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Sport as a Behavioral Economics Lab

Working Paper No. 2021-20

CREMA Südstrasse 11 CH - 8008 Zürich www.crema-research.ch

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Contribution prepared for the forthcoming book: Hannah J. R. Altman, Morris Altman, and Benno Torgler (Eds.) (2021). *Behavioural Sports Economics*. New York: Routledge

ABSTRACT

Sporting events can be seen as controlled, real-world, miniature laboratory environments, approaching the idea of "holding other things equal" when exploring the implications of decisions, incentives, and constraints in a competitive setting (Goff and Tollison 1990, Torgler 2009). Thus, a growing number of studies have used sports data to study decision making questions that have guided behavioural economics literature. Creative application of sports data can offer insights into behavioural aspects with implications beyond just sports. In this chapter, we will discuss the methodological advantages of seeing sport as a behavioural economics lab, concentrating on the settings, concepts, biases, and challenging areas. Beyond that, we will discuss questions that have not yet been analysed, offering ideas for future studies using sports data. We will further reflect on how AI has evolved; focusing, for example, on chess, which provides insights into the mechanism and machinery of decision-making.

* For helpful comments and suggestions thanks are due to the Jillian Cortese and Alison Macintyre.

Introduction

Sports economics, or the study of sport using economic theory, has been with us for some time and has generated interesting insights into several different topics. Of course, one principle that sits behind all this analysis is the methodology or approach through which we try and apply our thinking to sports data. The behavioural economics revolution of recent years has given economists an additional lens through which they can examine the world around them – this is no different for the analysis of sports data. We have seen an increase in the number of papers that have utilised sports data to gain insight or understanding into individual, group, or other types of behaviour. We have used economics to explore sports data and aspects of the real-world that are often very difficult to access or observe, such as performance and incentives. These aspects are much easier to study in the world of sports, as sport data is all-encompassing and available in almost every type of sport. To discuss how behavioural economics influenced research with sports data, we will first discuss setting conditions that provide insights to the advantage of sports data. Next, we will discuss a set of concepts that have been explored or are worth exploring in more detail. These concepts were chosen ad hoc and therefore are not a complete list of valuable concepts. Moreover, as the list is relatively substantial, we do not provide a full list of available studies, but rather a set of studies that clarify the area of exploration and those where we see further possibilities and avenues. We therefore apologize in advance if some scholars feel that their work should have been mentioned under these concepts. This process was like wandering through a field of gems with only a small bag in which to collect them – you obviously cannot collect them all, nor could you even be sure of total gems available in the field. We cherrypicked the gems that we felt best represented the discussion we were trying to build. We finish the article by discussing some areas that have influenced or were influenced by behavioural economics, focusing specifically on biases and linking behavioural economics with AI, which will become a more dominant area in the future

(Schmidt 2020, Torgler 2020). Looking at chess, for example, provides insights into the mechanism and machinery of decision-making and how such mechanisms can be programmed to derive more realistic cognitive architectures (Torgler 2021a). We will clarify why past insights are valuable from a behavioural economics perspective, and what we can expect in terms of future perspectives.

Settings

In this section we will identify interesting settings that allow us to understand how sports can be seen as a "real-world laboratory" (Goff and Tollison 1990, Torgler 2009, Kahn 2000) where we can test behavioural questions in a relatively controlled high-stakes environment, and where information is transparently available for outsiders to explore (rather than hidden as is often the case in the labour market). However, as controllability is influenced by and subject to various elements and aspects, we try to provide a set of examples.

Rule Changes

With game rule changes, we are approaching conditions of a natural experiment (Chan, Savage, and Torgler 2019); accordingly, scholars have focused on those rule changes since almost the beginning of sports economics. A frequent example that appears in the literature examines how changes in the number of referees (change in enforcement ability) affect players' behaviour in environments such as basketball (McCormick and Tollison 1984), ice hockey (Levitt 2002), or soccer (Witt 2005). There are historically fascinating examples in which randomization of referees was introduced, such as in the 1998-99 National Hockey League (NHL) season when the assignment of one or two referees to a match was done randomly (Levitt 2002). Chan et al. (2019) also explored not just the one rule change, but repeated changes that led to a return to the original condition. This allowed readers to see not just a first adaption process, but also re-

adaption. Rule changes are particularly interesting from a behavioural economics perspective because a key intention of sports rule change is to change the behaviour within the game (Elias and Dunning 1966, Chan et al. 2019). Such changes can affect aspects such as emotionality, predictability, uncertainty, cooperation, or the psychology of an athlete in general. The beauty is not only in the uncertainty created, but also in understanding the implications of observing behaviour in a relatively close micro-environment that has only limited spill-over effects from other areas. Uncertainty in other natural environments beyond sports is usually more complex and less controlled.

Those empirical explorations are important as behavioural economics needs to get the psychology as well as the economics right, and therefore how humans respond to incentive changes and changes in their constraints and opportunities. Thus, linking economics and psychology together in the way behavioural economics can help to gain insights into the mechanisms of behavioural change using data beyond experimentation. If we are keen to understand how a billiard player adapts to changes it is not enough to just assume she/he is familiar with the physics and mathematics of producing perfect shots. We need to understand how those players act, learn, and adapt. Herbert Simon has clearly won that debate against Milton Friedman: training them requires answering "why" questions. Think about heuristics (and potential biases) and decision-making with a mind-set that tries to understand how the actual world of sports works and evolves with all its underlying mechanisms. This means that rule changes can be seen as some sort of a resilience test that helps us to understand those mechanisms better.

Institutional Factors

There are interesting links between the way that institutions are set up and how they influence human behaviour that is often overlooked, which borders on ironic given that most are little

more than social norms that are sufficiently long-lived, becoming an institution by formalising a set of rules to govern how people should act and behave. The process of becoming an institution describes a feedback mechanism between individuals and groups on shared social norms and the mores of acceptable behaviour (Savage 2019). However, it also signifies that it takes a significant length of time and stability for a norm to become institutionalised, implying that they do not change quickly and are likely well out of step with the norms of a quickly evolving society. This is no different for sporting institutions, especially those that have been functional for centuries, as the values and norms of the society that built the institution may have moved on, leaving the institution struggling to remain relevant or effective.

Institutions define incentives and, therefore, behaviours. A good example is a study provided by Duggan and Levitt (2002). The ancient and noble sport of Sumo Wrestling was considered to be above the cheating and corruption that plagued nearly all others. However, the authors revealed that is not the case when looking at how the structure of the competition was examined through a more behavioural lens. The analysis focused on the how the sport's unique competition structure incentivised collusive behaviours between opponents at a kink point in the tournament structure (when moving from seven to eight wins) where the payoff – a promotion of rank – significantly increased for one competitor if they were successful (eight wins). The eighth win has four times the value of a typical win. The analysis showed that on any other bout when there was no such increased incentive to win, the outcomes were within the expected win/loss ratios, but on the rounds where one player would receive the promotion, the probability of their winning escalated dramatically. Effectively they demonstrated that the opposing player was willing to collude by throwing the bout in order to ensure the promotion (moving up a single spot would be worth $3000), but they also found that when these competitors next faced each other the 'favour' was returned as the promoted player would most likely lose the match. Such collusion shows that this cannot be explained purely by an athlete

effort story. Match rigging also increased as the tournament ended. The results show that wrestlers on the bubble on day 15 are victorious 25 percent more often than would be expected. On the other hand, excess winning likelihoods disappeared in tournaments with a high level of media scrutiny. Their findings are interesting for several reasons. It shows that corruption was present in even a sport thought to be above such activities, but more importantly it demonstrated that the incentive structure put in place by the sporting institution had a significant impact on the attitudes and behaviours of players i.e., it inadvertently created a focal point for player collusion at a specific point in every tournament. In addition, their results show that the cost of detection also matters. Increasing media scrutiny can help to reduce collusive behaviour, while an interesting avenue for further investigation would be whether, and to what extent, sports disciplines have barriers to entry in the market that affect corruption or innovation by lacking competitive pressure.

