Bonus Incentives and Team Effort Levels: Evidence from the 'Field'[#]

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Abstract

This study explores the effect of bonus incentive mechanisms with a focus on how such a scheme influences aggregate production levels of teams of workers, specifically. We identify this using data from a highly competitive setting in professional sport, which involves a unique tournament design rule in an elite European rugby competition. The modelling results demonstrate qualified evidence that introducing bonuses to encourage teams to score via the most-difficult, highest-reward mode, incentivises teams to increase effort to earn the bonus, and without reducing production after the bonus is achieved.

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1. Introduction and Literature

It is well established how bonus schemes affect incentive structures at an individual level, while more recent literature continues to contribute to this theme. Bénabou and Tirole (2016) assess bonus pay along several labour-market dimensions, while Holmström (2017) serves as an elegant primer on several related issues far wider than just the existence of the bonus itself. However, empirical economic literature on how bonuses affect the collective performance of fixed teams of workers in a state of competition remains limited—something that this paper seeks to redress.[1,2] This is despite the question being raised as a burning issue long ago by Alchian and Demsetz (1972), and evidence that team-based incentives are more potent than individual ones (Hamilton, Nickerson and Owan, 2003).[3] Rather, the existing literature predominantly centers on elements of individual behaviour within the team environment, such as free-riding (for instance, Kim and Vikander, 2013).

To this end, we endeavour to investigate the possible influence of a specific team-based bonus scheme on professional team behaviour, using data from the sport of rugby—an intuitively appealing setting with a number of attractive economic features, discussed further onwards. In doing so, the results can help to inform the effective design of incentive mechanisms across a wide range of industries in which certain scenarios might arise requiring a more tightly targeted elicitation of real effort. This is particularly true for the common contest type whereby two teams within the same organisational

[1] Friebel, Heinz, Krueger and Zubanov (2017) is a recent and important exception here, showing that a random assignment of team bonuses within a retail chain proved to be effective, producing a significantly positive—and considerable in magnitude—net present value in terms of both sales and operating profit.
[2] In this context, 'fixed' means that agents cannot transfer between teams within the relevant setting. See Bandiera, Barankay and Rasul (2013) as a counterexample—where agents can move during the experiment.
[3] Despite the seminal nature of Hamilton *et al*. (2003), further recent countering evidence has emerged, including Cornelissen, Dustmann and Schönberg (2017), which considers a far broader range of occupations and workplaces; as well as Burgess *et al*. (2017), showing the public-sector scheme under investigation was effective only with small-sized teams.

department are competing for a prize. Specifically, one that is non-exclusive; and where the basis for evaluation is a metric other than the primary unit performance measure itself, though still nonetheless complementary.

More generally, teams in various sports—like in many industries—comprise numerous interacting workers, engaging in joint production. The setting is also a similarly intense and high-stakes one in which the level of competition between the rival firms is fierce (indeed with adversarial physical contact), and thus clearly reveals the observable implications of behavioural phenomena. Moreover, the regulations that govern production (i.e. rules of play) are almost always patently well-defined and enforced by the match officials, and understood by the participants. For these (and various other) reasons, Lenten, Libich and Stehlík (2013: p. 646) state that: "*Sports data provide a valuable opportunity for empirical testing of hypotheses arising from theoretical analyses of games, incentives, and strategies in economics*".

Gould and Winter (2009) leverage the sports perspective (as we do here), albeit with individual player-level data from baseball, finding a worker's effort level to be positively associated with that of their colleagues, if the employees' efforts are strategic complements in team production. It is straightforward to infer that, unlike in baseball (where some tasks are highly substitutable), the roles of all members of rugby teams tend more towards the complements end of the continuum. This case proves to be a common theme in the (more general) related literature. Adams (2006) previously demonstrated that bonus incentives (albeit not dichotomous) are indeed effective under these conditions. Meanwhile, numerous implications of strategic complements arise for issues related to this study, such as optimal asymmetric principal treatment of identical team members (Bose, Pal and Sappington, 2010) and effects of returns to scale (McGinty, 2014).

