Is There Persistence In Sequences of Consecutive Football Results?

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A question of enduring fascination to sports fans concerns the nature of persistence in sequences of consecutive match results

- Does a sequence of wins build a team's confidence and morale, increasing the probability that the next match will also be won?
- Or does it create pressures or breed complacency, increasing the likelihood that the next match will be drawn or lost?
- Does a sequence of losses sap confidence or morale, increasing the probability of a further loss in the next match?
- Or does it inspire greater effort, increasing the likelihood that the next match will be won or drawn?

Examine these questions using English league results data for 40 seasons (1969-70 to 2008-09, inclusive)

Table 1: longest sequences of consecutive results in data set based on four criteria:

- matches without a win
- matches without a loss
- consecutive wins
- consecutive losses

Breaks between seasons are ignored

Table 1: Longest runs of consecutive results, 1969-70 to 2008-09

Matches unbeaten		End-month	**Consecutive wins**		End-month
Arsenal	49	Oct-04	Arsenal	14	Aug-02
Nottm Forest	42	Nov-78	Newcastle Utd	13	Oct-92
Chelsea	40	Oct-05	Reading	13	Oct-85
Reading	33	Feb-06	Charlton Athletic	12	Mar-00
Bristol Rovers	32	Jan-74	Fulham	12	Oct-00
Liverpool	31	Mar-88	Liverpool	12	Oct-90
Arsenal	30	Oct-02	Luton Town	12	Apr-02
Leeds Utd	30	Feb-74	Manchester Utd	12	Aug-00
Consecutive defeats			**Matches without a win**		
Sunderland	17	Aug-03	Derby County	36	Aug-08
Walsall	15	Feb-89	Cambridge Utd	31	Apr-84
Brighton & Hove Albion	12	Jan-73	Hull City	27	Nov-89
Brighton & Hove Albion	12	Oct-02	Oxford Utd	27	Aug-88
Carlisle Utd	12	Dec-03	Newport County	25	Jan-71
Barnet	11	Oct-93	Rochdale	25	Aug-74
MK Dons	11	Mar-04			
Stoke City	11	Aug-85			
West Bromwich Albion	11	Dec-95			

Table 2: Empirical unconditional and conditional match result probabilities

n	Probability of a win, conditional on n = number of previous consecutive matches without a win		Probability of a win or draw, conditional on n = number of previous consecutive losses		Probability of a loss, conditional on n = number of previous consecutive matches without a loss		Probability of a loss or draw, conditional on n = number of previous consecutive wins	
	Home (1)	Away (2)	Home (3)	Away (4)	Home (5)	Away (6)	Home (7)	Away (8)
0	**0.477**	0.247	0.753	0.523	0.247	0.477	0.523	0.753
1	0.465	0.236	0.731	0.494	0.232	0.464	0.496	0.738
2	0.451	0.228	0.715	0.474	0.222	0.449	0.478	0.716
3	0.438	0.219	0.695	0.456	0.210	0.438	0.460	0.693
4	**0.433**	0.216	0.686	0.442	0.199	0.423	0.451	0.663
5	0.422	0.212	0.670	0.415	0.191	0.406	0.424	0.646
7	0.409	0.202	0.611	0.413	0.168	0.387	0.382	0.583
10	0.396	0.190	-	-	0.132	0.344	-	-
15	0.344	0.177	-	-	0.114	0.303	-	-
20	0.346	0.163	-	-	0.086	0.294	-	-

Of 81,258 matches in data set, 38,775=home wins, 22,426=draws, 20,057=away wins; therefore 0.477 = 38775/81258 is the unconditional home win probability (col(1) n=0), and so on

Two types of reversals: WD|L reversals - cols (3)-(6); W|DL reversals - cols (1), (2), (7) & (8)

Col 1(n=4): 0.433 = 6610/15260 is home win probability conditional on home team having played at least four consecutive matches without a win, prior to the match in question

