

## THE PRESENCE OF UNCERTAINTY IN SPORT – A LITERATURE REVIEW

GERGELY CSURILLA<sup>1,2,\*</sup>, TAMÁS STERBENZ<sup>1</sup>

---

*Received 2022 January 19; Revised 2022 March 03; Accepted 2022 March 03;  
Available online 2022 May 5; Available print 2022 May 30.*

©2022 Studia UBB Educatio Artis Gymnasticae. Published by Babeş-Bolyai University.



This work is licensed under a Creative Commons Attribution-Non Commercial-NoDerivatives 4.0 International License

---

**ABSTRACT.** The notions of luck, risk, noise, and uncertainty could be often read in sports-related literature. However, there was not published a study so far that attempts to summarize the differences and similarities among them. In this paper, we aim to review the most influential papers, books carried out in relation to these concepts. As the topic of uncertainty in sports literature is quite diverse, therefore, we followed a review method aiming for theory development instead of a systematic review. Using an alternative review methodology enabled us to organize the existing theories in three main categories based on who is affected by the uncertainty: spectator, athlete, and sport level. The main finding of our paper is that uncertainty has distinct consequences at different levels. The demand for sport requires a certain level of uncertainty from the fans' point of view to maintain the uncertainty of outcome. Athletes, on the other hand, are adversely affected by uncertainty. In sport level, the impact of the uncertainty on the results should be carefully managed. The topic of uncertainty in sport is characterized by contradiction. From the perspective of spectators, an adequate amount of uncertainty is required to maintain an interest in the sport. However, the athletes do not prefer uncertainty which they could not influence. It is up to decision-makers in sport to establish such regulation which they can balance with the uncertainty to maintain the interest of spectators and to encourage athletes for the best performance.

**Keywords:** *Uncertainty of Outcome, Competitive Balance, luck, noise, risk*

---

<sup>1</sup> *Sport Economics and Decision Making Research Centre, Hungarian University of Physical Education, HUNGARY*

<sup>2</sup> *Institute of Economics, Centre for Economic and Regional Studies, Hungarian Academy of Sciences Centre of Excellence, HUNGARY*

\* *Corresponding author: csurilla.gergely@tf.hu*

## Introduction

Uncertainty is a fundamental part of the sport, and especially of competitive sport. If all results of competitions could be perfectly predicted, the demand for sport tends to be ceased. No one would be interested in a competition where always the expected wins against the underdog because there would not be any excitement due to the certain outcome. Uncertainty in outcome is a mandatory element of sports contests, that makes the whole sports industry so particular. Many previous studies applied different concepts about uncertainty – like luck, risk, noise. The main conclusions of the previous findings are quite similar, consequently, all concepts could be interpreted rather as synonyms than as different meanings.

Uncertainty in sport has been studied from different perspectives in the scientific fields but mainly from two aspects. One aspect is the sport analytical studies, where researchers tried to quantify the amount of luck in sports which cannot be explained by the performance of teams, athletes (Aoki et al., 2017; Getty et al., 2018; Gilbert & Wells, 2019; Mauboussin, 2012). The other, and probably the more complex, aspect belongs to the sports economic and management disciplines, where the Uncertainty of Outcome Hypothesis (Alavy et al., 2010; Baimbridge, 1998; Borland & Macdonald, 2003; Buraimo & Simmons, 2015; Neale, 1964; Rottenberg, 1956; Szymanski, 2006) and competitive balance (Arboix-Alió et al., 2019; Budzinski & Pawlowski, 2014; Gyimesi, 2020; Szymanski, 2003; Zambom-Ferraresi et al., 2018) are extensively investigated. The economic concept of noise should be also mentioned (Lazear, 1986; Lazear & Rosen, 1981) which is the difference in workers' efforts and the output of production. The notion has been transposed into sport sciences as well, where the noise is the difference in the performance of athletes and the outcome of the contest (Csurilla et al., 2019; Sterbenz et al., 2014, 2019).