The tournament-design feature that we exploit in our identification strategy of bonus-scheme influences is as follows: in rugby, there are multiple scoring modes, with a try—the most valuable but hardest to achieve—being the most crowd-pleasing. A try is worth five match points, plus an extra two if 'converted' via a successful place kick. In a highly competitive global sports market, this has guided administrators (as the principal) towards direct policy to extrinsically motivate scoring more through tries specifically, instead of via the alternative common methods—penalty conversions and drop goals (each worth three). The most evident way in which this has occurred in the last few decades is via the increasing proliferation of 'bonus' league point systems. In fact, most tournaments in the sport now award teams one league point for scoring at least four tries in a match, or some variant to this, in addition to the standard four points for winning that match.[4]

Lenten and Winchester (2015) found Super Rugby's try bonus to incentivise more tries to be scored by teams (the agent), by significantly raising their probability of scoring at least one try in the final 8 minutes (out of 80) of the match, when this try would secure the bonus (i.e. having already scored three after 72 minutes).[5] Centering on multitasking, the main effect they identified was for teams that already had the match result secure, thus turning their attention towards earning the 'secondary prize'.

The following section of the paper discusses the background of the professional rugby bonus-point setting in relation to the team-production problem, with the data introduced at a summary level. Section 3 then presents the methodology used and the results of the

[4] Hogan and Massey (2017) explore the alternative of simply increasing the par value of an unconverted try (relative to the other modes). During the last century, this value was increased from three to four in 1972 and then to five in 1993. The value of drop goals was previously reduced from four in 1949.

[5] Super Rugby is the equivalent premier Southern Hemisphere league. Ironically, despite being the first major competition to introduce the four-try bonus at its inception in 1996, it recently altered (from the 2016 season) its try bonus to reward teams instead with a bonus point for scoring at least three tries more than the opposition team, meaning that only one team at most can earn a try bonus in any given match. This variant had already been used in the French domestic league, 'Top 14', since its 2007/08 season.

formal modelling component of the paper. Finally, section 4 concludes by briefly recapping the implications of the main results on the research question for economic interest.

2. Background and Data

To test for bonus-point effects on try scoring, we make use of a natural experiment from the European Rugby Cup (ERC), which from 1995/96 to 2013/14 in the Northern Hemisphere was the elite-level club/provincial competition in the sport, comprising the top-performing teams from England, France, Ireland, Italy, Scotland and Wales.[6] In this league, a try bonus was introduced from the 2003/04 season, allowing us to treat and compare its effects on try scoring with the baseline case of prior seasons.[7] Lenten and Winchester's methodology has greater dynamic precision by using minute of scoring; however, our more general framework has the advantage of also testing the bonus effect in ways permitting altered strategic and/or tactical behaviour in the first 72 minutes, even through player-selection (and other) decisions taken prior to the match.[8]

A key attractive economic feature of our policy setting is the highly asymmetric nature of the incentives that the try bonus induces. The team earning it essentially obtains its full value, whereas the opponent bears a comparatively small, though non-negligible, cost (in expected terms) of conceding it. Thus, there may be an apparent mutual incentive for both

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[6] After this period, the European Rugby Champions Cup (ERCC)—created essentially as a breakaway tournament by the English and French Unions—superseded the ERC from season 2014/15 onwards, with numerous structural differences to its predecessor. Thus, our sample period does not extend beyond that timeframe.

[7] A 'narrow-loss' bonus—for losing the match by seven or fewer points—was introduced contemporaneously. However, as Lenten and Winchester (2015: p. 387) explain, the incentive effect of this bonus is intertwined with the pure incentive to win the match, and hence difficult to identify uniquely. Since 2014/15, the Top 14 reduced its narrow-loss bonus threshold to five or fewer points.

[8] Bandiera, Barankay and Rasul (2009) demonstrate how personal bonus incentives for managers, based on the performance of their teams, can affect their worker selection decisions. In rugby, it is straightforward to imagine how the try bonus could similarly affect *ex-ante* team selection and tactical decisions made by the head coach.

teams to collude in scoring four or more tries each. However, our data do not support any evidence (not even anecdotal) of such tacit collusion.