Monte Carlo analysis: in the absence of persistence, we assume that the statistical model (below) accurately represents the distribution of match results in each season in each division

The result of the match between home team i and away team j is generated as follows

Home win (k=2)	if $\mu_2 < y^*_{i,j} + \varepsilon_{i,j}$	
Draw (k=1)	if $\mu_1 < y^*_{i,j} + \varepsilon_{i,j} < \mu_2$	
Away win (k=0)	if $y^*_{i,j} + \varepsilon_{i,j} < \mu_1$	[1]

where $y^*_{i,j} = \alpha_i - \alpha_j$; α_i and α_j are parameters reflecting the playing strengths of team i and team j; μ_1 and μ_2 are additional ('cut-off') parameters; and $\varepsilon_{i,j} \sim N(0,1)$ is a random disturbance term, following a standard Normal distribution (with zero mean and variance of one)

The disturbance term represents the random element in the result of the match between teams i and j

Table 3:Premiership table 2008-09 and ordered probit team quality parameter estimates

	Won	Drawn	Lost	League points	Win ratio	$\hat{\alpha}_i$
Manchester United	28	6	4	90	.8158	1.6534
Liverpool	25	11	2	86	.8026	1.4863
Chelsea	25	8	5	83	.7632	1.3943
Arsenal	20	12	6	72	.6842	1.1348
Everton	17	12	9	63	.6053	.8941
Aston Villa	17	11	10	62	.5921	.8372
Fulham	14	11	13	53	.5132	.6379
Tottenham Hotspur	14	9	15	51	.4868	.5685
West Ham United	14	9	15	51	.4868	.5622
Manchester City	15	5	18	50	.4605	.4771
Wigan Athletic	12	9	17	45	.4342	.3757
Stoke City	12	9	17	45	.4342	.3944
Bolton Wanderers	11	8	19	41	.3947	.2242
Portsmouth	10	11	17	41	.4079	.3004
Blackburn Rovers	10	11	17	41	.4079	.2744
Sunderland	9	9	20	36	.3553	.1556
Hull City	8	11	19	35	.3553	.1808
Newcastle United	7	13	18	34	.3553	.1809
Middlesbrough	7	11	20	32	.3289	.0685
West Bromwich Albion	8	8	22	32	.3158	0

Cut-off parameters: $\hat{\mu}_1$= -.7119 $\hat{\mu}_2$= .0250

Illustrative fitted match result probabilities (show implications of variations in $\hat{\alpha}_i$ and $\hat{\alpha}_j$)

	Home win	Draw	Away win
Liverpool v Middlesbrough	0.673	0.209	0.118
Middlesbrough v Liverpool	0.309	0.285	0.406
Aston Villa v Blackburn	0.563	0.252	0.185
Blackburn v Aston Villa	0.417	0.284	0.299
Man City v Wigan Athletic	0.501	0.269	0.230
Wigan Athletic v Man City	0.480	0.274	0.246
All matches (average)	0.455	0.255	0.290

Illustrative fitted match result probabilities are calculated using

$$P(\text{home win}) = 1-\Phi(\hat{\mu}_2-\hat{y}^*_{i,j})$$
$$P(\text{draw}) = \Phi(\hat{\mu}_2-\hat{y}^*_{i,j})-\Phi(\hat{\mu}_1-\hat{y}^*_{i,j})$$
$$P(\text{away win}) = \Phi(\hat{\mu}_1-\hat{y}^*_{i,j}) \quad [2]$$

where Φ is the distribution function for the standard Normal distribution; and $\hat{y}^*_{i,j} = \hat{\alpha}_i-\hat{\alpha}_j$

Simulations: enable comparisons between observed numbers of reversals and numbers of reversals that should be obtained if [1] is the statistical model that describes correctly the distribution of match results if there is no persistence

Two test statistics to test for persistence:

- number of WD|L reversals
- number of W|DL reversals

In each case, test statistic is τ = total number of match results divided by total number of reversals

Observed τ is similar to its expected value: null of no persistence cannot be rejected