Institutions have been developed to help codify and regulate international sport with the creation of professional associations and presence of referees as the on-field arbiter of the rules. These institutions ensure that the negative aspects of competitive sports, i.e., aggression, conflict, and violence do not degenerate into a free-for-all, and that they mirror the acceptable behaviours we observe within our modern societies (Howell 1975, Cooper 1989, Riordan 1993). In line with this, Caruso et al. (2017) explored the relationship between international football competitions and conflict across several international football tournaments including the FIFA World Cups, Olympic Games, Champions Cups, and Under 20's World Cups between 1994 and 2014 to analyse the impact that national differences (identity) had on match aggression and conflict. They conclude that while the impact of any one referee on enforcing the institution's position is not clear, the analysis of several decades of competitions across numerous international tournaments enabled them to ascertain the true impact of the referees controlling conflict during those matches. Furthermore, they demonstrate that FIFA, the

institution governing football, was able to have a positive impact on behaviour by limiting or directing social violence through the control of referees. By examining aggression and violence through the awarding of red or yellow cards and in-game fouls for minor indiscretions, they demonstrated that match referees had a significant institutional impact on the on-field transgressions that negated the significance of virtually all the national identity variables. This result demonstrates that when an institution's rules and expectations are well aligned and are consistently applied and updated, they can have a significant positive impact on behavioural outcomes. The authors also warn "that if an institutional approach is adopted the evidence suggests that it needs a certain degree of flexibility and prescience, rather than a rule based reactive rigidity" (Caruso et al. 2017, p. 538).

Disruptions

The sports environment, team sports in particular, provides an interesting environment to explore organizational disruptions. In-season changes, such as dismissing head-coaches, offers a natural avenue of investigation, allowing us to understand the implications of major management changes. Such head coach changes are frequent enough to allow detailed exploration. Van Ours and van Tuijl (2016) report mean in-season head-coach changes between 4.2 (Netherlands Eredivisie) and 8.4% (Italy Serie A) for seven European football leagues, covering 14 seasons, starting with the 2000/2001 season. Their results indicate that a replacement improves performance.

Another interesting aspect is understanding what happens if a team recruits a highly talented athlete; a star. Sports allows us to explore and track what happens individually and teamwise over time. It can therefore provide better insights into dynamics that are difficult to observe in the normal labour force. Evidence regarding CEOs indicates that top performers achieve success only for a while, fading out quickly and leading to a sharp decline in teams'

functioning (Groysberg, Nanda and Nohria 2004). Those insights indicate that companies cannot gain from a competitive advantage by hiring stars, considering that they do not stay with organizations for a long time (Groysberg, Nanda and Nohria 2004). Having detailed data on how players interact with each other on the field (e.g., who interacts with whom throughout the game or even during training sessions) allows us to observe and understand better how stars are integrated into the team, how that integration evolves over time, and whether and to what extent an integration is affected by the actual structure of the team itself (e.g., level of heterogeneity across a number of factors such as age, experience, loyalty to the team, salary, etc.). Future studies can also explore in more detail how technological disruptions such as Big Data, AI, or quantum computing affect the game itself (Torgler 2020).

Pressure

Experiments involving pressure and stress have been directly linked to the breakdown in judgment, rational decision making, and the generation of mistakes via an individual's inability to correctly weight options (Wright 1974). This can result in inefficient or poor outcomes as individuals fail to correctly scan alternative options (Keinan 1987). As pressure increases, individuals are less able to make rational choices, resulting in a greater number of irrational choices (Meichenbaum 2007). However, it remains unclear exactly how much additional pressure is required to detrimentally affect decisions (Jamal 1984), and part of this problem derives from differences in the underlying model being used in the stress function. For example, Sullivan and Bhagat (1992) outline four of the most common models, which included: 1) higher levels of performance require at least some moderate level of stress; 2) a positively correlated relationship such that only through high stress could high performance be achieved; 3) a negatively correlated relationship where high stress results in low performance levels; 4) and finally that stress and performance are totally unrelated. Additional issues arise

when non-linear models like an inverted 'U' shape function (Allen et al. 1982, Meglino 1977, Yerkes and Dodson 1908) are adopted over linear ones – where lower levels of stress may actually aid in performance, but once the turning point (threshold) has been reached any additional stress is detrimental to performance (see e.g., Baumeister 1984, Baumeister and Showers 1986).

Sports allow us to pin-point the actual pressure experienced (magnitude and direction of stress) relatively precisely. Savage and Torgler (2012) explored the impact of different stress factors on elite athletes during penalty shoot-outs at the FIFA World Cup and the UEFA Euro Cup competitions between 1978 and 2008. They found that predicable, anticipated, and experienced stress factors (routinely experienced stress determinants), such as crowd size (noise) or game level, have no impact on performance. However, the less anticipated stressors such as final shots to win/lose appeared to have significant impacts on likelihood of success. A large positive difference promotes performance (positive stress) and improves the probability of a successful shot by about 17%, while a negative difference reduces performance (negative stress) and decreases the probability of a successful shot by about 45%. This indicates a substantial and asymmetric effect for top athletes, which means that they also respond differently to detrimental incentive effects (high rewards or the threat of severe failure). Krumer (2020) shows that penalty kicks are not just a "lottery". Exploring the probability of winning a shoot-out by looking at teams from different divisions indicates that higher-ranked soccer teams perform better in penalty kicks.

The penalty kick environment has also been used to understand the effect of a supportive audience on performance. Dohmen (2008) found that players in the German Bundesliga (seasons between 1963 and 2004) were more likely to "choke" when playing in front of their home audience. Thus, empirical evidence using sports data are useful as such data can help to discriminate between theories. For example, in this case one can discriminate

between a social facilitation or social support hypothesis that suggests that performance is boosted by a friendly environment, and a social pressure hypothesis which argues that it can impair performance (Dohmen 2008) via a higher psychological pressure due to higher expectations. As Butler and Baumeister (1998) stress "it may be more painful to have friends and family see one fall flat on one's face. A supportive audience could conceivably increase pressure, concern, and self-consciousness, which in principle could have a detrimental effect on performance" (p. 1213). Applying an experimental approach, they observe that choking under pressure around a supportive audience is found in skill-based tasks but not in easy tasks, despite finding supportive audiences to be more helpful and less stressful. This led the authors to conclude that people were not aware of the debilitating effect of supportive audiences.

Beyond such experiments, sports data provides a controlled setting in the real world to explore whether or not – and in what conditions – choking under pressure matters. Dohmen (2008, p. 652) stresses that penalty kicks are not free of problems. Only a selected group of players is explored; therefore, a selection effect may lead to a lower bound estimate, as those who are better able to cope with stress are more likely to be selected for such penalty kicks. Using penalty kicks in World Cups after a draw would help to reduce such a problem as it may increase the distributions of ability to choke (or not) under pressure (despite some ex-ante training). Dohmen also stresses that for Bundesliga data, the stakes might not be high enough to observe significant choking, which also means that such results would be lower bound estimates (compared to other settings). Using World Cup or UEFA European Cup data would mean exploring players in a higher stress environment:

> On 17 July 1994, at the Los Angeles Rose Bowl, Brazil attempted to secure its fourth Federation Internationale de Football Association (FIFA) World Cup trophy, in probably one of the most memorable shootouts in World Cup history. One of Italy's greatest ever players and a shining light of the tournament, Robert Baggio, took what was to be the final shot of the US World Cup. Baggio placed the ball on the spot, while Taffarel, the Brazilian goal keeper, took his

> position on the line in front of 94 000 spectators. The fascinating aspect of such a 'high pressure' situation is the fact that after 4 years of preparation, several matches before this final, 120 min of game time, and eight prior penalty attempts, one single shot held the match outcome in the balance. If Baggio misses then Italy loses the greatest prize of all in football, namely the World Cup; if he is successful Italy still can retain a glimmer of hope of being world champions. As many readers may know, Baggio's shot not only missed but it soared metres over the crossbar, which meant that Italy lost the tournament and Brazil became the 1994 World Cup champions (Savage and Torgler 2012, pp. 2423-2424).

Beyond soccer, one can explore other environments that require a high level of precision. Harb-Wu and Krumer (2019) looked at professional biathlon athletes, as a biathlete has to perform the exact same non-interactive task of shooting the exact same number of times. As the authors point out, this allows exploration of within-biathlete variation (e.g., with and without being in front of a supportive audience). Moreover, as all biathletes need to perform the precision task, a selection effect as discussed in Dohmen (2008) is less of a problem (although individuals may select themselves into that sports field). Their large data set covers 16 seasons including 144 World Cup events, 12 World Championships and 4 Winter Olympic Games – and the results indicate for both genders that biathletes from the top quartile struggle more in their home turf compared to competitions abroad.

