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Teams' Reponses to Changed Incentives: Evidence from Rugby's Six Nations Championship.

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Abstract: The paper analyses teams' responses to rule changes designed to encourage more entertaining play in Rugby Union's Six Nations Championship. We use a data set of all scores in the competition since 1883 to analyse the impact of rule changes on teams' strategic decisions.

We find that increasing the points for a try leads to more tries per match. We also find evidence that teams may be prepared to concede penalties, which are worth fewer points in order to prevent more costly tries. The switch to a winner takes all format in 1994 also led to more tries being scored. Unlike most other major rugby competitions, the Six Nations does not award bonus league points for scoring a certain number of tries and we consider whether this would increase try scoring. Our results may have practical applications given ongoing concerns about a decline in try scoring in the Six Nations.

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1: INTRODUCTION.

Orthodox economic theory suggests that economic agents respond to incentives. Szymanski (2003) describes how sports contests can be useful frameworks for analysing various types of economic behaviour. The present paper analyses the impact of rule changes in Rugby Union designed to encourage more entertaining play on team behaviour. Specifically we focus on rule changes which changed the relative values of different scoring methods. Such changes were designed to encourage more exciting attacking play. We analyse the impact of these changes on the Six Nations Championship (the Six Nations) an international competition which has been played annually since 1883 apart from breaks enforced by the two World Wars. There have been calls for further rule changes in recent years in order to make the Six Nations more attractive to fans, particularly to television audiences (Butler, 2014). Our paper offers some insights on the merits of some of the changes that have been proposed.

The balance of the paper is structured as follows. Section 2 provides a brief summary of the relevant literature. The Six Nations Championship is described briefly in section 3, followed by a description of the scoring system in rugby in section 4. The model is outlined in section 5 and results are contained in section 6. Some conclusions are set out in section 7.

2: PREVIOUS STUDIES.

Szymanski (2003) describes how sports contests can be useful frameworks for analysing various types of economic behaviour. Frick (2003) outlines a literature survey of contest theory in sport, mainly with reference to individualistic sport settings.

A number of papers have analysed the effect of changing relative rewards in team sports which is the focus of the present paper. For example, several authors have analysed the impact of increasing the number of points awarded for a win in soccer leagues from 2 to 3, a move designed to encourage teams to attack more. Brocas and Carrillo (2004) theoretically demonstrated that teams may play more defensively under the three-point rule. Haugen (2008) showed the opposite. Guedes and Machado, (2002) using regression control strategy, found in the case of the Portuguese first division that the three-point rule only affected the behaviour of underdog teams, which became more defensive, the opposite of what the rule change was intended to achieve. Aylott and Aylott (2007) in a study of matches in seven countries found that the number of goals increased in the 2–3 years after the rule change except in Germany. Dilger and Geyer (2009) using a difference-in-differences approach

found that the three-point rule reduced the probability of drawn matches in the German Bundesliga. Moschini (2010), using fixed-effects models of games in 35 countries over 30 years, found that the three-point rule increased the number of goals and decreased the probability of tied games. His analyses showed that the three-point rule made matches more exciting in many non-European countries, but in European countries, the magnitude of the effects was smaller and in some cases negative. Dewenter and Namini (2013) use a game theoretic model and find that increasing the number of points for a win did not necessarily induce teams to attack more. Hon and Parinduri (2014) using regression discontinuity find no evidence that the three-point rule made Bundesliga matches more exciting nor did it increase the number of goals or make matches more decisive.

Bannerjee et al (2007) analysed rule changes in the National Hockey League (NHL) relating to the points awarded in matches which were tied at the end of normal time. In 1983/84 the NHL introduced a 5 minute sudden death overtime period in the case of matches that were tied at the end of normal time. If the match remained tied at the end of the overtime period the teams were awarded 1 point each but if one team scored in overtime it was awarded 2 points and the losing team none. This had the unintended effect of encouraging defensive play in overtime. In 1999/00 the NHL amended this rule to provide that a team scoring a winning goal in overtime would still receive 2 points but the losing team would receive 1 with both teams continuing to receive 1 point each if the match remained tied at the end of overtime. Bannerjee et al (2007) report, that while this had the desired effect of encouraging more attacking play in overtime, it also had the unintended effect of inducing more defensive play in the closing stages of normal time.

A recent paper by Lenten and Winchester (2015) found that awarding bonus league points for scoring four tries or more increased the number of tries scored in matches in the Super Rugby Championship.[1] Such bonus point arrangements are a feature of many rugby competitions. Their study which only analysed the impact of the try bonus in the final stages of matches found that tries were more likely to be scored during that period by teams who stood to earn a bonus point by scoring an additional try, but only when the result was already likely decided. Nevertheless, on the basis of these results, they suggest that bonus points encourage more attacking play, "whereby teams run the ball more (and kick less) in an attempt to score tries."

[1] This is a competition comprising teams from Australia, New Zealand, and South Africa.

3: THE SIX NATIONS CHAMPIONSHIP.

One difficulty with trying to analyse the impact of rule changes in rugby is that there are few competitions that can be used as a case study. Traditionally there were no club championship competitions in many of the major rugby playing countries, due to the fact that the sport remained amateur until 1995. England had no national club championship until 1988, while in Ireland and Wales national leagues were only established in 1991. Scotland has had a national championship since the mid 1970s. France was an exception having a national club championship which dates back to 1892. Owen and Weatherston (2004) cite a lack of reliable data for the period prior to the introduction of professionalism in rugby as a further obstacle to empirical analysis.

One rugby competition with a long history is the Six Nations, an international competition which has been played annually since 1883. Originally there were four participating teams: England, Ireland, Scotland and Wales. France joined the Championship in 1910 but did not participate from 1932 to 1939 re-joining when the Championship resumed after the Second World War in 1947. Italy joined in 2000 when the competition changed from the Five to the Six Nations.

