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HOW CLOSE TO THE TRAPDOOR? MEASURING THE VULNERABILITY OF MANAGERS IN THE ENGLISH PREMIERSHIP

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How close to the trapdoor? Measuring the vulnerability of managers in the English Premiership

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Abstract

What strategy should a football club adopt when deciding whether to sack its manager? This paper describes a development of an earlier model to include the different ambition levels of different clubs, and applies it to all 20 Premiership clubs at the start of the 2002-03 season.

A measure of how close a manager is to the trapdoor is to see how many matches he can afford without a win and still not drop through the trapdoor. This measure is calculated for the Premiership clubs at the start of the 2002-03 season, assuming that a team alternates draws and losses, in the period before a win is obtained.

For the majority of clubs in the Premiership, the manager's vulnerability is strongly related to the total number of points scored last season. For clubs where this is not true, the difference in vulnerability can easily be understood by taking into account the level of ambition of the club, the performance of the team in the latter half of the 2001-02 season, or the appointment of a new manager.

The safest manager in the Premiership seems to be Gary Megson at West Bromwich Albion, who can afford to go 21 matches without a win and still not fall through the trapdoor. At the other end of the scale, Peter Reid's position at Sunderland appears to be the most precarious, but even his performance is above the trapdoor level for now.

Background

What strategy should a football club adopt when deciding whether to sack its manager? An earlier paper (Hope, 2002) introduced a simple model assuming that a club's objective is to maximize the number of league points that it scores per season.

A brief description of the original model is given in the rest of this section. The rest of the paper extends the model to incorporate different levels of ambition, develops a measure of manager vulnerability, applies the extended model and the measure of vulnerability to all the clubs in the English Premiership, and concludes with a discussion of the results and suggestions for future research.

In the original model, the club's strategy consists of three choices:

- the length of the honeymoon period during which it will not consider sacking a new manager,
- the level of the trapdoor, the average number of points scored per game; if the manager's performance falls below this, he will get the sack,
- the weight that it gives to more recent games compared to earlier ones when calculating the manager's performance.

There are five types of manager: poor, fair, good, excellent and world class. A club with a poor manager will on average be in the bottom three positions, a good manager will on average equal the mean performance of the 20 clubs in the league, and a team with a world class manager will on average be in the top three. Fair managers are in between poor and good, and excellent ones are between good and world class. But the club cannot observe the quality of its manager directly. Instead it looks at results on the pitch.

After his first game in charge the performance of the manager is given by

$$perf(1) = result(1)$$

where

$$result(m) = \begin{cases} 0 & \text{if the game was lost} \\ 1 & \text{if the game was drawn} \\ 3 & \text{if the game was won} \end{cases}$$

After any subsequent game his performance is given by an exponentially weighted average of his results to date:

$$perf(m) = smooth * result(m) + (1 - smooth) * perf(m-1)$$

The club's decision problem is complicated by the likelihood that a change of manager will initially *inspire* the team and get a *boost* in performance, and then require some time to *rebuild*, during which the team's performance will *drop*. And

even the best manager will eventually see his performance drop somewhat with *age*, and even more as his skills and relationship with the club *decay*.

Whenever a new manager is appointed, he will demand a *contract* for a number of seasons, and a hefty *salary*. If he is sacked before his contract expires, the club will have to pay it up, using money that could otherwise have been used to *buy success* on the pitch, for example through buying new players.

So the essence of the club's dilemma is this: every time it sacks a manager it may get a short-lived boost in performance, but it incurs a substantial cost and a subsequent period of rebuilding, both of which cost points. But if it doesn't sack a mediocre manager, it will continue to perform badly.

If the club sets the honeymoon period too short, it risks wasting money by sacking a lot of managers, some of whom might have turned out to be excellent or world class, but unlucky in their first few games. If it sets the honeymoon period too long, it will keep even poor managers for longer than their performance would merit.

If the club sets the trapdoor too high, it will sack a lot of managers, some of whom could be superb managers going through a sticky spell. Too low, and even mediocre managers will never get the sack.

If the club relies too much on the most recent results, it will sack a lot of managers, as even a short bad patch will lead to dismissal. Too little, and it will take a long while to sack even those managers whose performance has aged and decayed.

Data from the last six seasons of the Premiership were used to calibrate the model. As firm estimates of most of the inputs were not available, they were represented by probability distributions. The mean values of *inspire*, *boost*, *rebuild* and *drop* imply that the sacking of a manager leads on average to the loss of 10.2 points while the new manager rebuilds the team, and the mean values of *contract* , *salary* and *buy_success* imply that on average the number of points lost from paying up a sacked manager's contract is an additional 2.4 points.

