avaí	1.4597	0.0150	0.0134	0.0137
Bahia	1.0436	0.0106	0.0095	0.0090
Botafogo	1.0754	0.0110	0.0098	0.0096
Ceará	0.9855	0.0100	0.0090	0.0087
Chapecoense	1.2431	0.0126	0.0113	0.0111
Corinthians	0.8227	0.0084	0.0075	0.0069
Cruzeiro	1.0941	0.0112	0.0101	0.0098
CSA	1.3752	0.0141	0.0126	0.0128
Flamengo	0.9453	0.0096	0.0086	0.0078
Fluminense	1.1086	0.0113	0.0101	0.0097
Fortaleza	1.1984	0.0122	0.0109	0.0103
Goiás	1.5593	0.0158	0.0141	0.0139
Grêmio	0.9696	0.0099	0.0088	0.0084
Internacional	0.9463	0.0096	0.0086	0.0081
Palmeiras	0.7921	0.0081	0.0072	0.0068
Santos	0.8160	0.0083	0.0075	0.0069
São Paulo	0.7232	0.0073	0.0065	0.0061
Vasco da Gama	1.0857	0.0110	0.0098	0.0094

```
param = tibble(Model = 0:3,
               gamma = c(exp(mod_0$gamma), exp(mod_1$gamma), exp(mod_2$gamma), exp(mod_3$gamma)),
               tau = c(NA, NA, exp(mod_2$tau), exp(mod_3$tau)),
               lambda_10 = c(NA, NA, NA, exp(mod_3$lambda_xy["10"])),
               lambda_01 = c(NA, NA, NA, exp(mod_3$lambda_xy["01"])),
               mu_10 = c(NA, NA, NA, exp(mod_3$mu_xy["10"])),
               mu_01 = c(NA, NA, NA, exp(mod_3$mu_xy["01"])),
               eta_1 = c(NA, mod_1$eta[1], mod_2$eta[1], mod_3$eta[1]),
               eta_2 = c(NA, mod_1$eta[2], mod_2$eta[2], mod_3$eta[2]),
               phi_1 = c(NA, mod_1$phi[1], mod_2$phi[1], mod_3$phi[1]),
               phi_2 = c(NA, mod_1$phi[2], mod_2$phi[2], mod_3$phi[2]),
               kappa = c(NA, mod_1$kappa, mod_2$kappa, mod_3$kappa))
kable(param, digits = 4, caption = "Other parameters",
      col.names = c("Model", "$\\gamma_h$", "$\\tau$", "$\\lambda_{10}$",
```

```
                    "$\\lambda_{01}$", "$\\mu_{10}$", "$\\mu_{01}$", "$\\eta_1$",
                    "$\\eta_2$", "$\\phi_1$", "$\\phi_2$", "$\\kappa$"))
```

Table 3: Other parameters

Model	γ_h	τ	λ_{10}	λ_{01}	μ_{10}	μ_{01}	η_1	η_2	ϕ_1	ϕ_2	κ
0	1.4957	-	-	-	-	-	-	-	-	-	-
1	1.4990	-	-	-	-	-	2.8341	3.6016	0.2261	0.2075	1.5566
2	1.4994	1.2284	-	-	-	-	2.8341	3.6016	0.2261	0.2075	1.5566
3	1.6761	1.2707	0.7697	1.0283	1.2564	0.7582	2.8341	3.6016	0.2261	0.2075	1.5566