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Match Outcome Uncertainty and Sports Fan Demand: An Agnostic Review and the Standard Economic Theory of Sports Leagues

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One of Rottenberg's (1956, The baseball players' labor market. *Journal of Political Economy*, 64, 242–258) foundational sports economics hypotheses is that fans prefer their team to win but with more match outcome uncertainty (MOU) rather than less. The testable implication is that increase in home team win chances and match 'tightness' should lead to increased fan demand for live attendance. It is safe to say that the verdict by those that voice one, especially recently, is that empirical results offer only occasional and weak support for Rottenberg's hypothesis. We show that a more agnostic examination of the literature suggests that there is much more evidence failing to reject Rottenberg's hypothesis than previously acknowledged. We also show that Rottenberg's hypothesis is only one alternative generated by the standard economics of sports leagues. Rejecting Rottenberg's hypothesis does not necessarily reject the importance of MOU with a different predicted sign as a demand determinant. This suggests additional testing tasks for the body of work that has moved on to loss aversion based on the prospect theory.

Keywords: Outcome uncertainty; home win probability; game tightness; literature review.

Introduction

Purely descriptively (that is, without mathematical or graphical intuition), Rottenberg (1956) specified the demand for sports attendance (Fort, 2005). Under

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the 'preferences' determinant, he hypothesised that fans prefer both wins by their home team and match outcome uncertainty (henceforth, MOU). This hypothesis implies that an increase in home team win chances and match 'tightness' should each increase fan demand for attendance. In this paper, this is referred to as the Rottenberg hypothesis or 'the RH' for short.[1]

Subsequent empirical work tested the RH by estimating the impact of home team win chances and match tightness on demands for both live attendance and for TV broadcasts.[2] It is safe to say that the verdict, especially recently, is that there is only occasional and weak evidence supporting the RH. Some of those verdicts go even farther, suggesting that MOU, itself, has been overplayed as a determinant of fan demand. In addition, a growing body of literature has moved on to explain the rejection of the RH with loss aversion from prospect theory.

We attempt to contribute to this literature in two ways. First, the verdict on the RH rests on the report aggregation choices and particular criteria. We attempt to present the results in the literature more agnostically. We also have the advantage of finding papers unavailable to or missed by previous literature reviews that cast a verdict on what the literature finds. The demonstrated diversity of its results, under this agnostic approach, might spur renewed interest in the RH and fan demand.

As our second and directly related contribution, we use the standard economics of sports leagues to show that there are alternatives to the RH. Rejecting the RH does not reject MOU, itself, as a determinant of fan demand. Any hypothesis test depends on both the null and alternative and rejecting *the RH* begs testing other alternative hypotheses from standard theory.

This should not be surprising. MOU is a preference phenomenon. Claiming that it must have the same empirical impact over time, for all fans, of all sports, regardless of their viewing choice (live or on TV) seems the epitome of preference restriction by the analyst. To us, this is akin to finding that the income effect for hamburger is positive for some consumers, negative for others, and concluding that, since there is no overwhelming result either positive or negative, then there must not be an income effect. Instead, there are both positive (normal) and negative (inferior) income effects and it would be astonishing if they were the same across all hamburger consumers.

Just as with income effects, MOU is strictly a hypothesis about preferences. Just as there are normal and inferior goods with respect to changes in income, it is reasonable that MOU may increase demand for some fans but not all fans. This seems

[1]A similar approach to Rottenberg's (1956) other 'invariance hypothesis' is in Fort *et al.* (2016) and Fort (2022). Since there is no further mention of this other hypothesis in the rest of the paper, there is little chance of confusion.

[2]Rottenberg (1956) only discussed attendance. The extension to TV is natural enough, but technically not Rottenberg.

even more apparent depending on which sport is under examination or the country where those fans reside. Rottenberg (1956) offered one hypothesis about *baseball* fan attendance demand, but it was just that, one hypothesis about fan preferences.

The paper proceeds as follows. In the second section, we document the verdict on the RH and MOU, itself, in the literature and provide a more agnostic categorisation approach to the results in the literature. The agnostic categorisation is applied to the literature on MOU in the third section. In the fourth section, we place both the RH and the related empirical work in the standard context of the theory of sports leagues, showing the variety of alternatives to the RH. Conclusions and suggestions for future research round out the paper.

Past Verdicts and an Agnostic Methodology

The verdict in the literature about the RH and MOU, itself, is based on (1) estimated sign congruence with expectations and statistical significance, (2) a level of aggregation of the results and (3) some adopted criterion of the pervasiveness of results. If an author judged the bulk of their regression results to reject, jointly under sign congruence and strict statistical significance, subsequent authors just repeated the judgement. Not only do subsequent authors offer a unified conclusion but then others accept that conclusion in their later research designs. Or, if it is a literature review piece, a table of these claimed outcomes, criteria unchallenged, is used to lead to another level of aggregated judgement of the results across papers.

Examining these verdicts by other researchers and reviewers raises questions. Statistically speaking, how does one reach a verdict? What does a mixed verdict in an individual paper, or across papers really mean? Our first task is to address these issues using a more agnostic and disaggregated set of criteria for presenting the results in the literature so that researchers can draw their own conclusion about MOU.

Statistically speaking, how does one reach a verdict? The overwhelming response in the literature is to go strictly with expected sign and statistical significance. The presence of both is taken as ‘strong’ evidence, but without statistical significance the result is taken to be ‘weak’ evidence at best. Outright rejection is incorrect sign with the statistical significance.

There are well-known problems with this use of strict statistical significance. Imbens (2021) summarised the limitations of basing judgement, especially judgement with policy implications, solely on statistical significance. In policy cases, he argues, point estimates and confidence intervals or even better. Bayesian intervals are often more informative summary statistics. Imbens does not advocate banning *p*-values outright, pointing out that technically they are strongest when testing a null hypothesis is the ‘natural goal’. Finally, he criticised the overemphasis on statistical significance as a criterion for publishable work, which can lead to abusive 'p-hacking' (simply running models for the sake of finding significant *p*-values).

Thus, while statistical significance provides information about the analysis, it is not the only determining factor, especially when making policy prescriptions.[3] Put another way, statistical significance gives important information about the explanatory power of variables in a model, but not the only or even the overriding information about the variables. It is just as important to know about correct sign and adherence to the theory being tested. Further, any number of data issues can result in statistical insignificance, e.g. multicollinearity, omitted variables and limited data variation.

What does a mixed verdict in an individual paper, or across papers in a literature review, really mean? In the literature, there are additional criteria added to this, namely, that both an overwhelming result and a pervasive result are required. These additional criteria are particularly exclusionary with the requirement of both expected sign and statistical significance.

This is easiest to see in the previous reviews of the literature.[4] Listing the aggregated conclusions of authors, based on expected sign and statistical significance, Szymanski (2003) offers this compound conclusion on MOU (p. 1156):

> There seems to be an emerging consensus that demand for match tickets peaks at the point where a home team's probability of winning is about twice that of the visiting team, i.e., a probability of around 0.66…Several reviewers have commented upon just how unbalanced a contest characterized by this probability would be, and in most datasets (*sic*) there are relatively few observations involving such extremely unbalanced contests.