Basketball is another environment that allows exploration of performance under pressure in a more controlled way, especially when looking at free throw percentages as a measure of performance (for a discussion see Cao et al. 2011). Each free throw attempt is taken from the same location, which means that the physical difficulty is constant. In addition, contrary to a penalty kick, the performance is not confounded by a response of another player (e.g., goalkeeper in a penalty kick). Contrary to penalty kicks, free throws occur very frequently and for most players. This makes it possible to explore the heterogeneity in shooting skills and stress resistance and means that results are less driven by a selection effect. Moreover,

psychological factors may still matter because, as Cao et al. (2011) stress, free throws are still a non-trivial task with failure rates for most NBA players. Their results indicate that there is some choking but the effects (e.g., playing at home) are small. However, choking becomes more dominant at the end of the game (decline in success by around four percentage points when the shooter's team is down by one or two points in the final minute). The negative effects increase to 6.3 and 8.8 percentage points for the last 15 seconds when down by two or one points, respectively. The choking effect is also stronger for players who are worse free throw shooters. Toma (2017) followed up on basketball free throws looking at both females and males at the college and professional levels. Interestingly, male college players who eventually play at the professional level choke more in the final seconds of a close game. Toma's argument is that they feel more pressure to perform due to their career expectations. He also finds no evidence of a gender difference in choking behaviour.

Cohen-Zada, Krumer, Rosenboim and Shapir (2017) explored tennis to understand human behaviour under pressure. They looked at the effect of competitive pressure on the likelihood of winning the game, instead focusing on the number of unforced errors or winning shots. The strength of their measure is its objectivity:

> While two observers can debate whether or not a certain shot should be considered as a forced or unforced error, and whether or not the previous shot led to the forced error, in our case winning a game is an undeniable fact" (p. 178).

Interestingly, they find that increasing the level of stakes reduces performance for men. They seemed to choke under competitive pressure, while women choke less. Thus, women show superiority in this setting regarding competitive pressure. They argue that those results are "consistent with evidence in the biological literature that levels of cortisol, which is known to impede the performance of both men and women, commonly escalate more substantially among men than women in response to achievement-related challenges" (p. 188).

Hickman and Metz (2015) take advantage of the ability to look at performance on the last hole of the golf tournament on PGA tours, allowing them to observe a substantial variation in key pressure situations. Obviously, making or missing a putt can have a considerable influence on the finishing position and the monetary reward. Their innovation is to have this direct link to a monetary reward, which is less in the case if you fail in your free throw performance in the NBA. An interesting addition is that they have data on the exact location of players' golf balls before and after each shot (down to an inch). Their results indicate that increasing the value of a putt by around $50,000 decreases the likelihood of a player making the putt by one percentage point. However, that magnitude is greater for specific shots such as those taken from five to 10 feet away. Not surprisingly, less experienced players are more negatively affected by pressure.

One of the major issues limiting the empirical analysis of the stress/performance relationship beyond the sports environment is measurement (measuring an individual's performance and then comparing it to another). Performance is not fully comparable in most workplaces, even between two individuals doing the same job, because regardless of the metric used to measure performance it needs to be analyzed using the same underlying characteristic or the statistical inference erodes (Allison 1999). For example, the environmental conditions, incentive structures, support systems, or any number of other exogenous factors may not be identical for both individuals. Given the broad availability of information on athletes and the relatively controlled conditions under which they compete, the use of the sporting environment has been fruitful. However, the modern era of Big Data may make this an even better experimental laboratory – many players now wear IoT (internet of things) devices during competition that track heart rates, blood pressure, speed, distance, and a range of other geotagged data that could be coupled to the on-field behavior and choices made by players.

This combination of new data could combine biological and physiological aspects with decision sciences (for a discussion, see Torgler 2020).

Beyond Physical: eSports

When it comes to the human body's non-sympathetic responses to stress, our brains cannot tell the difference between reality and imagination. Our bodies release stimulants like adrenalin and cortisol when we are stressed or when we imagine being stressed (Hamilton 2018). This psychological effect also works in a number of other situations, e.g., the placebo. Under the placebo effect we believe we have received a drug that will have a certain effect. Since our mind is unable to distinguish between reality and imagination, it will often supply the required sensation or, where possible, the stimulation to replicate what was expected – such as the diminishing of pain. Studies have also shown that we can imagine our bodies fighting cancer (Eremin et al. 2009) or recovering body function after a stroke (Kho et al. 2014) and our mind rewires itself to make it happen. Many of the aspects of sports explored by behavioural economists in the past have more than likely been confounded with physical aspects or skill of the athletes being studied – one such example is sporting momentum (see e.g., Gauriot and Page 2018, Cohen-Zada, Krumer and Shtudiner 2017). Thus, eSports offers the opportunity to disentangle such mental and physical aspects. Psychological momentum (which will be discussed in more detail later) can work as positive and negative momentum and alters behaviour and performance by the perception of an individual (Iso-Ahola and Dotson 2016). It has been argued that positive psychological momentum improves the individual's confidence, and by extension their competence which allows them to successfully complete the task at hand in a better and faster manner – this then increases the individual's expectations of success on the next task. The problem with this argument is that it is directly related to physical attributes of the individual, i.e., the assumption is that if the individual can complete a task faster (or

better) they were either not exerting maximum effort or were doing so inefficiently. The physicality issue poses a problem when trying to compare momentum between athletes as it is unclear if individuals were actively conserving energy for future effort (or if they were already at maximum effort), and how we can determine the comparative differences in effort and energy between players. Again, we could turn to eSports where physical aspects are less important in comparison to the mental (or psychological) ones – removing one of the confounds and making it clearer to analyse momentum.

Concepts

Prospect Theory

There are many contentious or unclear theoretical concepts that are difficult to empirically prove, and several experiments and behavioural concepts are traditionally explored in laboratory settings that may be better served if we can utilise the quasi-natural field aspect of sports. For example, Prospect Theory has only occasionally been tested in the real world with real-world losses (Page at al. 2014), but it may be much easier to test in an environment with clear incentives, strategic actions, and real-world gains and losses. Prospect Theory relies on a lack of adaption (habituation) of losses in terms of the individuals' (or perhaps the groups') reference point (Kahneman and Tversky 1979). This point is supported anecdotally by gamblers who often "chase their losses" or take on additional risk when they are behind but may also take on more risk due to an endowment (house money) effect where a newly acquired gain has not been habituated and can be gambled without fear of loss (Thaler and Johnson, 1990). However, it may be possible to explore this effect within the sporting context with variations in risk behaviour in game (during) and out of game (after) – where post game we would expect the players to now be in a 'cold' state and able to habituate the losses, but during a game the players in a 'hot state are likely to chase losses (see Loewenstein 2005). There may

also be many potential avenues from which to approach this topic, from both the individual and team levels. Individual sports could be used to provide insight into how players habituate losses during highly incentivised tournament matches and may be compared to choices made during non-competitive or low incentive matches. Alternatively, this could be explored in conjunction with the group assessment of risk (see below) with team sports – where individuals and teams could be examined for changes in risk attitudes (behaviour) during matches. Additionally, it might be possible to explore differences between one-shot, repeated, and knock-out games – to see if strategic elements make a difference in choices being made.

Goal Setting

The concept of goal setting, where a fixed goal provides an aspirational point of reference, is an extension to Prospect Theory, where the reference point moves after gains or losses have been habituated (see Locke 1968, Locke et al. 1990). If the theory holds, then individuals are more likely to work harder to achieve a difficult goal than they would if no goal or an easily achieved one was set. An extension of this theory could be that during sports competitions or tournaments (rather than single matches), losses could inspire players to strive harder or take on more risky options to achieve the stated goal. For example, as the probability of success wanes (decreases) the players may be willing to adopt riskier and riskier gambles in an attempt to overcome the lower probability. This often occurs in tournaments where teams or individuals hold an expectation of where they should finish (regardless of if that is first place, fifth, or merely making it out of the first stages).

