Uncertainty of outcome hypothesis in sports

Hipótesis de la incertidumbre de resultado en deportes

Jose Reynaldo Molano Ramirez

Universidad Nacional de Colombia

Facultad de Ciencias Económicas

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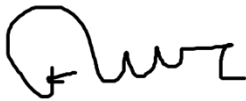
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Resumen

Hipótesis de la incertidumbre de resultado en deportes

Este trabajo presenta la revisión de estudios empíricos, que pusieron a prueba la Hipótesis de la Incertidumbre del Resultado propuesta por Rottenberg (1956), en diferentes deportes y con grupos particulares de espectadores. En primer lugar, se revisan los aspectos teóricos relativos a la Hipótesis de la Incertidumbre del Resultado, el equilibrio competitivo, la incertidumbre del resultado del juego, los determinantes de la asistencia a los deportes, entre otros. Además, considera siete artículos empíricos seleccionados críticamente y los compara en función de variables y resultados compartidos. Este trabajo explora investigaciones realizadas en la Liga Nacional de Hockey, el fútbol alemán, el béisbol coreano, la Major League Soccer, el fútbol holandés y el críquet. El análisis de esta selección concluye con que la mayoría de los estudios rechazan la Hipótesis de la Incertidumbre del Resultado, aunque no represente una conclusión sólida debido a la diversidad de deportes y grupos analizados.

Keywords: Hipótesis de incertidumbre de resultado, incertidumbre de resultado, asistencia a deportes.

Abstract

Uncertainty of outcome hypothesis in sports

This work presents the revision of empirical studies, which tested the Uncertainty of Outcome Hypothesis proposed by Rottenberg (1956), in different sports and with particular groups of spectators. First, it reviews the theoretical aspects concerning the Uncertainty of Outcome Hypothesis, competitive balance, game outcome uncertainty, determinants of sports attendance, among others. Furthermore, it considers seven critically selected empirical articles and compares them based on shared variables and results. This work explores research done in the National Hockey League, German soccer, Korean baseball, Major League Soccer, Dutch soccer, and cricket. The analysis of this selection concluded with most of the studies rejecting the Uncertainty of Outcome Hypothesis, even though it does not represent a solid conclusion due to the diversity of sports and groups analyzed.

Keywords: Uncertainty of outcome hypothesis, uncertainty of outcome, sports attendance.

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List of abbreviations

UOH	Uncertainty of Outcome Hypothesis
UO	Uncertainty of Outcome
GOU	Game Outcome Uncertainty
US	United States
LA	Loss Aversion
US	United States
CB	Competitive Balance
STH	Season Ticket Holder
NHL	National Hockey League
WP	Winning Percentage

1 Introduction

1.1 Introduction and motivation

In major league sports competitions, increasing attendance, either by TV or in-stadiums, is one of the main priorities for teams to generate revenue with tickets and the different services offered during the games. Moreover, it contributes to generating income and, in this way, investing in bringing new players and talent to keep up with the competition. For sports economists and sports management researchers, finding the potential determinants of sports stadium attendance has become a priority in the last decades (Schreyer & Ansari, 2021).

In his seminal work, Rottenberg (1956) includes the importance of competitive balance. He states that teams participating in a championship should be equally balanced to increase the uncertainty of the result; this scenario of equal probabilities would increase fans' interest to attend. Rottenberg's (1956) work is widely known in sports economic literature as the Uncertainty of Outcome Hypothesis (UOH). It has guided empirical works testing it and trying to understand the consumer's interest in professional sports (Schreyer & Ansari, 2021).

Therefore, different professional sports leagues try to keep a competitive balance nowadays and, in this way, keep a greater uncertainty. For instance, the North American sports model uses salary caps, TV revenue sharing, and the competitions are under strictly structured leagues; England, on the other side, promotes "financial fair play" and regulation on money from external competitions (Plumley et al., 2018).

The review made by Schreyer & Ansari (2021) states that there is still an ongoing debate regarding the validity of Rottenberg's (1956) UOH and also denotes the need for more studies testing it in different sports and groups.

As the understanding of the UOH is significant in sports, specially for sports management and economists, and there are still debates around this topic, the studies in this area are of high importance. Therefore, this master thesis analyzes empirical research made in particular sports and with different groups of fans to examine the influence of competitive balance and outcome uncertainty (OU) on the resulting attendance.

1.2   Goal of the thesis

The main goal of the thesis is to provide a literature survey of empirical studies concerning the UOH. The sub-goals of the thesis consist of: first, a review of the theoretical literature related to the UOH, sports attendance, and competitive balance to comprehend the concepts and create a solid base for further understanding of the existing empirical research in this field. Second, a critical review and analysis of seven empirical articles concerning UOH in different sports.

1.3   Structure of the thesis

This master thesis is structured as follows: chapter 1 states the motivation, goals, and structure of the thesis; chapter 2 consists of a review of the theoretical literature concerning the UOH, competitive balance and sports demand, among others; chapter 3 compiles an overview of seven empirical studies testing the UOH, the common variables between them and a comparison of the presented results; and chapter 4 shows the summary, a review of goal attainments and the conclusions.

2 Theory

For sports economists and sports management researchers, finding the determinants of sports attendance has become a priority in the last decades. In general, the main goal is to increase the number of spectators in order to generate more income with tickets and the different services offered during the games. As a result, the teams can invest in bringing new players and talent to keep up with the competition. (Schreyer & Ansari 2021).

2.1 Determinants of sports attendance.

Sung & Mills (2018) classify the determinants of sports attendance in three main categories:

- Outcome uncertainty.

- Absolute quality.

- Other determinants.

Outcome uncertainty refers to the uncertainty that can exist over the outcome of a sports contest. This concept has guided most of the studies regarding the demand for sports contests, initially proposed as the Uncertainty of Outcome Hypothesis (UOH) by Rottenberg (1956), where he states that fans tend to attend more those sports events in which there is more uncertainty regarding the result instead of predictable outcomes. Thus, more measures for increasing this uncertainty should be implemented to achieve more spectators.