Previous studies mainly investigated uncertainty at a sports level. However, uncertainty influences the behaviour of athletes as well. From an economic point of view, Lazear & Rosen (1981) presented that the uncertainty, called noise in their study, causes performance retention on behalf of workers if they are not compensated for the negative effects caused by uncertainty. Sterbenz & Gulyás (2016) found a similar case in sport and formulated the theory of rational untrained athlete (RUA). The RUA says that in sports, where usually uncertainty in outcome appears, the rational attitude of athletes is performance retention. Due to the complexity, the real added value of an athlete could not be recognized or measured. In team sports, the phenomenon of social loafing exists (Latané et al., 1979) if the added value of a teammate to the victory could not be determined accurately (Sterbenz & Gulyás, 2016). Uncertainty in the environment also affects the preparation of athletes (Bortolotti, 2021).

The individual and the structure of sport play an important role when it is about the measurement of uncertainty or performance. This can be illustrated by the case of basketball and chess where the basketball has a closed and the chess an opened system. While a closed system is characterized by perfect information, there is not any hidden information; as in the case of an open system, the problem of asymmetric information occurs. In chess, the performance of an individual is represented by the Elo rating which gives a fairly accurate picture of the power ranking of chess players. In contrast, there are plenty of rating systems in basketball to illustrate players performances; however, none of these is as accurate as the Elo rating due to the asymmetric information.

As we briefly presented above, there are plenty of attempts in sport to measure uncertainty, or at least to separate from the results to get the real performance of teams, athletes. In this paper, we review and summarize the existing literature in connection with uncertainty, luck, risk or noise. Our primary goal is to systemize the previous studies to better understand the nature of uncertainty and the existing research directions. There are plenty of papers concerning luck, noise or uncertainty on sport; however, a review about them is still missing. We attempt to fill this gap in the literature with our paper.

### **Material & methods**

As the topic of uncertainty in sports literature is quite diverse in terms of concepts, aims and disciplines, we did not intend to follow an ordinary review methodology. Furthermore, the topic of uncertainty and sport became popular only in the last decades, the number of papers published on the topic is limited. By following a systematic literature review methodology, we tend to miss essential papers and thoughts which cannot be found in scientific databases. Therefore, we used the review method aiming for theory development (Paul & Criado, 2020). We looked for scientific studies, articles, books written in relationship with uncertainty, noise, luck not only in sports literature but also in other multidisciplinary fields. We searched for sport-related literature in the databases with the following keywords: uncertainty, luck, noise, risk. Nevertheless, we did not intend to review all the studies carried out on the topics of uncertainty in the outcome and competitive balance; both topics would be worth a separate review article.

### **Results**

In the economic literature, Knight (1921) was the first who attempted to separate the notation of risk and uncertainty. He stated that in the case of uncertainty, the probability of occurrence cannot be measured, while the risk

can be formulated mathematically. Later this theory or hypothesis was disproved and it is not even widespread (Bélyácz, 2010), neither researchers in sports science did not follow this distinction (Csurilla & Sterbenz, 2018). Since then, countless studies have been conducted to measure uncertainty in the sport. Using the existing literature on the, we formulated a framework for the uncertainty in sport from three perspectives: the spectator level (i.e., consumer), the athlete level, and the sport or the regulatory board level (i.e., the decision-maker of sports regulations). We present separately the results of the three perspectives.

### *Spectator level*

One of the best known and widespread theories related to uncertainty is the Uncertainty of Outcome Hypothesis (UOH). The OUH is similar to the Competitive Balance (CB) studies; however, the UOH not only measures the degree of competitive balance but also investigates its consequences for the demand. In this respect, the CB relates rather to the decision making level.

The pioneers of OUH were Rottenberg (1956) and Neale (1964) who hypothesized first that the excessive dominance of a team or an athlete reduces the interest for a competition because the outcome of competition becomes predictable. This gave birth to the OUH which states that the closer the outcome of a competition, the higher the demand will be for it (Borland & Macdonald, 2003; Szymanski, 2006).