The model keeps a running tally of the points scored for 380 games (10 Premiership seasons). Clearly it is not enough to just run the model once for ten seasons. Many of the model inputs are highly uncertain, and even if they were not, the results of individual games certainly are. So the model is run 5000 times for ten seasons with each combination of choice variables, sampling different values from the uncertain inputs, recording the sackings and results of each game, and calculating the mean number of points per season for the club.

Using RISKOptimizer, from Palisade Corporation, the optimal strategy for a club would seem to be to allow a manager a honeymoon period of 8 games, and then sack him only if his weighted average performance with a smoothing value of 0.121 (putting 47% of the weight on the last five games) falls below 0.74 points per game.

A club adopting this strategy would obtain on average 56.8 points per season, compared to a Premiership average of 51.8 points. It would employ an average of 5.7 managers every ten seasons, against the Premiership average of 4.5 managers.

The original model was clearly only a first attempt at applying management science techniques to the hiring and firing of football managers. But in a field where quantitative decision modelling so far seems to have been absent, it was a start.

We now introduce an extension of the model to include the different ambition levels of different clubs, and apply it to all 20 Premiership clubs at the start of the 2002-03 season.

Different ambition

The previous model was implicitly calibrated for the average club in the Premiership. In reality it is clear that there is also a group of clubs at the top of the Premiership whose objectives are focussed on success in European competition. And there is another group who have no realistic thoughts of a top 3 finish, and whose ambition is simply to remain in the Premiership. Call these three groups medium, high and low ambition respectively.

For clubs of medium ambition, the probability of picking each type of manager is as in the previous model. Table 1 shows the five types of manager that are assumed to be available, their quality measured by g(normal), the mean points per game they will obtain, and the probability of obtaining them each time a new manager is hired. For the Premiership, the appropriate values of the parameters are
$G = 1.37$, $d = 0.27$, $P(d) = 0.2$, $P(2d) = 0.15$ (Hope, 2002).

Table 1	**The five types of manager for clubs of medium ambition**	
Type	***g(normal)***	**probability**
World class	$G + 2d$	$P(2d)$
Excellent	$G + d$	$P(d)$
Good	G	$1 - 2(P(2d) + P(d))$
Fair	$G - d$	$P(d)$
Poor	$G - 2d$	$P(2d)$

Clubs with high ambition are assumed to have more money to spend, and so will not appoint poor managers. Clubs with low ambition have less money to spend, and will not be attractive to the very best managers. They are assumed not to appoint world class managers. Both adjustments take the form of multiplying the probability of picking the remaining types of manager by $1/(1-P(2d))$, with the values for the Premiership as shown in table 2, rounded to the nearest percent.

Table 2	**The probabilities for clubs of high and low ambition**	
Type	**High ambition**	**Low ambition**
World class	0.18	0
Excellent	0.24	0.24
Good	0.35	0.35
Fair	0.24	0.24
Poor	0	0.18

Using RISKoptimizer, the best strategy for clubs with high ambition comes out as a honeymoon of 7 games, a trapdoor of 0.82 and smooth of 0.114 (putting 45% of the weight on the last five games), giving 58.4 points per season, and employing 5.9 managers in 10 seasons on average[1]. This is slightly but significantly better than the

[1] From 730 sims and 5000 iterations per sim, and constrained values for honeymoon (1 to 20), trapdoor (0.5 to 1), and smooth (0 to 0.3), and a higher value for mutate (0.25).

original optimal strategy, which gave a mean of 58.0 points per season, employing 5.0 managers on average. By having a larger value for trapdoor, it is less tolerant of a run of poor results.

For clubs with low ambition, the best strategy comes out as a honeymoon of 8 games, a trapdoor of 0.66 and smooth of 0.106 (putting 43% of the weight on the last five games), giving 50.9 points per season and employing 5.3 managers in 10 seasons on average[2]. With a lower trapdoor and smooth, it is more tolerant of poor results than the original optimal strategy, which gave a mean of 49.9 points per season, employing 8.1 managers on average.

The optimal strategies for the three groups of clubs are summarized in table 3.

Table 3 **Optimal strategy by level of ambition**

	Honeymoon *(games)*	**Trapdoor** *(points per game)*	**Smooth**
High ambition	7	0.82	0.114
Medium ambition	8	0.74	0.121
Low ambition	8	0.66	0.106

Source: RISKOptimizer runs

[2] From 867 sims and 5000 iterations per sim, and constrained values for honeymoon (1 to 20), trapdoor (0.5 to 1), and smooth (0 to 0.3), and higher value for mutate (0.25)

How close to the trapdoor?