Sung & Mills (2018) show that several other determinants for sports attendance can help leagues and teams make decisions and impact their revenue. Some of these aspects include important economic characteristics, such as "price, population, and income to account for attributes of each team or geographical area". Lawson et al. (2008, as cited in Sung & Mills, 2018) and Jewell and Molina (2005, as cited in Sung & Mills, 2018) have included other socio-demographic variables related to the population income, composition, and size.

There are additional characteristics that can be important to understand fan interest in sports matches. Researchers have found that rivalry is one attribute that positively affects viewership demand and stadium attendance; accordingly, it has called their attention for further investigation and has turned into economic and managerial inquiries. Even though there is no clear definition, and it varies in the studies, the researchers reference it with the derby matches in European soccer or the divisional alignment for United States (US)

major leagues (Sung & Mills, 2018). Some other works have defined rivalry as the intensity of competition reported by fans (Havard et al. 2013, as cited in Sung & Mills, 2018), expert opinion (Szymanski & Winfree, 2018, as cited in Sung & Mills, 2018), or through experimentally derived measures (Mills et al., 2017 as cited in Sung & Mills, 2018).

Apart from OU and other determinants that can affect sports events attendance, it is essential to note that fans or consumers treat expected wins differently from how they treat expected losses, as the prospect theory specifies (Kahnemann & Tversky, 1979, as cited in Coates & Humphreys, 2012). Coates & Humphreys (2012) argue that most of the previous studies that investigate the relation between OU and sports attendance, typically assume a symmetric relationship between these two factors, forcing to treat the effects of an unbalanced match where the home team is expected to win, the same as treating it as if the home team would be expected to lose, which is not compatible with prospects theory.

It is important to note that the UOH does not consider the fan decision to attend the game based on the expected outcome of their home team, a concept that in the literature of sports demand is known as loss aversion (LA) (Coates et al., 2014), term primarily used to describe the tendency of fans who value and mostly prefer a home win or a potential upset, i.e., an unexpected victory when the home team is likely to lose (Besters et al., 2019, p. 118). As Coates et al. (2014, p.963) argue, "consumer decisions under LA differ from those under the UOH".

Overall, the complex relationship existing between game outcomes and demand suggests that the UOH as it has been used in the literature needs to be thought more cautiously. "An expanded theory of outcome uncertainty that explicitly incorporates decision making under uncertainty and key features of these decisions like loss aversion, framing, and other elements of unexpected utility maximization would go a long way toward improving our understanding of the expected game outcome-attendance relationship." (Coates & Humphreys, 2012)

2.2   Uncertainty of outcome hypothesis

Rottenberg (1956) gave the first definition of the concept and the specifications for sports demand and included comprehensive determinants such as team quality, goodness, income, market size, and uncertainty over the result to explain variations in stadium attendance. Overall, he stated that attending a sports event is more attractive for fans if the outcome is uncertain instead of a known one; a term that for the gross of sports demand research has been called the Uncertainty of Outcome Hypothesis (UOH).

2.2.1 Competitive balance.

The UOH is commonly connected to the concept of competitive balance (CB), also proposed by Rottenberg (1956). There is no universally accepted definition for this concept, but it generally refers to the balance between competitors in terms of resources, quality, talent, etc. (Besters et al. 2019).

The assumption is that the more a match or competition has fairly equal competitors, the more uncertain the result will be than comparing it with a contest with unequal competitors. In this regard, a balanced competition will attract more fans. Therefore, sports authorities or managers must increase the CB to attract more attendees, using different measures, rules, and regulations. For example, major leagues in the United States commonly implement salary caps, wage-bill, or talent allocation schemes to balance their competitions (Besters et al., 2019).

Jane (2014) describes CB as the level of uncertainty existing in a league composed of relatively competitive members in terms of strength, while game uncertainty refers to the relative capabilities of two teams trying to win a game. As he states, "both factors are important to the fans' perception, and they capture two different concepts of outcome uncertainty" (Jane, 2014, p. 178).

US sports economists developed the theoretical bases on the determinants of competitive inequality levels in sports leagues, with North American sports leagues in mind. Unsurprisingly, the development of these studies tends to lead to comparisons between North American and European models. Several differences between the two models directly impact some factors, such as the ability to compete or revenue generation. For example, the North American sports models use a draft system that allows the worst team of the previous season to choose first from the best rookies, then the second-worst team, and so on. Furthermore, some North American major leagues work under salary caps, share television revenue equally, and compete exclusively in internally structured leagues (Plumley et al., 2018).

Plumley et al. (2018) state that in the case of Europe, there are some other external factors to consider, especially in English football, such as owner investment, Financial Fair Play *"to curb excessive overspending and promote financial sustainability"* but also regulation on the money gained from Pan-European competitions such as the UEFA Champions League, which has been mentioned as a potential impact on competitive balance.

Both professional sports models are aware of the importance of competitive balance in their structures and the repercussions that it can have for their market (Plumley et al.,

2018). As Groot (2008) states, *"each competitor has an inherent interest in maintaining the health of their rivals"* (p.25, as cited in Plumley et al., 2018) or as Neale (1964) concludes, *"Oh Lord, make us good, but not that good"* should be the prayer of the teams (as cited in Czarnitzki & Stadtmann, 2002).

2.2.2 Types of outcome uncertainty

Cairns et al. (1986 as cited in Czarnitzki & Stadtmann, 2002, p.103) distinguish between three different types of OU where the criteria of differentiation relay to a time horizon:

- Uncertainty of match outcome refers to the short-term perspective and the uncertainty that can exist when the probabilities of winning are similar for both teams, which can positively affect attendance.

- The medium-term perspective refers to the uncertainty of the season result and can be measured in two ways: referring to the team who will win the season; therefore, the more teams there are still playing, the higher the uncertainty will be. The second way refers to the uncertainty from fans' perspectives who want their team to win the championship.