The format of the Six Nations has remained virtually unchanged over time. It is played on a league format with teams playing each other once each season with home field advantage rotating from one year to the next. Teams are awarded 2 points for a win and 1 point for a draw although draws in rugby are relatively unusual.[2] Prior to 1994 if two or more teams finished level on points at the top of the table, the Championship was shared between them. In 1973, for example, the Championship was shared by all 5 of the then participating teams as each of them won their 2 home matches. Since 1994 the Six Nations has been decided on a "winner-takes-all" format. When two or more teams finish with the same number of league points, rankings are decided on the basis of points difference, i.e. difference between total points scored in matches less points conceded, thus providing for a single outright winner of the championship since that date.

Increasing the number of teams from 5 to 6 has resulted in an unbalanced fixture schedule with some teams having 3 home and 2 away matches each season while others have 2 home

[2] Of 1,135 matches played in the Six Nations between 1883 and 2015 only 64 (5.6%) resulted in draws.

and 3 away. As with many sports leagues there is a degree of home bias in the Six Nations. (Thomas et al, 2008 and Vaz et al, 2012),[3]

Table 1 gives details of the number of times each country has won the Championship since 1883.

Table 1: Six Nations Championships by Country 1883-2015.

	Pre WWI	Inter-War	1947-93	1994-2015	Total
Wales	9	6	18	5	38
England	9	10	11	6	36
France	0	0	18	7	25
Scotland	11	7	5	1	24
Ireland	6	5	8	3	22
Italy	dnp	dnp	dnp	dnp	0

Source: http://www.rbs6nations.com/en/championship/roll_of_honour.php#LjsaoqJ6Fu8yqX5D.97

Wales have the most Championship wins at 38 despite having the smallest population of any of the participating countries. England is ranked next. France lag someway behind although they did not participate in most years prior to 1947 and have the highest number of wins since then. Italy has yet to win the Championship.

4: SCORING IN RUGBY.

There are various different ways of scoring in rugby and the relative value of these has been changed on several occasions to encourage more exciting attacking play. A try or touchdown is scored by grounding the ball on or over the opponent's goal line. Note that unlike American Football the ball must actually be grounded. A team scoring a try also gets to have a shot at goal, known as a conversion. In addition teams may also elect to have a shot at goal if awarded a penalty. Penalties are awarded for all but relatively minor infringements and unlike soccer the penalty is taken from wherever on the pitch the infringement occurred. Thus a team must decide whether a penalty is within kicking distance of the opponent's goal. A drop goal is scored by kicking the ball over the crossbar of the opponent's goal from open play.

[3] Over the entire period from 1883 to 2015 the ratio of home wins in the Six Nations was just over 60%.

Table 2 shows how the scoring regime in rugby has evolved over time.

Table 2: Rugby Union Scoring

	Try	Conversion	Penalty Goal	Drop Goal	Goal from Mark	Converted try /Penalty
1883	Local custom		-	-	-	-
1886	1	2	-	3	-	-
1889	1	2	2	3	4	1.50
1892	2	3	3	4	4	1.67
1894	3	2	3	4	4	1.67
1906	3	2	3	4	3	1.67
1949	3	2	3	3	3	1.67
1972	4	2	3	3	3	2,00
1978	4	2	3	3	-	2.00
1993	5	2	3	3	-	2.33

Source: http://www.rugbyfootballhistory.com/scoring.htm Accessed 30.4.2015.

Originally a try did not count as a score. Scoring a try simply entitled a team to have a shot at goal and if a team converted a try by kicking the ball over the opponents crossbar between the uprights this was deemed to constitute a "goal". Thus originally matches were decided by the number of goals scored by each team as in soccer and proposals for a points scoring system were rejected by the RFU in 1875, 1881 and 1882.[4] Nevertheless, in many cases local custom was to award a point for a try and in the early years of the Six Nations a try was worth 1 point with a further 2 awarded for a conversion. In 1886 this was formalised in the official rules which also provided for a drop goal which was worth 3 points. In 1889 penalty goals (worth 2 points) and a goal from a mark (worth 4 points)[5] were introduced. In 1892 the value of a try was increased to 2 points and a conversion to 3 points while a penalty was increased to 3 points and a drop goal to 4 points. In 1894 the relative values of tries and conversions were reversed with a try increasing to 3 points while a conversion was reduced to

[4] http://www.rugbyfootballhistory.com/scoring.htm Accessed 30.4.2015.