Observed τ is significantly **higher** than its expected value: reversals occur less frequently than they should occur if the null is true

null is rejected in favour of an alternative hypothesis of **positive** persistence

Observed τ is significantly **lower** than its expected value: reversals occur more frequently than they should when null is true

null is rejected in favour of an alternative hypothesis of **negative** persistence

To generate expected mean durations of sequences of consecutive results under null of zero persistence=›

- 160 sets of ordered probit estimates of parameters of [1] are obtained

- Using actual fixture calendars as originally completed, a computer program then generates a complete set of simulated match results for the full 40-season period, under assumption of no persistence, by substituting randomly drawn values of $\varepsilon_{i,j} \sim N(0,1)$ into [1]

- Exercise is repeated 5,000 times in order to generate 5,000 sets of simulated match results each of which covers the 40-season period

Comparison between simulated and observed conditional probabilities confirms that the actual probability of a reversal is higher than simulated probability under assumptions of no persistence

To test the null for each of the 5,000 sets of simulated match results, calculate test statistic τ (number of matches ÷ number of reversals) for each of two types of reversal

Examine sampling distributions of the two sets of 5,000 simulated τ, => critical values for acceptance or rejection of null of no persistence

Persistence tests are carried out for all 40 seasons and for 8 sub periods of 5 seasons each

Table 4

Table 4 Tests for persistence in sequences of consecutive match results

	Monte Carlo simulations						Actual	
	p0.5	p2.5	p5.0	p95.0	p97.5	p99.5	τ	p-value
Sequences without a loss or sequences of losses: ratio of matches played to WD/L reversals								
1970-2009	2.194	2.197	2.198	2.213	2.215	2.217	2.197	.0556
1970-1974	2.191	2.198	2.202	2.245	2.250	2.258	2.228	.7284
1975-1979	2.147	2.155	2.159	2.201	2.205	2.213	2.184	.7480
1980-1984	2.135	2.142	2.146	2.187	2.191	2.198	2.153	.3152
1985-1989	2.160	2.168	2.171	2.213	2.217	2.225	2.203	.3988
1990-1994	2.163	2.171	2.175	2.216	2.220	2.228	2.173	.0764
1995-1999	2.187	2.196	2.200	2.242	2.246	2.255	2.205	.2216
2000-2004	2.198	2.205	2.208	2.252	2.257	2.265	2.216	.2964
2005-2009	2.207	2.215	2.219	2.262	2.266	2.275	2.215	.0528
Sequences of wins or sequences without a win: ratio of matches played to W/DL reversals								
1970-2009	2.199	2.203	2.204	2.219	2.220	2.223	2.182	.0000
1970-1974	2.193	2.201	2.205	2.248	2.251	2.258	2.200	.0428
1975-1979	2.151	2.158	2.162	2.202	2.206	2.215	2.151	.0104
1980-1984	2.138	2.147	2.151	2.192	2.196	2.205	2.149	.0836
1985-1989	2.162	2.170	2.174	2.216	2.221	2.228	2.175	.1112
1990-1994	2.166	2.174	2.178	2.220	2.225	2.232	2.178	.0948
1995-1999	2.192	2.201	2.206	2.249	2.253	2.262	2.165	.0000
2000-2004	2.204	2.213	2.217	2.261	2.266	2.274	2.211	.0368
2005-2009	2.217	2.227	2.230	2.276	2.281	2.289	2.229	.0792

Overall: sequences of match results are subject to statistically significant, negative persistence effects

On average, sequences of consecutive wins and sequences of consecutive matches without a win tend to end sooner than they would if there were no statistical association between the results of consecutive matches after controlling for heterogeneous team strengths

Summary

Monte Carlo analysis is used to investigate phenomenon of persistence in sequences of consecutive football results=›

Compare actual numbers of 'reversals' of sequences of consecutive results with numbers expected if there was no persistence

A comparison between the simulation results and 40 years of English match results data provides evidence of a negative persistence effect