One way of measuring how close a manager is to the trapdoor is to calculate how far his present performance is above it.

clearance(m) = perf(m) – trapdoor

But this is not a very satisfactory measure. Clubs with different ambition levels employ different smoothing, as shown in table 3, which take the performance of their managers down at different rates if they start to perform poorly.

This section describes two better measures in enough detail to allow them to be reproduced. Anyone not interested in the details can skip to the next section to see the data and results for the Premiership.

One better measure of how close a manager is to the trapdoor is to see how many losses it would need to take him down through it.

By definition in the model

$perf(m) = smooth * result(m) + (1 - smooth) * perf(m-1)$

so, if $result(m+i) = 0$, for i = 0,…,I

$perf(m) = (1 - smooth) * perf(m-1)$

$perf(m+1) = (1 - smooth)^2 * perf(m-1)$

$perf(m+i) = (1 - smooth)^{(i+1)} * perf(m-1)$

Let $perf(m+I) < trapdoor <= perf(m+I-1)$, then

$(1 - smooth)^{(I+1)} * perf(m-1) < trapdoor <= (1 - smooth)^{(I)} * perf(m-1)$

$(1 - smooth)^{(I+1)} < trapdoor/perf(m-1) <= (1 - smooth)^{(I)}$

Taking logarithms:

$(I^*) * \ln(1-smooth) = \ln(trapdoor) - \ln(perf(m-1))$

(where int(I*) = I)

$I^* = (\ln(trapdoor) - \ln(perf(m-1)))/ \ln(1-smooth)$

So $I = int((\ln(trapdoor) - \ln(perf(m-1)))/ \ln(1-smooth))$

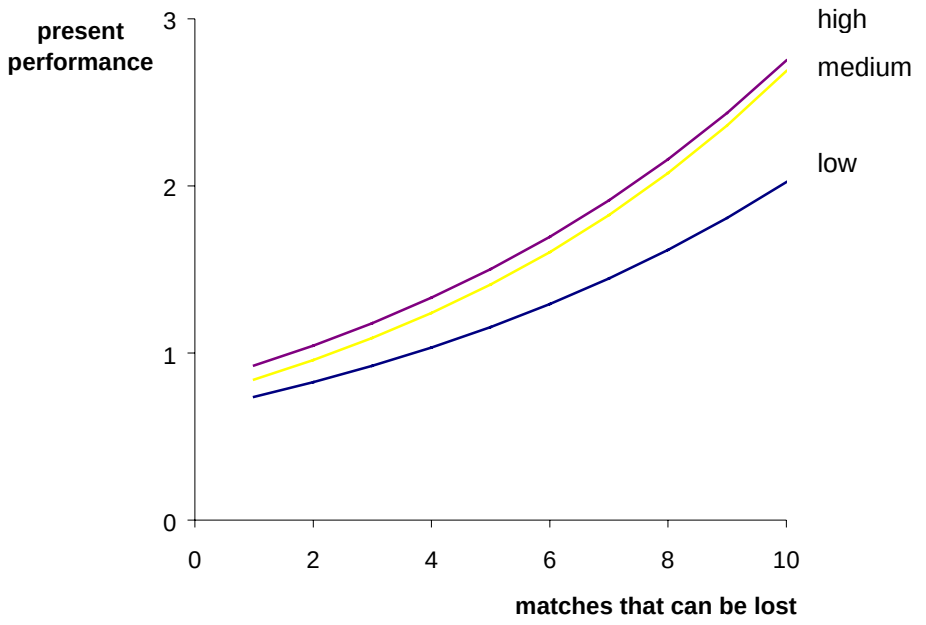
If I < 0, the manager is already below the trapdoor. If I = 0 the manager will drop below the trapdoor if he loses the next match. In general, the manager can lose I matches without dropping below the trapdoor.

Changing the formula around gives the critical values of perf as:

perf(m-1) = exp(ln(*trapdoor*) – (I*)*ln(1-*smooth*))

Figure 1 shows these critical values of present performance.

Figure 1 Critical values for performance by ambition level



The special case of a new manager

A new manager will not be sacked until the honeymoon is over, so in one sense

I = *honeymoon* - 1

for a new manager. However, a performance that lost the first *honeymoon* – 1 matches would actually lead to the sack after the next match, even if it was won, as the manager's performance would not recover enough to avoid the trapdoor. To avoid this, the manager needs *perf(honeymoon)* >= *trapdoor*. By definition,

perf(I) = 0, so if all subsequent matches are won,

perf(I+1) = 3**smooth*

perf(I+2) = 3**smooth* + 3**smooth**(1-*smooth*)

= 3**smooth**(1 + (1-*smooth*))

perf(I+3) = 3**smooth* + (3**smooth* + 3**smooth**(1-*smooth*))*(1-*smooth*)

= 3**smooth**(1 + (1-*smooth*) + (1-*smooth*)^2) etc.