That is, the literature rejects the RH. But then, based on a tally of all forms of outcome uncertainty—match, seasonal and championship—Szymanski claims only a distinct minority of work on the 'uncertainty of outcome' that supports the RH, observing, 'This is remarkable given the weight that is placed on this argument in policy making and antitrust cases' (p. 1156).

We hasten to note that if Szymanski had stuck solely to the results of MOU reported in his review, the evidence is just the opposite. From his own Table 2 (pp. 1157–1158), the eight works are listed as estimating *MOU impacts per se*,

[3]These warnings harken back to Leamer's (1983) scold about the 'con in econometrics', but also include the modern 'p-hacking' criticisms summarised in Gelman and Loken (2014) and Gelman (2019).

[4]The first review was Cairns *et al.* (1986). With so few attendance demand studies at that time, they wisely concluded, "It should be clear from this discussion that economists have a long way to go before they can claim to have adequately tested the uncertainty of match outcome hypothesis" (p. 19).

four are listed as 'support' for the RH, two are listed as 'weak support' for the RH and two are listed as 'no support' for the RH. The tally from works solely about MOU, adhering to the strict requirement of expected sign and statistical significance, is 4-4. If the statistical significance requirement is relaxed, the tally becomes 6-2 failing to reject the RH.

Borland and MacDonald (2003) found 18 articles analysing MOU (their Appendix Table 2, pp. 496–497), concluding (p. 486):

> 'Evidence of the effect of match-level uncertainty of outcome on match attendance is relatively weak…Of 18 studies identified, only about three provide strong evidence of an effect on attendance…'

At least, they cast their verdict solely on MOU results. But, they also used the criterion of a statistically significant positive effect of greater MOU on attendance. If that statistical significance requirement were weakened, another seven of the works they reviewed might provide an evidence supporting the RH. Another five are judged based on 'mixed' but statistically significant results. Thus, only three studies find statistically significant contradictory evidence on MOU.[5]

Literature reviews are not alone in their restrictive verdict. Buraimo *et al.* (2007) stated (in their Abstract):

> For such a popular hypothesis, there is, then, curiously little empirical support. It might be concluded that, within the range of outcome uncertainty actually observed in sports leagues, variations in it from game to game are not in fact important to spectators considering whether or not to attend.

Actually, it isn't exclusively that game to game variations in MOU which are not important to spectators, since there were statistically significant findings as well directly countered to the RH.

This is not lost on Pawlowski *et al.* (2018, p. 174):

> Over several decades, numerous papers have tested the impact of uncertainty—in particular game uncertainty—on the demand for sport. In contrast to the widespread belief in the UOH by policy makers, however, this empirical literature offers ambiguous findings. While there is some

[5]There are other reviews, but they did not catalogue results aiming to ascertain the empirical veracity of MOU in demand studies. Fort (2006) argued that the work may not have carefully analysed MOU, itself. Villar and Guerrero (2009) focussed on the objective functions, measurements and econometric modelling techniques. Schreyer and Ansari (2021) identified the methodological challenges and literature pertinent to the future research areas. Dawson and Downward (2005) offered measurement critiques. Štrumbelj (2016) suggested about the problems inherent in the use of derived betting odds. Pawlowski (2013) argued about the limits of revealed preference and the additional value of a stated preference approach. Skrok (2016) raised a host of other issues.

> supportive evidence for the relevance of seasonal uncertainty, match-level attendance studies seldom find that the more tickets are sold the more uncertain the result of the game is anticipated to be. In contrast, most studies show that stadium attendance rises as the certainty of a home team or away team win rises.

Borland and Lye (1992) list their league position difference MOU variable but did not report the estimated coefficients. Forrest and Simmons (2006) went so far as to omit home win probability (without its square) as an MOU variable from their three attendance regressions, based on a statistical significance call. Buraimo (2008) did the same, using the same variable, on the same grounds for two TV viewing regressions.

Given the issues associated with the strict statistical significance requirement and the addition of criterion for both consistent and pervasive results, we adopt a more agnostic approach. We present the results of every regression run rather than the aggregated verdict in each paper, with its own regression results. We choose categories that simply list the actual estimation results in the papers. While the tallies under this agnostic approach are reported, we leave it to the reader to draw their own conclusions.

The designations when one variable (possibly including its square) is used to capture MOU are as follows. 'Correct, significant' means the estimated coefficient was correct sign and statistically significant at the authors' chosen significance level. The remaining designations are 'correct, insignificant', 'incorrect, significant' and 'incorrect, insignificant'. For papers that used more than one variable (excluding a variable's square) to capture OU, the preceding designations include the results if *both* variables gave the same results. But we also add 'one correct, significant' and 'one correct, insignificant' in case the either of the two variables gave different results.

To derive our sample of MOU papers, we began by starting a list from the past literature reviews, Cairns *et al.* (1986), Szymanski (2003), Borland and MacDonald (2003), Villar and Guerrero (2009) and Schreyer and Ansari (2021). Then, we augmented the list using Google Scholar and the keywords 'outcome uncertainty', 'game uncertainty', 'match uncertainty' and 'competitive intensity'. We continued under each keyword until no more relevant papers were found. For example, there were no more relevant listings under the keyword 'outcome uncertainty' after 39 Google Scholar pages. The result was a list of 202 papers.

After that, we went through each paper individually to identify only papers about MOU. Not all papers are consistent in this regard, some use 'outcome uncertainty' in their titles in the general sense of competitive balance, a practice that causes some confusion. The concept of MOU is captured in match-level outcomes.

Competitive balance, on the other hand, is determined by the variation in playing talent across the teams in the league. Clearly, MOU and competitive balance are related. If there is a high level of competitive balance across a league, one would expect high MOU as well. But MOU and competitive balance are not the same thing.[6]

We rejected 90 papers that used 'outcome uncertainty' as a descriptive but, in our opinion, were about competitive balance. The result was a list of the 112 papers on the MOU, with a total of 639 regressions, over the period 1988–2021. Full references to all 112 of the papers are in the Appendix.[7]

Agnostic Literature Review

In this section, we present the results found in the 639 regressions in the 112 papers in our sample under the more agnostic categorisation scheme detailed in the last section. We also do so under a few intuitively important 'breakouts'—over time, by sport, across countries and for live attendance versus TV viewing.

Table 1 lists the number of papers and the number of MOU regressions by year and decade. The vast bulk of the analysis is very recent. 76.8% of the papers and 88.7% of the regressions appeared in print after 2009.

Table 2 breaks the number of papers and the number of regressions out by the 18 sports analysed in the literature to date.[8] 55.3% of the papers and 57.7% of the regressions were on soccer data. Baseball is a distant second with 8% of the papers and 7.4% of the regressions. Tennis is an even more distant third in terms of regressions at 3.9%.

From Table 2, past work on MOU is decidedly soccer centric. This may well be in keeping with the distribution of interests in sports around the world. But as a matter of academic investigation, it doesn't seem any critical mass has been reached in any other sport. For example, American versions of football are second in terms of numbers of papers at just 6 each for pro and college, compared to the 62 papers on soccer.

[6]The growing literature can be seen using the unbiased estimates of MOU and competitive balance in Lee *et al.* (2019a, 2010b) and Fort and Lee (2020).