- The last one is the long-term perspective, and it relates to the uncertainty of outcome when there is no domination by one team in the league in the long run. If one team has the chance to win the championship consecutively, fans from that team and other teams can lose interest in attending the matches (Cairns et al., 1986, p.6, as cited in Czarnitzki & Stadtmann, 2002, p.103). As Besters et al. (2019, p.118) recognize, few studies focus on the long-run uncertainty. In general, research studies focus on match-level data from a few seasons in a single country and investigate testing the UOH.

Different studies in the sports economics literature try to find the relation between the certainty/uncertainty of the event and its impact on attendance either to the stadium or by TV views. Most of these studies conclude by showing a function graphic plot resulting from their regression models. This graphic compares the independent variable uncertainty of outcome vs. the dependent variable attendance. A U-shaped graphic, i.e., when the attendance grows as the uncertainty does, will mean support to the UOH, while an inverted U-shaped graphic concludes the opposite.

Concerning the existing literature on stadium attendance for major sports leagues, Schreyer & Ansari (2021, p.13) show in their review that a big part of the research has been done is in Football/Soccer as the most popular sport with 107 from the 235 total articles considered. This review also notes that the most popular topic between the manuscripts with a specific theme (143) was the uncertainty of outcome with 45 publications. Furthermore, one of every four publications is related to both CB and OU, including a wide variety of terms including championship uncertainty, competitive uncertainty, loss aversion, outcome uncertainty, uncertainty, uncertainty of outcome, and uncertainty of results (Schreyer & Ansari, 2021, p.16).

Schreyer et al. (2016) shows a compilation of studies from short-term OU or game outcome uncertainty (GOU) in football/soccer, as mentioned, the most popular sport in stadium attendance research field, made in different countries and temporalities, showing the results supporting or not supporting UOH, an important base for further studies in the field.

Overall, there are mixed opinions concerning the UOH. Schreyer et al. (2016) argue that a possible explanation for the ambiguity in the results could rely on the perception or the behavioral response to GOU. Moreover, the ambiguity seems to remain in studies that use samples for the same specific league. Another alternative that can explain the different results of the studies could be, as Schreyer et al. (2016) discuss, that the approach from the authors to understand consumer demand hasn't been appropriate due to two principal reasons. First, the data they usually use refers to the fans who decided to buy the ticket for the game but not the actual decision to attend the game physically. And second, the data doesn't differentiate between fans who go on game days and the season ticket holders (STH), an essential group with different behavior and attitudes.

STHs are generally described as the most loyal fans by the professional sports teams; that's why economists interested in drivers of the games tend to assume that all STHs attend all the games in a season (Benz et al. 2009, p.19, as cited in Schreyer et al. 2016) starting from the idea that, as a general seek, sports fans tend to connect their emotions to their team success. As Lahvicka (2013, as cited in Schreyer et al. 2016) states, that occurs when fans leave before the ending of a match if their team is several goals behind, they can not handle seeing their team losing, but if it's the opposite and the team is winning, they tend to stay and celebrate with the team. STHs and other fans, in general, enjoy their team winning. Still, in the study made by Sloan (1979) assessing the mood of college basketball spectators before and after a loss, an easy win, and a difficult win, it was shown

that fans increased their positive emotions after a well-earned victory than in an easy win, i.e., when there was more uncertainty (as cited in Schreyer et al. 2016, p.194).

Overall, Schreyer & Ansari (2021, p.16) show in their work a relatively consistent output of studies testing the UOH in the last decade, showing that there is an alive interest in demonstrating its validity. However, there is still a need for research in regional or popular niche sports, emerging sports, and more diverse investigation objects (Schreyer & Ansari, 2021, p.22).

3 Empirical results

Since there is still a considerable debate about the validity of the UOH (Schreyer & Ansari, 2021, p.16) this chapter outlines seven articles concerning this topic in the last decade, in which the UOH has been tested with real data in different sports leagues. The chapter will consist of a short review of each article, showing the approach and methodologies taken by the authors and a detailed comparison concerning various aspects of the research.

The articles presented in this chapter resulted from a search process in the current literature of UOH with the following selection criteria. The main goal was to find research articles in which the UOH was tested inq particularly defined temporalities and sports. Therefore, the definitive search equation included the terms "Uncertainty of outcome hypothesis", "sport", "sports", and "outcome uncertainty", as can be seen in the search statement as follows:

("uncertainty of outcome hypothesis" OR "game outcome uncertainty" OR "uncertainty of outcome") AND (sports OR sport) AND ("attendance" OR "attendance demand")

The term "game outcome uncertainty" was included in the equation to make it broader but will be used as an exclusion criterion in the following steps. Since there was more literature from different research fields but related to the first part of the equation, it was necessary to include the terms "sports" and "sport" as conditionals, but also to limit it to "attendance" or "attendance demand".

With this equation, Web of science showed 82 results and Scopus 44, which were compiled in an excel file where duplicates were deleted, resulting in 99 articles. The next step consisted of a detailed reading of articles' abstracts and title to eliminate the pieces that were not empirical works where the UOH was tested in a particular sport and temporality. But also, selected articles had to explicitly show their focus in game outcome uncertainty/match-level uncertainty as well as their concordance with the theoretical framework proposed by the seminal work of Rottenberg (1956), leaving twenty four articles. The final selection was under own consideration, checking for articles in the last decade and reading in detail the sports and characteristics. This last step concluded with seven articles.

3.1 General overview

This section presents a brief overview of each one of the seven articles selected, showing the main insights, variables and results. Furthermore, showing in some of them a graphic

plot of the resulting relationship between the concerning variables.

3.1.1 Game Attendance and Outcome Uncertainty in the National Hockey League (Coates & Humphreys, 2012).

In this article, Dennis Coates and Brad R. Humphreys investigate the existing relationship between attendance, outcome uncertainty, and team quality in the biggest hockey league in the world, the National Hockey League (NHL) in the USA. They analyze the data from five seasons starting in the 2005-2006 season to the 2009-2010 season. In particular, they analyze game level attendance from the league and betting markets data to understand GOU. As they state, betting markets are an excellent source to understand the factors of outcomes in sporting events (Sauer, 1998, as cited in Coates & Humphreys, 2012). Furthermore, variables derived from these markets are better proxies than forecasts. At the same time, they argue that there are just a few previous studies that use betting market data testing UOH, and they show little consistency due to the misuse or wrong assumptions from linear or quadratic measures.