The OUH could be investigated in three different dimensions; match, seasonal and long-run levels (Borland & Macdonald, 2003; Szymanski, 2006). To measure OUH in a match level is the most difficult, and the existing evidence for it is also relatively weak (Borland & Macdonald, 2003). Moreover, the demand for a game is not determined by the uncertainty, rather the quality of the teams does matter concerning interest – fans prefer the massive victory of their own team over a close result (Borland & Macdonald, 2003; Szymanski, 2006). With seasonal data, there is a more reliable evidence for the relationship between uncertainty and attendance. If the degree of evenness is greater in a sporting competition within a season, the higher the attendance will be (Borland & Macdonald, 2003). For the long-run effect, two studies also found evidence for the higher demand when the competition is balanced (Humphreys, 2002; Schmidt & Berri, 2001).

While the existing literature on the topic of OUH is profound, there is still controversial evidence for the existence of UOH. The UOH may have some effect on the demand of sport; however, uncertainty in outcome affects demand only intra-seasonal or inter-seasonal (Borland & Macdonald, 2003). Mainly three factors tend to cause the changes in demand for sports competitions. The quality of the contest, the quality of viewing, and the price of a game ticket (which differs between teams) are associated with higher attendance (Borland

& Macdonald, 2003). More recent studies argue that the UOH is no longer important (Buraimo & Simmons, 2008, 2015; Pérez et al., 2017). Supporters of the home team do not prefer to attend on a game that is predicted to be close in the score (Buraimo & Simmons, 2008), and UOH also does not affect the demand of television audience (Buraimo & Simmons, 2015; Pérez et al., 2017).

#### *Athlete level*

In the economic literature, the phenomenon of noise can be attributed to uncertainty at an individual level (Csurilla & Sterbenz, 2018). In economics, noise is the uncertainty during production and the resulting error in measurement (Lazear, 1986). If there is a significant amount of noise during the production, the labor's effort and the production output will not be consistent. The noise can be even positive or negative if the labor's performance is overestimated or underestimated. In the presence of noise, the labor's efforts will decrease (Lazear, 1998). Consequently, an incentive system must be set up for workers that protects them from the effects of noise, while making them responsible for their efforts (Milgrom & Roberts, 2005).

Sterbenz et al. (2014) were the first, who implemented the noise concept into the sport. Based on their interpretation, noise is the difference in the endeavors and efforts made by athletes in the hope of success during preparation and at the competition, and the results of the contests; this is the uncertainty in results. The uncertainty or noise is much more present in complex sports (like team sports) compared to individual sports (Sterbenz et al., 2014). The uncertainty can arise from different sources, like subjective judgment, weather conditions, or contact with the opponent (Sterbenz et al., 2014, 2019). The uncertainty affects the behavior of athletes in sport; therefore, incentive systems are needed to encourage sporting participants to perform at their best (Sterbenz et al., 2014).

For the problems arising from the noise or uncertainty, the Tournament Theory provides a solution to encourage maximal effort for employees or athletes (Lazear, 2018; Lazear & Rosen, 1981). The Tournament Theory was aimed to formulate a new incentive system for the business industry but the idea is derived from the design of tennis tournaments. In Tournament Theory, the payoff structure is pre-determined, the allowance is independent from the absolute, only dependent on the relative performance of the individual (Lazear, 2018). In most sports, it does not usually matter which team scored the most points or goals but who was able to overcome the opponent team as many times as possible.

Many sports competitions do not have a direct financial reward system, as is the case with the Olympic Games. However, the prestige of winning a medal at the Olympics and the subsequent business opportunities, make these competitions alike as the Tournament Theory. The lack of payoff structure makes the analyses of the incentive systems' efficiency in some sports impossible.

The measurement of uncertainty is also difficult at an individual level as the performance of athletes is hectic and influenced by several factors that could not be accounted for (Csurilla et al., 2019, 2021).