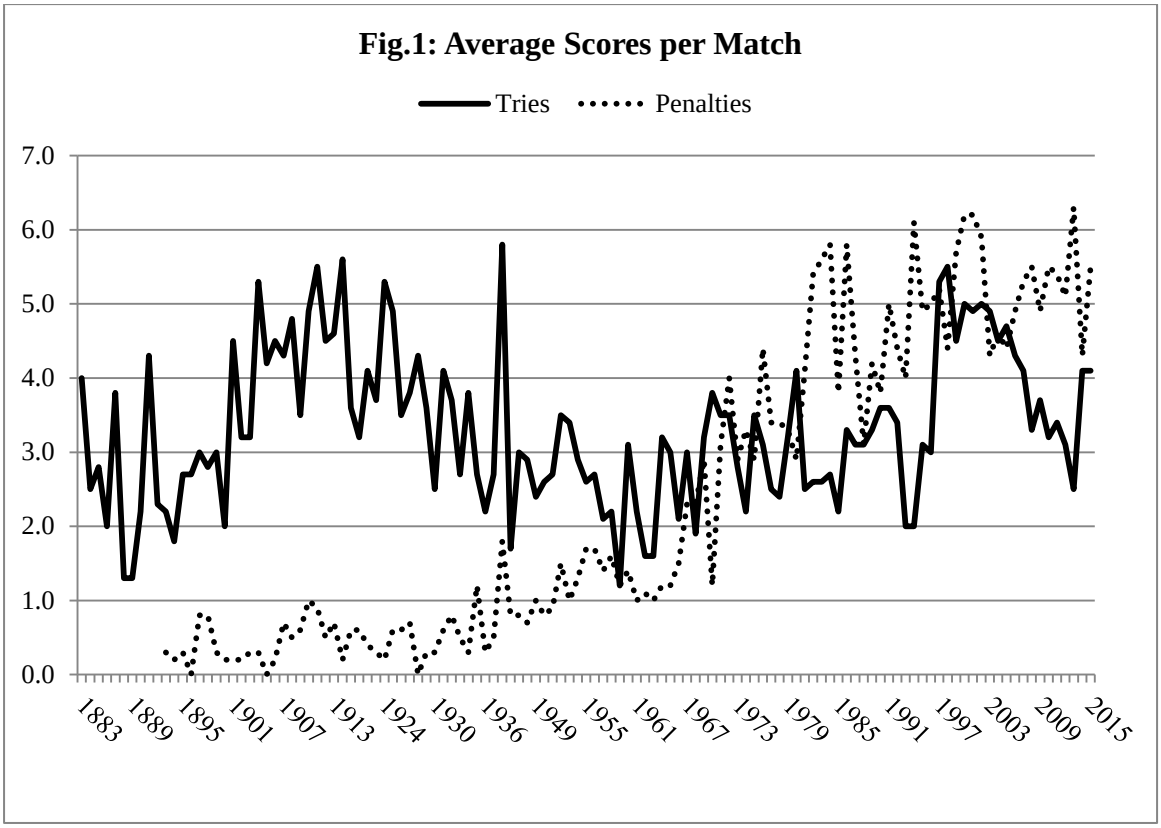
[5] A player making a clean catch when the ball had been kicked by the opposition could call for a mark entitling the player to a free kick out of hand and the player could attempt to score from the resulting free. Only 8 goals from marks were scored in 655 Six Nations matches played between 1889 and 1978 when this method of scoring was abolished. The last goal from a mark was scored in 1931.

2 points.[6] In 1906 the value of a goal from a mark was reduced from 4 to 3 points while in 1949 the value of a drop goal was also reduced from 4 to 3 points. In 1972 the value of a try was increased from 3 to 4 points and in 1992 it was increased again to 5 points. On both occasions the value of a conversion remained unchanged at 2 points. The goal from a mark was abolished in 1978.

When penalties were first introduced in 1889 a converted try was worth 1.5 penalties. Overtime the relative value of a converted try has increased and by 1993 a converted try was worth 2.33 penalties. These changes were intended to encourage more exciting attacking play leading to a higher number of tries being scored. (Eastaway and Haigh, 2014)

Fig.1 illustrates the average number of tries and penalties per match in the Six Nations from 1883 to 2015.

Fig.1: Average Scores per Match



Source: http://www.rbs6nations.com/en/matchcentre/match_data.php#choCQZQVmAzW1voM.97 and http://en.espn.co.uk/scrum/rugby/series/index.html?trophy=2

[6] The value of a converted try thus remained unchanged at 5 points.

The chart shows how, over time, the number of tries per match has declined while the number of penalties has increased. The decline in the number of tries and the growing number of penalties has been a constant concern (Collins, 2009). Nevertheless, as the chart illustrates, until the 1970s the number of tries exceeded the number of penalties per match. For most of the period since then, however, there have been more penalties per match than tries.

There was a brief period from the mid-1990s up to 2003 when the number of tries per match did increase, which at the time was seen as reflecting a systematic shift..

> "Six Nations 2004 provided a clear example of how much the game of rugby has changed over recent and not so recent years.
>
> In 2004, for example, there was one penalty goal for every try. **Ten years ago, there were 3 times as many penalty goals as tries and 20 years ago twice as many.**" (World Rugby, 2004, p.1, emphasis in original).

Such sentiments proved misplaced as tries per match declined with 2004 being something of an exception to the general trend and penalties have exceeded tries for most of the past 40 years. In 2013 there were 6.3 penalties scored per match "the highest since the Five Nations Championship restarted after the Second World War in 1947." (World Rugby, 2013, p3).