Moreover, this study makes a clear statement regarding their focus on stadium attendance, and they don't consider television viewership or STHs.

For the purposes of the research, the authors used the following variables:

- Attendance.
- Home win probability.
- New Arena dummy.
- First game dummy.
- Match day of the week.
- Previous season win %.
- Current season win % to date.
- Home goals scored per game to date.
- Home goals allowed per game to date.
- Home Penalty minutes per game to date.
- Visitor win % to date.
- Visitor goals scored per game to date.
- Visitor goals allowed per game to date.
- Visitor penalty minutes per game to date.

The results of their research do not support the UOH. Furthermore, they suggest an expanded model of the UOH where the key features of decision making under uncertainty can be included (features like loss aversion and framing).

The evidence presented in this article shows alignment with the NHL's conviction that most of their fans want to see high-scoring games by home and visiting teams. Thus, this could increase attendance. But at the same time, attendance can be negatively affected by a poor defense or by allowing goals by either team.

For the convenience of the further analysis, this article will be referenced as (1).

3.1.2 Against all odds? Exploring the role of game outcome uncertainty in season ticket holder's stadium attendance demand (Schreyer et al., 2016).

In this study, Dominik Schreyer, Sascha L. Schmidt, and Benno Torgler analyze the information on individual physical attendance from 13.892 season ticket holders supporting a German professional football club and their decision to attend regarding the GOU present in the match. As they state, STHs are an essential group inside the fans of a club and can be described as the most loyal ones; their decision to attend could depend on time and costs of transportation to the game. As they state, it's also necessary to note that even having a ticket for every game, STHs can decide not to attend a game due to the attached feelings to the team or the sport. Thus, for them, attending a game where there can be an inevitable loss may be painful, and they would try to avoid it, as loss aversion theory suggests.

The authors conducted two studies, one concerning the decision to attend the game, and another one regarding the time of arrival to the stadium. The former analyzes the detailed admission information for 13892 STHs across one entire season of one of the major teams from the Bundesliga (17 consecutive games in the 2012/2013 season). The information that was available for the researchers also included socio-demographic data from every individual in the STHs group.

The second study used the data of 3113 STHs, who attended all consecutive 17 games in the season.

In the studies, the authors used a random-effects model with the following variables:

- Attendance.
- Winning probability of the home team.

- Probability inequality of the three outcomes.
- STHs' age on game day.
- STHs' sex (male = 1; 0).
- STHs' geographic location (external = 1; 0).
- Number of season tickets bought anteseason.
- Type of accommodation (standing = 1; 0).
- Distance from field to seat.
- Cost of the season ticket.
- STH has missed last home game (yes = 1; 0).
- STH has resigned for next season (yes = 1; 0).

Furthermore, to be able to compare with the previously existing research, they extend their model by adding five UOH proxies that were used to measure GOU derived from league standings and not from the betting markets, adding the independent variables:

- Dummy to see if home team is favorite.
- STH is late (yes = 1; otherwise = 0)
- STHs' estimated travel time in minutes.
- STHs' distance to the stadium in kilometers.
- Global league-based home advantage.

The resulting plot can be seen in Figure 1, in this case, the comparation is made between the dependent variable *"admission"* vs the independent variable *"winning probability of the home team"*. In this figure is possible to see the U-shaped relationship between the two variables.

– Please insert figure 1 about here. –

For the second study, the authors add the following variables to the previous ones and, in this way, evaluate the entrance time to the stadiums.

- Time of admission (in minutes; prior to kick-off)
- Probability of one team leaving the stadium as a winner.
- Absolute difference between WPH and WPA.

- Absolute distance between the teams in the leagues ranking.

- Global league-based home advantage.

Both studies show concordance with the UOH for STHs, each in its regard. The first one concludes that these fans tend to favor home games where the result is uncertain, especially for those STHs that have an increased cost to attend to the stadium, i.e., those who live outside of the city and younger STHs. From the second study, researchers conclude that GOU increases STH's arrival time before the game, especially for two groups:

- STHs in the stadium area;

- STHs living outside the stadium city.

For the convenience of the further analysis, this article will be marked as (2).

3.1.3 Just looking for a good game: competitive balance in the Korean Professional Baseball League (Hoon Lee et al., 2016).

In this research work, Young Hoon Lee, Hayley Jang, and Rodney Fort develop an analysis of attendance in the Korean Professional Baseball league (KBPL) and, as they mention, the first evidence of the empirical power of the UOH in the KBPL. They analyze the annual attendance data from the league from 1983 to 2010. They state that the KBPL can be an excellent new testing ground for the UOH for two main reasons. First, all the teams (one excluded) are "wholly owned subsidiaries of parent companies, primarily serving as parent company advertising vehicles". Second, there is less geographic identification with the teams because there are three teams in Seoul and five in other major cities in Korea.

The regular season consists of 133 games from early April to early October; the team with the best regular-season winning percentage (WP) gets a place in the seven games Korean series. The opponent is decided in a five-game series between the second place in the regular season and the winner between a best-of-five series between the third and fourth places.

In the research, the authors used the following variables:

- Attendance.
- Annual average attendance per game for one team in one year.
- Annual gate revenue divided by total annual attendance.
- Real per capita gross regional product of specific team host city in one year.

- Population (1000) of specific team host city in one year.
- Total innings pitched by Chan Ho Park in MLB in an specific year.
- Total at-bats by Seung-yeop Lee, in an specific year.
- Specific team WP in year t.
- Play-offs dummmy (1 if team i made the play-offs in a specific year).
- Game uncertainty.
- Play-offs uncertainty.
- Consecutive season uncertainty.
- Seating capacity of stadium.
- Dummy for summer olympics.
- Dummy for FIFA world cup.