Interdependent Preferences

Another theory that has proven difficult to empirically explore has been that of interdependent preferences (Pollak 1976), where the preferences of an individual are co-dependent on the

preferences of others. While this is fundamentally at odds with the rational choice self-interested homo-economicus model of a utility maximiser, behavioural economics has repeatedly shown that individuals regularly deviate from the behaviour expected from this model. However, the sporting environment may provide us with an interesting environment to explore what happens when both self and collective interests are present – such as wanting to maximise their own payoff, but where others are required to reach this goal. For example, player contracts or wages in individual sports are purely dependant on the players own performances and skills. However, in team sports we observe that an individual's ability to excel in their own position is directly dependent on those around them, as such every player's success depends on that of another (Frank 1984). Sports data provides an unusually large amount of interconnected data on performance and earnings that can be exploited to explore how the contract negotiations of similar players are linked to the performance of teammates and other players of similar skills. As such, even superstars with the highest ranking may be concerned about the ranking and incentives of those around them (Postlewaite,1998), and not just their absolute position or earnings. A great example of this relationship could be seen between Michael Jordan arguably the greatest basketball player of all time and his long-time teammate Scottie Pippen:

> He helped me so much in the way I approached the game, in the way I played the game. Whenever they speak Michael Jordan, they should speak Scottie Pippen. Everybody says I won all these championships. But I didn't win without Scottie Pippen. That's why I consider him my greatest teammate of all-time (Michael Jordan, 2020: The Last Dance).

Strategic Interactions

The analysis of sports in the sports economics methodology has been doubly focused on many traditional and mainstream sports but there may be some significant advantages to exploring more strategic games such as chess, go, or poker to analyse strategic and k-level thinking.

Strategic thinking may also open the door to explore free riding, minimax, or maximin as sporting strategies.

(Group) Risk

Early experiments in social psychology (Stoner 1961, Bem et al. 1965) show that groups are more likely to take on more risk than the individuals that make up those groups. Termed as a "risky shift", the analysed groups almost always took on more risk. It may be that individuals feel more comfortable adopting more risk if they can share the responsibility (blame) for a failure amongst the group, but if that responsibility falls on the individual, they are more risk adverse. This may also be related to the concept of "group think" (Janis 1972), where the individual may be more concerned about what others think as opposed to their own self-assessment. Rather than question those in charge or above them on the hierarchical chain, individuals will suppress their own views if they do not align and converge on a risk assessment based on a focal point rather than a distribution of the group (see, e.g., Bénabou 2013). We have observed the disasters that can occur when group think is allowed to flourish in the financial markets. The Global Financial Crisis (GFC) was rooted in the belief that the US housing market could not fail – until it did. This is not the first time the finance industry came close to collapse caused by a group think situation, this problem was described as data-think, where everyone is relying on the same data: the fact that "everyone will be wrong about the same thing at the same time brought hedge fund Long-Term Capital Management close to collapse in 1998" (Hill 2018)[1]. Thus far economics (especially behavioural) has predominately focused on individual decision makers and how risk preference, risk type, risk seeking/aversion has impacted their choices. Obviously, this becomes more complicated if we wish to explore

[1] Hill, A. (2018). Why groupthink never went away. Financial Times, May 7th, 2018. Available from https://www.ft.com/content/297ffe7c-4ee4-11e8-9471-a083af05aea7

group behaviour and attitudes, however, this may be where the sporting arena may be helpful. Goff and Tollison (1990, pp. 6–7) define it thus: "Sports events take place in a controlled environment and generate outcomes that come very close to holding 'other things equal'". Thus, sporting events can be seen as 'quasi-natural field experiments' where subjects are acting in the natural environment instead of an artificial laboratory environment (natural incentives to perform) and players compete in an actual high-stakes contest with real incentives to be successful (Goff and Tollison 1990). In such an environment it may be possible to explore whether group assessments of risk differ from that of the individual. For example, an individual may be personally risk seeking, but they play in a team that has a demonstrably risk averse to attitude.

(Mismatched) Incentives

We know that there have been mismatched incentives in sports due to the winner take all market (Frank and Cook 1995), where a small variation in performance or skill results in very large changes in payoffs. To quote Ricky Bobby[2] "if you're not first, you're last". Effectively summing up the problem: you are either the winner or you are nothing, and in such an environment any advantage can make the difference. This becomes especially apparent in the use of performance enhancing drugs (PED), extreme training regimes, and the adverse health outcomes athletes may be willing to accept (Humphreys and Ruseski 2011). The short-term payoffs for cheating or abusing their health must outweigh any potential long-term damage or health concerns. The question for us to consider: is there a behavioural approach on how we could realign incentives and payoffs? This seems to fit within a temporal discounting problem

[2] Talladega Nights: The Ballad of Ricky Bobby – starring Will Ferrell and Sacha Baron Cohen, directed by Adam McKay is a parody on NASCAR Racing (2006).

as current (or short term) rewards are valued much higher than future (long term) losses, where current consumption (utility) is overweighting the future negatives.

Biases

We will next discuss a set of biases and how sports have helped to explore such biases empirically. The list is far from complete; however, a nice overview of biases in general is provided by Dobelli (2013). Future studies could map them in more detail with available evidence in sports or how those biases can be analysed in detail in the sports setting. We focus on an interesting set that shows the power of sports data in exploring commonly discussed biases in behavioural economics. That also means that we do not intend to provide a detailed literature overview of papers within the area that we are discussing. Such an attempt would go beyond the aim and scope of this book chapter.

Sunk Cost Fallacy or Escalation Effects

One can only assume that sports clubs are subject to sunk cost fallacy when investing in players. This means that they deviate from the classical economics approach, which would assume that club decision makers would only consider incremental costs in their decision making. The empirical design of using sports data has the advantage of holding the industry and competitive conditions constant, and of observing the actual reactions of the decision makers (Pedace and Smith 2013). One of the first studies to explore sunk costs in the sports environment was conducted by Staw and Hoang (1995). They were inspired by experimental studies that explored sunk-costs effects focusing on resource utilization (see Arkes and Blumer 1985). When analysing the psychology of sunk costs, Arkes and Blumer (1985) find strong support that sunk costs are robust judgement errors (e.g., psychological justification of such a maladaptive behaviour is due to the desire to not appear wasteful (p. 125)). The innovation

from Staw and Hoang (1995) was exploring the sunk-cost effect in a natural organizational setting using sports data (NBA data). They focused on the idea that people may perceive an association between draft order and the prospect of future performance (strong expectation of performance that persists long after the decline in court skills):

> In our view, the presence of cognitive bias, commitment, wastefulness, and justification may all be interwoven in natural situations. In the case of the NBA, taking a player high in the draft usually involves some extremely high, often biased, estimates of the person's skills. The draft also involves a very visible public commitment, one that symbolizes the linkage of a team's future with the fortunes of a particular player. Moreover, the selection of a player high in the draft signals to others that a major investment is being made, one that is not to be wasted. If the draft choice fails to perform as expected, team management can expect a barrage of criticism. Having to face hostile sports commentators as well as a doubting public may easily lead to efforts to defend or justify the choice. In the end, team management may convince itself that the highly drafted player just needs additional time to become successful, making increased investments of playing time to avoid wasting the draft choice (p. 492).

The argument is that once the actual performance data in the NBA are available such a signal should not provide any further information about a player's ability (Borland, Lee, and Macdonald 2011). Focusing on playing time, survival in the league, and the likelihood of being traded, they found evidence for such a sunk-cost effect. For those better drafted players, they observed more playing time, a longer NBA career, and a lower probability to be traded (controlling for other important predictors such as performance, injury, or trade status). Camerer and Weber (1999) extended on that study by collecting a new sample and testing alternative rational explanations. They found an effect which was around half as strong in magnitude and statistical strength but that supported Staw and Hoang (1995)'s basic conclusions while improving the methodological approach via accounting for alternative explanations. Such results are additionally supported by Coates and Oguntimein (2010) and

Groothuis and Hill (2004), who found that the draft number affects NBA career duration even after controlling for performance measures. Leeds, Leeds, and Motomura (2015) further extend on those studies by focusing on the transition between states (lottery versus nonlottery or first versus second round picks) and allowing them to apply a regression discontinuity approach in the hope of handling omitted variable biases or causality issues. Their regression discontinuity results indicate that a lottery pick or first-round draft choices receive no more playing time for their draft status (over those drafted later).