We use data from the 1,227 ERC group-stage matches (bonuses do not apply in the knockout stage, in which the incentives change again), covering all 19 seasons of the competition's history as stated above, but excluding 1995/96.[9] Weather data (see discussion on p.13) are collected from *World Weather* (nearest available to stadium). Despite the existence of an extensive existing literature (for example, Moschini, 2010) on football's shift to three points for a win—essentially representing a bonus point for winning by a margin of one goal or more—that bonus suffers from the same identification problem as rugby's narrow-loss bonus (see footnote 7). In addition, rugby teams have different scoring options from which to choose (see Appendix for a full list of these); whereas in football, there is only one. For these reasons, we believe that the rugby try-bonus-point setting offers a far superior test of team behaviour arising from bonus incentives.

Defining *BP* as our bonus-point match identifier, the data show that in the seasons from 2003/04 onwards, average combined tries per game actually decreased by 15.2% from 5.31 (our control group, henceforth *BP*=0) to 4.51 (treatment, or *BP*=1), arguably in direct quantitative contrast to expected intuition. However, given the standard and well-known empirical regularity of home-ground advantage in team sports, the data generating process of try scoring is safely presumed to be different between home and away teams. This can be seen clearly in comparing the relative distributions in the left-hand and right-

[9] In the inaugural season, English and Scottish teams did not compete (one team from Romania was admitted instead) owing to their respective national Unions being unable to reach a television rights agreement with the (then) Five Nations Committee. Because of this, and other structural changes after this season, our sample is redacted to commence from 1996/97. Incidentally, one match (Calvisano versus Leeds, 15 January 2006) was cancelled, and therefore excluded from the sample.

hand panels of figure 1 below (explained further later on), and as such we henceforth examine the two team groupings separately. Doing so proves to be empirically substantiated, as an intriguing qualitative contrast arises from this differentiation. For home teams, mean tries per match reduced from 3.21 to 2.62, with a simple difference-in-means *t*-test producing a miniscule *p*-value of 6.1×10^{-5}; whereas for away teams, the reduction was comparatively modest, from 2.11 to 1.89 (*p*-value of 0.044). Furthermore, the home-away difference-in-difference means between the treatment and control groups is also significant at 5% (*p*-value of 0.044).

***** Figure 1 about here*****

Rather than in means, the most likely influence of the bonus is to induce a non-monotonicity into the try-frequency distribution in the local range around the threshold itself. This is because the system explicitly weights scoring the fourth try in the primary standings ranking criterion—league points. Previously, the marginal incentive to score each try (disregarding its elemental impact on the match result itself) was that tries scored—the team's total in all group matches—merely formed the secondary criterion, after league points (essentially then a linear combination of the number of wins and draws).[10]

The left-hand panel of figure 1 shows, for home teams, the (percentage) frequencies of scoring different numbers of tries, with all numbers above six aggregated. This panel substantiates how, despite there generally being a lower (higher) incidence of home teams

[10] It is worthwhile noting here that, while our economic reasoning behind the incentives involved is framed predominantly in terms of extrinsic rewards of the try bonus (i.e. the point itself), the relevant agents undeniably may be contemporaneously motivated by the accompanying intrinsic rewards associated with achieving the bonus (as obvious examples, pleasing their fans and personal glory).

scoring high (low) numbers of tries during the bonus-point era, the rule was still effective in incentivising a noticeable number of four-try scores, which otherwise would likely have remained as only three-try (or even two-try) scores. The right panel shows again how for away teams—which are generally less often in a position to earn the try bonus—the rule appears to have had a far less profound effect on scoring outcomes.

Aside from the distributional properties of by-team try scoring, we also examine the proportion of total 'scoring events' accounted for by tries (including penalty tries and ignoring try conversions), as a casual check of effort reallocation towards more incentivised tasks, as demonstrated by Burgess *et al*. (2010). This proportion was marginally higher in the *BP*=1 period, at 49.9% compared with 48.9% previously—this is true similarly if home and away teams are separated. Correspondingly, the try-bonus era also saw a fall in the share of scoring events accounted for by both penalty conversions and drop goals (from 48.0% to 47.3% and from 3.1% to 2.8%, respectively). These descriptive statistics provide a more supportive picture of the try bonus via possible substitution-of-effort effects, and also suggest that other factors may be more responsible for the reduction in mean tries discussed earlier.