[7]We have made a focussed effort but almost surely, we have mis-characterised some papers or simply missed some published works. Hopefully, those errors were purely random. The result is a vastly larger number of papers than found even in the most recent review, Schreyer and Ansari (2021).

[8]The references in the Appendix contain some work on women's sports and college sports. But, we do not provide any breakout on men's versus women's or college versus professional regressions.

Table 1. MOU Papers and Regressions, Annually and by Decade.

Year	#papers	#regressions	% of Regressions
1988	1	4	0.6%
1992	3	6	0.9%
1994	1	1	0.2%
1997	1	3	0.5%
1999	2	4	0.6%
2000	1	3	0.5%
2002	3	9	1.4%
2003	1	2	0.3%
2004	2	6	0.9%
2005	1	1	0.2%
2006	1	3	0.5%
2007	3	7	1.1%
2008	3	7	1.1%
2009	3	16	2.5%
2010	5	30	4.7%
2011	2	4	0.6%
2012	5	14	2.2%
2013	4	8	1.3%
2014	5	38	5.9%
2015	6	37	5.8%
2016	6	77	12.1%
2017	11	60	9.4%
2018	16	112	17.5%
2019	11	48	7.5%
2020	5	65	10.2%
2021	10	74	11.6%
Total	112	639	100.0%
Decades			
1980s	1	4	0.6%
1990s	7	14	2.2%
2000s	18	54	8.5%
2010s	71	428	67.0%
2020s	15	139	21.8%
Total	112	639	100.0%

Table 2. MOU Papers and Regressions by Sport.

Sport	#papers	#regressions	% of Regressions
ARFB	3	23	3.6%
Baseball	9	47	7.4%
Boxing	2	12	1.9%
College MBKB	3	19	3.0%
College FB	6	24	3.8%
Cricket	2	7	1.1%
Cycling	3	18	2.8%
Formula 1	1	9	1.4%
Golf	1	4	0.6%
Handball	2	8	1.3%
Hockey	2	12	1.9%
MMA	1	1	0.2%
NASCAR	1	2	0.3%
NBA BKB	1	24	3.8%
NFL FB	6	15	2.3%
Rugby	5	20	3.1%
Soccer	62	369	57.7%
Tennis	2	25	3.9%
Total	112	639	100.0%

Note: ARFB is Australian Rules Football.

Table 3 breaks the number of papers and the number of regressions out by the 23 countries where the data for each regression were generated and also aggregated by continent.[9] Most notably, 62.6% of the regressions cover Europe, but primarily Germany (24.7% of the regressions) and England (12.7% of the regressions). Another 28.4% cover North America, although they are all on data from the United States. So, 90.3% of the regressions are on European and North America data. The papers about Asian sports cover only China, Korea and Taiwan (2.5% of the regressions). And, there is not a single paper about any sport played in Africa. No doubt, the lack of data plays a role in the paucity of analysis of some sports in some countries.

Table 4 shows that the analysis of gate attendance has the edge over the analysis of TV viewing, 60.7% of the papers and 55.6% of the regressions, to 35.7%

[9]The reader will note that two of the ‘countries’ listed are ‘Europe’ and ‘International’, this latter also Europe but more restricted in the number of countries. We could not fold these aggregated data for some of the analyses into separate countries and left them as is. Where relevant in our comparisons, below, at the level of ‘Europe’, both are included.

Table 3. MOU Papers and Regressions by Analysed Country.

Country	#papers	#regressions	% of Regressions
Australia	5	30	4.7%
Belgium	1	2	0.3%
Brazil	2	8	1.3%
China	1	2	0.3%
Denmark	3	6	0.9%
England	21	81	12.7%
Europe	3	54	8.5%
France	1	2	0.3%
Germany	19	158	24.7%
Ireland	2	3	0.5%
International	1	2	0.3%
Italy	6	19	3.0%
Korea	1	11	1.7%
New Zealand	2	6	0.9%
Norway	2	3	0.5%
Peru	1	2	0.3%
Portugal	1	2	0.3%
Russia	1	7	1.1%
Scotland	1	3	0.5%
Spain	8	52	8.1%
Switzerland	1	6	0.9%
Taiwan	1	3	0.5%
US	34	177	27.7%
Total	118	639	100.0%
Continents			
Asia	3	16	2.5%
Europe	71	400	62.6%
North America	34	177	27.7%
South America	3	10	1.6%
Oceania	7	36	5.6%
Total	118	639	100.0%

Note: Three papers analysed more than one country separately each. Johnsen and Solvoll (2007), Denmark and Norway (2); Sachetti *et al.* (2014), England, Australia, and International (3); Jespersen and Pedersen (2018), Germany, Spain, England, Italy (4).

Table 4. MOU Papers and Regressions by Attendance and TV Viewing.

Attendance/TV	#papers	#regressions	% of Regressions
Attendance	64	355	55.6%
TV	40	284	44.4%
Both	8	—	
Total	112	639	100.0%

of the papers and 44.4% of the regressions, respectively. This appears to be due to the relatively later availability of the viewing data. The first TV analysis in our sample (Paul and Weinbach, 2007) appeared a full two decades after the earliest attendance demand study in our list (Peel and Thomas, 1988).

Table 5 lists the variables that were used in the 639 regressions and our assignment of their regression results under our categorisation scheme.[10] At the highest possible level of aggregation, the strict requirement of statistical significance would have 24.4% of the regressions failing to reject the RH. Relaxing that requirement increases the percentage to 47.4% of the regressions where one or all variables at least produced the correct sign, and another 7.5% that used more than one variable at least produced one correct sign.

However, several specifications have most of their regression results failing to reject the RH. We count 11 specifications with at least 10 regressions, not counting the DK category. Under the strict statistical significance requirement, five of these have most of their regressions failing to reject the RH. Relaxing that restriction adds the ‘point spread and score difference’ specification and one tie (league place difference).

We do not examine every single specification in the literature. However, ‘home win probability and square’ clearly dominates in Table 5, the choice in 147 regressions (23.0% of the total 639 regressions). This particular case of ‘home win probability and square’ is also important because it has led to a line of inquiry based not only just on its rejection of the RH, but also on a reformulation of fan preferences adhering to loss aversion based on the prospect theory.

Researchers using this measure claim that a positive sign on the primal and a negative sign on the square [henceforth, the (+, −) sign pattern] fails to reject the RH. Attendance would rise with increased home win probability but, at some

[10]In Table 5, ‘DK’ designates ‘Don’t Know’ either because the authors specified a variable but then abandoned it or because we simply could not understand an author’s explanation of the interpretation. Our apologies in the latter case.

Table 5. OU Regressions Empirical Verdict Tally by Variable Choice, 1988–2021.