If *trapdoor <= perf (I+1),* then I = *honeymoon* –1

If *perf(I +1) < trapdoor <= perf(I+2),* then I = *honeymoon* – 2

In general if *perf(I+n-1) < trapdoor <= perf(I+n),* then I = *honeymoon* – n.

As, in most cases, n will be <=4, the easiest thing is simply to calculate *perf(I+n)* for n = 1,2,3,4 etc. The results in table 4 show that for all three ambition levels, n = 3, so I = honeymoon – 3, for a new manager.

Table 4 Perf by number of games won

n	low *perf(I+n)*	medium *perf(I+n)*	high *perf(I+n)*
1	0.32	0.36	0.34
2	0.60	0.68	0.65
3	0.86	0.96	0.91
4	1.08	1.21	1.15
trapdoor	0.66	0.74	0.82

Not winning rather than losing

A second and more general measure of how close a manager is to the trapdoor is to see how many matches he can afford without a win. In this more general case, assume *result(m+i) = y,* for i = 0,…,I . If *y* = 0, we are back to the special case of losing every match; alternately losing and drawing is approximated by *y* = 0.5. Drawing every match would give *y* = 1.0, but would not be interesting to look at, as it would not lead to the manager's performance falling below the trapdoor for any ambition level.

$$perf(m) = (1 - s) * perf(m-1) + s * y$$

$$perf(m+1) = (1 - s)^2 * perf(m-1) + (1 - s) * s * y + s * y$$

$$perf(m+2) = (1 - s)^3 * perf(m-1) + (1 - s)^2 * s * y + (1 - s) * s * y + s * y$$

$$perf(m+i) = (1 - s)^{(i+1)} * perf(m-1) + s * y * (1- (1-s)^{i+1})/(1-(1-s))$$

$$= (1 - s)^{(i+1)} * perf(m-1) + y * (1- (1-s)^{i+1})$$

$$= y + (1 - s)^{(i+1)} * (perf(m-1) - y)$$

where *s* is *smooth*.

Let *perf(m+I) < trapdoor <= perf(m+I-1)*

then

$y + (1 - s)^{(I+1)} * (perf(m-1) - y) < trapdoor <= y + (1 - s)^{(I)} * (perf(m-1) - y)$

$(1 - s)^{(I+1)} < (trapdoor - y)/(perf(m-1) - y) <= (1 - s)^{(I)}$

taking logarithms:

$(I^*) * \ln(1-s) = \ln(trapdoor - y) - \ln(perf(m-1) - y)$

(where int(I*) = I)

$I^* = (\ln(trapdoor - y) - \ln(perf(m-1) - y))/ \ln(1-s)$

So $I = \text{int}((\ln(trapdoor - y) - \ln(perf(m-1) - y))/ \ln(1-s))$

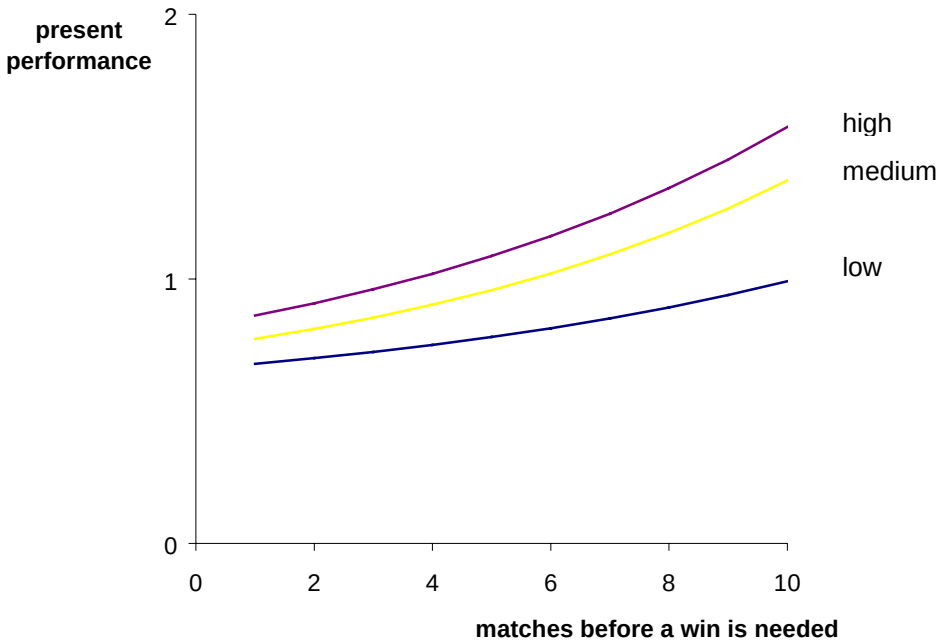
If I < 0, the manager is already below the trapdoor. If I = 0 the manager will drop below the trapdoor if he does not win the next match. In general, the manager can go I matches without winning and still not drop below the trapdoor if he wins the next match. It is this formula, with $y = 0.5$, that is used in the next section to look at all 20 Premiership clubs.