### *Sport level*

The CB studies are strictly bounded to the OUH studies but without investigating the unpredictable results' effect on attendance. A general assumption is that a competition should be balanced to maintain interest in the long run (Fort & Maxcy, 2003; Humphreys, 2002; Zimbalist, 2002). As the UH, the CB could be analyzed in distinct time horizons as well, like the game, mid-term or seasonal, in the long-term (Gyimesi, 2020).

For the importance of CB, several ordinary examples can be found. For instance, in the early years of the 2000s, the FIA (Fédération Internationale de l'Automobile) has attempted to break Schumacher's victory series with numerous rule changes to restore uncertainty in winners of Formula 1 world championships (Vörös, 2017). It is up to decision-makers in sport to prevent monopoly or duopoly situations in sports competitions to secure uncertainty in outcomes (Zimbalist, 2002).

In recent decades, the number of studies, examining the uncertainty in sports at the sport level, has been increased. Perhaps the main reason behind the popularity of this topic is the nature of sports competitions. Competitions in sports are usually held in isolated, closed systems; the same rules are followed in the matches and the competitions. Consequently, a large amount of data is created that allows researchers to analyze the statistical patterns in different sports (Aoki et al., 2017).

The studies mostly applied the conceptual framework of luck and skill (Aicinena, 2013; Aoki et al., 2017; Croson et al., 2008; Elias et al., 2012; Getty et al., 2018; Gilbert & Wells, 2019; Loland, 2016; Mauboussin, 2012; McKinnon, 2013; Simon, 2007). Luck is usually defined as the uncertainty of the outcome or the randomness in a game (Elias et al., 2012; Furtado, 2020; Gilbert & Wells, 2019; Pluchino et al., 2018). Based on another approach, luck is the difference between the expected outcome and the actual outcome of a game (Mauboussin, 2012; McKinnon, 2013). The expected outcome is essentially the power ranking of the participants before a season, cup or tournament that can be based on an official (e.g., Elo rating in chess) or an unofficial (e.g., betting odds) ranking. The degree of luck depends on how many times and by how much an underdog team can prevail over its higher-ranked opponent. In a sport where the higher-ranked always wins, the expected and actual output will be the same, there is no luck involved in the sport. The difference between the two expected and actual outcomes will therefore be the unexpected results, in other words, the uncertainty or the randomness (Elias et al., 2012; Taleb, 2007; Tetlock & Gardner, 2015).

Luck, whether it is good or bad, plays a significant role in sport, all sports are a combination of merit and luck. In sports, merit is the dominant principle but sometimes luck also influences the outcome of contests (Loland, 2006; Mauboussin, 2012). The competitive sports contests are basically skill-based; however, the influence of luck should be minimized (Simon, 2007). If luck dominates instead of skill in a sport, the luck distorts and undermines the essence of sport (Simon, 2007).

If the sports are compared based on the degree of luck, the luck, or uncertainty, plays a greater role in team sports – and mainly in ball games due to the complexity and the random effects involved (Loland, 2006, 2016; Sterbenz et al., 2014). Mauboussin (2012) introduced the phenomenon of ‘paradox of skill’ which can be occurred when highly skilled teams meet and the game will be decided by the luck. However, if we compare sports based on luck over several seasons, we can get similar results due to the high level of skill in competitive sports (Csurilla & Sterbenz, 2018; Elias et al., 2012; Mauboussin, 2012).

There is still no clear empirical evidence for the more luck or uncertainty involved in team sports because only a study applied data about the team and individual sports as well. Getty et al. (2018) compared major league sports with the fantasy counterpart, and with the cyclocross. In this case, the team sports were clearly luckier compared to the individual one. Between the team sports, most of the studies found that basketball is the best predictable, there is the least uncertainty involved in the outcome of games (Aoki et al., 2017; Getty et al., 2018; Mauboussin, 2012). Only the findings of Gilbert & Wells (2019) present a different result, they found the most skill-based sport is the American football, the basketball was only the second one. However, compared to other papers, Gilbert & Wells (2019) followed a different methodology. They predicted game level uncertainty that tends to lead the distinct results. Aoki et al. (2017) applied data about team sports in European leagues but also found basketball as the most skill-based sport.