Based on the results, the study supports the UOH for GOU and consecutive season uncertainty. However, the second study is not statistically significant. As the authors conclude, KBPL fans are just looking for "a good game".

For the convenience of the further analysis, this article will be referenced as (3).

3.1.4 Estimation of game-level attendance in major league soccer: Outcome uncertainty and absolute quality considerations (Sung & Mills, 2017)

In this research article, Hojun Sung and Brian M. Mills investigate attendance in the MLS regarding Outcome uncertainty and absolute quality. This study primarily shows the growth that the MLS has had in the last years and the increase of football audience both on TV and physically in stadiums in the USA. Furthermore, they argue that the academic interest that the league is receiving could rely on its peculiar single-entity organizational structure. In this structure, the league controls the new players to promote balance and competitiveness.

The study analyses all the regular-season MLS games from 2010 to 2015, with 1855 match-level individual observations. To estimate the uncertainty of outcome, the authors used data from the betting markets, specifically from one of the most popular betting websites.

For achieving the goal of the study, the authors chose the following equation and variables:

- Attendance.

- Weather (Clear, cloudy, precipitation).

- Rivalry.

- Soccer specific stadium.

- Stadium age.

- Home winning probability.

- Home and away ELO rating.

- Standard deviation from the elo rating.

- Home and away designated players or possible superstars.

- Home and away designated players salary.

- Home and away team age.

- Home and away market median household income.

- Population.

The resulting plot can be seen in Figure 2, in this case, the comparation is made between the dependent variable *"attendance"* vs the independent variable *"Home win probability"*. In this figure is possible to see the U-shaped relationship between the two variables.

– Please insert figure 2 about here. –

The article concludes by not supporting the UOH, stating that MLS fans' behavior could be related to loss aversion, or at least, they show interest in a team that has a bigger chance to win against the other. In the case of this league, the reputation of the teams and star player performance could be an essential element for demand. Additionally, the authors recommend that MLS increase absolute talent and provide conditions in which certain teams can become relatively dominant. In the case of MLS, rivalry matches do not represent a positive effect on attendance.

For the convenience of the further analysis, this article will be referenced as (4).

3.1.5 How outcome uncertainty, loss aversion, and team quality affect stadium attendance in Dutch professional football (Besters et al., 2019).

In this work, Lucas M. Besters, Jan C. van Ours and Martin A. van Tujil develop an empirical study concerning stadium attendance, outcome uncertainty, and team quality in the Dutch football league. As the authors state, this league has not ever been into the top leagues from Europe, and the teams have not been protagonists in European club

competitions. Still, the league is very popular in the Netherlands and after the season 2015-2016, ranked 5th in the top of European leagues attendance with 19.500 attendants after Germany (43500), England (36500), Spain (28500), Italy (22000) and France (21000). Remarkably, this league has been the only one from the big European leagues that introduced playoffs (in the 2005-2006 season) at the end of the season for qualification to continental football competitions, but also for increasing interest and attendance.

The researchers use data from the Dutch professional football for sixteen seasons, starting in 2000-2001 to 2015-2016. Regarding every match, the data contains information on the attendance, general weather conditions during the day, competing teams, location (stadium, stadium capacity, city, province), and fixed betting odds to measure the outcome uncertainty status.

To reach the research goals the authors used the equation and variables that will be explained below.

- Attendance.
- Team quality.
- Cumulative surprise.
- Home win probability.
- Match expectation.
- Dummy for promoted teams.
- Pre-match rank difference.
- Dummy to see if the match is for the championship.
- Dummy to see if the match is to classify to the UEFA Champions league for home and away team.
- Dummy to see if the match is to classify to the UEFA Europa league for home and away team.
- Dummy to see if the match is for Relegation for home and away team.
- Dummy for Derby.
- Weekday.
- Temperature.
- Precipitation.

The study concludes by rejecting the UOH for match-level uncertainty. As the authors state, the results match better with a reference-dependent preference concordant to loss

aversion. In the case of seasonal uncertainty, the study supports the UOH concerning the championship victory and the classification to the UEFA champions league. Furthermore, they find a positive impact of the introduction of play-offs on match attendance, but only for these play-off matches and not for the regular season. Additionally, team fans are less interested in play-off games against a repeating opponent despite the high uncertainty regarding the winner.

For the convenience of the further analysis, this article will be referenced as (5).

3.1.6 Uncertainty of outcome or strengths of teams: an economic analysis of attendance demand for international cricket (Sacheti et al., 2014).

In this research article, Abhinav Sacheti, Ian Gregory-Smith, and David Paton study the impact of short-term uncertainty, long-term uncertainty, and team strength in cricket attendance. The authors describe Cricket as a valuable context to test the ideas of the UOH and CB due to two main reasons. First, the particular structure that international elite Cricket uses, in which teams play with each other in a series of matches, allows an easy distinction between short-term and long-term uncertainty. But additionally, Test cricket, in which a single game can be played during five days, makes it possible to measure a possible change of the uncertainty of outcome during the course of a match. Another factor to consider is the modality for professional cricket; the elite level of this sport is played between teams representing countries, which doesn't happen in most professional sports where the best level of performance can be found at the club stage.

In this case, they use the model from over 380 Test matches played by home teams in England, Australia, and New Zealand between 1980 and 2012.

In their study the researchers used the following equation and variables:

- Attendance.
- Total match attendance divided by number of days of play.
- Absolute difference in ICC Test ratings prior to match.
- Square of absolute difference in ICC Test ratings prior to match.
- ICC Test rating of home team prior to match.
- Dummy for series certainty (1 if series result was decided prior to Test; 0 otherwise).
- Dummy for final day (1 if match result was certain prior to final day; 0 otherwise).
- Real weekly earnings in region match played in.

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- Dummy for rain (1 if at least 40 overs lost due to rain or bad light on any day of match; 0 otherwise).
- Holidays (1 if match period included at least one public holiday; 0 otherwise).
- Dummy variables for opposition teams.