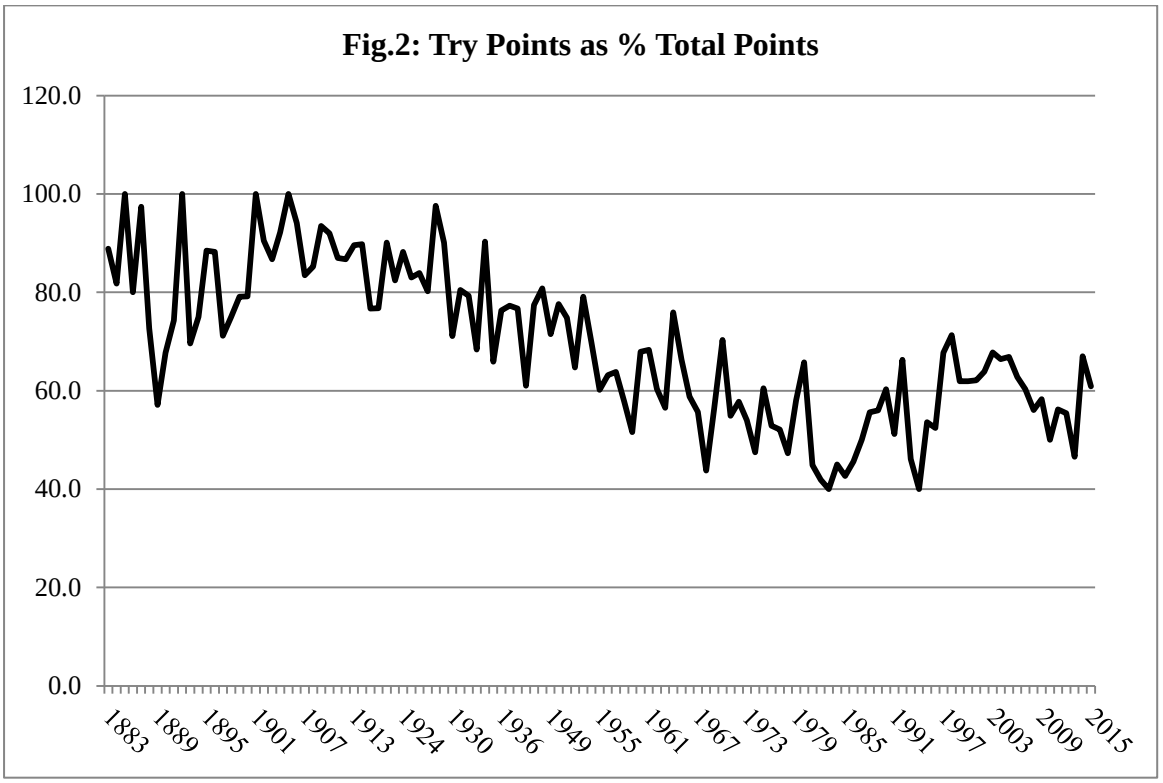
Another way of considering this is to look at the proportion of total points accounted for by tries (including conversions) which is illustrated in Fig.2. This figure declined steadily throughout the 20th century. There was some increase in the late 1990s but again this trend has been reversed since 2000.

Concern about the declining number of tries scored in Six Nations matches have therefore re-emerged in recent years.

> "The average number of tries scored per game was 3.1 – a rate of scoring that was the lowest in the history of the 6 Nations." (World Rugby, 2012, p.1)

> "Overall, there were 37 tries scored in Six Nations 2013, giving an average of 2.5 per match. This was not only the lowest average in Six Nations history, but the lowest in the 18 years since the Game went professional in 1995." (World Rugby, 2013 p.1).

Coach of the New Zealand national team, Steve Hansen, stated he had big concerns about the game, "because there are not enough tries being scored, which is turning the fans away."[7] Such concerns may also reflect the need to make the sport more attractive to television audiences given the growing importance of broadcast revenue following the introduction of professionalism.



Source: http://www.rbs6nations.com/en/matchcentre/match_data.php#choCQZQVmAzW1voM.97 and http://en.espn.co.uk/scrum/rugby/series/index.html?trophy=2

5: MODELLING THE EFFECT OF SCORING CHANGES.

Given that the scoring system has been revised on a number of occasions in order to encourage teams to put more emphasis on scoring tries, an obvious question arises as to whether such rule changes have proven effective. Depending on the answer to that question, and assuming that encouraging more try scoring remains an objective, then it may also be necessary to consider whether there may be more effective ways of achieving such an outcome. For example, many rugby championship competitions award bonus league points to teams for scoring 4 or more tries in a match as a way of encouraging more attractive attacking play. The Six Nations is actually somewhat unusual in not having bonus league points. Lenten and Winchester (2015) argue that the Six Nations could benefit from the

[7] http://www.msn.com/en-gb/sport/rugby-union/hansen-boring-try-less-rugby-has-to-change/ar-BBieZCh

introduction of bonus points. In similar vein, World Rugby, rugby's international governing body observed:

> "This increasing paucity of tries in the Six Nations has not been replicated in the Tri Nations/The Rugby Championship where try-scoring rates have continued to change from year to year. One variable that could contribute to this fact is that The Rugby Championship incorporates a bonus points system." (World Rugby, 2015, p.5)

Others have suggested further adjustments to the rules in relation to scoring and one option which has been tried on an experimental basis in lower level leagues in Australia is to afford teams scoring a try the option of going for a second touchdown which would be worth three points instead of a conversion kick for two points (Butler, 2014). A similar rule was introduced in the NFL. James (2014) advocates the more widespread adoption of the Australian 3 point conversion option along with a reduction in the value of penalties and drop goals from 3 point to 2.

In seeking to answer these questions we can regard teams as having a choice between two opposing playing strategies. The first which we describe as "attacking" involves players running with and passing the ball in order to score tries. Traditionally, in a Six Nations context, the French team with their so-called "Gallic flair" were seen as embodying this approach. The second more "defensive" strategy involves the 8 forwards (or pack) operating as a group keeping a tight hold on the ball combined with the two half-backs kicking for field position with the aim of confining play as far as possible within the opponents half on the basis that sufficient opportunities to kick points would arise due to opposition errors, a style traditionally known as "10 man" rugby as the faster running back players were effectively ignored. This is obviously something of a simplification between two extreme choices. In addition teams may obviously be forced to adapt to the prevailing weather conditions as a passing strategy becomes far more risky in very wet conditions as the chances of fumbling the ball and thereby losing possession are obviously greater. Nevertheless we can view changes in the number of points awarded for scoring a try relative to penalties or drop goals as designed to encourage teams to adopt a more attacking strategy.[8]

[8] There have been other changes to the rules over time also designed to achieve such an outcome. For example, the ability of teams to kick for field position has been reduced by a rule change which provides that if a player kicks the ball into touch from outside their team's 22 metre line, unless the ball touches the ground before it goes out of play, the lineout (throw-in) will take place in line with where the ball was kicked from rather than the point where it went out of play.