On the other hand, further evidence for a sunk costs effect has been found when looking at Major League Baseball managers (Predace and Smith 2013) and the Australian Football League (AFL) (Borland et al. 2011), although the AFL study only found limited evidence that was largely concentrated around players' initial seasons at a club. Predace and Smith (2013) were motivated to understand whether new manager retention decisions were affected by whether or not the poor choice was made by a previous manager. Their results indeed indicate that poor performing players were significantly more likely to be divested by new managers than they were by continuing managers. Keefer (2015) criticized previous studies by stressing that players' draft numbers are a measure of expected productivity. Keefer (2017) also criticizes that the first-round players are not always the first player chosen by their team. Keefer (2017) uses the NFL draft as a natural experiment, using fuzzy RD as first round players selected near the round cut-off receive a very large wage premium (first round wage premium of around 36 to 38%). Players selected near the round cut-offs are therefore essentially randomized and can be used to identify a sunk cost effect via the effect of compensation on, for example, the number of games started. One may also argue the superstars are easier to see as their overall level of skill stands out, but as you proceed back into the general draft pool athletes become more clustered and the skill levels between players becomes smaller which means that it becomes much more difficult to observe skill differences. At this point the

decision becomes much more random – this may not actually be a reflection of players' actual overall potential but just on what is observably different at this early point in their career. The results indicate sunk cost effect (a 10% increase in compensation was linked with 2.7 additional games started). However, Keefer (2015) criticized that such a result may just represent heuristic thinking and therefore the question emerges whether or not the sunk-cost fallacy persists when teams receive performance feedback. He therefore explored the exogeneous variation in compensation when players become eligible for free agency or change teams. Here, he also finds a substantial sunk cost effect.

It is interesting to look beyond these results to other sports fields, such as soccer. Soccer is fascinating, due to having fewer restrictions in maintaining a competitive balance between teams in the form of salary caps or a draft system. However, using German Bundesliga data, Hackinger (2019) finds that playing time is mainly driven by previous or predicted performance, which means that coaches and managers ignore high transfer fees in that decision process. Alternatively, the Oakland Athletics (A's) baseball club fiscal and statistical strategy was made famous by the 2011 movie Moneyball starring Brad Pitt as club manager Billie Beane (see also Lewis 2004). The A's have built a highly competitive and successful team, able to compete with baseball heavyweights like the New York Yankees or the Boston Red Sox by going against the mainstream by embracing sunk cost thinking. In recent years they have been trading away 'superstars' to build a better team – in a statement to the Wall Street Journal[3] Oakland GM David Forst said:

> We've always had to operate a little differently than everybody else. We're never afraid to be wrong, and if that involves trading away good players, then we're OK with that, because, ultimately, we have a lot of conviction in the players we're getting in our half of the deal.

[3] Story sourced from the Wall Street Journal at https://www.wsj.com/articles/the-moneyball-as-find-a-new-inefficiency-other-teams-players-11566322019.

Action Bias

Behavioural economics has challenged the classical assumption that how an outcome comes about should not matter. We often feel the emotion of regret when looking back on what turned out to be bad decisions. There is substantial available evidence that indicates people regret actions more if the outcome is reached by action rather than inaction (for an overview see Zeelenberg et al. 2002). But Zeelenberg et al. (2002, p. 314) also stress the importance of accounting for decisions made in response to things that happened earlier. This means that if the prior outcomes were negative, you are more likely to be inclined to improve future outcomes and therefore regret inactions more. Using scenarios from the sports domain (soccer coach decisions), they confront subjects in an experiment with a situation in which soccer coaches either won or lost a match prior to the current one. Their findings indicate that previous negative outcomes provide a reason to act and that decisions not to act, which are followed by a negative outcome, trigger regret. Thus, when a prior game was lost, a coach who acted would feel less regret than one who did not act. At least the active coach tried to prevent (further) losses.

In general, experiments are useful in that context as you can explore what happens if two individuals arrive at the same negative outcome with and without acting. Such laboratory experiments can be extended by applying physiological measures such as heart rate variability monitors, that have been used as physiological markers of emotions (see, Dulleck et al. 2011, 2014, 2016, Torgler 2019, Macintyre et al. 2021). Sports data is also useful as it allows going beyond using hypothetical questions which was the core methodological approach to explore action biases (Bar-Eli et al. 2007). Bar-Eli et al. (2007) therefore looked at elite goalkeepers during penalty kicks to explore whether an action bias existed in the real-world. Goalkeepers are experienced in their decision-making domain and highly motivated to perform well. Penalty kicks are also interesting in that context; due to the almost simultaneous-move game

characteristic, goalkeepers cannot de facto afford to wait to see how the player kicks the penalty (Bar-Eli et al. 2007). The authors stress that the norm for goalkeepers in penalty kicks is to act, which means jumping to the right or the left. Data from 286 penalty kicks shows that goalkeepers chose to jump to their right or left in 93.7% of cases, while the utility-maximising behaviour would have been to stay in the goal's centre if the decision were based on the probability of stopping the ball. The authors show that if a goalkeeper behaves according to the probability matching principle, they should stay in the centre for around 28.7% of the kicks but they only choose to stay in 6.3% of the time (see Figure 1). They therefore conclude that action bias could explain such a behaviour: "[I]f the goalkeeper stays in the centre and a goal is scored, it looks as if he did not do anything to stop the ball" (p. 614).

Figure 1: Penalty Jump and Kick Direction and Stopping Based on Bar-Eli et al. 2007

		Jump direction			
		Left	Centre	Right	Total
Kick direction	Left	18.90% 29.6%	0.30% 0.0%	12.90% 0.0%	32.20% 17.4%
	Centre	14.30% 9.8%	**3.50%** **60%**	10.80% 3.2%	**28.70%** **13.4%**
	Right	16.10% 0.0%	2.40% 0.0%	20.60% 25.4%	39.20% 13.4%
	Total	49.30% 14.2%	**6.30%** **33.3%**	44.40% 12.6%	39.20% 14.7%

Source: Bar-Eli et al. 2007, pp. 612-613. Notes: The chances of stopping a penalty (number of balls stopped/total number of jumps to that direction) are in green, jump direction is in black.

Future studies could explore whether the level of action bias is influenced by specific contextual factors (e.g., importance of the game) or individual characteristics (e.g., experience, gender, age, etc.). Bar-Eli et al. (2007) also notes issues around the dynamics: "If goalkeepers will always choose to stay in the center, however, kickers will start aiming all balls to the sides, and it will no longer be optimal for the goalkeeper to stay in the center" (p. 616). This may also

be linked to the general question whether biases attenuate, fully disappear, or even reverse once they are reported to a broader audience (see, e.g., Schwert 2003).

Outcome Bias

A commonly discussed bias in behavioural economics is outcome bias, which means that we evaluate decisions based on the results rather than the actual decision process itself. Sports are an interesting setting to explore outcome biases because of the importance of performance appraisal. Sports data allows going beyond the lab, which has been the dominant method to explore outcome biases and performance appraisal. Kausel et al. (2019) focused on penalty shoot-outs as the outcome of a penalty shoot-out (who wins or loses), which seemed to be unrelated to actual in-game performance beforehand (performance at the individual player level as well as the team level). The ability to work with these data is a significant improvement over working with field data, as in the latter we are faced with the problem that actual performance is correlated with outcomes, which makes it hard to explore an outcome bias. Such independence between performance and outcome can then be linked to football players' subjective performance ratings. Kausel et al. (2019) therefore tested whether players on the winning team received better ratings than those on a losing team. Their data (which were derived from major soccer tournaments such as FIFA World Cup, UEF European Championship, and UEFA Champions League) indicate that winning the penalty had a positive effect on reporters' performance ratings, even after excluding players who participated in the penalty shoot-out. Beyond that, they found such an effect remains when using fixed effects (within-players' design).

Expert and Judge's Biases

Merkel et al. (2021) explored performance appraisal by looking for signs of optimism and/or positivity bias in rating semi-annual performance appraisals in the youth academy of a German Bundesliga. The interesting thing is that this allowed exploration of three types of evaluations: a rating of predicted future performance, a rating of remembered performance during the last half-year, and record of instantly reported ratings of the actual performance in individual matches. Those ratings are important as they affect athletes' possibility to progress to the next age group. Their results indicate that predicted and remembered performance ratings significantly exceeded actual ratings. Such a deviation is more pronounced for the predicted performance, which indicates some asymmetry between looking forward and backward. Such biases may be unintentional, while other biases can be more intentional.

Nationalistic biases have offered an interesting avenue for past explorations. In general, events such as the Olympics provide a rich data source to explore such biases; as various fields such as ski jumping, figure skating, diving, etc. rely on judges' scores. As Zitzewitz (2006, p. 68) points out:

> [I]n most settings, attempts to study favoritism empirically would be frustrated by the difficulty of observing where one should expect favoritism (e.g., who is "friends" with whom).