Variables	#regressions	Percent	Correct, signif	Correct, insignif	Incorrect, signif	Incorrect, insignif	One correct, signif	One correct, insignif	DK
Actual bet ratios	12	1.9%	0	0	0	0	0	0	12
Day of competition	1	0.2%	0	1	0	0	0	0	0
Draw prob	8	1.3%	6	0	1	1	0	0	0
Games back diff and score diff	11	1.7%	9	0	0	0	2	0	0
Handicap	3	0.5%	3	0	0	0	0	0	0
Home and away ELO product	4	0.6%	2	1	0	1	0	0	0
Home win prob	35	5.5%	16	5	6	1	2	0	5
Home win prob and home win prob diff	1	0.2%	0	0	1	0	0	0	0
Home win prob and home win prob x (1 − home win prob)	4	0.6%	0	0	0	4	0	0	0
Home win prob and square	147	23.0%	11	36	75	25	0	0	0
Home win prob and Theil Index	2	0.3%	0	0	0	2	0	0	0
Home win prob minus actual win prob	1	0.2%	1	0	0	0	0	0	0
Home win prob minus away win prob plus draw prob	4	0.6%	0	3	1	0	0	0	0
League place diff	20	3.1%	1	8	4	5	0	1	1
League place diff and square	6	0.9%	0	0	6	0	0	0	0
Markov surprise	1	0.2%	1	0	0	0	0	0	0
Markov suspense	1	0.2%	1	0	0	0	0	0	0
Markov suspense and surprise	7	1.1%	7	0	0	0	0	0	0
Point spread	32	5.0%	2	3	26	1	0	0	0
Point spread and score diff	18	2.8%	0	0	0	0	11	7	0
Point spread and square	4	0.6%	0	2	0	2	0	0	0
Point spread local and market	4	0.6%	0	0	0	4	0	0	0

Points diff	6	0.9%	1	1	0	4	0	0	0
PPG diff	1	0.2%	0	0	0	1	0	0	0
Race position churn	2	0.3%	1	1	0	0	0	0	0
Rating diff	60	9.4%	19	12	5	9	12	3	0
Rating diff and square	6	0.9%	0	0	0	0	6	0	0
Rating diff square	4	0.6%	0	0	4	0	0	0	0
Score diff	15	2.3%	9	3	0	3	0	0	0
Score spread diff	4	0.6%	1	0	0	1	2	0	0
Survey suspense rating	1	0.2%	1	0	0	0	0	0	0
Survey suspense rating and square	2	0.3%	1	1	0	0	0	0	0
Suspense stages and dominance	2	0.3%	2	0	0	0	0	0	0
Theil Index	62	9.7%	18	8	23	13	0	0	0
Theil Index and square	17	2.7%	1	3	11	2	0	0	0
W% diff	5	0.8%	5	0	0	0	0	0	0
W% diff square	1	0.2%	1	0	0	0	0	0	0
Win prob and win prob minus actual prob	7	1.1%	7	0	0	0	0	0	0
Win prob diff	109	17.1%	25	55	8	20	1	0	0
Win prob diff square	1	0.2%	1	0	0	0	0	0	0
Win prob minus actual win prob	1	0.2%	1	0	0	0	0	0	0
Win prob ratio	4	0.6%	2	2	0	0	0	0	0
Win prob ratio and league place diff	1	0.2%	0	0	0	0	1	0	0
wins diff	2	0.3%	0	2	0	0	0	0	0
Total	639	100.0%	156	147	171	99	37	11	18
			24.4%	23.0%	26.8%	15.5%	5.8%	1.7%	2.8%

estimated point the squared term reveals that fan preference for tight games dominates the attendance choice.

Researchers then claim that a lack of statistical significance in the (+,−) sign pattern or, more importantly because it ends up occurring frequently, a (−,+) sign pattern rejects the RH. Attendance would decline with home win probability up to a calculable home win probability, and only increase when home win probability gets large. Both results reject the RH because fans are supposed to prefer higher chances for their team, and at higher home win probability games are claimed to be less tight, also violating MOU.

Table 5 shows that 'home win probability and square', under the strict statistical significance criterion, fails to reject the RH in 7.5% of its 147 regressions. However, relaxing that assumption raises that rate to 32.0% of the regressions using 'home win probability and square'. Further, moving away from the all-or-nothing aggregate assessment available in Table 5, to a level of disaggregation, reveals the following about the use of this specification.

Table 6 lists the 'home win probability and square' papers, by either the (+,−) or (−,+) sign pattern finding. Under each outcome, the papers are organised by a sport, showing their dependent variable (Attendance or TV). The number of regressions in each paper is also shown along with whether the primal and/or squared term were statistically significant.

The (+,−) sign pattern, proposed as failing to reject the RH, was found in 51 regressions across 14 papers. The (−,+) sign pattern proposed as rejecting the hypothesis was found in 86 regressions across 19 papers. Evidence on both sides was found in four papers.[11] Nearly, all the evidence rejecting the RH is found in soccer data. Only 3 of the 19 (−,+) sign pattern papers were about a sport other than soccer. While 6 of the 14 (+,−) sign pattern papers use soccer data, the other 8 spanned 5 sports—baseball, rugby, hockey, handball and Australian rules football.

Also from Table 6, adherence to the strict statistical significance criterion reveals 14 regressions failing to reject the RH in 4 papers. Only one is about soccer and all concern the attendance estimation. On the other side, 75 regressions reject the RH across 16 papers. All but two of these papers are about soccer, and only two of the soccer results pertain to TV viewing. It appears that the rejection of the RH, using 'home win probability and square' is also a decidedly soccer-centric finding.

In the rest of the section, we take a lesson from Table 6 and look at further disaggregation of the 639 regression results in our sample of papers. Table 7 lists regression outcomes under our chosen categorisation for the 18 sports analysed in our sample of papers. As with the lesson from Table 6, soccer represents 57.7%

[11]It is difficult to decide how to think about the much higher number of regressions run in the 19 versus the 14, 86 to 51. We simply point out that the averages are 4.5 and 3.6 regressions per paper.

Table 6. Empirical Verdict Tally, Home Probability and Square, 1988–2021.