Changing the formula around gives the critical values of perf as:

$perf(m-1) = y + \exp(\ln(trapdoor - y) - (I^*)*\ln(1-s))$.

Figure 2 shows these critical values of present performance for $y = 0.5$.

Figure 2 Critical values for performance by ambition level



Now, for a new manager, by definition, in this more general case

perf(I) = *y*, so if all subsequent matches are won,

perf(I+1) = *y**(1-*s*) + 3*s*

perf(I+2) = 3*s* + (*y**(1-*s*) + 3*s*)*(1-*s*)

= *y**(1-*s*)^^2 + 3*s**(1 + (1-*s*))

perf(I+3) = 3*s* + (*y**(1-*s*)^^2 + 3*s**(1 + (1-*s*))*(1-*s*)

= *y**(1-*s*)^^3 + 3*s**(1 + (1-*s*) + (1-*s*)^2)

etc.

If *trapdoor* <= *perf (I+1)*, then I = *honeymoon* –1

If *perf(I +1)* < *trapdoor* <= *perf(I+2)*, then I = *honeymoon* – 2

In general if *perf(I+n-1)* < *trapdoor* <= *perf(I+n)*, then I = *honeymoon* – n.

As, in most cases, n will be <=3, the easiest thing is simply to calculate *perf(I+n)* for n = 1,2,3. For *y* = 0.33, n = 2 for all ambition levels. For *y* = 0.5, n = 2 for clubs with high ambition and n = 1 for medium and low levels of ambition.

The English Premiership at the start of the 2002-03 season

We now apply the results of the previous two sections to all twenty clubs in the English Premiership at the start of the 2002-03 season.

Table 5 shows the assignment of the clubs to the three ambition levels. Six clubs are assumed to have high ambition, five clubs have low ambition, and the remaining nine have medium ambition.

Table 5 Ambition level by club

	ambition
Arsenal	high
Aston Villa	medium
Birmingham City	low
Blackburn Rovers	medium
Bolton Wanderers	low
Charlton Athletic	low
Chelsea	high
Everton	medium
Fulham	medium
Leeds United	high
Liverpool	high
Manchester City	medium
Manchester United	high
Middlesbrough	medium
Newcastle United	high
Southampton	low
Sunderland	medium
Tottenham Hotspur	medium
West Bromwich Albion	low
West Ham United	medium

The main source for the assignment in table 5 is the handicapping information available from bookmakers at the start of the season. Table 6 shows this information from an online source, bet365.co.uk. The way the handicapping works is that at the end of the 2002-03 season, the number of points shown in table 6 is added to the actual points scored by the club, and a bet is paid out at 15 to 1 on the club with the highest total.

Table 6 shows that the top six clubs are quite distinct from the rest, and these are the six clubs assumed to have high ambition. As Newcastle player, Andy O'Brien puts it, "We're determined to keep last season's momentum going and to keep moving forward…We haven't really achieved anything yet, but nobody needs to tell us that." (O'Brien, 2002). Newcastle were 4th in last season's Premiership.

At the bottom, things are not so clear, but only the bottom five clubs have been taken to have low ambition, either because they are newly promoted, or because they have

traditionally struggled against relegation. Everton and Sunderland are both big clubs, whose ambition must presumably extend beyond just staying in the Premiership.

Table 6 Handicap points by club

Manchester United	0
Arsenal	3
Liverpool	6
Leeds United	9
Chelsea	12
Newcastle United	12
Tottenham Hotspur	20
Manchester City	22
Aston Villa	23
Fulham	25
West Ham United	26
Blackburn	27
Middlesbrough	29
Everton	31
Sunderland	31
Charlton Athletic	33
Southampton	33
Bolton Wanderers	35
Birmingham City	35
West Bromwich Albion	39

Source: http://www.bet365.co.uk/home/index.asp

Table 7 shows the recent performance of the managers of all twenty Premiership clubs, as measured by the variable perf(m) in the model, which gives more weight to the most recent games. The outstanding recent performance of Arsene Wenger is clear, but the table shows that four other managers, including those at two of the promoted clubs, are averaging over 2 points from recent games. Three managers are averaging less than 1 point per game.