The sports environment, on the other hand, allows us to explore whether judges are nationalistically biased. Beyond that, Zitzewitz (2006) explored whether such a bias varies with strategic considerations, which would indicate *intentionality*. The sports setting also provides the opportunity to explore incentives based on different institutional conditions. Zitzewitz (2006, p. 69) discusses the differences between ski jumping and figure skating. In ski jumping, judges are chosen by the Federation International du Ski (FIS), while national federations choose the judges to be represented at Olympics in figure skating. Zitzewitz (2006) even observes that in figure skating, bloc judging or vote trading is found. One would therefore expect more nationalistic biases in figure skating. In addition, as FIS selects judges based on

pre-Olympic events, one may expect to observe more nationalistic biases in the Olympics compared to the pre-Olympic events (which he finds to be true). In general, Zitzewitz (2006) finds a relatively large effect. For example, a nationalistic bias in figure skating translates to an average of 0.7 higher ranking position placement. He stresses that some of his findings make it difficult to rationalize with tastes (e.g., for a particular national style of skating) or unconscious biases:

> Examples include the fact that the national identity and past judging bias record of the other panel members appears to affect scores or the fact that biases vary in a way that accords with judges' career concerns (p. 70).

Emerson, Seltzer and Lin (2009) looked at diving competitions from the 2000 Summer Olympic Games to see whether judges have preferences for individual divers due to, for example, style. They stress that a residual from their model represents the difference between judges' scores and the predicted score of judges for a diver given the nationalities of the judge and the diver. They conduct an analysis of variance predicting the residuals using individual divers as explanatory factor, which means that the coefficient would indicate a judge's preference for individual divers due to unobserved reasons after controlling for nationalistic preferences (p. 130). Their results indicate that only one judge reported differences that are of statistical significance. Overall, they observe strong evidence of nationalistic favouritism.

Further studies judges' or referees' biases looked at gymnastic judges (Flessas et al. 2015, Heiniger and Mercier 2019), combat sports (Myers et al. 2006), soccer (Torgler 2004, Pope and Pope 2015). Ansorge and Scheer (1988) looked at gymnastic competition at the 1984 Olympic Games and found judges not only overscore gymnasts from their own countries, but also underscore gymnasts from countries who are in close competition with their own country. Campbell and Galbraith (1996) find some evidence that the bias against Olympic figure-skaters is stronger for medal contenders than for competitors who are less strong.

Zitzewitz (2014) also explored the interesting policy adjustment of reducing transparency among the International Skating Union (ISU) via no longer reporting which judge gave which score after the vote trading scandals in the 1998 and 2002 Olympics. ISU hoped to reduce outside pressure on judges in order to reduce favouritism and corruption, but Zitzewitz (2014) was able to show that nationalistic bias and vote trading actually increased slightly without being statistically significant after the reforms. He points out that "[i]f nationalistic bias has increased in importance relative to vote trading, we might expect to see a single positive outlier score when a compatriot is on the panel" (p. 23).

The literature on referees' home court biases is closely connected to this literature, particularly in the area of soccer. The paper by Garicano, Palacios-Huerta, and Prendergast (2005) on extra allowance time when the home team is behind by one goal (compared to when being ahead by one goal) influenced many studies. Dohmen and Sauermann (2016) provide an excellent overview of that area of research. When looking at extra time they conclude that there is evidence for systematic referee bias in the second half of the game. The effect is strongest when the home team is one goal behind before the stoppage time begins. In addition, the bias is larger in Spain compared to Germany, possibly due to the higher travel distance (longer than 700 kilometres, compared to 400 in Germany). Dohmen and Sauermann (2016) also review other decisions such as awarding goals or penalty kicks, as they have a more immediate impact on the outcome of a game. The overview indicates that home-biases are visible for penalty kicks. Home teams benefit from a larger fraction of awarded penalty kicks that are wrongly given or disputable when being behind by one goal (see Dohmen 2008b). Similarly, various studies (but not all) found a bias regarding the award of yellow and red cards, controlling for players' behaviour, noting that bias is triggered by the crowd density (Dohmen and Sauermann 2016). Overall, Dohmen and Sauermann (2016) summarize the biases into two categories: those driven by social and those by material payoffs. Social payoffs are linked to the size and

composition of the supporting crowd, or distance to the crowd. However, they stress that social forces can be partly offset by material payoffs, such as increasing the referees' wages or by better monitoring their decisions.

The question of what happens with referee bias once the stadium is empty is an interesting avenue to consider. After a serious act of hooligan violence between supporters from Calcio Catania and Palermo Calcio in 2007, the Italian government forced teams to play their home games without spectators if they had stadiums with deficient safety standards. Pettersson-Lidbom and Priks (2010) took advantage of the situation to study the difference in an empty stadium. Using data from Serie A and Serie B for the season 2006/2007 up to the point when all teams (apart from Catania) played in front of spectators again (842 games), they find that referees significantly change their behaviour in games played without spectators. Home teams are punished less harshly than the away teams with spectators, but more harshly without spectators. Similarly, Bryson et al. (2021) take advantage of the COVID-19 pandemic as a natural experiment which induced a near-complete absence of fans in sporting arenas. Using a large data set from 6481 football games and 17 leagues played before and after the mid-season shutdown, they find that the absence of crowds reduces home advantages. Significantly fewer yellow cards were awarded to the away team without a crowd, narrowing down the gap between the home and away teams by around a third.

Hot Hand Fallacy and Momentum Effect

A natural avenue in the history of behavioural economics was the exploration of whether we see patterns where there is actual randomness. Our brains are usually well-equipped to see patterns, as such a skill increases survival chances. However, one cannot exclude the possibility that we are subject to cognitive illusions. In one of the most famous sports papers, Gilovich, Vallone, and Tversky (1985) investigated whether or not there is a hot hand in basketball by

looking at the Philadelphia 76ers in the 1980-81 season, as a large number of individuals (including sports experts) believe that a player has a better chance of making a successful shot after having made the last two or three. The innovative approach looked at conditional probabilities for nine players (shooting percentage of having missed or hit the last shot, last two, and last three). Their study could not find a hot hand. In fact, eight of the nine players' probability of a hit was actually lower following a hit than a miss.

That result inspired a very large set of different studies, which are too numerous to properly discuss. One goal of the studies was to achieve more controllability. The problem is that the game itself is subject to a rich context where other effects may take place. For example, a "hot shooter" may believe they are on fire and may therefore take more difficult shots, which may reduce the success rate. Or the opposing team may start guarding a "hot shooter" more closely, reducing future success rates (Koehler and Conley 2003). Consequently, studies focused on measuring and analysing free throw successes. However, this focus is not free of problems. First, there is a high probability of success in free throws (around 75%) and this brings the problem of potential time lags (Koehler and Conley 2003). New free throw opportunities are often too far apart. Thus, researchers started looking at long distance shootout contests such as the annual NBA competition where eight of the best 3-point shooters compete against each other, taking five uncontested shots for five pre-determined sports around the 3-point arc, allowing for sixty seconds to finalize all the shots. A hot hand hypothesis would suggest that a shooter would have fewer runs (e.g., HHHHH (one run) versus HMHMH (five runs) but that does not seem to be the case (Koehler and Conley 2003). When comparing expected and actual runs, Koehler and Conley (2003) indicate a lack of a hot hand effect on NBA Long Distance Shootouts. However, Burns (2004) emphasizes that the hot hand phenomenon has two separate components: the hot hand belief regarding dependence and a hot

hand behaviour following streaks. In other words, invalidating a belief does not necessarily invalidate the behaviour that is based on that belief (p. 300):

> There is no doubt that the beliefs people hold play an important role in their decision making and thus identifying those beliefs is useful. However, unless one thinks it is better to score less in basketball than would be possible if a simple cue was given some weight, then it appears that a research focus on belief without regard to behavior has led to the mis-analysis of an important decision-making phenomenon(p. 327).

Stressing the advantage of analysing reason in Gigerenzer's (2000) framework of adaptiveness, Burns (2004) uses simulations to show that streaks are valid allocation cues for deciding who should be given a shot, allowing the team to score more.