(+, −) 14 papers,	Sport	Dep Variable	#regs, signif, signif	Tightness
McDonald and Rascher (2000)	Baseball	Attendance	1 yes, yes 2 yes, no	No
Owen and Weatherston (2004a)	Rugby	Attendance	3 no, no	No
Owen and Weatherston (2004b)	Rugby	Attendance	3 no, no	No
Benz *et al.* (2009)	Soccer	Attendance	3 no, no	No
Coates and Humphreys (2012)	Hockey	Attendance	1 no, no	No
King *et al.* (2012)	Rugby	Attendance	1 yes, no 1 no, no	No
Jena and Reilly (2016)	Soccer	Attendance	1 yes, yes	Yes
Cox (2018)*	Soccer	TV	1 yes, no	No
Storm *et al.* (2018)	Handball	Attendance	2 yes, yes	No
Nielsen *et al.* (2019)	Soccer	Attendance	3 no, no	No
Sung *et al.* (2019)*	Soccer	TV	1 yes, no	No
Baydina *et al.* (2021)*	Soccer	Attendance	2 no, no	No
Karg *et al.* (2021)*	ARFB	Attendance	10 yes, yes 7 no, no	No
Paul (2021)	Hockey	Attendance	9 no, no	No
(−, +) 19 papers	**Sport**	**Dep**	**Signif**	**Tightness**
Peel and Thomas (1992)	Soccer	Attendance	4 yes, yes	No
Czarnitzki and Stadtmann (2002)	Soccer	Attendance	2 no, no	No
Buraimo and Simmons (2008)	Soccer	Attendance	1 yes, yes	No
Buraimo and Simmons (2009)	Soccer	Attendance	1 yes, yes	No
Lemke *et al.* (2010)	Baseball	Attendance	17 no, no	No
Coates *et al.* (2014)	Baseball	Attendance	3 yes, yes	No
Di Domizio and Caruso (2015)	Soccer	Attendance	1 yes, yes	No
Schreyer *et al.* (2016)	Soccer	Attendance	14 yes, yes	No
Cox (2018)	Soccer	Attendance	1 yes, yes	No
Pawlowski *et al.* (2018)	Soccer	TV	16 yes, yes	No
Sung and Mills (2018)	Soccer	Attendance	6 yes, yes	No
Sung *et al.* (2019)	Soccer	TV	1 yes, no	No
Wallrafen *et al.* (2019)	Soccer	Attendance	3 yes, yes	No
Wallrafen *et al.* (2020)	Soccer	Attendance, TV	5 yes, yes	No
Baydina *et al.* (2021)	Soccer	Attendance	4 yes, yes 1 no, no	No
Buraimo *et al.* (2021)	Soccer	Attendance	9 yes, yes	No
Buraimo and Simmons (2021)	Soccer	Attendance	3 yes, yes	No
Karg *et al.* (2021)	ARFB	Attendance	1 yes, yes	No
Nalbantis and Pawlowski (2021)	Soccer	Attendance	3 yes, yes	No

Note: * indicates that the paper found evidence of both (+, −) and (−, +).

Table 7. Empirical Verdict Tally by Sport.

Sport	#regressions	Percent	Correct, signif	Correct, insignif	Incorrect, signif	Incorrect, insignif	One correct, signif	One correct, insignif	DK
ARFB	23	3.6%	13	8	1	0	0	0	1
Baseball	47	7.4%	16	3	3	23	2	0	0
Boxing	12	1.9%	3	2	7	0	0	0	0
College MBKB	19	3.0%	1	0	0	0	11	7	0
College FB	24	3.8%	8	5	6	3	2	0	0
Cricket	7	1.1%	0	1	0	0	6	0	0
Cycling	18	2.8%	6	0	0	0	12	0	0
Formula 1	9	1.4%	5	4	0	0	0	0	0
Golf	4	0.6%	1	2	0	1	0	0	0
Handball	8	1.3%	6	2	0	0	0	0	0
Hockey	12	1.9%	1	11	0	0	0	0	0
MMA	1	0.2%	0	1	0	0	0	0	0
NASCAR	2	0.3%	1	1	0	0	0	0	0
NBA BKB	24	3.8%	0	0	24	0	0	0	0
NFL FB	15	2.3%	5	4	0	6	0	0	0
Rugby	20	3.1%	3	13	0	4	0	0	0
Soccer	369	57.7%	69	90	130	58	4	1	17
Tennis	25	3.9%	18	0	0	4	0	3	0
Total	639	100.0%	156	147	171	99	37	11	18
Percentage			24.4%	23.0%	26.8%	15.5%	5.8%	1.7%	2.8%

of the regression evidence on the RH found across all 18 sports listed in Table 7. Under the strict statistical significance requirement, 18.7% of the soccer regressions fail to reject the hypothesis. Relaxing that constraint, the percentage jumps to 43.1% and another 1.4% in regressions using more than one variable to capture the soccer MOU.

Table 7 also shows that most of the regression results for many of the 17 other sports fail to reject the RH. Under the strict statistical significance criterion, this is true for 8 of these 17 other sports (47.1%). Under the strict restriction, it takes soccer to swing the balance across sports to rejection of the RH. Relaxing that restriction, six more sports fail to reject the hypothesis, raising the rate to 82.4% of the sports. So, without the statistical significance restriction, soccer and only three other sports in Table 7 reject the RH—baseball, boxing and NBA basketball.

Table 8. Empirical Verdict Tally Team Sport versus Non-Team Sport.

	#regressions	Correct, signif	Correct, insignif	Incorrect, signif	Incorrect, insignif	One correct, signif	One correct, insignif	DK
Team sports	568	122	137	164	94	25	8	18
Individual sports	71	34	10	7	5	12	3	0
Soccer only	369	69	90	130	58	4	1	17
Excluding soccer	199	53	47	34	36	21	7	1

Digging just a bit deeper, Table 8 compares the verdict on the RH across the team and individual sports. We recognise that 'teams' produce boxing, cycling, Formula 1, golf, MMA, NASCAR and tennis, but the measures used in the literature were all individual athlete specific. Team sports clearly dominate in the literature to date with 88.9% of the regressions. But breaking the results out between team and individual sports yields a very interesting observation.

In Table 8, under the strict statistical significance requirement, most of the regressions fail to reject the RH for individual sports. Relaxing that restriction, the same becomes true for the team sports excluding soccer. Further, again with the restriction relaxed, the number of regressions on all team sports that fail to reject the hypothesis, 259, is almost identical to the number that rejects, 258. But there are an additional 33 regressions that use more than one variable to specify MOU that also fails to reject the hypothesis.

Disaggregation by 21 individual countries, and two categories that are Europe-wide, is given in Table 9. As for the RH, under the strict statistical significance requirement, rejections occur in 17 countries and TV broadcasts across Europe. Relaxing that restriction, eight individual countries including both England and the United States, and both categories across Europe, fail to reject the hypothesis. That would make 13 countries and the 2 categories across Europe (65.2% of the entries in Table 9) that fail to reject the hypothesis.

One of the most interesting findings is in Table 10. As noted in Table 4, 55.6% of the regressions involved gate attendance and 44.4% TV viewers. Under the strict statistical significance requirement, the verdict is overwhelming at the gate where 16.9% of the rejections fail to reject the RH. The result is higher for TV viewers at 33.8%. Relaxing that restriction, the percent of attendance regressions failing to reject the RH rises to 43.9% at the gate and 51.8% for TV viewers.[12]

[12]Earlier, in Table 7, concerning the use of 'home win probability and square', 2 of 14 (+, −) papers and 3 of 19 (−, +) concern TV viewing data. By that evidence, there doesn't appear to be any schism in the findings along attendance versus TV viewer lines.

Table 9. Empirical Verdict Tally by Country.