Therefore, to drill further into all of these possibilities, we test various hypotheses via before versus after comparisons of scoring outcomes around $x = 4$, where x denotes the number of tries scored after 80 minutes of play (i.e. match completion). Starting conventionally with the uniform null of no effect, the first pair of alternative hypotheses is unconditionally based. These hypotheses are more suitable for modelling pre-match decisions—that teams will purposely target the try bonus (that is, $\Pr(x = 4)$ is higher when $BP = 1$); but in doing so may indirectly undermine subsequent try production in excess of the threshold ($\Pr(x \geq 5)$ is lower when $BP = 1$). The second hypothesis follows logically from the standard labor assumption in sport of increasing marginal cost of effort (see Leeds and von Allmen, 2014: p. 267), and how dynamically if some effort is expedited, higher effort than before to chase the bonus in one period is subsequently offset by lower post-bonus effort than previously in the following period. It also tests whether a team tries to prevent its opposition from achieving the bonus after doing so itself.

The second pair of alternatives is conditional on how marginal try scoring evolves during a match. Specifically, within the scenario of teams having scored three tries turning their attention to earning the bonus by expediting effort exertion ($\Pr(x=4 \mid x \geq 3)$ is higher when $BP=1$), then reducing their attacking effort—to below baseline—upon scoring a fourth ($\Pr(x \geq 5 \mid x \geq 4)$ is lower when $BP=1$).

Table 1 shows the comparative scoring likelihoods via these hypotheses. For away teams, introducing the try bonus did not qualitatively affect try scoring around the relevant range. However, for home teams, the same is true only for $\Pr(x=4)$—see upper-left columns—while $\Pr(x \geq 5)$ is significantly lower (with the null rejected at the strong 1% level) when the bonus is present. In an incidental result, $\Pr(x \geq 3)$ is significantly lower at 1% for home teams (from 0.518 to 0.420), and at 5% for away teams (from 0.330 to 0.269), although this provides an imperfect view of the selection of cases into the conditional samples. From this, the try bonus superficially appears to be counterproductive—failing to increase the incidence of teams scoring four tries (an above-average number) as intended, yet reducing the likelihood of teams scoring additional tries once the bonus has been secured.[11] Further insight is consequently sought on these mechanisms, and as such the two conditional probability hypotheses are considered.

***** Table 1 about here*****

Under the try bonus, $\Pr(x \geq 5 \mid x \geq 4)$ is analogously lower for home teams, although now only weakly so (at 10% significance), but interestingly $\Pr(x = 4 \mid x \geq 3)$ is now significantly higher, and at the standard level of 5%, implying the bonus to be more effective. Incidentally, in unreported further comparisons, we find that the difference in the corresponding means for each of $\Pr(x \geq 3 \mid x \geq 2)$ and $\Pr(x \geq 6 \mid x \geq 5)$ are insignificant—true for both home teams and away teams. This result is intuitively expected, since marginal try scoring outside the specified range discussed earlier is presumably unaffected by the try bonus.

Even still, we should exercise caution at these preliminary results, as they take no account of possible data selection biases. In fact, figure 2 (see black line) shows that, although average tries declined in the first ERC season that bonus points were used, overall there was nonetheless a clear pre-existing downward try-scoring trend that persisted long after bonuses were introduced, which was due to a multitude of other factors. Furthermore, the faint grey line shows that a similar contemporaneous decline (17.3% from *BP*=0 to *BP*=1) in try scoring occurred in the Six Nations, which did not adopt bonus points until

[11] Having a large lead is independently correlated with reduced incentives to score more tries, which may be exacerbated by the try bonus after the fourth try is scored. In the 103 *BP*=1 cases in which the home team scored exactly four tries, it won 95 of these matches (compared with 42 from 53 when *BP*=0), with an average margin of 18.03 points, and with 67 (over 70%) by a margin of 14 (two converted tries) or more.

2016/17—well after our sample period concludes.[12] To account for these, we conduct regression analysis with various controls and fixed effects, as described in the following section.