Interestingly, studies that measured luck, mostly predicted the uncertainty in the team, not in individual sports. Only a study focused on the individual sports, predicting the luck-based noise in Olympic sports. (Csurilla et al., 2021) compared 14 sports at the Summer Olympic Games. They found swimming, table tennis, and gymnastics as the three sports with the least luck involved, the shooting, tennis, and modern pentathlon as the most affected by luck in the sample.

At last, a theoretical methodology to compare sports based on skill should be mentioned as well. Mérő (2008) uses the notion of ‘class difference’ as a unit of measurement to investigate the depth of a sport. A ‘class difference’ exists when the stronger player has at least a 75% chance of defeating the other one. The threshold of 75% was benchmarked from chess where this is roughly the difference between the classifications of chess players. The main concern with the method is that it requires huge data sets that do not available in most sports.

## Discussion

In this paper, we attempted to review and synthesize the most essential literature carried out on the topic of uncertainty and sport. As the topic of uncertainty in sport has become the focus of interest for researchers in the last decade, and a review study has been missing so far, our paper fills an important gap in the literature.

Uncertainty is a central element of the sport, especially of the elite sport. The uncertainty in outcome provides the excitement towards the unpredictable or surprising results which make the sport so special and affects the demand for a sport. It could be assumed that the more uncertainty in a sport, the more the demand will be for it. However, the correlation between uncertainty and sport is not linear, uncertainty could have a bad influence on demand for sport in extreme cases. If a sport is completely unpredictable, the outcome will be decided only by luck, the interest would disappear for it. No one would be interested in a sporting event where the efforts of athletes do not affect the results of the competition. Also, from the athlete's point of view, if the outcome of a contest is dependent on their efforts, they would not be motivated to prepare for the competition. As the economic theory claims about noise, which is basically the uncertainty in production, the labor must be protected from the effects caused by noise (Milgrom & Roberts, 2005). In sports, where uncertainty or noise plays a significant role, incentive systems should be designed that encourages the athlete to perform at their best (Sterbenz et al., 2014, 2019). For that purpose, the Tournament Theory could provide a possible solution (Lazear & Rosen, 1981) in which individuals are rewarded by their relative performance instead of absolute.

The lack of uncertainty in outcome would not so harmfully affect the athletes' attitudes towards the preparation to the game in short term, but the consequences would be quite the same as with the full predictability in long term. If an athlete is aware that a better position cannot be achieved despite any efforts, the motivation would also disappear.

The uncertainty plays an important role in the case of spectators as well. The demand for a sporting event depends on several factors, and uncertainty is also an essential one, even if it matters only in the long run. The matchday attendance is influenced by the quality of the game or an overwhelming victory over the away team. From the perspective of demand, the importance of uncertainty in sport does not have a significant impact as researchers assumed before. Maybe the spectators are accustomed to a certain degree of uncertainty, they only realize its importance when there is a noticeable change in it. This finding may give a new impetus to new UOH research which has not paid attention to the change in uncertainty so far.

The whole topic of uncertainty in sport is characterized by contradiction. From the perspective of spectators, an adequate amount of uncertainty is required to maintain an interest in the sport. However, the athletes do not prefer uncertainty which they could not influence. It is up to decision-makers in sport to establish such regulation which they can balance with the uncertainty to maintain the interest of spectators and to encourage athletes for the best performance.

The papers, carried out on the topic of CB, could provide essential information for decision-makers when they have to intervene in the regulation of a competition to maintain interest for it. The CB differs from sport to sport, from season to season; it is a data-intense measure of uncertainty that provides an opportunity to examine interventions in the short term. In contrast, the papers, quantified luck, examined the predictability of sports, the relationship between efforts of athletes, teams and the outcomes of contests. Both could be essential at the reregulation of a sport. The CB solves the spectators needs to break the monopoly of a team and make the sport interesting for them again. With quantifying luck, the needs of athletes could be monitored to maintain the role of skill in a sport. For example, comparing the sports based on the luck could help for the International Olympic Committee to maximize the demand for the events by modifying the existing regulations.