Table 7 Recent performance by club

Club	Manager	Points/game
Arsenal	Arsene Wenger	2.79
Aston Villa	Graham Taylor	1.20
Birmingham City	Steve Bruce	1.71
Blackburn Rovers	Graeme Souness	1.56
Bolton Wanderers	Sam Allardyce	0.91
Charlton Athletic	Alan Curbishley	0.91
Chelsea	Claudio Ranieri	1.60
Everton	David Moyes	1.77
Fulham	Jean Tigana	1.05
Leeds United	Terry Venables	- [1]
Liverpool	Gerard Houllier	2.40
Manchester City	Kevin Keegan	2.54
Manchester United	Alex Ferguson	2.05
Middlesbrough	Steve McClaren	1.04
Newcastle United	Bobby Robson	1.74
Southampton	Gordon Strachan	1.26
Sunderland	Peter Reid	0.82
Tottenham Hotspur	Glenn Hoddle	1.24
West Bromwich Albion	Gary Megson	2.34
West Ham United	Glenn Roeder	1.63

Note:
1. Leeds have not yet played any league matches under Terry Venables

Figure 3 shows the recent performance plotted against the points scored in the whole of season 2001-02. In general, the correlation between the two measures is close, but the figure shows the good recent performance of Arsenal and Everton, and the relatively poor performance for a promotion-chasing club, 5 wins in the last 12 matches, of Birmingham City at the end of last season, before the playoffs.

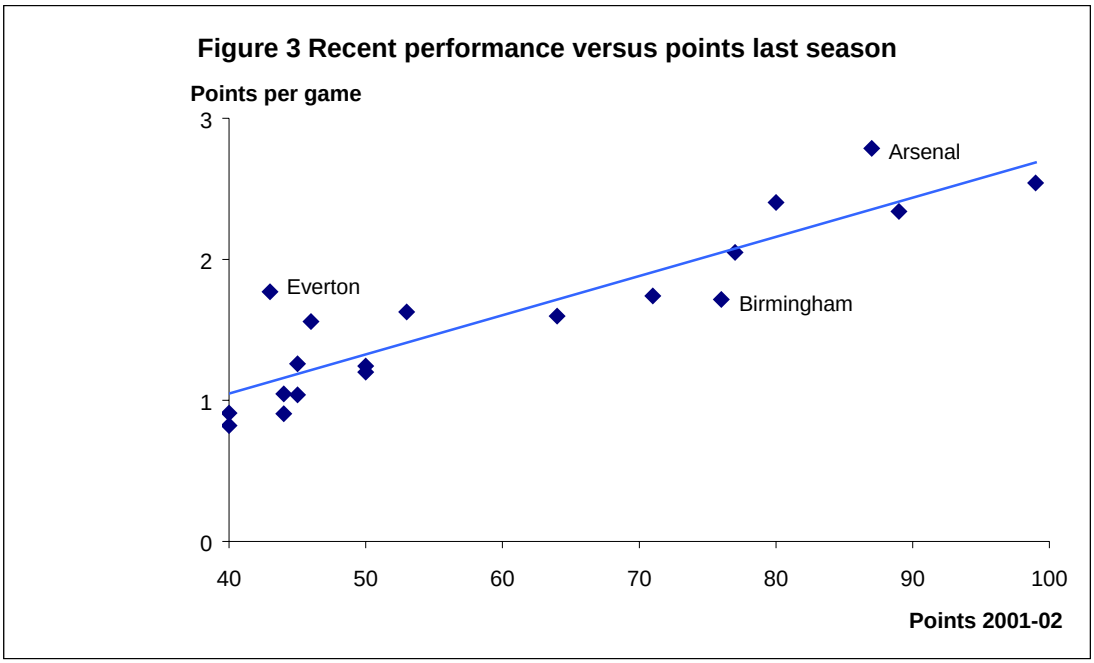
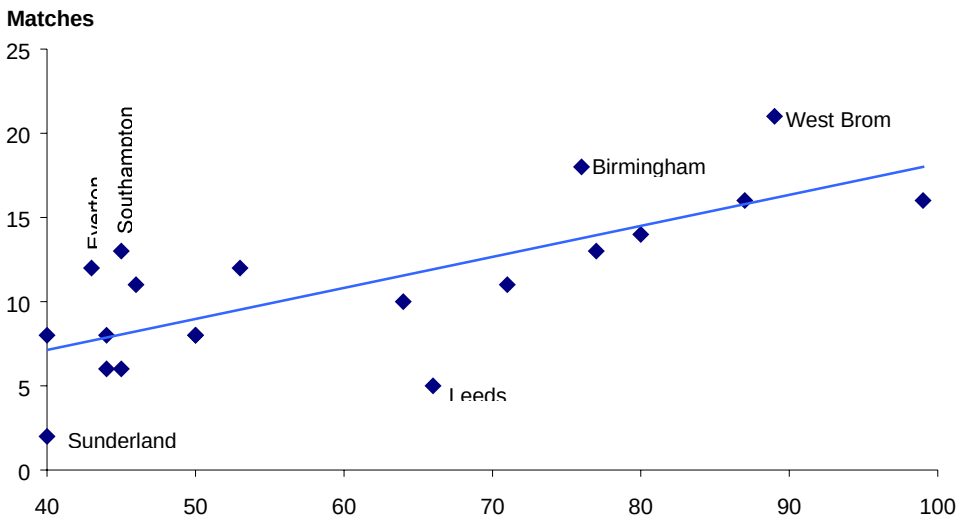


