Measuring the effects of rest and tiredness in soccer and tennis outcomes

Chloé Lepert
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Advisor: Professor Stigler

Agenda

- Soccer
    - Question asked
    - Literature review
    - Data
    - Models and their outcomes
    - Soccer conclusions
- Time permitting: Tennis

How does the number of days since a previous match impact a soccer team's performance?

Table 3: Distribution of rest time (in days) for home and away teams

		Visitor						
		2	3	4	5	6	7	8
	2	128	9	1	0	3	0	1
	3	12	343	155	22	38	121	7
	4	0	165	238	43	38	91	61
Home	5	1	26	50	63	31	90	31
	6	3	22	34	42	110	278	41
	7	0	118	74	93	302	798	110
	8	1	3	47	42	32	106	272

Existing research on tiredness in soccer focuses on ability to complete physical tasks

- Carlos Lago Penas looked at distance run at certain speed by players over a succession of matches with low rest between matches and found no differences

- Dupond et. al. found that soccer players playing 2 times a week had a higher rate of injury but did not have worse physical performance

Data

- R package “engsoccerdata” provides dates, and results for all matches involving English team in the past century
    - We look at matches between 1995 and 2015 to ensure data completeness
    - Variables we look at include: the date, home team, visitor team, number of home goals, number of visitor goals

Data - Rest days - 1

- The first division of English soccer team plays in the Premier League along with other English championship (FA Cup,…) and European championships (Europa League Champions League)
    - In the Premier league each team plays each other twice in a round robin fashion
    - All other games are part of tournaments in which the best team moves forward
- We use all matches to compute the rest days of teams
- Calculate the effect of number of rest days on Premier league matches

Data - Rest days

	Sun	M	Tue.	W	Thu.	F	Sat.	Sun.	M	Tue.	W	Thu.	F	Sat.	Sun.
Man City	PL - 11						PL -12							PL - 13	
Arsenal	PL - 11			CL - 1/4			PL - 12								PL - 13
Man United	PL - 11							PL - 12							PL - 13

- 2 variables for rest:
  - Number of days of rest
  - Whether or not the number of days of rest exceeds 5 (high rest) or not (low rest)
- On day 12, Man City plays Arsenal at home. Man City has 6 days of rest (high rest) and Arsenal has 3 (low rest)
- On day 13, Arsenal plays Man Unites at home. Man United has 7 days of rest (high rest) and Arsenal as 8 days (high rest)

Data - Control variables

- Total number of matches played in a season
- Attacking strength and defensive weakness
  - Attacking strength = average number of goals scored by a team / average number of goals scored in the premier league
  - Defensive weakness = average number of goals conceded by a team / average number of goals conceded in the premier league
  - Calculate attacking strength and defensive weakness using the previous year’s performance