***** Figure 2 about here*****

3. Modelling Results

In this endeavour, we estimate binary-response models for the various try-scoring-outcome hypotheses by the team of interest (home or away) in each match. Using the first unconditional hypothesis for purposes of illustration, we estimate a very general probit model of the following form

$$\Pr\left(x_{i,j} = 4\right) = \Phi\left(\alpha BP_{i,j} + \mathbf{x}_{\mathbf{i,j}}^{'}\boldsymbol{\beta}\right) \tag{1}$$

where x is now indexed for team i (home and away, respectively) within match j, BP is the regressor of primary interest (for all matches from 2003/04), and $\mathbf{x}_{\mathbf{i,j}}^{'}$ is a vector of explanatory variables controlling for crucial within-match factors. Finally, α and $\boldsymbol{\beta}$ represent the corresponding sensitivity parameter estimates. Analogous models are subsequently estimated for each of the other three alternative hypotheses discussed above.

These explanatory variables are listed in table 2. Given the distinction of home and away outcomes, two (*AT* and *LD*) variables control for the extent of home-ground advantage factors. We also include four (*SD*, *PB*, *WR* and *GR*) relative team-ability variables, permitting for the possibility of improved ERC competitive balance over the sample period (aggregate scoring tends to be lower in matches with more evenly balanced teams). Then, *QK* and *EL* allow for cases of diminished incentives to earn the try bonus in the

[12] The Six Nations is the corresponding annual elite-level European rugby tournament for national teams. It was known as the Five Nations Championship (prior to Italy's admission in 2000) in the first three years of the sample period.

season's final round of group matches. The last three variables (*DG*, *RF* and *WS*) account for how weather and match conditions may operationally affect the degree of difficulty of try scoring. All models contain unreported fixed effects for nationality of the referee (RNFEs), home team (and by implication, venue; HNFEs), and away team (ANFEs). Moreover, given the compelling time-domain story in figure 2, a linear time trend by season (*TT*) is also included—this accounts for trends in tactical evolution and other rule changes (also coaches' responses to these) occurring over the sample period.

***** Table 2 about here*****

Table 3 reports summary statistics for all of these variables, specifically the means, standard deviations, medians, maximums and minimums; with the former split into the *BP*=0 and *BP*=1 groups, permitting identification of possible selection biases that would have to be controlled for. For most variables, the means of both groups are quantitatively comparable. As a counterexample, it is seen that average attendances were noticeably higher in the period following the introduction of bonus points; however, this is likely due predominantly to the general increasing popularity of the competition over time. Nevertheless, this reinforces the inclusion of attendance as an important explanatory variable in our models. Analogously, season scheduling evolved over the relevant timespan (for a variety of reasons) such that in later years, a greater proportion of matches were played in the winter months, which could manifest itself in the weather variables.[13]

[13] In the *BP*=0 period, only 32.8% of matches were played on or after 1 December in their respective seasons, with this proportion rising dramatically to 69.5% in the *BP*=1 period. Match scheduling was modified throughout the sample period to include more matches in later months, mainly because of: (i) competition expansion; and (ii) accommodating other competitions (e.g. the Rugby World Cup) in the match calendar.

These changes also prompted administrators to schedule more matches at earlier kick-off times, hence the day-game variable has a markedly higher mean in the bonus-point era.

***** Table 3 about here*****

Table 4 then displays the model estimates of the (average) marginal effects for both of the simple probability hypotheses ($n = 1{,}227$ across the board). Herein, *BP* is shown to be insignificant for both teams in terms of each of the $\Pr(x = 4)$ and $\Pr(x \geq 5)$ models, with the latter result refuting the possibility of a post-bonus decline in effort for home teams, as strongly suggested within the uncontrolled comparisons. Also, for home teams in the former hypothesis, the *BP* point estimate is of marginal-to-weak significance (*p* value of 0.104)—much unlike the simple comparison—which is at least of potential interest to note when looking ahead to further results discussed next.[14] In addition, all of the significant control variables, notably *SD*, have signs explainable by what intuition would expect, although the clear majority are insignificant.

***** Table 4 about here*****

When drilling further via the conditional probability hypotheses (the marginal effects of which are shown in table 5), we see that for home teams, $BP = 1$ increases $\Pr(x = 4 \mid x \geq 3)$ significantly, at the standard 5% level. In this case, the increase in the point estimate of probability is more than 10%, compared with its former magnitude.

[14] We re-estimated all models using a linear probability estimator instead, in which this corresponding *BP* estimate is weakly significant (*p* value of 0.083). These models are revisited at greater length later.