Table 8 shows how close to the trapdoor the manager of each club is, as measured by the number of matches before a win is required to keep him clear of the trapdoor, and figure 4 shows this plotted against the points scored in the whole of season 2001-02. It is assumed that a team alternates draws and losses, giving on average 0.5 points per game, in the period before a win is obtained.

Table 8 Time before a win is required by club

	matches
Arsenal	16
Aston Villa	8
Birmingham City	18
Blackburn Rovers	11
Bolton Wanderers	8
Charlton Athletic	8
Chelsea	10
Everton	12
Fulham	6
Leeds United	5
Liverpool	14
Manchester City	16
Manchester United	13
Middlesbrough	6
Newcastle United	11
Southampton	13
Sunderland	2
Tottenham Hotspur	8
West Bromwich Albion	21
West Ham United	12

Figure 4 Time before a win is required versus points last season



According to this analysis, the safest manager in the Premiership is Gary Megson at West Bromwich Albion, who can afford to go 21 matches without a win and still not fall through the trapdoor. This security is down to a combination of a good recent performance and an assumed low level of ambition by the club, who are assumed to see survival in the Premiership this season as a success.

Next safest is Steve Bruce, who again benefits from the low ambition of Birmingham City this season, even though his recent performance is only the 8th highest amongst the 20 managers.

Arsene Wenger and Kevin Keegan are joint third, with Wenger only kept off the top spot because of the high ambition of Arsenal.

Figure 4 shows that David Moyes at Everton and Gordon Strachan at Southampton are also much safer than the points scored by their clubs last season would suggest. In Moyes' case this is due to the upturn in performance after he took charge in March 2002, which was seen in figure 3. Many fans at Everton seem optimistic:

"This is like a dream come true…All we wanted was a coach who could actually, well, coach. One who believed in developing players individually and also crafting a team." (O'Brien, 2002)

In Strachan's case it is the low ambition of Southampton that is most helpful.

At the other end of the scale, Peter Reid's position at Sunderland appears to be the most precarious. Sunderland had only three wins in the last 19 matches of last season, and the club is assumed to want more than just Premiership survival this season. Many fans seem almost ready to write Reid off:

“Unless Reid serves up a blinding start to the season, the sheer frustration and anger will boil over very quickly. Personally I feel that the first game against Blackburn at home is already a must-win game for Reid…” (Bulmer, 2002).

The model indicates that Reid’s position is not quite as bad as that, but if Sunderland don’t win one of their first three matches, Reid’s performance will drop below the trapdoor for a club of medium ambition of 0.74 points per game.

If Sunderland’s ambition is actually lower than assumed, and they would be satisfied with Premiership survival, as suggested by a recent quote attributed to star striker Kevin Phillips,

“My aim - and our aim - is to finish in a better position than last season.” (Phillips, 2002),