The results support the UOH for the short-term uncertainty of outcome by demonstrating a meaningful impact on attendance demand. Furthermore, they support absolute team strength when using the model for long-term uncertainty.

For the convenience of the further analysis, this article will be referenced as (6).

3.1.7 How we can enhance spectator attendance for the sustainable development of sport in the era of uncertainty: A re-examination of competitive balance (Hun Sung et al., 2020).

In this work, Sang Hung Sung, Doo-Seung Hoong, and Soo Young Sul test the UOH in Korean Baseball stadium attendance, but in this case, they look from the competitive balance perspective. They develop the study stating that sports are a great tool to promote "feelings of national identity, social cohesion, and community empowerment" and in this way contribute to the countries' sustainable development. But they also state that previous research on professional sports has been focused on the USA, European Countries and less in some other regions.

In this study, the authors use the data from 10 teams from 2015 to 2017, three seasons including 2160 games. The following measures and variables were used:

- Seat occupancy rate.
- Home team winning % against visiting team.
- Home team winning % for whole seasons.
- Competitive balance with a visiting team.
- Competitive balance with entire teams.
- Income of home team's province.
- Income of visiting team's province.
- Population of home team's hometown.
- Population of visiting team's hometown.
- TV viewer ratings of home team games.

- TV viewer ratings of visiting team games.

- Weekends dummy.

The resulting plot can be seen in Figure 3, in this case, the comparation is made between the dependent variable *"seat occupancy rate"* vs the independent variable *"competitive balance"*. In this figure is possible to see the inverted U-shaped relationship between the two variables.

– Please insert figure 3 about here. –

The study concludes not to support a positive effect of the UOH in the stadium attendance, demonstrating that for Korean baseball fans, the WP of the team matters more than the GOU that can exist for the upcoming match.

For the convenience of the further analysis, this article will be referenced as (7).

3.2   Common variables used for analysis.

As seen in the previous section the studies (2), (3), and (6) developed in German soccer, Korean baseball, and cricket, respectively, show support to the UOH. While studies (1), (4), (5), and (7) investigating Hockey, USA soccer, Dutch soccer, and Korean baseball reject it. This section will analyze the common variables used among the studies, followed by a comparison of the research results.

3.2.1   Outcome uncertainty

As can be inferred, all the studies use OU as a variable in the models, but it is necessary to clarify how each one extracts it from the available data. The studies (1), (2), (4), and (5) use betting market odds for this purpose, all of them from the most popular websites in the country of research. These studies take the home win probabilities and its squared value in case of significant changes. From this subgroup, three out of four papers concluded not to support the UOH.

On the other side, studies (3), (6), and (7) use a different approach each. In the case of the work done in (6) with Cricket, the authors take OU as the absolute difference between the ratings given to each team by the International Cricket Council. Additionally, it is worth mentioning that as described in the article overview, in this study the authors handle more variables referring to the uncertainty due to the particular format of test Cricket, i.e.,

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the uncertainty of a game but when the series is still going, and the uncertainty in the last day. Finally, studies (3) and (7), both done in Korean baseball, use OU with the WP but in different ways. The former uses the absolute difference between WP and the league average; the latter use the OU as the CB existing between the local team and the visiting teams, but it also includes in the model the CB with the entire teams in the league. In this case, two out of three studies support the UOH.

Even though the selection criteria for the articles included explicitly the use of game-level outcome uncertainty, the articles which additionally to that specification included analysis of seasonal-level uncertainty were not excluded. That is the case of studies (3), (5), and (6). In the case of the article (3), the researchers tried to find the role of the consecutive season winning uncertainty in stadium attendance, as they call it, the impact of dynasties. It is similar to (6), where they explore the ratings given by the International Cricket Council and its impact in the long term. Furthermore, in work (5), the authors assume the season's value for the teams regarding the classification to the play-offs.

In terms of competitive balance or team strength, some articles in this selection analyze its effect by introducing a variable into their models. For instance, study (1) analyzes each team quality, including characteristics such as the WP calculated based on the games played in previous seasons, goals scored, goals allowed, and penalty minutes accumulated. Additionally, in this investigation, the researchers ran the model simulating perfect competitive balance, i.e., the maximum OU for every competition, and in this way, try to find the attendance that would result, getting as an outcome that there was a negative relationship between maximum OU and stadium attendance with a decreasing trend in fans attending the match. Research (3) categorize by one side team quality, including in this group the WP of the team in some previous year, and one variable to indicate, if the team made it to the playoffs. The other group includes competitive balance consisting of game uncertainty together with play-off uncertainty and consecutive season uncertainty.

Article (4) shows an excellent example of characterizing the team quality. In this case, the authors elaborated their quality indicators for the home and visitor teams. In this approach, they calculated Elo ratings, i.e., ratings for quality that can show the team strength and quality of performance and are updated after every game. This case includes variables such as goals difference, the game's result, and probability expectation for a win, among others. The Elo rating of the teams is included in the model used by the authors.

In the case of the article (6), and as was already mentioned, team strength is an indicator given by the International Cricket Council and is included in the model. Furthermore, it

is used to calculate the GOU.

3.2.2 Demographic and socio-economic factors.

Socio-demographic factors play a vital role in some of the studies of the presented selection. That is the case of the article (2); in both studies done by the authors, variables such as gender, age, distance to the stadium, and the estimated travel time, among others, are helpful to understand the additional factors that affect STHs in their decision to attend a match or their decision on the arrival time to the stadium.

Considering the MLS in the article (4), the authors included variables related to the market, the team, and the stadium such as home and away team players average age, home and away market median household income, population, stadium age, and a variable indicating if the stadium is soccer-specific.

In the case of Korean baseball, studies (3) and (7) include some variables due to its demonstrated influence in, as they call it, the seat occupancy rate in the stadiums. In both studies, the average income of home and visitor teams regions, together with the population of their territories, are included.