Data - Response

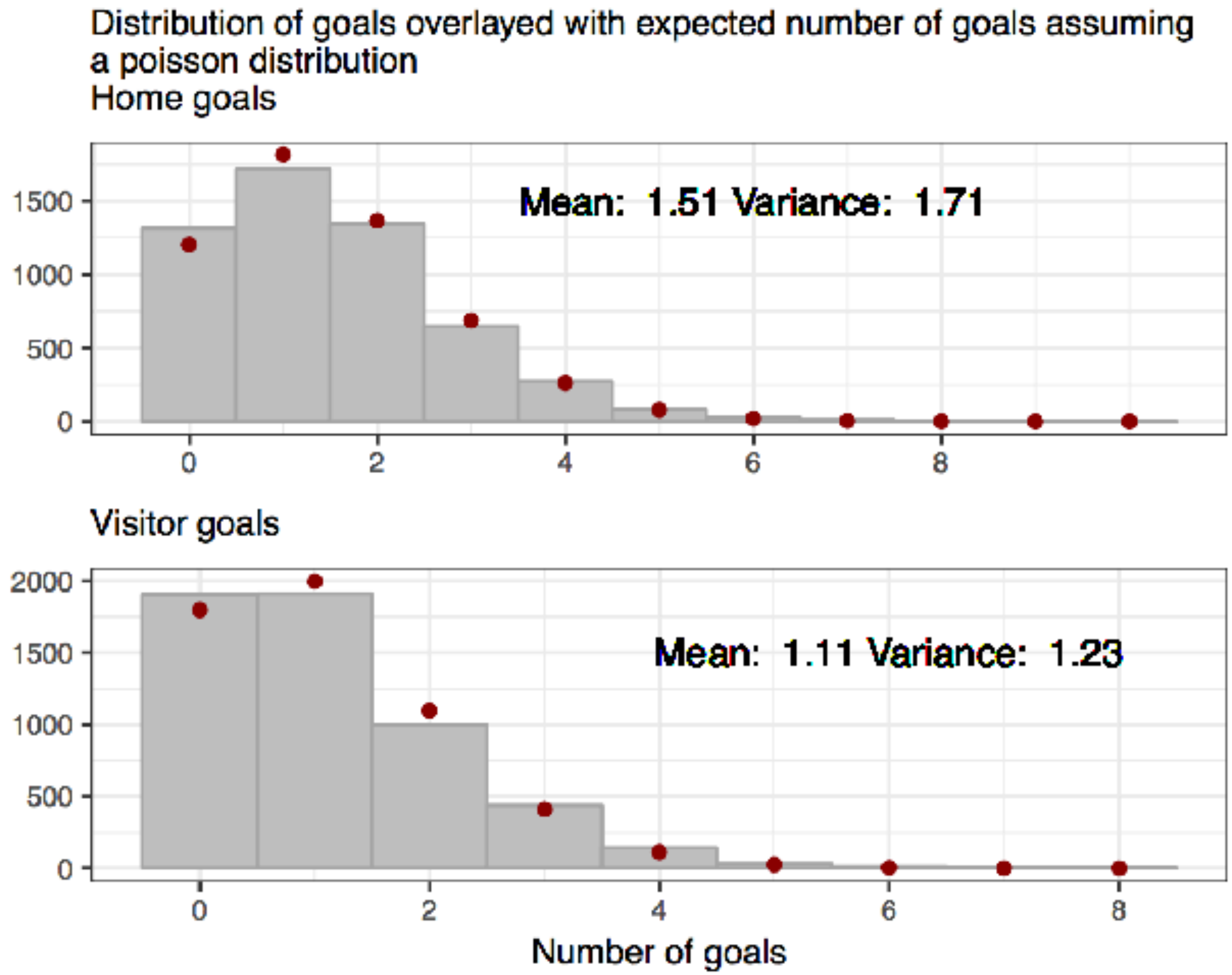


Table 2: Distribution of game outcomes

Outcome	Number of games	Share of games
Home win	1,966	0.458
Tie	1,143	0.266
Visitor win	1,187	0.276

Models

- GLM with Poisson Link
- Linear model for goal difference
- Proportional odds cumulative logit model
- Bivariate Poisson

GLM with Poisson link

- Let $j = h, a$ be an indicator for whether we are modeling home or away games.
- Let $G_{j,i}$ be the number of home or away goals in game i.
- Let x_i be the predictors for game i.
- Assume that $G_j \sim Poisson(\lambda_j)$. $P_P(G_{j,i} = g_{j,i}) = \frac{\lambda_j^{g_{j,i}} e^{\lambda_{j,i}}}{g_{j,i}!}$
- The parameter λ_j is a linear combination of the predictors X_j: $\lambda_j = X_j \beta_j$

Table 5: Generalized Linear Models with Poisson link

	Dependent variable:			
	Home goals		Visitor goals	
	(1)	(2)	(3)	(4)
Team rest (days)	−0.004 (0.009)		−0.007 (0.011)	
Opponent rest (days)	−0.001 (0.009)		0.005 (0.011)	
Team rest > 5 days		0.047 (0.031)		−0.044 (0.036)
Opponent rest > 5 days		−0.052* (0.031)		0.043 (0.037)
Team attacking strength	0.371*** (0.050)	0.377*** (0.050)	0.427*** (0.053)	0.425*** (0.053)
Opp. defensive weakness	0.274*** (0.061)	0.280*** (0.061)	0.238*** (0.061)	0.239*** (0.061)
Team load	0.015*** (0.003)	0.017*** (0.003)	0.011*** (0.003)	0.010*** (0.003)
Opponent load	−0.020*** (0.003)	−0.021*** (0.003)	−0.024*** (0.004)	−0.023*** (0.004)
Constant	−0.036 (0.205)	−0.077 (0.199)	−0.025 (0.231)	−0.041 (0.223)
Observations	4,296	4,296	4,296	4,296
Log Likelihood	−6,597.132	−6,595.641	−5,804.871	−5,804.193
Akaike Inf. Crit.	13,208.260	13,205.280	11,623.740	11,622.390
Note:				*p<0.1; **p<0.05; ***p<0.01

Bivariate Poisson

- Assume that $G_j \sim Poisson(\lambda_j + \lambda_g)$.
- The parameter λ_g is a linear combination of the predictors X: $\lambda_g = X_g \beta_j$

The probability distributions for the number of goals by the home and away team is given by:

$$P_{BP}(G_h = g_h, G_a = g_a | \lambda_h, \lambda_a, \lambda_g) = e^{-(\lambda_h + \lambda_a + \lambda_g)} \frac{\lambda_h^{g_h}}{g_h!} \frac{\lambda_a^{g_a}}{g_a!} \sum_{i=0}^{min(g_h, g_a)} \binom{g_h}{i} \binom{g_a}{i} i! \left(\frac{\lambda_g}{\lambda_g \lambda_a} \right) \quad (1)$$