It is therefore necessary to consider how changes in the points scoring system are likely to influence team behaviour. Clearly if more points are awarded for scoring tries, we would expect teams to attempt to score more tries, i.e. adopt a more attacking strategy. In simple terms a reasonable starting assumption would be that the number of tries scored will depend on the number of points awarded for a try as opposed to other scores which can be expressed as follows:

$$T = f(UT_{pts}, Pen_{pts}, DG_{pts}) \qquad (1)$$

where T is the average number of tries per match and the variables $UT_{pts}, P_{pts}, DG_{pts}$ represent the number of points awarded for an unconverted try, a penalty goal and a drop goal respectively.

When a team scores a try it has the opportunity of scoring additional points by means of a conversion. Thus there is a question as to whether teams will only take account of the number of points awarded for an unconverted try or are they likely to factor in the fact that there is the possibility of scoring additional points by converting the try. If the latter is the case then we can rewrite equation (1) as follows:

$$T = f(CT_{pts}, Pen_{pts}, DG_{pts}) \qquad (2)$$

where CT_{pts} is the number of points awarded for a converted try.

There is no guarantee that a conversion attempt will succeed and presumably teams are likely to take this into account when deciding on whether or not they should adopt a more attacking style of play.[9] Thus, rather than acting on the basis of the number of points awarded for a converted try, teams may take into account the probability that conversion attempts will be successful. For example, suppose a try is worth 5 points and a conversion a further 2 points. If the team's kicker has a 50% success rate then the team might consider that, on average, scoring a try is likely to be worth 6 points rather than 5 (if they only consider the value of an

[9] The decision is further complicated by the fact that the position from which the conversion kick is taken (and thus the difficulty of the kick) is determined by where the ball is touched down. The kick must be taken from a point perpendicular to the goal line in line with where the ball was grounded and the kicker may go out up to 22 metres from the goal line. Thus even after crossing the line with the ball, the player has an incentive to try and ground the ball as close to the goalposts as possible while the defending team still has an incentive to minimise the damage suffered by forcing the player to ground the ball as close to the sideline as possible in order to increase the difficulty of the conversion kick. What proved to be a short term dip in the conversion success rate in the Six Nations in 2004 prompted World Rugby (2004) to speculate that "An explanation for this could be that defences are organised in such a way that try scoring is being pushed further and further towards the touchlines."

unconverted try) or 7 (which assumes all conversion will be successful). We can therefore rewrite equation (2) as:

$$T = f(AdjCT_{pts}, Pen_{pts}, DG_{pts}) \qquad (3)$$

where $AdjCT_{pts}$ represents the number of points for a converted try adjusted to take account of the probability that the conversion kick will be successful.

In this context it is worth pointing out that the success rate for conversions has increased steadily over time and indeed dramatically so over the past 20 years as Table 3 illustrates.

Table 3: Conversion Kicks % Success Rate.

Pre WWI	36.0
1920-1939	36.4
1947-1971	47.9
1972-1992	52.8
1993-2015	70.1

Source:
http://www.rbs6nations.com/en/matchcentre/match_data.php#choCQZQVmAzW1voM.97 and
http://en.espn.co.uk/scrum/rugby/series/index.html?trophy=2

In the years up to World War II on average only 36% of conversion attempts were successful. This increased to 48% during the 1947-1971 period; 53% in the 1972-1992 period and to 70% in the period since 1993.[10] We do not have data on the success rate for penalty and drop goal attempts, although generally the same player would take both conversion and penalty kicks and thus we would expect to observe a similar pattern. An improvement in the accuracy of goal kicking over time might encourage a more defensive strategy option, other things being equal, as the chances of winning matches by relying on a kicking strategy increase.

6: ECONOMETRIC RESULTS

We collected annual data for the 6 Nations championship from 1883 to 2015 on the number of tries, penalties and drop goals scored. The details are summarised in table 4. We

[10] In dividing up the post World War II era we have chosen the years when the number of points awarded for a try changed. A further factor at work here is the fact that the ban on professionalism was removed at the end of 1995 with the dramatic improvement in the conversion success rate having occurred since then, although the improvement may also reflect simple innovations such as the introduction of a kicking tee for kicks compared with the traditional approach which involved the kicker building a small mound of earth on which to place the ball.

constructed variables to account for the points awarded for tries, conversions, penalties and drop goals over time (see table 2 above). We also constructed dummy variables to account for various other rules changes, such as the introduction of yellow cards in 2000 (see below).

Table 4: Summary Statistics

Variable	Mean	Stn. Dev
Tries Per Game	3.311	1.041
Conversion Rate	0.472	0.122
Points for a Try	3.388	1.052
Points for a conversion	2.017	0.128
Points for a penalty	2.826	0.667
Points Drop Goal	3.372	0.485

Table 5 reports the results of regressions of performance (measured by tries per game) on variables that measure the various rules changes insofar as they affected the points awarded for various scores in rugby.

The first column shows a regression of tries per game on variables representing the points awarded for an unconverted try, a penalty and a drop-goal respectively (see equation 1 above). The coefficient on the try variable suggests that if the points awarded for a try were to be increased by one, then this would lead to an extra 0.612 tries per game. This is not particularly surprising. Similarly as expected increasing the points awarded for a penalty reduces tries scored per game. What appears surprising, at least initially, however, is that points awarded for a drop goal have a positive effect on tries scored per game, although this may simply reflect a time effect. Drop goals occur when an attacking team has achieved a significantly threatening position from which either a try or drop goal is possible. The same strategic play yields the outcome of either a try or a drop goal, while factors such as the existing score, time remaining are likely to have an important influence on the option chosen.[11]

Column 2 of Table 5 repeats the analysis of column 1 except that we included as a repressor the points awarded for a converted rather than an unconverted try, i.e. equation 2. The

[11] The authors are grateful to Moore McDowell for pointing this out.