Finally, for $\Pr(x \geq 5 \mid x \geq 4)$, the *BP* marginal-effect estimates prove to be insignificant for both teams.

***** Table 5 about here*****

As with the simple comparisons, the main qualitative effects of the try bonus are on home teams—an expected result, since these teams far more often approach and exceed the threshold during the match, whereby the existence of the bonus may influence their behaviour. In contrast to the comparisons, however, the regression model results broadly suggest that—when conditioned on other match-specific and time-specific factors—the try bonus is more influential in affecting behaviour, and in a manner conducive to more desirable try-scoring outcomes, as administrators intended.[15]

As a brief commentary on overall model selection, the reported models appear to be highly valid. Not only is this inference drawn from the sensibility of the marginal effect estimates as already discussed, but is also as evidenced by the goodness-of-fit of the models, relative to expectations. Also in this regard, corresponding linear probability estimates (unreported but available on request), a test of model robustness, were similar qualitatively. Apart from *BP* in the first model (see footnote 17), only five (out of 103) coefficient estimates across the eight models from tables 4 and 5 demonstrated altered significance levels.

Overall, the evidence—albeit qualified—shows that the try bonus is extraneously effective in producing greater try-scoring outcomes, by encouraging teams to score an

[15] The following 2003 quote, by the then ECR Chief Executive Derek McGrath, serves to substantiate the inference that rugby's administrators intended the try bonus specifically as a way of incentivising try scoring: "*The bonus points system will encourage and reward positive, attacking play*…" (https://munsterrugby.ie/2003/07/18/heineken-cup-bonus-points-system/, accessed 26 February 2020).

above-average number (four) of tries, and without the possible unintended consequence of teams scoring fewer tries beyond the bonus threshold.[16] This outcome is in line with the results of Friebel *et al*., (2017) showing no evidence of gaming the bonus. It nonetheless contrasts other contributions to the existing theoretical principal-agent literature. Bénabou and Tirole (2003) present a model which, under certain conditions, shows performance incentives to be weak positive reinforcers in the short run, and strong negative enforcers in the long run. Meanwhile, Schnedler (2010) demonstrates that bonuses can give rise to a "perceived-income" effect, which can overwhelm the underlying incentive effect, and reduce total effort in net terms.

Our conclusions also appear to dismiss any suggestion that the bonus point system played a role in causing the general decline in try scoring observed throughout the sample-period era. This inference is supported by unreported estimates from models identical to those in table 4, except with the dependent variable based on $\Pr(x<3)$; showing *BP* to be insignificant for both home and away teams. That is to say, the bonus has not found to be associated with an increase in incidence of teams scoring low numbers of tries.

4. Conclusion

This study sought to test the effectiveness of bonus schemes as a means of raising effort levels, specifically by teams of workers in a professional and highly competitive setting, towards more favourable production outcomes. Harnessing scoring data from elite rugby matches, we find qualified evidence that the existence of the try bonus incentivises (home) teams to target scoring an above-average threshold of tries—relative to games in

[16] Despite this finding, such unintended consequences of badly designed sports rules are nonetheless quite common throughout the history of the industry, reinforcing the importance of having tested the latter hypothesis. For more details, please see Kendall and Lenten's (2017) catalogue of analogous case studies, which includes rugby.

which no bonuses are awarded—in a manner consistent with economic intuition. Furthermore, these teams are not liable to reduce their scoring output beyond the fourth try, once the bonus has been secured.

For numerous analogies in other industries in which bonus schemes are common, the result reinforces the general importance of the policymaker designing such mechanisms that are effective while mitigating possible perverse unintended consequences of those policies, prior to their implementation. It also highlights some general economic lessons that can be learnt in terms of the desire to arrest the decline of try-scoring in rugby. One apparent reform that could be considered by rugby administrators is lowering the threshold to three tries—achievable by both teams in a larger proportion of matches. Another that might also be contemplated is creating multiple bonus thresholds, which would maintain further incentives for continued production beyond the initial bonus threshold.