Country	#regressions	Percent	Correct, signif	Correct, insignif	Incorrect, signif	Incorrect, insignif	One correct, signif	One correct, insignif	DK	Total
Australia	30	4.7%	13	13	1	0	2	0	1	30
Belgium	2	0.3%	2	0	0	0	0	0	0	2
Brazil	8	1.3%	1	4	3	0	0	0	0	8
China	2	0.3%	0	2	0	0	0	0	0	2
Denmark	6	0.9%	0	2	0	4	0	0	0	6
England	81	12.7%	24	26	20	2	4	0	5	81
Europe	54	8.5%	7	34	0	13	0	0	0	54
France	2	0.3%	1	1	0	0	0	0	0	2
Germany	158	24.7%	34	16	74	30	0	4	0	158
Ireland	3	0.5%	1	2	0	0	0	0	0	3
International	2	0.3%	0	0	0	0	2	0	0	2
Italy	19	3.0%	1	0	11	7	0	0	0	19
Korea	11	1.7%	9	0	0	0	2	0	0	11
New Zealand	6	0.9%	0	6	0	0	0	0	0	6
Norway	3	0.5%	0	0	0	3	0	0	0	3
Peru	2	0.3%	0	0	0	2	0	0	0	2
Portugal	2	0.3%	0	0	2	0	0	0	0	2
Russia	7	1.1%	0	2	4	1	0	0	0	7
Scotland	3	0.5%	1	2	0	0	0	0	0	3
Spain	52	8.1%	11	5	9	1	14	0	12	52
Switzerland	6	0.9%	0	2	4	0	0	0	0	6
Taiwan	3	0.5%	0	1	0	2	0	0	0	3
US	177	27.7%	51	29	43	34	13	7	0	177
Total	639	100.0%	156	147	171	99	37	11	18	639

Table 10. Empirical Verdict Tally Attendance versus TV.

	#regressions	Percent	Correct, signif	Correct, insignif	Incorrect, signif	Incorrect, insignif	One correct, signif	One correct, insignif	DK
Attendance	355	55.6%	60	96	129	56	8	1	5
TV	284	44.4%	96	51	42	43	29	10	13

The soccer-centric nature of all the previous tallies led us to examine just soccer, breaking out the results by attendance and TV viewing regressions across countries. Table 11 shows 15 individual countries and the Europe aggregate totaling 219 attendance regressions and 9 individual countries totaling 150 regressions for

TV viewing (the same 369 soccer regressions from Table 7). All countries with TV viewing regressions also had attendance regressions, except for Switzerland.

First, consider Table 11 under the strict statistical significance requirement. The highest level of aggregation is in the 'totals' rows in the table. At that level, only

Table 11. Attendance versus TV, Soccer by Country.

Attendance	#regressions	Percent	Correct, signif	Correct, insignif	Incorrect, signif	Incorrect, insignif	One correct, signif	One correct, insignif	DK
Brazil	1	0.5%	0	0	1	0	0	0	0
China	2	0.9%	0	2	0	0	0	0	0
Denmark	3	1.4%	0	0	0	3	0	0	0
England	38	17.4%	10	3	20	0	1	0	4
Europe	48	21.9%	7	32	0	9	0	0	0
France	2	0.9%	1	1	0	0	0	0	0
Germany	79	36.1%	15	8	47	8	0	1	0
Ireland	3	1.4%	1	2	0	0	0	0	0
Italy	10	4.6%	1	0	8	1	0	0	0
Norway	2	0.9%	0	0	0	2	0	0	0
Peru	2	0.9%	0	0	0	2	0	0	0
Portugal	2	0.9%	0	0	2	0	0	0	0
Russia	7	3.2%	0	2	4	1	0	0	0
Scotland	3	1.4%	1	2	0	0	0	0	0
Spain	10	4.6%	0	0	9	0	1	0	0
US	7	3.2%	0	1	6	0	0	0	0
Totals	219	100.0%	36	53	97	26	2	1	4
TV									
Brazil	7	4.7%	1	4	2	0	0	0	0
Denmark	1	0.7%	0	0	0	1	0	0	0
England	37	24.7%	11	22	0	2	1	0	1
Germany	53	35.3%	8	4	23	18	0	0	0
Italy	9	6.0%	0	0	3	6	0	0	0
Norway	1	0.7%	0	0	0	1	0	0	0
Spain	26	17.3%	7	5	0	1	1	0	12
Switzerland	6	4.0%	0	2	4	0	0	0	0
US	10	6.7%	6	0	1	3	0	0	0
Totals	150	100.0%	33	37	33	32	2	0	13

16.9% of the regressions fail to reject the RH for soccer attendance, that is, France, Ireland and Scotland (and note that this is with a single regression in each case).

At the highest level of aggregation in Table 11 for TV viewers, still under the statistical significance requirement, 22.0% of the regressions fail to reject the RH, that is, England, Spain and the United States. Interestingly, all three of these countries were on the other side, rejecting the hypothesis, for soccer attendance.

Relaxing the statistical significance requirement, at the highest aggregate level in Table 11, failure to reject jumps to 40.6% for soccer attendance and 46.7% for soccer TV viewers. However, only Brazil is added to England, Spain and the United States. And, as with the others, Brazil was also on the other side of the results for soccer attendance. Fan preferences *vis-a-vis* MOU appear decidedly different for live soccer versus soccer on TV.

And we come to the end. If one adheres to the strict statistical significance requirement, the weight of the evidence appears to reject the RH. This is true in the aggregate and in the disaggregated examinations by sport, by country and comparing attendance and TV viewers. Of course, the verdict swings significantly toward failure to reject the RH when the statistical significance restriction is relaxed. There is also the interesting evidence that fan preferences appear to be different for live soccer versus soccer on TV. We leave the verdict to the reader and their consideration of statistical results.

However, of overriding importance in the presentation thus far, is that all the evidence—in 112 papers with 639 regressions—concerns just the RH. We think the breakouts of the empirical results in the literature by sport, country and live attendance versus TV viewing reveal more about the impact of MOU on demand than offered solely by the RH. Appealing to our income effect analogy in the introduction, rejecting say income normality does not reject income effects altogether. In the next section, we consider competing MOU hypotheses offered by the same standard economic theory of sports leagues that generated the RH.

MOU in a Standard Sports Economics Theoretical Context

Coates *et al.* (2014, pp. 959–960) stated flatly:

> Interestingly, neither Rottenberg (1956)…nor any subsequent researcher, developed a model of consumer behavior to motivate this observation; the UOH has been accepted as an accurate description of the outcome of consumer choices with no theoretic basis for more than 50 years.

Well, technically, Rottenberg's was a *descriptive* theory at a time when that was often good enough, but we take their point about the subsequent period. In the same vein, Pawlowski *et al.* (2018) stated that, 'The UOH (uncertainty of outcome hypothesis) lacks a solid theoretical base'. Both of these works offer an alternative to the RH, namely, loss aversion theory based on prospect theory.[13]

We agree that MOU could use more theory, and loss aversion based on prospect theory is one approach. However, moving on in this fashion seems to assume that standard economic theory of sports leagues only generates the RH. In this section, we show that there are other hypotheses from the standard economic theory of sports leagues. From this perspective, as a theory replacement, a full confrontation with standard theory by loss aversion preferences seems to be the logical step.

The RH is worth reviewing in detail for two reasons. First, it has specific implications for empirical specifications that appear to us to have been missed, especially in the 'home win probability and square' specifications that led the researchers quoted above in the direction of loss aversion preferences. Second, a standard sports economics theoretical treatment shows that the RH is only one hypothesis.

Rottenberg (1956) is extremely dense in ideas per page. Technically, the specific words 'game outcome uncertainty' do not appear in that paper. The term 'outcome uncertainty' appears twice, on p. 246, talking about its use to justify the reserve clause in MLB player contracts at the time of his writing. But he is plain about its meaning, all on that single page:

> The defense most commonly heard is that the reserve rule is necessary to assure an equal distribution of playing talent among opposing teams; that a more or less equal distribution of talent is necessary if there is to be uncertainty of outcome; and that uncertainty of outcome is necessary if the consumer is to be willing to pay admission to the game… It (attendance) is a negative function of the goodness of leisure-time substitutes for baseball in the area and of the dispersion of percentages of games won by the teams in the league.