magnitude and sign of the coefficients are almost the same as in column 1. In column 3 we repeat the analysis using the points awarded for a converted try adjusted to take account of the probability of a successful conversion kick, i.e. equation 3.[12] The results again suggest that an increase in the number of points awarded for a try has a significant impact on tries scored.[13]

Table 5: Impact of Points Changes

	(1)	(2)	(3)	(4)
VARIABLES	TPG	TPG	TPG	PPG
UT_{pts}	0.612***			1.738***
	(0.120)			(0.162)
DG_{pts}	1.050***	0.997***		-1.204***
	(0.214)	(0.215)		(0.185)
Pen_{pts},	-0.521***	-0.491**		
	(0.184)	(0.188)		
Conv % success rate				0.813
				(1.202)
CT_{pts}		0.584***		
		(0.124)		
Adj. CT_{pts}			0.196***	
			(0.0929)	
Constant	-0.832	-1.822*	2.477	-0.202
	(0.778)	(0.944)	(0.433)	(0.922)
Observations	121	121	111	111
R^2	0.229	0.209	0.039	0.892

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

The fourth column repeats the analysis using penalties scored per game as the dependant variable. The score awarded for a penalty is not included as a regressor because there is almost no variation in its value of the time period for which we observe the dependent

[12] For each season we used the average conversion success rate over the previous 10 years as a measure of the probability of conversion success and then multiply the number of points awarded for a conversion by this probability to determine the adjusted points for a converted try.

[13] As a robustness check we re-ran the try per game regressions for the period from 1920 to 2015 and 1947 to 2015 but the results were largely unchanged.

variable. The regression shows that penalties scored rose with the score awarded for a try and fell with the score awarded for a drop goal. The quality of kicking (as measure by the successful conversion rate of tries) has a positive but insignificant effect on penalties scored. An increase in the number of penalties scored following the increase in the number of points awarded for scoring a try might appear counterintuitive. However, one possible explanation is that increasing the value of a try relative to a penalty may have had the unintended consequence of encouraging teams to concede more penalties in order to prevent tries being scored.

We then ran the various regressions again only this time we used the value of a try relative to penalties and drop goals rather than the actual points values for the different score types.[14] The results are shown in Table 6.

Table 6: The Relative Value of a Try

	(1)	(2)
VARIABLES	TPG	TPG
UT_{pts} relative to Pen DG_{pts}	0.703**	
	(0.338)	
$AdjCT_{pts}$ relative to Pen DG_{pts}		0.515*
		(0.268)
Constant	2.532***	2.594***
	(0.411)	(0.413)
Observations	111	111
R^2	0.038	0.033

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

In the first column, we regress tries per game on the value of an unconverted try relative to that of weighted average of a penalty and a drop goal. As expected increasing the value of a try by one point (relative to that of penalty or drop goal) increases the number of tries per

[14] Penalties and drop goals represent an alternative means of scoring to tries. Since 1949 both penalties and drop goals have been worth 3 points so the relative value of a try to both is the same. Pre-1949 the number of points for penalties and drop goals were different so we estimated a weighted average value for penalties and drop goals to reflect the frequency of both types of scoring. We then used this weighted average value to estimate the relative value of a try. Over the period from 1893 when the first penalty was scored in a Six Nations match, to 1948 there were, on average 10 times as many penalties as drop goals scored.

game by 0.703. The second column repeats the analysis but using the relative value of a converted try adjusted for the probability of the conversion being successful. As with our original results including conversions makes little qualitative difference to the magnitude or the sign of the coefficient.

We now consider the impact of certain other rule changes on try scoring in Table 7.[15]

Table 7: Winner Takes All and Sin Bins

	(1)	(2)	(3)	(4)
	Winner-Takes-All		Sin-Bins	
VARIABLES	TPG	PPG	TPG	PPG
Winner Takes All	0.865***	3.669***		
	(0.233)	(0.346)		
Sin Bin			0.866***	3.460***
			(0.269)	(0.451)
Constant	3.153***	1.597***	3.196***	1.823***
	(0.0995)	(0.153)	(0.0978)	(0.170)
Observations	121	112	121	112
R^2	0.104	0.505	0.080	0.349

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The first column shows the impact on tries per game of introducing (in 1994) a winner takes all policy. The adoption of the policy has lead to an increase in tries per game. Column 2 of the table shows that the new regime has also lead to an increase in penalties per game. This would require a more detailed analysis in light of the extensive economic literature on the design of prizes in sporting contests which is beyond the scope of the present paper. (See, for example, Szymanski, 2003).

[15] Rugby has seen ongoing rule changes mainly designed to favour attacking, e.g. in the case of a scrum the defending team's 3 back row players would frequently break off the scrum and take up defensive positions as it was clear that the opposing team was going to secure possession but now they are required to remain bound to the scrum until the opposition have actually picked the ball out. We cannot factor in all of these rule changes and have thus focussed on two specific changes which we regard as the most significant, namely the switch to a winner takes all prize and the introduction of the "sin-bin".

In 2000 the yellow card or sin bin was introduced in the Six Nations. A player receiving a yellow card is expelled from a match for 10 minutes and cannot be replaced leaving the team a player short for this period of time.[16] This can be seen as an attempt to discourage teams from giving away penalties in order to prevent the opposition scoring a try.[17] The third and fourth columns of table 7 include a dummy which accounts for the introduction of the sin bin in the Six Nations from 2000. If the sin-bin constitutes an effective deterrent to conceding penalties in order to prevent tries we would expect to observe some increase (decrease) in the number of tries (penalties) scored post 2000.[18] In fact the variable has statistically significant positive effect on the number of tries and penalties per game. The latter result suggests that the sin bin may not constitute an effective deterrent to conceding penalties in order to prevent tries while the positive effect on tries scored may be attributable to the fact that the chances of scoring a try increase when the opposition is a player short.