We hope that our paper, with reviewing the existing literature, provided a deeper and better understating of the nature of uncertainty in sport. We presented that uncertainty is an essential part of the sport that is important for all actors (spectators, athletes, decision-makers) from different aspects. Based on our findings, we strongly encourage decision makers in sport to pay more attention to measuring and monitoring uncertainty in sporting contest to maintain the interest toward them.

## **Conclusions**

The topic of uncertainty in sport has a steadily growing literature, however, a review article has been missing so far. We attempted to fill this gap with our paper. We created a framework that enabled us to investigate the uncertainty in sport from three perspectives: the spectator level, the athlete level, and the sport level. The main finding of our paper is that uncertainty has distinct consequences at different levels; therefore, the impact of the uncertainty on the results should be carefully managed.

## **Authors' Contribution**

All authors have equally contributed to this study and should be considered as main authors.

## REFERENCES

- Aicinena, S. (2013). The Impact of Chaos, Complexity, and Luck on Coaching Success. *International Journal of Social Sciences and Education*, 3(3), 551–565.
- Alavy, K., Gaskell, A., Leach, S., & Szymanski, S. (2010). On the Edge of Your Seat: Demand for Football on Television and the Uncertainty of Outcome Hypothesis. *International Journal of Sport Finance*, 5(2), 75–95.
- Aoki, R.Y.S., Assuncao, R.M., & Vaz de Melo, P.O.S. (2017). Luck is Hard to Beat: The Difficulty of Sports Prediction. *Proceedings of the 23rd ACM SIGKDD International Conference on Knowledge Discovery and Data Mining*, 1367–1376. <https://doi.org/10.1145/3097983.3098045>
- Baimbridge, M. (1998). Outcome uncertainty in sporting competition: The Olympic Games 1896–1996. *Applied Economics Letters*, 5(3), 161–164. <https://doi.org/10.1080/758521374>
- Bélyácz, I. (2010). Kockázat vagy bizonytalanság?. Elméletörténeti töredék a régi dilemmáról [Risk or uncertainty?. A fragment of the history of theory on an old dilemma]. *Közgazdasági Szemle (Economic Review - Monthly of the Hungarian Academy of Sciences)*, 57(7), 652–665.
- Borland, J., & Macdonald, R. (2003). Demand for sport. *Oxford Review of Economic Policy*, 19(4), 478–502. <https://doi.org/10.1093/oxrep/19.4.478>
- Budzinski, O., & Pawlowski, T. (2014). The Behavioural Economics of Competitive Balance: Implications for League Policy and Championship Management. *SSRN Electronic Journal*, 19(89), 1–32. <https://doi.org/10.2139/ssrn.2493764>
- Buraimo, B., & Simmons, R. (2008). Do Sports Fans Really Value Uncertainty of Outcome? Evidence from the English Premier League. *International Journal of Sport Finance*, 3(3), 146–155.
- Buraimo, B., & Simmons, R. (2015). Uncertainty of Outcome or Star Quality? Television Audience Demand for English Premier League Football. *International Journal of the Economics of Business*, 22(3), 449–469. <https://doi.org/10.1080/13571516.2015.1010282>
- Croson, R., Fishman, P., & Pope, D. G. (2008). Poker Superstars: Skill or Luck? *CHANCE*, 21(4), 25–28. <https://doi.org/10.1007/s00144-008-0036-0>
- Csurilla, G., Gyimesi, A., Kendelényi-Gulyás, E., & Sterbenz, T. (2019). Nyári Olimpiai Játékokon Szereplő Sportágak Összehasonlítása a 'Zaj' Szerepén Keresztül [Comparison of Summer Olympic Sports through the Role of 'Noise']. *Magyar Sporttudományi Szemle*, 20(5), 3–7.
- Csurilla, G., Gyimesi, A., Kendelényi-Gulyás, E., & Sterbenz, T. (2021). Where is Victory Most Certain? The Level of Luck-based Noise Factor in Summer Olympic Sports. *Acta Oeconomica*, 71(3), 369–386. <https://doi.org/10.1556/032.2021.00018>
- Csurilla, G., & Sterbenz, T. (2018). A bizonytalanság szerepe a sportban [The role of uncertainty in sport]. *Magyar Sporttudományi Szemle*, 19(5), 18–22.
- Elias, G.S., Garfield, R., & Gutschera, K.R. (2012). *Characteristics of games*. MIT Press.
- Fort, R., & Maxcy, J. (2003). "Competitive Balance in Sports Leagues: An Introduction". *Journal of Sports Economics*, 4(2), 154–160. <https://doi.org/10.1177/1527002503004002005>