Studies around the hot hand fallacy or a momentum effect have explored beyond basketball (namely in baseball, tennis, golf (including golf putting), soccer, volleyball, darts, tenpin bowling, or horseshoe tossing), but a key problem remains that such studies fail to understand the actual cognitive processes around it in more detail (Alter and Oppenheimer 2006). Focusing on neuroscientific insights or identifying settings are interesting avenues that have a biological background. Burns (2004), for example, cites neuroscientific evidence that:

> demonstrated that different areas of the brain are more activated by streaks than by nonstreaks. Not only do specific areas of the brain react to streaks, but the strength of the signal is related to the length of the streak. If the brain is wired to notice streaks, then it is unsurprising if it is also found that people utilize streaks in making choices. Furthermore it also implies that doing so is probably useful in some way (p. 299).

Page and Coates (2017) used professional tennis matches to understand the importance of a winner effect that could be driven by testosterone changes, arguing that the winner effect might be mediated by a physiological feedback loop: "winning leads to higher levels of, or increased sensitivity to, testosterone, which in turn raises the likelihood of further victories" (p. 531). However, testosterone should not drive the results for female tennis players (females have 10

to 20 percent of the testosterone levels of males, Coates 2012). Their results indeed indicate sex differences. Men who won a closely fought tie-break had around 60% chance of winning the following set, while this winner effect did not exist among women. The importance of focusing on the biology has been advocated by Coates (2012), looking in detail at traders. He stresses that:

> economics needs to put the body back into the economy. Rather than assuming rationality and an efficient market – the unfortunate upshot of which has been a trading community gone feral – we should study the behavior of actual traders and investors, much as the behavioural economists do, only we should include in that study the influence of their biology (p. 36).

In general, behavioural economics has failed to fully explore the possibilities of biology (Torgler 2016). Several recent contributions have shown that we can learn a lot studying humans from an evolutionary perspective (see, e.g., Wilson 2019). Surprisingly, several behavioural economists have been very critical regarding evolutionary psychology. Thaler (2015), for example, stresses in his book *Misbehaving* that "accepting the theory of evolution as true does not mean that it needs to feature prominently in an economic analysis. We know people are loss averse; we don't need to know whether it has an evolutionary explanation" (p. 261). Tversky is also said to have pointed out: "Listen to evolutionary psychologists long enough and you'll stop believing in evolution" (Lewis 2017, p. 336). This somehow goes back to the academic fight or intellectual battle between Gigerenzer and Tversky and Kahneman (see in detail Lewis 2017). Gigerenzer emphasized the importance of adaptive theories and the relation between the mind and the environment rather than the mind alone (for a discussion see also Torgler 2021b). In his *Psychology Review* article Gigerenzer (1996) stressed that "the issue is not whether or not, or how often, cognitive illusions disappear. For him, the focus should be rather the construction of detailed models of cognitive processes that explain when and why they disappear" (p. 592). Gigerenzer (2004) also recollects the following discussions with Herb Simon:

> Herb applauded the demonstrations of systematic deviations from expected utility by Kahneman, Tversky, and others. But what did he think when the followers of Kahneman and Tversky labeled these demonstrations the study of ''bounded rationality?'' I asked him once, and his response was ''That's rhetoric. But Kahneman and Tversky have decisively disproved economists' rationality model.'' Herb was surprised to hear that I held their notion of cognitive illusions and biases to be inconsistent with his concept of bounded rationality. I think he liked their results so much that he tended to overlook that these experimenters accepted as normative the very optimization theories that Herb so fought against, at least when the results were interpreted as cognitive illusions. A true theory of bounded rationality does not rely on optimization theories, neither as descriptions nor as norms of behavior… A systematic deviation from an ''insane'' standard should not automatically be called a judgmental error, should it? ''I hadn't thought about it in this way,'' Herb replied (pp. 396-397).

(Limited) Attention or Hyper Attention

Players and fans alike are always looking for a win, and anything that might help that outcome is warmly embraced, however, anything that 'might' impinge upon success quickly becomes anathema, even if it is completely illogical. For example, the colour green is seen as a major problem for equestrian riders and NASCAR drivers – even a hint of green being worn in the audience spells bad luck for a horse and its rider[4], because green was linked back to major NASCAR accidents in the 1920's[5]. While some of the superstitions held by players when it comes to certain colours may seem odd, there is a good amount of research to back some of it up. While it sounds like a myth, being in the red corner for Olympic combat sports such as boxing, taekwondo, Greco–Roman wrestling, and freestyle wrestling, does statistically improve the chances of winning (Hill and Barton 2005). This colour effect has been shown to

[4] Sourced from Eclipse magazine https://eclipsemagazine.co.uk/5-horse-racing-superstitions-explained/
[5] Sourced from https://jalopnik.com/how-the-color-green-became-a-deadly-bad-luck-superstiti-1763008917

carry over to eSports with 'death matches' in 2004's First-Person Shooter (FPS) game Unreal Tournament. Ilie et al. (2008) found that over a 3-month period (1347 observations) the red teams won 54.9% of the matches – even though players were anonymous, and the player avatars were visually identical except for the team colours. Piatti et al. (2012) undertook an analysis of the red effect on professional Rugby League (Australia) teams over 30 years (1979-2008), which covered 5604 individual matches. They found that wearing some amount of red resulted in teams winning more often than teams without any red in their jersey stripes – specifically, that by shifting from no-red to a little increased the probability of winning by 4.3 percentage points and by shifting from a little red to red being a major colour in the strip increased the probability of winning by 7.5 percentage points. While the effect has been shown to be present across several sports, the underlying cause of the effect is still not clear, i.e., is it as simple as just the increased visibility of the colour, or is it biologically encoded in our DNA from a millennium of evolution? It would be interesting to extend this research to understand the role colour in all aspects sport.

One of the oldest sports training tips across the world is probably "keep your eyes on the ball," it does not matter which sport was being talked about – but one would assume it is relevant for non-ball sports as well i.e., watch the puck (clay pigeon), focus on the target (bullseye), etc. But what happens when athletes become stressed and take that maxim to extremes? As discussed above, high levels of stress and pressure can lead to individuals making sub-optimal decisions – one of the reasons for this is hyper-vigilance (Schultz 1966, Janis and Mann 1977). Essentially, this is when athletes begin to second-guess their choices and switch from the usual automatic and instinctual behavioural responses into a more laborious and time-consuming step-by-step thought process (Beilock and Carr 2001, Bourne and Yaroush 2003, Lehner et al. 1997). The hyper attention focus on every detail, rather than natural processes, results in slowed reaction times and degraded performance, reverting to maladaptive

overthinking (Epstein and Katz 1992) or obsessive focus on singular aspects or tasks to the neglect of all else. This can lead to an inability to respond to or quickly react to changes outside the focal point – a possible example of this is Biaggio's 1994 FIFA World Cup finals penalty shot miss, where he was so focused on correctly striking the ball, he may have not given enough attention to aiming where he was kicking the ball (which went flying well above the cross bar).

Challenging Topics: Some Examples

In this section, we will discuss how sports data can provide a tool for the exploration of challenging topics, particularly if we try to go outside the laboratory or observe human behaviour in the labour force. We will briefly discuss three examples.

Cooperation

Team sports data allow us to explore in detail how players cooperate and interact, as one is able to see how athletes interact together and under what circumstances (e.g., decisiveness of the game situation). While the cooperation literature is quite extensive (for an overview, see, e.g., Christakis 2019), the dynamics of cooperation are still not well enough understood beyond a lab or simulation setting. In repeated interactions, a higher payoff can be achieved through conditional cooperation or reciprocity. In other words, following rules of good behaviour can be a good strategy. Game theorists have explored this question in detail. Through repeated interaction, you can achieve peaceful cooperation; for example, as exemplified by the Folk theorem. Future expected punishment can enforce cooperation, despite a strong short-term conflicting interest (incentive to cheat). In other words, "prospect of vengeful retaliation paves the way for amicable cooperation" (Nowak and Highfield 2011, p. 29). Various punishment strategies can then be discussed, as by Axelrod (1984), via a tournament or competition that resulted in identifying the winning strategy. Tit-for-tat, developed by Anatol Rapoport,

performed best in this setting. Nowak and Highfield (2011) report fascinating simulations conducted by Martin Nowak. His innovation was introducing chance (cooperation with a certain probability). The most powerful strategy in the dynamic interplay of cooperation and selfishness in a world that started with primordial chaos (random strategy) was a generous tit-for-tat strategy. Always meet cooperation with cooperation; but when faced with defection, cooperate for one in every three encounters. In other words, the recipe for forgiveness was probabilistic. In another simulation the winning strategy was: "If we have both cooperated in the last round, then I will cooperate once again. If we have both defected, then I will cooperate (with a certain probability). If you have cooperated and I defected, then I will defect again. If you have defected and I have cooperated, then I will defect" (p. 43).