Table 8: Bivariate model for number of goals scored by each team

		(1)	(2)
Home	Intercept	-0.254***(0.017)	-0.252***(0.018)
	Visitor defensive weakness	0.427***(0.005)	0.418***(0.005)
	Visitor load	-0.021***(0)	-0.019***(0)
	Visitor rest (days)		-0.004***(0.001)
	Visitor rest >5 days	-0.081***(0.003)	
	Home attacking strength	0.451***(0.004)	0.45***(0.004)
	Home load	0.014***(0)	0.013***(0)
	Home rest (days)		0.001 (0.001)
	Home rest >5 days	0.06***(0.002)	
Visitor	Intercept	0.1***(0.02)	0.046**(0.022)
	Visitor Attacking strength	0.5***(0.004)	0.506***(0.004)
	Visitor load	0.008***(0)	0.008***(0)
	Visitor rest (days)		-0.01***(0.001)
	Visitor rest >5 days	-0.075***(0.003)	
	Home defensive weakness	0.275***(0.005)	0.278***(0.005)
	Home load	-0.028***(0)	-0.028***(0)
	home rest (days)		0.01***(0.001)
	Home rest >5 days	0.055***(0.003)	
Game	Intercept	0.156 (0.179)	0.872***(0.164)
	Visitor attacking strength	-0.891***(0.054)	-0.891***(0.059)
	Visitor defensive strength	-2.785***(0.073)	-2.641***(0.083)
	Visitor load	-0.008**(0.003)	-0.012***(0.004)
	Visitor rest		0.054***(0.011)
	Visitor rest >5 days	0.456***(0.086)	
	Home attacking strength	-1.241***(0.08)	-1.289***(0.077)
	Home defensive weakness	-0.478***(0.054)	-0.505***(0.058)
	Home load	0.057***(0.003)	0.051***(0.003)
	Home rest (days)		-0.07***(0.01)
	Home rest >5 days	-0.129***(0.035)	

Linear Model for goal difference

- Square root of a poisson random variable can be approximated as a normal r.v.
- Difference of square root goals can be modeled by linear model

Table 6: Linear model for the difference in goals scored

	Dependent variable:
	Goal difference
Team rest (days)	−0.005 (0.010)
Opponent rest (days)	−0.003 (0.010)
Team attacking strength	0.399*** (0.057)
Team defensive weakness	−0.277*** (0.057)
Opp. attacking strength	−0.380*** (0.050)
Opp. defensive weakness	0.364*** (0.066)
Team load	0.019*** (0.003)
Opponent load	−0.015*** (0.003)
Constant	−0.037 (0.246)
Observations	4,296
R^2	0.138
Adjusted R^2	0.136
Residual Std. Error	0.878 (df = 4287)
F Statistic	85.434*** (df = 8; 4287)
Note:	*p<0.1; **p<0.05; ***p<0.01

Proportional Odds Logit Cumulative model

We have three possible outcomes: a home win, tie, or visitor win. Each outcome has a probability π_i of happening. The probabilities of the three outcomes sum to 1 as no other outcome is possible. $\pi_h + \pi_t + \pi_v = 1$