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Table 1: Uncontrolled Comparisons of Try-scoring Outcomes

	$\Pr(x=4)$				$\Pr(x \geq 5)$			
	Home		Away		Home		Away	
	BP=0	*BP*=1	*BP*=0	*BP*=1	*BP*=0	*BP*=1	*BP*=0	*BP*=1
Mean	0.122	0.130	0.092	0.078	0.243	0.173	0.092	0.073
Variance	0.107	0.113	0.081	0.072	0.184	0.143	0.084	0.068
t-value	0.439		-0.794		-2.844		-1.106	
p-value	0.661		0.427		0.005		0.269	
n	436	791	436	791	436	791	436	791
	$\Pr(x=4 \mid x \geq 3)$				$\Pr(x \geq 5 \mid x \geq 4)$			
	Home		Away		Home		Away	
	BP=0	*BP*=1	*BP*=0	*BP*=1	*BP*=0	*BP*=1	*BP*=0	*BP*=1
Mean	0.235	0.310	0.278	0.291	0.667	0.571	0.500	0.483
Variance	0.181	0.215	0.202	0.207	0.224	0.246	0.253	0.252
t-value	1.993		0.273		-1.944		-0.230	
p-value	0.047		0.785		0.053		0.819	
n	226	332	144	213	159	240	80	120

Note: significance throughout the paper is based on two-tailed tests, given the framing of the null hypothesis.

Table 2: Explanatory Variable List

	Definition
BP	**Match Played under Bonus-points Rules**
AT	Match Attendance in Thousands
LD	Log of Distance (km) Travelled by Away Team
SD	Net (Home Team – Away Team) Group Seedings[17]
PB	Net Points Behind Current Group Leader[18]
WR	Net Win Ratio in Current Season (Before the Match)
GR	Net Current Group Rank
QK	Net Dummy for Team Mathematically Qualified for Knockout Stage
EL	Net Dummy for Team Mathematically Eliminated from Knockout Stage
DG	Game Played in Daytime Slot (Kick-off Prior to 1430, Local Time)
RF	Rainfall (mm) in City on Match Day[19]
WS	Average Wind Speed (km/h) in City of Match
TT	Linear Time Trend, by Season of the Match

[17] Until the 2008/09 season, only number one seeds were designated officially for the purpose of the group draw. For all seasons prior to that, we use a comparable past-data method to infer lower-order seeds, for the sake of consistency.
[18] All values for this variable within the *BP*=0 period have been doubled to ensure comparability, as during the earlier era, a win was worth only two points rather than four.
[19] Although five matches in the sample were played at either at the Millennium (Cardiff) or new Wembley (London) Stadiums, both of which are roofed, none of the respective match reports indicate that the roofs were closed, leaving this variable unaffected.

Table 3: Summary Statistics

	BP=0[*]	*BP*=1[*]	Std.Dev.	Median	Max.	Min.
BP	**0.000**	**1.000**	**0.479**	**1.000**	**1.000**	**0.000**
AT	6.015	10.800	6.751	7.917	75.569	0.000
LD	6.489	6.474	0.692	6.732	7.716	3.734
SD	0.000	-0.001	1.717	0.000	4.000	-3.000
PB	0.665	0.689	5.724	0.000	21.000	-22.000
WR	-0.075	-0.102	0.487	0.000	1.000	-1.000
GR	0.234	0.228	1.543	0.000	4.000	-3.000
QK	0.002	-0.005	0.174	0.000	1.000	-1.000
EL	0.034	0.001	0.370	0.000	1.000	-1.000
DG	0.062	0.207	0.363	0.000	1.000	0.000
RF	2.951	2.364	5.596	0.250	70.100	0.000
WS	16.389	17.257	9.818	15.200	55.700	0.200
TT	3.330	12.004	5.001	9.000	17.000	0.000

[*]Mean of respective group of observations.