3.2.3 Rivalry.

Some of the studies in the selection include dummy variables concerning the audience's particular attention to one match, due to the rivalry history that two teams have. For instance, article (6) describes a known rivalry in International Cricket between England and Australia; as the authors explain, it impacts price and demand.

In the same way, the authors studying MLS in the article (4) include a variable concerning rivalry in the model. In the MLS exist some particular games similar to derby matches in Europe but called MLS rivalry cup games; these matches are already defined and, as shown in the case of Cricket, generate an essential impact on attendance. Similarly, in article (5), the model uses a control variable stating if the match analyzed is a derby or not.

3.3 Results comparison

As discussed in chapter 2, all the empirical studies concerning UOH conclude showing their support or rejection of the UOH and the graphic relation of either the OU or CB against

the stadium attendance. This section compares the results and important insights from some of the articles.

In the case of the articles for this selection, as seen in section 3.1, four out of seven showed rejections of the UOH. Therefore, the majority was obtained by the group of articles that don't support the UOH. Still, it is worth mentioning essential characteristics for the studies supporting it. In the case of the paper (2), the key argument to consider is that the survey was developed with STHs, fans who, as the authors describe, are the most loyal ones in the teams. Their decision will depend only on the costs that imply arriving at the stadium, a factor that from the beginning can make a significant impact. The decision could be less difficult for them to take than for another type of fan. The results showed that STHs react positively to high OU, especially those with the highest coordination costs, i.e., spectators living outside the city or far from the stadium. Additionally, this group will prefer to arrive earlier to the most competitively balanced matches.

Furthermore, the case of cricket in the article (6) represents a particular case that can not be seen in many sports due to the game format and the different uncertainties that can exist there. Being one of the most extensive studies in this selection in terms of temporality, the results show that cricket fans want to watch their team win, but they mainly want to watch high-quality cricket.

The studies (1) and (5), made in the NHL and Dutch football, respectively, and two of the most extensive investigations in terms of inputs introduced into the models and temporalities considered, concluded both not supporting the UOH and showing an inclination to loss aversion theory to explain their results. Furthermore, (1) makes a clear statement for Rottenberg's (1956) theory reconsideration, suggesting a bigger model that can include certain parameters of decision-making under uncertainty, better explaining the relationship between the game outcome and the attendance. At the same time, in (5), loss aversion dominates the decision for stadium attendance but without a preference for a home win.

In the case of the MLS in the article (4), the UOH was rejected because fans prefer a difference in team qualities; they prefer to watch big wins even if the visitor team wins. This could be related to the way of managing the new talents in the league's single-entity approach. As the authors argue, assigning superstar players into teams has provided unbalanced matches, thus, generating interest for fans. They also conclude showing a positive outcome for dynasties in the league, in which the fans can perceive those teams more attractive to watch.

An interesting case to analyze further is the one presented in studies (3) and (7), both

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made in Korean baseball but with different temporalities. The former studies twenty-seven seasons and concludes supporting the UOH, while the latter analyzes three years and rejects it. Both models include the same base and socio-demographic variables for the analysis, such as winning percentage of both teams, competitive balance, income, and population from both teams' regions. Nevertheless, (3) adds more control variables, such as playoff uncertainty, consecutive season uncertainty, ticket price, among others. The more extended temporality and robustness of the model could be helpful to conclude that this study represents a more solid base for future studies.

It is important to consider the amount of time or matches analyzed by the studies presented, as it can be an important factor when interpreting the results. The longest study was the one made in (6), but it only included 380 games due to the format of cricket and the teams considered. Next one is (3) with a close difference with the previous in terms of the years analyzed, it sudies approximately 35910 games from 1982 to 2012. After all, these two studies concluded supporting the UOH. However, the articles from the selection that reject the UOH, analyze the data with similar temporalities. For instance, (1) and (4) study four years, while (7) studies three seasons. Furthermore, (5) studies fifteen seasons including the additional games in the play-offs, as previously explained. It is worth mention that study (2), introducing the particular line of studies in a group such as STHs, in this case, analyzes just one season. Although it is a small amount of time compared to other studies testing the UOH, it has a positive result supporting the UOH and shows important insights regarding this group of fans, and leaves the path open for further investigation in it.

Table 1 shows the summary of this chapter by detailing the important aspects of every article presented; the year, country, sport, time analyzed, measure used for OU and the general result regarding support to the UOH.

– Please insert table 1 about here. –

All in all, in this articles selection, the majority concluded not supporting the UOH. However, it is necessary to mention that it can't be used to infer or demonstrate the validity of the theory due to the differences in the sports, sports modalities, and methodologies used. Moreover, the authors chose a wide range of different variables in the research, and these variables differ from study to study. Nevertheless, a few variables are repeating in more than two research papers like rivalry and competitive balance by measuring the teams strength and quality. It shows the value these variables have for studying and

better understanding of UOH and its impact of game attendance. And, therefore, it is worth paying more attention to it in further studies. Lastly, based on the analysis, it is important to note the significance of demographic and socio-economic factors for revealing additional reasons that can affect game attendance.

4   Summary & conclusion

4.1   Summary

This work presents the revision of empirical studies, which tested the Uncertainty of Outcome Hypothesis in different sports and with particular groups of spectators. First, it reviews the theoretical aspects concerning the Uncertainty of Outcome Hypothesis, competitive balance, game outcome uncertainty, determinants of sports attendance, among others. Furthermore, it considers seven critically selected empirical articles and compares them based on shared variables and results. This work explores research done in the National Hockey League, German soccer, Korean baseball, Major League Soccer, Dutch soccer, and cricket. The analysis of this selection concluded with most of the studies rejecting the Uncertainty of Outcome Hypothesis, even though it does not represent a solid conclusion due to the diversity of sports and groups analyzed.