- Furtado, B.A. (2020). *Contributions of Talent, Perspective, Context and Luck to Success* [Preprint]. <https://arxiv.org/abs/2001.00034>
- Getty, D., Li, H., Yano, M., Gao, C., & Hosoi, A. E. (2018). Luck and the Law: Quantifying Chance in Fantasy Sports and Other Contests. *SIAM Review*, 60(4), 869–887. <https://doi.org/10.1137/16M1102094>
- Gilbert, D.E., & Wells, M.T. (2019). Ludometrics: Luck, and how to measure it. *Journal of Quantitative Analysis in Sports*, 15(3), 225–237. <https://doi.org/10.1515/jqas-2018-0103>
- Gyimesi, A. (2020). League Ranking Mobility Affects Attendance: Evidence From European Soccer Leagues. *Journal of Sports Economics*, 21(8), 808–828. <https://doi.org/10.1177/1527002520944451>
- Humphreys, B. (2002). Alternative Measures of Competitive Balance in Sports Leagues. *Journal of Sports Economics*, 3(2), 133–148.
- Knight, F.H. (1921). *Risk, uncertainty, and profit*. Houghton Mifflin Company.
- Latané, B., Williams, K., & Harkins, S. (1979). Many hands make light the work: The causes and consequences of social loafing. *Journal of Personality and Social Psychology*, 37(6), 822–832. <https://doi.org/10.1037/0022-3514.37.6.822>
- Lazear, E.P. (1986). Salaries and Piece Rates. *The Journal of Business*, 59(3), 405. <https://doi.org/10.1086/296345>
- Lazear, E.P. (1998). *Personnel Economics for Managers*. Wiley. <http://www.loc.gov/catdir/toc/wiley022/97007933.html>
- Lazear, E.P. (2018). Compensation and Incentives in the Workplace. *Journal of Economic Perspectives*, 32(3), 195–214. <https://doi.org/10.1257/jep.32.3.195>
- Lazear, E.P., & Rosen, S. (1981). Rank-Order Tournaments as Optimum Labor Contracts. *Journal of Political Economy*, 89(5), 841–864.
- Loland, S. (2006). Olympic Sport and the Ideal of Sustainable Development. *Journal of the Philosophy of Sport*, 33(2), 144–156. <https://doi.org/10.1080/00948705.2006.9714698>
- Loland, S. (2016). Simon on Luck and Desert in Sport: A Review and Some Comments. *Journal of the Philosophy of Sport*, 43(1), 15–25. <https://doi.org/10.1080/00948705.2015.1119048>
- Mauboussin, M.J. (2012). *The Success Equation: Untangling Skill and Luck in Business, Sports, and Investing*. Harvard Business Review Press.
- McKinnon, R. (2013). Getting Luck Properly Under Control. *Metaphilosophy*, 44(4), 496–511. <https://doi.org/10.1111/meta.12044>
- Mérő L. (2008). *Észjárások—Remix—A racionális gondolkodás ereje és korlátai*. Tericum.
- Milgrom P., & Roberts J. (2005). *Economics, Organization & Management*. Nemzeti Tankönyvkiadó.
- Neale, W.C. (1964). The peculiar economics of professional sports. *The Quarterly Journal of Economics*, 78(1), 1–14. <https://doi.org/10.2307/1880543>
- Paul, J., & Criado, A.R. (2020). The art of writing literature review: What do we know and what do we need to know? *International Business Review*, 29(4), 101717. <https://doi.org/10.1016/j.ibusrev.2020.101717>