Table 4: Marginal Effects from Simple Probability Probit Models

	$\Pr(x=4)$				$\Pr(x \geq 5)$			
	Home		Away		Home		Away	
BP	**0.057**	**(0.035)**	**0.014**	**(0.029)**	**-0.010**	**(0.036)**	**0.016**	**(0.027)**
AT	0.001	(0.002)	-0.004[*]	(0.002)	0.002	(0.002)	-0.003	(0.002)
LD	0.028	(0.020)	0.004	(0.016)	0.024	(0.020)	-0.001	(0.015)
SD	-0.019[***]	(0.007)	0.022[***]	(0.006)	-0.030[***]	(0.007)	0.018[***]	(0.005)
PB	-2.6×10^{-4}	(0.004)	-1.4×10^{-4}	(0.003)	-0.011[**]	(0.005)	0.003	(0.003)
WR	-0.002	(0.043)	0.006	(0.034)	0.015	(0.046)	-0.046	(0.030)
GR	-0.008	(0.013)	0.012	(0.011)	-0.009	(0.014)	-0.008	(0.010)
QK	0.056	(0.058)	-0.005	(0.047)	-0.135[**]	(0.056)	0.007	(0.039)
EL	-0.022	(0.037)	-0.006	(0.029)	0.026	(0.037)	0.039	(0.025)
DG	-0.019	(0.028)	0.024	(0.020)	0.046	(0.028)	0.004	(0.020)
RF	-0.002	(0.002)	-0.001	(0.001)	-0.005[**]	(0.002)	0.001	(0.001)
WS	-0.001	(0.001)	-4.4×10^{-4}	(0.001)	0.002	(0.001)	4.8×10^{-4}	(0.001)
TT	-0.006[*]	(0.004)	-0.003	(0.003)	-0.009[**]	(0.004)	-0.003	(0.003)
RNFEs	Yes		Yes		Yes		Yes	
HNFEs	Yes		Yes		Yes		Yes	
ANFEs	Yes		Yes		Yes		Yes	
Psd-R^2	0.056		0.146		0.292		0.271	

Note: we denote 1, 5 and 10% significance levels with [***],[**] and [*]; and figures in parentheses are standard errors, which are clustered at team level.

Table 5: Marginal Effects from Conditional Probability Probit Models

	$\Pr(x = 4 \mid x \geq 3)$		$\Pr(x \geq 5 \mid x \geq 4)$	
	Home	Away	Home	Away
BP	**0.114** (0.051)**	**0.043 (0.093)**	**-0.097 (0.083)**	**-0.045 (0.130)**
AT	-2.3×10^{-4} (0.004)	-0.002 (0.007)	0.005 (0.005)	0.008 (0.013)
LD	0.037 (0.038)	0.022 (0.050)	0.001 (0.047)	-0.022 (0.073)
SD	-0.012 (0.014)	0.035* (0.018)	-0.015 (0.017)	0.004 (0.028)
PB	0.011 (0.009)	0.004 (0.010)	-0.017 (0.010)	-0.002 (0.013)
WR	0.024 (0.089)	0.104 (0.103)	0.024 (0.105)	-0.284* (0.151)
GR	3.0×10^{-4} (0.028)	0.035 (0.033)	0.001 (0.033)	-0.063 (0.051)
QK	0.166 (0.106)	-0.051 (0.140)	-0.255** (0.125)	0.011 (0.188)
EL	-0.092 (0.070)	-0.111 (0.083)	0.107 (0.086)	0.189* (0.114)
DG	-0.088 (0.055)	0.024 (0.064)	0.113 (0.069)	-0.007 (0.095)
RF	0.001 (0.004)	-0.001 (0.004)	-0.004 (0.005)	0.006 (0.005)
WS	-0.002 (0.002)	-0.002 (0.003)	0.003 (0.003)	0.003 (0.004)
TT	0.017 (0.037)	-0.005 (0.009)	-0.012 (0.009)	0.002 (0.013)
RNFEs	Yes	Yes	Yes	Yes
HNFEs	Yes	Yes	Yes	Yes
ANFEs	Yes	Yes	Yes	Yes
Psd-R^2	0.048	0.076	0.146	0.134
n	558	357	399	200

Note: we denote 1, 5 and 10% significance levels with ***, ** and *; and figures in parentheses are standard errors, which are clustered at team level.

Appendix: Explanatory List of Scoring Modes in Rugby

Term	Definition
Try	Successful grounding of the ball in the in-goal area (5 points)
Conversion	Kicking the ball over the crossbar with a place kick after a try is scored (extra 2 points)
Penalty	Free shot at the goal posts following a foul by the opposition (3 points)
Drop Goal	Drop-kicking the ball over the crossbar during open play (3 points)
Penalty Try	Automatic awarding of a try by the referee, when the team would have scored had the opposition not committed the act of foul play (5 points)