And, crucially, in footnote 21 on that same idea-laden p. 246:

> That is to say, the "tighter" the competition, the larger the attendance. A pennant-winning team that wins 80 per cent of its games will attract fever patrons than a pennant-winning team that wins 55 per cent of them.

He bolstered this later in the paper with this (p. 254):

[13] Coates and Humphreys (2012) started research down this path first. The two papers just cited continued the move in that direction.

> But in baseball, no team can be successful unless its competitors also survive and prosper sufficiently so that the differences in the quality of play among teams are not "too great."

For Rottenberg, MOU is a function of the distribution of talent. Increased MOU shifts the demand for attendance to the right. And attendance depends on both the home team chances and 'tighter' competition. Fan demand should increase with increases in either home team chances or game tightness. The policy issue for the league that follows from this is that differences in the quality of play between teams cannot be 'too great' if all teams wish to be economically successful.

From the foregoing, the RH can be characterised as it has been in the literature. The null is H_0: MOU impact on demand is zero against the alternative H_A: MOU impact on demand is positive. And MOU includes both home team chances and match tightness. Thus, a zero impact fails to reject the null and rejects the RH. A positive impact rejects the null, providing evidence in favour of the RH. But what if a fuller take on MOU using the standard economic theory of sports leagues yields other perfectly acceptable alternative hypotheses, especially the case where the impact of home team chances and/or match tightness is negative?

We think of college football in the United States. Fans in the stadium appear to prefer the titillation of match tightness for at most the first half of the game, and then simply want their team to win by a large margin. In fact, post-season chances often hinge on margin-of-victory against quality opponents.

On the other hand, fans watching college football on TV or streaming services feel the same as those in attendance for broadcasts of their favorite team (possibly their home team). Otherwise, TV fans just cruise channels to see how their hated rival team is doing, or for close games or upsets. But the conclusion from experience need not be that MOU, itself, does not explain fan choice even if the RH is not in operation.

In the standard economic theory of sports leagues, a team owner assesses market determinants of demand and chooses team 'quality' that maximises long run profit, within the structure of determination of the talent distribution across the league.[14] The result of that choice puts the owner in a particular short run situation, selling the resulting quality characteristics to fans at the gate and on media. Given the league talent distribution result, team quality characteristics will include win percent, playoff chances and a set of win probabilities and match tightness against all teams in the league.

[14] Other objective functions are in the literature, but the issue is that a particular quality is chosen, and fans enjoy that choice implicitly determined by their willingness to pay.

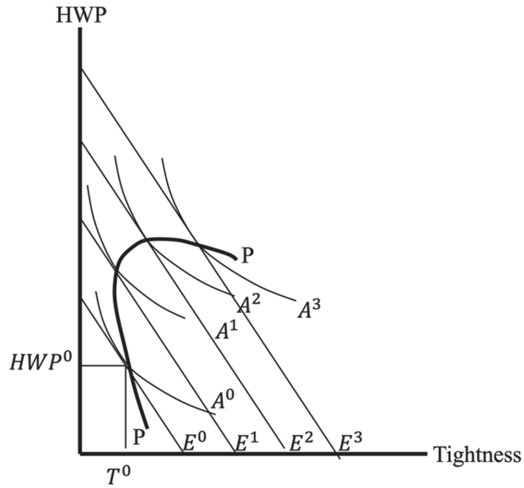

Fig. 1. Production, Preferences, Observed Home Win Probability, and Tightness.

The short run is portrayed in Fig. 1. Home win probability, HWP, and match tightness, T, help produce attendance and fan interest in TV viewing. Choice of team characteristics is subject to a constraint E, dictated both by home market revenue potential and league policy impacting the distribution of talent. For a given E, such as E^0, attendance isoquant A^0 is the highest achievable, with the cost minimising (profit maximising) combination (T^0, HWP^0). Relaxation of the constraint, $E^3 > E^2 > E^1 > E^0$, allows higher attendance levels $A^3 > A^2 > A^1 > A^0$.

For the specific configuration chosen on purpose in Fig. 1, the attendance expansion path is *PP*. For this team, when attendance increases from A^0 to A^1, $\frac{\partial A}{\partial \mathrm{HWP}} > 0$ but $\frac{\partial A}{\partial \mathrm{Tightness}} < 0$. This rejects the RH, but note that the net effect of increased MOU, including the marginal effects of both HWP and T, is positive. When attendance increases from A^1 to A^2, both $\frac{\partial A}{\partial \mathrm{HWP}} > 0$ and $\frac{\partial A}{\partial \mathrm{Tightness}} > 0$, failing to reject the RH. Finally, when attendance increases from A^2 to A^3, $\frac{\partial A}{\partial \mathrm{Tightness}} > 0$ but now $\frac{\partial A}{\partial \mathrm{HWP}} < 0$. The RH is rejected but, again, the net effect of increased MOU, including both HWP and T, is positive.

From the standard theory in Fig. 1, the RH is rejected unless the slope of the expansion path PP is positive. But home win probability and match tightness still determine the attendance increase even when the RH is rejected. Rejection of the RH does not reject the fundamental underlying explanatory power of home win probability and match tightness.

Another observation from Fig. 1 is quite important for those researchers interested in testing loss aversion against the standard economic theory of sports leagues. Any sign of $\frac{\partial^2 A}{\partial \mathrm{HWP}^2}$ is consistent with any change along PP. Whether the attendance increases at an increasing rate or at a decreasing rate with respect to

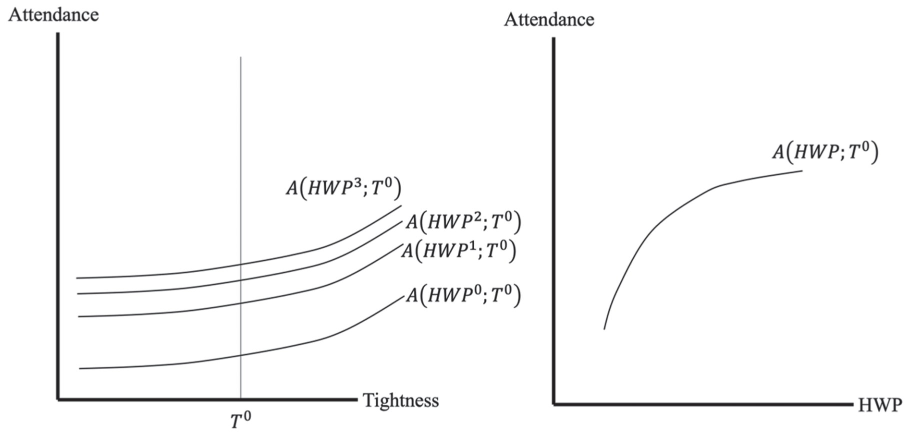

Fig. 2. Home Win Probability and Tightness.

home win probability is beside the point from any of the hypotheses that follow from the standard theory in Fig. 1. And this is just as true along PP where the effects of MOU fail to reject the RH as it is where the effects of MOU reject it.