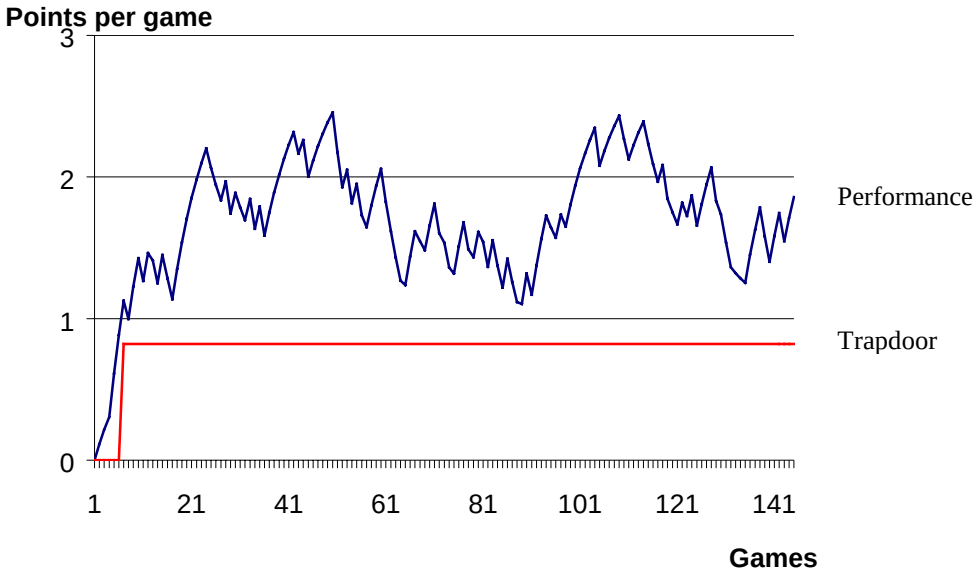
then Reid’s position is much safer, and he would be able to go six matches without a win and still not fall below the trapdoor for low ambition clubs of 0.66 points per game.

Finally, amongst the outliers, is Terry Venables at Leeds. As he only took charge of the team in July 2002, he is in the special position of a new manager in his honeymoon period. Because Leeds is an ambitious club, the model allows a honeymoon period of only 7 games, and has a high trapdoor of 0.82 points per game that must be reached by then. If Venables does not obtain a win by his sixth game in charge, he would be unable to climb above the trapdoor before his honeymoon period was over. Whether even an ambitious club like Leeds would be so unforgiving is questionable, although in 1974, in the precursor to the Premiership, Brian Clough was in charge of Leeds United for only 44 days and 9 division 1 (old) games (http://www.soccerbase.com/footballlive).

Venables predecessor at Leeds, David O’Leary, had a recent performance of 1.86 points per game when he was sacked, which would have allowed him not to win for 11 matches before falling below the trapdoor.

In fact, the performance of Leeds under O’Leary had always been well above even the trapdoor level of 0.82 points per game that would be appropriate for a club with high ambition, as can be seen from figure 5, apart from his first few games when the honeymoon period applied. It seems very likely that the reasons for his dismissal lay off the pitch rather than on it.

Figure 5 David O'Leary at Leeds



Similar charts are available for all the other Premiership managers on request, but are not included here for reasons of space.

Discussion and further research

1. Incorporating different levels of ambition into the model appears to give sensible results: the higher the level of ambition, the higher the optimal value for the trapdoor, while the smoothing constant and the honeymoon period remain essentially unchanged. Even for clubs with high ambition, the optimal trapdoor is well below one point per game.

2. For the majority of clubs in the Premiership, the manager's vulnerability is strongly related to the total number of points scored last season. For clubs where this is not true, the difference in vulnerability can easily be understood by taking into account the level of ambition of the club, the performance of the team in the latter half of the 2001-02 season, or the appointment of a new manager.

Repeating the vulnerability calculations shown here two or three times a season would perhaps be useful in countering the often excessive criticism of managers from some sections of the fans and the media.

3. In this version of the model, the performance of the manager after 1 game is just the result of that game:

$$perf(1) = result(1)$$

So after 1 game, a manager will have $perf(1) = 0$, 1 or 3. This means the value of *perf* for the first few games is strongly dependent on the result of the first game. Future versions of the model could refine this by giving the club the chance to set the *initial* performance level that it assumes for the incoming manager as a choice variable:

$$perf(0) = initial$$

Then

$$perf(1) = smooth * result(1) + (1 - smooth) * perf(0),$$

as for all subsequent games. This would reduce the significance of the first result, and perhaps remove the odd conclusion that a new manager at a club can be more vulnerable than the person he has replaced, as we observed at Leeds.

4. Development of the model to address the more important shortcomings identified in Hope, 2002, would still seem to be worthwhile. The best candidates for inclusion are incorporating home and away games, the quality of the opposition, and the importance of avoiding relegation.

Another goal is adapting the model so that it can be applied to the Nationwide League clubs in England, where the seasons consist of 46 games, and the financial circumstances are very different to those in the Premiership. Looking at other soccer leagues, in Spain and Italy particularly, or other sports, would also seem to be possible.

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