- Pérez, L., Puente, V., & Rodríguez, P. (2017). Factors Determining TV Soccer Viewing: Does Uncertainty of Outcome Really Matter? *International Journal of Sport Finance*, 12(2), 124–139.
- Pluchino, A., Biondo, A. E., & Rapisarda, A. (2018). *Exploring the role of talent and luck in getting success*. edsarx.  
<http://search.ebscohost.com/login.aspx?direct=true&db=edsarx&AN=edsarx.1811.05206> <=hu&site=eds-live
- Rottenberg, S. (1956). The baseball players' labor market. *Journal of Political Economy*, 64(3), 242–258.
- Schmidt, M.B., & Berri, D. J. (2001). Competitive Balance and Attendance: The Case of Major League Baseball. *Journal of Sports Economics*, 2(2), 145–167.  
<https://doi.org/10.1177/152700250100200204>
- Simon, R. (2007). Deserving to Be Lucky: Reflections on the Role of Luck and Desert in Sports. *Journal of the Philosophy of Sport*, 34(1), 13–25.  
<https://doi.org/10.1080/00948705.2007.9714706>
- Sterbenz, T., & Gulyás, E. (2016). The Rational Untrained Athlete: An Attempt to Resolve Sport Managerial Dilemmas with the Methods of Game Theory. In A. Gál, J. Kosiewicz, & T. Sterbenz (Eds.), *Sport and social sciences with reflection on practice* (pp. 191–203). University of Physical Education.  
<https://books.google.hu/books?id=iHT6swEACAAJ>
- Sterbenz, T., Gulyás, E., & Kassay, L. (2014). Incentive System in Hungarian High Performance Sport. *Physical Culture and Sport. Studies and Research*, 64(1), 53–63.
- Sterbenz, T., Világi, K., & Csurilla, G. (2019). Sport Analytics as a Tool for Effective Decision-Making. In M. Hughes, I. M. Franks, & H. Dancs (Eds.), *Essentials of Performance Analysis in Sport* (3rd ed., pp. 172–183). Routledge.
- Szymanski, S. (2003). The Economic Design of Sporting Contests. *Journal of Economic Literature*, 41(4), 1137–1187.
- Szymanski, S. (2006). Uncertainty of outcome, competitive balance and the theory of team sports. In W. Andreff & S. Szymanski (Eds.), *Handbook on the economics of sport* (pp. 597–600). Edward Elgar Publishing.  
[https://ideas.repec.org/h/elg/eechap/3274\\_62.html](https://ideas.repec.org/h/elg/eechap/3274_62.html)
- Taleb, N.N. (2007). *Foiled by Randomness: The Hidden Role of Chance in Life and in the Markets* (2nd ed.). Penguin Books.  
<https://search.library.wisc.edu/catalog/999944746002121>
- Tetlock, P.E., & Gardner, D. (2015). *Superforecasting: The art and science of prediction* (1st ed., p. 340). Crown Publishers.
- Vörös, T. (2017). Ösztönző szabályozás a versenyrendszerek kialakításában – A fizetési struktúra hatása a sportteljesítményre [Incentive regulation in competition design – the influence of pay-off structure on sport performance]. In M. Szmodis & G. Szóts (Eds.), *A Sportirányítás gazdasági kérdései – 2017: Vol. Magyar Sporttudományi Füzetek XVI*. (pp. 23–36). Magyar Sporttudományi Társaság.
- Zimbalist, A.S. (2002). Competitive Balance in Sports Leagues: An Introduction. *Journal of Sports Economics*, 3(2), 111–121.