This is portrayed in Fig. 2. In the left panel, for a given tightness, T^0, attendance increases (shifts upward) at a decreasing rate with respect to increase in HWP. As HWP increases from HWP^0 to HWP^1 to HWP^2 to HWP^3, the incremental increases in attendance decrease, that is $A(\text{HWP}^3;T^0) - A(\text{HWP}^2;T^0) > A(\text{HWP}^2;T^0) - A(\text{HWP}^1;T^0)$.

The right panel shows this relationship between attendance and HWP with $\frac{\partial^2 A}{\partial \text{HWP}^2} < 0$. Without burdening the reader with another figure, for the same, T^0, one could just as easily draw the case where $\frac{\partial^2 A}{\partial \text{HWP}^2} > 0$.

The upshot of all this is, first, the RH is based on both home win probability and match tightness as characteristics of MOU. Second, alternatives completely consistent with the standard economic theory of sports leagues still have home win probability and match tightness as determinants of fan demand. Third, neither failing to reject nor rejecting the RH requires anything about the sign of $\frac{\partial^2 A}{\partial \text{HWP}^2}$. Rottenberg (1956) never put any such requirement on his original descriptive theory hypothesis. All that had to happen was for demand to shift right with more MOU. Finally, testing, say, loss aversion against the standard economic theory of sports leagues requires testing against the standard theory in its entirety, not just the RH part of the theory.

Conclusions and Suggestions

One of Rottenberg's (1956) foundational sports economics hypotheses is that fans prefer their team to win but with more MOU rather than less. The testable implication is that increases in home team win chances and match ‘tightness’ should lead to increased fan demand for live attendance or media viewing.

It is safe to say that the verdict by those that voice one, especially recently, is that empirical results offer only occasional and weak support for Rottenberg’s hypothesis. This verdict rests on a strict statistical significance requirement and unspecified criteria concerning both the consistency and pervasiveness of results. Presenting the works agnostically, based on the results of all regressions in the literature, and relaxing strict statistical significance, the challenge to any unspecified additional criterion on consistency and pervasiveness appears to us to be formidable.

For example, even at the highest level of aggregation, 47.4% of our total 639 regressions fail to reject Rottenberg’s hypothesis and, among papers with 10 or more regressions, 6 of 11 have the majority if their regressions fail to reject, plus one tie. The same challenge holds, to greater and less extents, for disaggregation by sport, country and live attendance versus TV viewing.

Further, disaggregation of the regression results shows that past work is Euro-U.S. centric. It also is dramatically soccer centric. Disaggregation by sport shows that even for soccer, the agnostic tally has 43.1% of the regressions fail to reject Rottenberg’s hypothesis. Excluding soccer, 82.4% of the rest regressions on the rest of the sports fail to reject the hypothesis. Disaggregation by country, and further by attendance versus TV viewing, 43.9% of the attendance regressions and 51.8% of the TV viewing regressions fail to reject the hypothesis.

We also show that Rottenberg’s hypothesis is only one alternative generated by the standard economic theory of sports leagues. The hypothesis is strictly that demand increases with home win chances and match tightness, but the theory allows attendance to increase regardless of partial effects of either home win chances or match tightness. Further, there is nothing in the theory that suggests that the sign of the second derivative of the change in attendance with respect to home win chances contributes to either rejecting or failing to reject the hypothesis.

The review here leads us to the following suggestions for future research. Valid tests of the standard economic theory of sports leagues, including Rottenberg’s hypothesis, should include both home team win prospects and match tightness. This poses a problem for the popular use of home win probability as part of the test. For example, Table 5 shows that the posted expected closing point spread (just before the game commences) is an obvious candidate for tightness used in 58 MOU regressions in the literature. However, home win probability appears to be an almost perfect linear function of closing point spread.

Using a sample of 4,517 NFL games, Culver (2018) regressed closing point spread in the NFL (at kickoff time to open the game) on percentage of the time the favourite won at that spread, giving an implied win probability relationship of HWP = −0.0303 Spread + 0.5, with $R^2 = 0.9756$. Since the spread is always listed as a negative number (points given on the favourite), a one-point increase in the spread gives a 0.0303 increase in win probability. Since $1 - R^2$ remains to be explained, the error margin is $\frac{0.0224}{2} = 0.0122$ or about 1.2%.

For example, if home win probability is 0.6818, then implicitly the analyst is using the tightness associated with that home win probability, that is, a point spread of –6 points (favoured by one touchdown). Given this nearly strict linear relationship, a regression that uses home win probability and point spread cannot separate the two elements in Rottenberg's specification of fan demand behaviour.[15] There will need to be ingenuity and imagination in future specifications.

Second, our results suggest that the analysis is lacking for sports in countries besides England, Germany and the United States and for sports besides soccer. While future work on soccer could do with the inclusion of both elements of Rottenberg's hypothesis, it would expand knowledge if the work expanded to a wider variety of countries and beyond soccer.

Finally, all theoretical work extending the understanding of preferences, themselves, is to be applauded. Pawlowski *et al.* (2018, pp. 182–183) summarised that 'We conclude that the common finding that fans do not value game uncertainty can be explained by fans exhibiting loss aversion with regard to game uncertainty rather than differences between perceptions and measurements of game uncertainty'. The rest of the implications of the standard economic theory of sports leagues, posed in this paper, still poses a challenge to this view. Rejecting Rottenberg's hypothesis *might* reject the rest of the implications of the standard economic theory of sports leagues, but that remains to be shown.

Still, if future work rejects not just Rottenberg's hypothesis, but the theoretical constructs behind it like in our theory section, broader socio-psycho-economics explanations would be important. Budzinski and Pawlowski (2017) review behavioural economics findings (including those on prospect theory) about MOU and the rest of competitive balance.

Bee and Madrigal (2012) show ad emotional response; attitude toward the ad and attitude toward the brand are heightened after a suspenseful sporting event. Shafer (2014) finds suspense works indirectly to produce enjoyment in video gaming. Trent and Shafer (2020) find the same for suspense and outcome uncertainty watching eSports. Perhaps the work that follows after those reviewed here on 'suspense' will prove more enlightening than 'tightness' (in the appendix, Bizzozero *et al.*, 2016; Nalbantis *et al.*, 2017; Pawlowski *et al.*, 2018).

[15]Put another way, if an analyst put both home win probability and point spread in the same regression, the regression cannot be solved because home win probability is pretty much an exact linear combination of the point spread.

Finally, and in keeping with Rottenberg's main insight about the use and abuse of MOU and competitive balance by team owners, reaching the wrong conclusion about MOU results in the literature is confusing to policy analysts and policy makers outside the league. Owners always tout MOU and competitive balance as motivations for league policy. This is especially interesting to outside policy analysts when it pertains to league policy that reduces player pay or fan alternatives (e.g. league expansion). Reassessing the MOU literature may lead more to conclude in favour of the owner claims than previous literature reviews that cast a verdict on what the literature finds have allowed. It may be just as simple as fans really do respond to MOU.

Appendix. Empirical Works Reviewed But Not Cited Individually (112 Papers)

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