4.2   Review of goal attainment of the thesis

The initial review of the existing theory and seminal works on the Uncertainty of Outcome Hypothesis, competitive balance, and determinants of sports attendance made it possible to understand empirical research done in the field. With this theoretical base as a starting point, it was possible to search and select research with the established criteria in the databases and get the best insights from every one of the seven articles. Further, it was possible to critically analyze and synthesize the variables and models used by each article, to have a horizontal applicable comparison base. As a result, it all led to attaining the proposed goal.

4.3   Conclusion

As seen in the theoretical exploration and the analyzed studies, the UOH still has a long way to a conclusion due to all the unique characteristics that every sport can have and all the preferences that a spectator can show. As stated in Cotes & Humphreys (2012), a model that includes more characteristics of decision-making under uncertainty could make a huge impact and help to understand better the relationship between game outcome and attendance. The role of LA could explain most of the cases of rejection of the UOH, but with the consideration of the particular case of the MLS and the role of superstars in the teams.

It is important to note that, as shown in (6), more studies in specific sports such as cricket, in this case, could be beneficial to understand consumer reactions or preferences during different championship formats and different types of uncertainties. Moreover, more research should be done with different types of spectator groups like the one considered in (3). This study, as stated by the authors, pioneers the studies in season ticket holders, a group worth studying due to its particularities and insights for future research.

Overall, the study helped to get a broader understanding of the UOH theory. Moreover, the nature of the study objects was beneficial for finding specific aspects and trends of this topic, that can be helpful for further studies regarding the UOH and its impact on sports attendance.

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Appendix

Figures

Figure 1: Dependent variable "admission" vs independent variable "winning probability of the home team" for study (2).
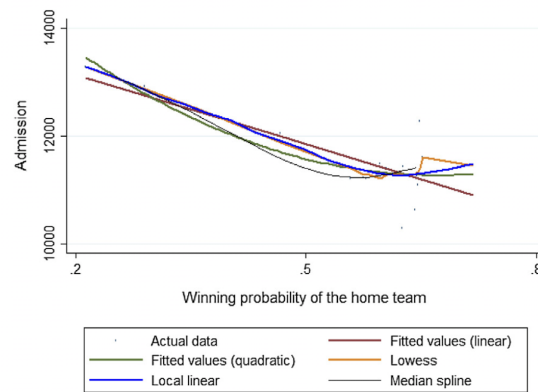

Figure 2: Dependent variable "Attendance" vs independent variable "home win probability" for study (4).
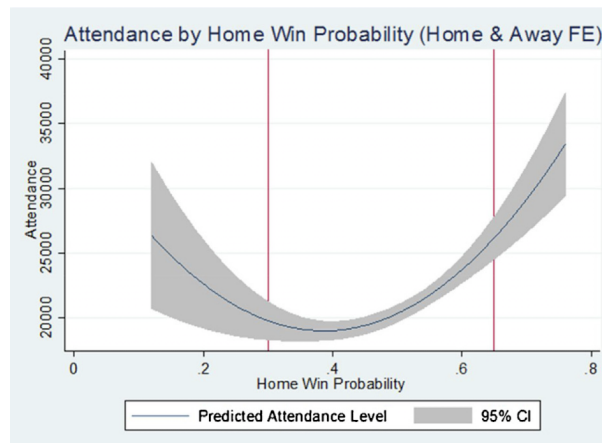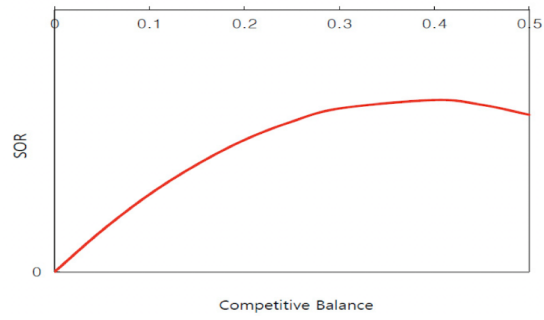
Figure 3: Dependent variable "Seat Occupancy Rate" vs independent variable "Competitive Balance" for study (7).

Tables

Article	Year	Country	Sport	Time analyzed	OU measure	Supports UOH
Game attendance and outcome uncertainty in the National Hockey League	2012	USA	Hockey	Five seasons (2005/2006-2010/2011)	Betting markets	No
Against all odds? Exploring the role of game outcome uncertainty in season ticket holders' stadium attendance demand	2016	Germany	Soccer	One season (2012-2013)	Betting markets	Yes
Just looking for a good game: competitive balance in the Korean Professional Baseball league	2016	Korea	Baseball	Regular-seasons and post-seasons in 1982-2012.	Winning percentage	Yes
Estimation of game-level attendance in major league soccer: Outcome uncertainty and absolute quality considerations	2018	USA	Soccer	All 2010-2015 MLS regular season games.	Betting markets	No
How outcome uncertainty, loss aversion and team quality affect stadium attendance in Dutch professional football	2019	Netherlands	Soccer	Seasons 2000/2001 - 2015/2016	Betting markets	No
Uncertainty of outcome or strengths of teams: an economic analysis of attendance demand for international Cricket	2014	England, Australia and New Zealand	Cricket	380 games between 1980 and 2011	Absolute difference between ICC ratings	Yes
How we can enhance spectator attendance for the sustainable development of sport in the era of uncertainty: A re-examination of competitive balance	2020	Korea	Baseball	2160 games over 3 years (2015-2017)	Winning percentage	No

Table 1: Data summary of selected articles.

Abstract. This work presents the revision of empirical studies, which tested the Uncertainty of Outcome Hypothesis proposed by Rottenberg (1956), in different sports and with particular groups of spectators. First, it reviews the theoretical aspects concerning the Uncertainty of Outcome Hypothesis, competitive balance, game outcome uncertainty, determinants of sports attendance, among others. Furthermore, it considers seven critically selected empirical articles and compares them based on shared variables and results. This work explores research done in the National Hockey League, German soccer, Korean baseball, Major League Soccer, Dutch soccer, and cricket. The analysis of this selection concluded with most of the studies rejecting the Uncertainty of Outcome Hypothesis, even though it does not represent a solid conclusion due to the diversity of sports and groups analyzed.