We provide some additional evidence on the impact of the sin-bin in Table 8 which shows both the number of sin-binnings per season and sin-binnings for the losing team as a percentage of the total. The date include red cards which we count as equivalent to two yellow cards (sin-bins) for the purposes of the table, although we have identified only 4 instances of red cards being issued since 2000.[19]

Table 8: Sin-Bins

	Total Sin-Bins	Losing Team Sin-Bins as % Total		Total Sin-Bins	Losing Team Sin-Bins as % Total

[16] As in soccer a red card constitutes a sending off in which case the player is excluded and cannot be replaced for the remainder of the match. Unlike soccer a player does not receive a red card for a second yellow. It is also important to note that in rugby a player can be sin-binned due to repeated offences by his team even if that individual was not guilty of any previous infringement. The object of the sin-bin is to discourage teams from using illegal methods to prevent their opponents scoring a try.

[17] A possible unintended consequence of increasing the relative values of tries is that teams may be more prepared to concede penalties as they are less costly.

[18] We might also expect an increase in tries via another channel in that a team's chances of scoring a try are likely to be increased if the opposition is a player short.

[19] It might be interesting to compare red cards before and after 2000 to see whether the introduction of the sin-bin has affected the number of red cards issued in matches. We should also point out that the data on sin-bins, particularly for earlier years is somewhat unreliable. We obtained it from individual match data on the Six Nations website which for most years from 2003 on we were able to cross reference against World Rugby's Six Nations Statistical Analysis Reports. In some instances the website shows the same player being repeatedly sin binned in successive matches and in one case a player is shown as being sin-binned in virtually every match he played which is clearly an error. We also cross checked against match data on the ESPN website but some errors may remain.

2000	12	50.0	2008	7	71.4
2001	10	77.8	2009	11	75.0
2002	14	85.7	2010	10	91.7
2003	8	63.6	2011	10	46.7
2004	4	50.0	2012	13	53.8
2005	5	80.0	2013	14	35.7
2006	11	72.7	2014	12	71.4
2007	7	71.4	2015	15	64.3
Annual Average 2000-2015				10	66.3

Source: http://www.rbs6nations.com/en/matchcentre/match_data.php#choCQZQVmAzW1voM.97 Last accessed 31.5.2015.

It is clear from the table that losing teams incur a much higher number of sin-binnings. We cannot identify causality from this result. One possibility is that teams that are being outplayed by their opponents concede far more penalties and thus incur more sin-binnings in which case the existence of the sin-bin will not affect the outcome of the match but may affect the winning margin. Alternatively it may be that incurring a sin-binning makes it more likely that a team will lose the match. This is an issue which may merit further study.

7: BONUS POINTS.

Our results indicate that increasing the number of points awarded for scoring a try would be likely to lead to an increase in the number of tries scored. An alternative that has been proposed is the introduction of a 3 point conversion option (Butler, 2014). Our results suggest that the number of points for a conversion appears to be far less important suggesting that the introduction of a 3 point conversion option would have little effect on try scoring. One problem with either option, of course is that they would both require changes in the sports rules, something which the organisers of the Six Nations cannot do unilaterally. An alternative that has been suggested is that the Six Nations should introduce bonus league points for scoring a certain number of tries in a match as is the case in many other rugby championships as a way of increasing try scoring.

In order to test the likely impact of introducing bonus points we ran a regression using scoring data for both the Six Nations and the Tri-Nations/Rugby Championship for the period from 1996, when the latter competition commenced, up to 2014, as the 2015 Rugby

Championship season had not been completed at the time of writing.[20] We insert a dummy variable in the regression for tries per game in the Rugby Championship to capture the fact that bonus league points are awarded for scoring four tries in the latter competition. The results, which are shown in Table 9, indicate that the absence of bonus points means that the number of tries per match is lower in the Six Nations. Of course this dummy will capture the effect of all differences between the two competitions and not just bonus points. Nevertheless our results suggest that this is an option which should be looked at further.

Table 9: Bonus Points

	(1)
VARIABLES	
Bonus	1.047***
	(0.266)
Constant	3.311***
	(0.0981)
Observations	140
R^2	0.101

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

On occasion in recent years the Six Nations has seen high levels of try scoring in the final round of matches usually in circumstances where the Championship is likely to be decided on points difference. This was the case, for example, in 2007.

> "In broad terms there were 2 different Frances on view in this year's RBS 6 Nations. There was the France of the first 4 matches and then came the France of the final game which was quite different from the rest. The circumstances surrounding this game were exceptional. Unlike almost all other matches, a win was not sufficient. The target was to score as many tries as possible and in order to achieve this, the strategy that day was to pass the ball." (World Rugby, 2007, p.4).

In similar circumstances in 2014, 33% of all tries were scored in the final round of matches, while the 2015 Championship produced an even more dramatic finale with 27 tries in the

[20] The Rugby Championship (formerly known as the Tri-Nations) is the Southern Hemisphere equivalent of the Six Nations and comprises the national teams of Australia, New Zealand, South Africa and, since 2012, Argentina.

final round of matches, 44% of the competition total and more than in any previous round of matches in the Six Nations history. This compares with an average of 2.9 tries per match in the first four rounds of the 2015 Championship, which was the second lowest rate of try scoring recorded in the Six Nations. (World Rugby, 2015) Four teams had a chance of winning the Championship going into the final round of matches in 2015 thus providing teams with a strong incentive to go for tries.[21] In a truly dramatic finale the Championship was decided by the final play of the final match – even in the final round matches are played sequentially rather than simultaneously unlike many other sports - thus giving teams playing last a possible advantage.

Traditional fans of the Six Nations might well bemoan a decline in the rate of try scoring.