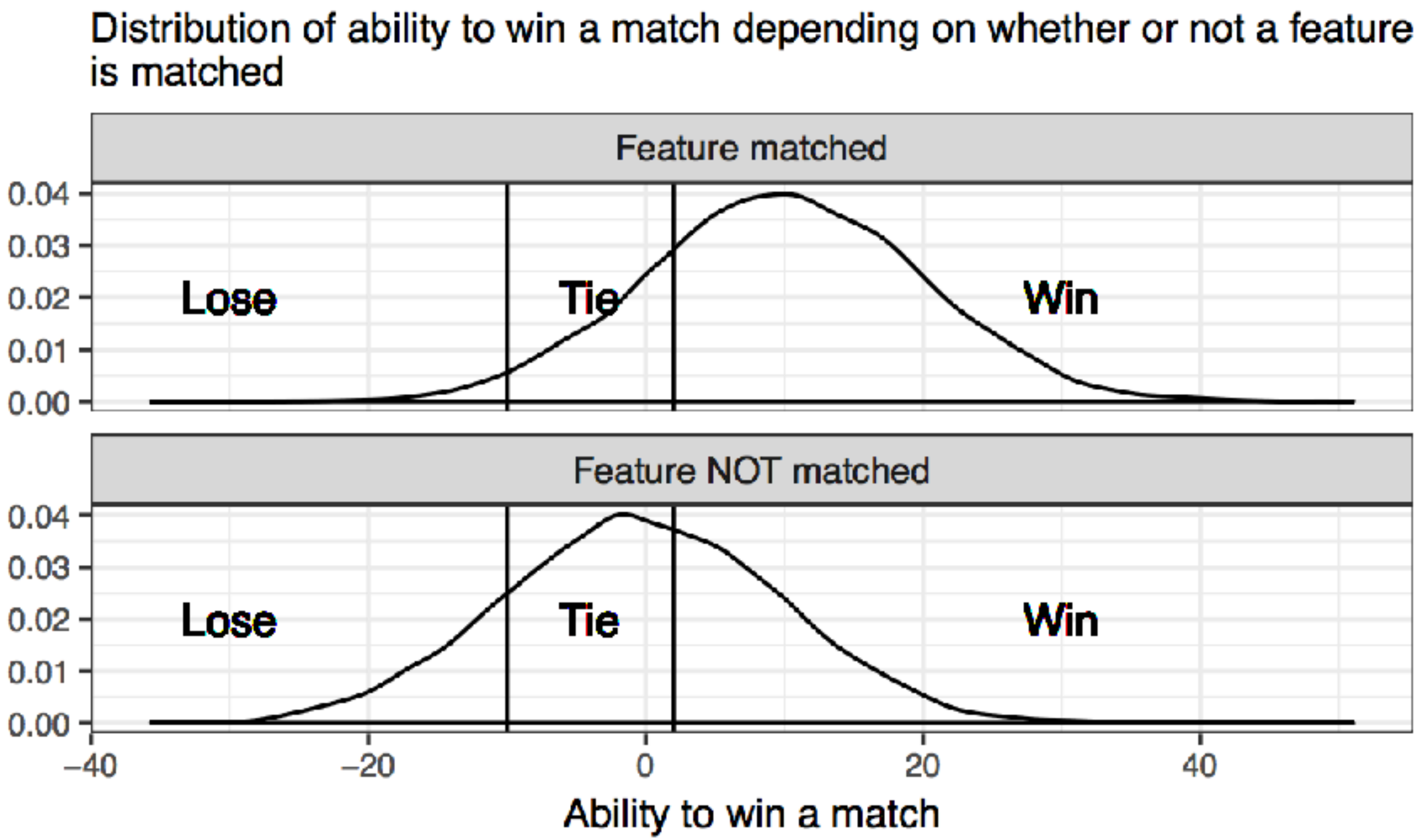
The probability that home loses is $1 - \pi_h - \pi_t = \pi_v$ and its log odds are $L_v = \log\left(\frac{\pi_v}{\pi_h + \pi_t}\right)$

The probability that home loses or ties is $1 - \pi_h = \pi_v + \pi_t$ and its log odds are $L_t = \log\left(\frac{\pi_v + \pi_t}{\pi_h}\right)$

The log odds of these two events are assumed to be a linear combination of the predictors; $L_v = \alpha_v + X\beta_v$ and $L_t = \alpha_t + X\beta_t$.

In the proportional odds model we require the coefficients β_v and β_t to be the same; $L_v = \alpha_v + X\beta$ and $L_t = \alpha_t + X\beta$.

Proportional Odds Logit Cumulative model



Discussion

- Tried 4 types of model
    - Only one resulted in a significant effect for rest
    - Proportional odd logit and GLM with poisson link have advantage of easy explainability
- We do not find an effect of rest on match outcomes. Possible reasons why:
    - Soccer is a low scoring game, rest may have an impact on performance but not a big enough one to be measured in scores
    - Teams have 23+ players but at most 14 play in a single match. Managers may be controlling for rest in the teams they field.

Tennis

Table 10: Effect of previous match length on winning probability by match type

	Dependent variable:	
	Win probability	
	(1)	(2)
Diff. in ranking points	0.351*** (0.007)	0.352*** (0.007)
Player is seeded	0.444*** (0.017)	0.446*** (0.017)
Opponent is seeded	−0.444*** (0.017)	−0.446*** (0.017)
Surface: carpet - PMLD (hours)		−0.029 (0.047)
Surface: clay - PMLD (hours)		0.033** (0.015)
Surface: grass - PMLD (hours)		−0.050** (0.023)
Surface: hard - PMLD (hours)		−0.011 (0.012)
Best of 3 - PMLD (hours)	0.024** (0.009)	
Best of 5 - PMLD (hours)	−0.096*** (0.018)	
Constant	0.000 (0.010)	−0.000 (0.010)
Observations	90,620	90,620
Log Likelihood	−56,641.040	−56,653.550
Akaike Inf. Crit.	113,294.100	113,323.100
Note:		*p<0.1; **p<0.05; ***p<0.01