> "The last weekend's average of nine tries per game had the effect of producing a tournament average of 4.1 tries per game, which was not a true reflection of the shape of the game in this year's competition. Eight of the first 12 matches, for example, averaged just 1.75 tries per game." (World Rugby, 2015, p.3).

While broadcasters' demand for sports content has increased dramatically, Szymanksi (2009) argues that what broadcasting wants is a coherent package from the organisers of sports events.

> "The genius of the NFL was to recognise that television wanted more than a game, it wanted a myth and a spectacle of Hollywood proportions, an 'appointment to view' and an epic narrative." (Szymanski, 2009)

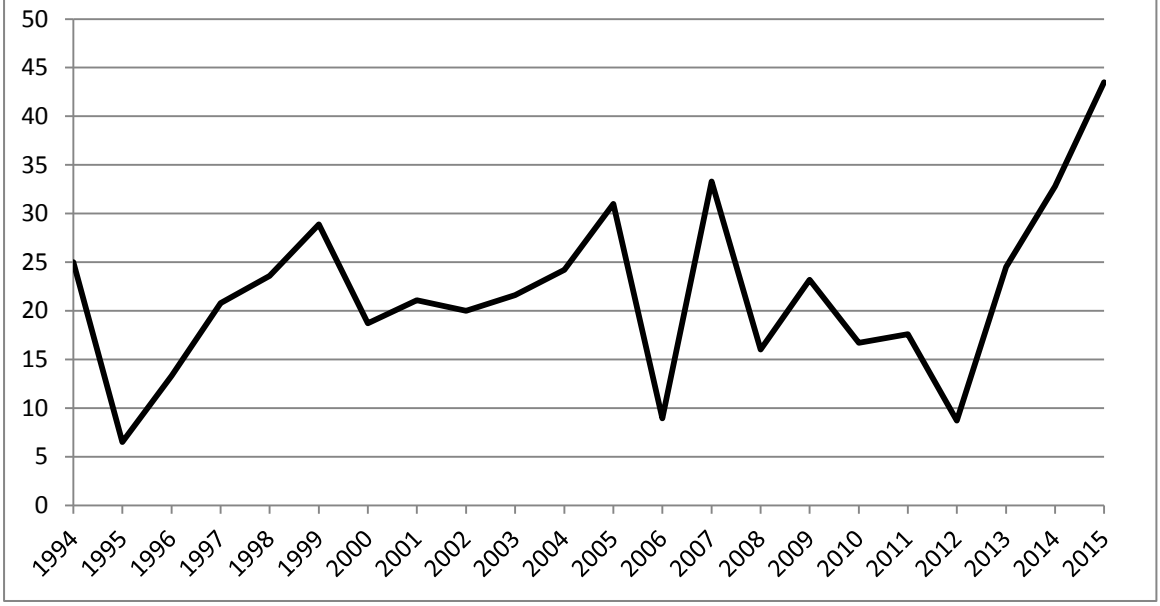
There are clear similarities with Sky's coverage of English football's FA Premier League.

There can be no doubting that the 2015 Six Nations produced a gripping finale arguably commensurate with the tournament organiser's extravagant description of it being the "World's Greatest Rugby Championship". This might make the Six Nations organisers (and television executives) reluctant to introduce bonus points. However, it is important to bear in mind that 2015 was something of a one-off as Fig.3 which looks at tries scored in the final round of Six Nations matches as a percentage of total tries scored in the competition for each season since 1994 illustrates. Introducing bonus points might reduce the possibility of climactic finales but these are rare in any event, whereas measures that increase try scoring

[21] England, Ireland and Wales had each won 3 of their 4 previous matches while England had a slightly better points difference than Ireland. While France had only won 2 out of 4, they could win the title by beating England in the final match if Ireland and Wales both lost.

such as bonus points might well enhance the overall attractiveness of the Championship to television audiences.

Fig.3: Tries in Final Round of Matches as % Total Tries Scored.



Source: http://www.rbs6nations.com/en/matchcentre/match_data.php#choCQZQVmAzW1voM.97

8: CONCLUSIONS.

Orthodox economic theory suggests that economic agents respond to incentives. There is an extensive literature using evidence from sports to provide insights into economic behaviour. The present paper analysed the impact of changes in the scoring system used in Rugby Union designed to encourage more entertaining attacking play using annual data from the Six Nations Championship a tournament which dates back to 1883,

Our results indicate that increasing the reward for scoring tries resulted in an increase in the number of tries scored per match and a corresponding decline in the number of penalties scored. To the extent that this was the objective of the rule changes, they can obviously be considered a success. Nevertheless, there are ongoing concerns that the rate of try scoring in the Six Nations is continuing to decline. Deciding to further increase the points awarded for scoring tries might not be a straightforward solution. Such a change would have to be implemented for the sport as a whole by the World governing body, which might not be easy to achieve. An alternative approach which has been adopted in many other rugby championships is to introduce bonus league points for scoring a certain number of tries in a

match. Our results indicate that the lack of a bonus points system results in fewer tries per match in the Six Nations that in its Southern Hemisphere counterpart the Rugby Championship. Such a change could be implemented by the Six Nations unilaterally. One argument against such a change is that it might prevent a repeat of the dramatic finale witnessed in the 2015 Championship. While the final round of matches in 2015 undoubtedly made for very dramatic television viewing, it is important to bear in mind that it was very much a one-off and may therefore not represent a good basis for making decisions on the future format of the competition. At the very least our results suggest that the bonus point option may merit further examination.

We also considered the impact of the switch to a winner takes all format in 1994 and the introduction of the "sin-bin" in 2000. The former had a positive impact on try scoring, although it also resulted in a far greater increase in the number of penalties so it is not clear that it resulted in teams adopting a much more adventurous approach. We find that the introduction of the "sin-bin" had a significant impact on both try and penalty scoring, while losing teams account for quite a high proportion of sin-bins.

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