We argue that the sports environment can also provide an interesting environment in which to understand cooperation and free-riding behaviour. Accordingly, we discuss an interesting study by Brouwer and Potters (2019) that focused on cyclists' breakaways. During such a breakaway, riders are required to cooperate if they are keen to build a lead over the chasing peloton that has more manpower. But there is a social dilemma in this situation. As air resistance can fatigue a rider, anyone in this newly formed "team" may try to minimize being in the leading position to have more energy for a final sprint (effort saving strategy). A rotation formation would be a highly cooperative formation to deal with free-riding incentives. Free-riding would mean refusing to lead the group, or underperforming by exerting less effort when at the front[6]. Such shirking is, as Brouwer and Potters (2019) found, harder to detect. The authors find a positive effect of group size and group strength on breakaway success, but the effect is concave (reaching the optimal level at 26 riders, meaning that adding another rider

[6] There is also the strategic issue where rider from leading teams try to join breakaways with the intention of slowing the overall pace to allow the peloton to catch up within a certain distance to the finish or to burn out the breakaway. Alternatively, they may also seek to ensure the peloton does success if the breakaway does not contain any GC contenders.

reduces the chances of success). In those situations where the benefits of free-riding are smaller, such as during mountain stages, breakaways are more likely to be successful.

Furthermore, we have previously stressed that interactions can be clearly measured in the sports context. This means we can explore how individual characteristics (e.g., dominance, beauty, experience, being new in a team, etc.) are connected to collaboration.

Emotions

Understanding emotions is important for behavioural economics as it contributes to a better understanding of human nature. As Simon (1983) emphasized, a general theory of thinking and problem solving requires incorporating the influence of emotion. We have substantial evidence in cognitive psychology or neuroscience that emotions influence memory, judgment, or decision-making. They have important functionalities that helped humans survive in meeting threats, challenges, and opportunities. They provide guidance in providing rapid and reliable information, acting as communication mechanisms in our social interactions and therefore acting as coordination tool (Keltner and Lerner 2010). Elster (1998) classified emotions into social emotions (e.g., anger, hatred, guilt, shame, pride, admiration, or like), counterfactual emotions (unrealized possibilities such as regret, rejoicing, disappointment, or elation), anticipatory emotions (e.g., fear or hope), realized emotions (e.g., grief or joy), and material emotions (e.g., envy, malice, indignation, or jealousy). Material emotions are a particularly interesting area when exploring emotions with sports data. There is substantial evidence that your relative income situation is connected to positional concerns and can affect your happiness or wellbeing or can trigger envy and jealousy (for a discussion, see Frey et al. 2013). One empirical challenge is identifying the proper reference group, another is the ease with which one can explore behavioural responses in the work environment due to positional concerns. The sports environment provides a unique opportunity to explore whether an increase in

income differences, which is transparently available for some disciplines such as basketball, leads to a performance increase or decrease in a competitive environment that often encourages social comparisons (Frey et al. 2013). Looking at basketball (NBA) and soccer (German Bundesliga) Frey et al. (2013) find support that relative income disadvantage is correlated with a decrease in individual performance. Such results are interesting from a policy perspective if those consequences are also found in other work environments (e.g., how to design pay-for-performance mechanisms to encourage performance and cooperation within teams). Schaffner and Torgler (2008) show that closeness affects positional concerns when comparing different reference groups using NBA data. The strongest effects of positional concerns on performance are found among players with similar work profiles (playing the same position and being a teammate) compared to other characteristics such geographical closeness, age, and experience closeness.

Social capital

Social capital has widely explored how social capital creates human capital (Coleman 1998, Paldam 2000), lubricates economic exchange (Putnam, 1983), builds networks, and creates trust (Coleman 1988, Fukuyama 2003, Portes, 1998, Woolcock and Narayan 2000). While sport has been examined through the lens of social capital theory, for the most part it has been outward looking. Specifically, researchers have explored how sport is used to engage with society to better the lives of players or the community, e.g., community development (Skinner et al. 2008, Walseth 2007), health and wellbeing (Kawachi, et al. 2008, Kim et al. 2020), participation rates (Kumar et al. 2018), or volunteerism (Darcy et al. 2014, Kay and Bradbury 2009). However, there seems to be very little research that looks inward to the effect of social capital on the way that players interact with each other or use their social capital to be more successful. Even though little research has looked internally, discussions have pointed to areas

that would be of great interest, for example, if social capital leads to more efficient transactions through access to more information, it should result in coordinated activities for mutual benefit and a reduction in the likelihood of opportunistic behaviour (Dasgupta 1999). The question remains if this would be relevant in competitive interactions as well as those of mutual benefit?

Social capital theory has been explored in many real-world environments but is always difficult to truly capture what is occurring, due to the amount of noise and other observable events. However, it may be possible to explore such theories in sport, specifically in strategic games where we could observe changes in player behaviour based on increased levels of social capital. The additional advantage here is that the sporting environment enables all other factors to be held constant. Poker tournaments is one sport in which we could observe players' strategies and styles as they play against differing opponents where they have greater or fewer interactions over time (interaction being a proxy for social capital, or at least social experience). Some of this could be explained with information theory, where players with more information on the competitors should result in more even or close competitions, and by extension it should be less likely that players directly engage each other and pick hands on which to compete. However, social capital would explain why these players engage in a form of coopetition where rather than compete directly with each other, they collaborate with each other to remove other players from the table – increasing the probability of winning overall.

One of the benefits of social capital in a strategic competitive environment like poker could be that players who have built up capital between them may be able to compete at a lower cost with each other than we would expect otherwise. For example, in multiplayer hands players with social capital would not 'push' as hard at each other and may engage in a type of strategic interaction known as coopetition or cooperative competition (Nalebuff and Brandenburger 1997). Rather than a zero-sum outcome, players may be willing to engage in this type of activity to lower losses even whilst competing. This theory has been very difficult

to explore in the real world as data where companies are engaged in coopetition are difficult to obtain and few laboratory experimentations in economics have been published (see management study by Kraus et al. 2018).

Back to the Future

From Chess to AlphaGo and Beyond

The miniaturization of electronics was led by the invention of the transistor in 1947 by Bell Labs, replacing the large vacuum tubes used up until that point. One of the unexpected side effects of this process was enabling computer technology to be used beyond its intended goals. This included the creation of the first 'home' computers, and computers being used in games like chess (Los Alamos chess in 1957). For the most part, these initial offerings were clunky and relatively easy to beat by human players, mostly due to the lack of a single winning strategy and the near infinite number of move options available to players. This began to change in the late 1970s with the Bell Labs offering (Belle) regularly beating Master level players. Over time the games have become better, mostly through brute force processing, i.e., memorising countless winning games and the pruning of irrelevant outcomes as moves are made. More recent systems have deviated from this blunt approach in lieu of more nuanced systems using artificial intelligence (AI) to play more like a human and anticipate moves. The first generation of these systems began with Deep Blue (IBM), which lost to world champion Garry Kasparov (4-2) in 1996, but after major upgrades beat Kasparov in 1997. Interestingly, the attempt to use AI to play chess was the easier option (and possibly based on Western bias of chess being the difficult game): Go is the much harder game for computers to solve. Go originated in China sometime around 1000BC and is still widely popular today in eastern Asia. It is played on a larger board (generally 17x17 or 19x19) with a greater number of possible moves. Estimates

of the number of legal moves[7] available on a 19x19 board is approximately 2.08×10^{170}. This is vastly more than chess and has the additional problem that a player can move to any open space on the board and is not restricted to the moves available to the remaining pieces. Given the massive numbers of potential moves it is not possible to follow the same strategies used by early Chess programs, thus Go requires a significant degree of intuition to pre-empt the opponent's strategy.

Historically, chess offered an ideal lab setting to test and explore cognitive processes (for a detailed discussion see Rasskin-Gutman 2009). In his autobiography *Models of My Life*, Herb Simon (1996) stresses that:

> For most of us those of us who have not won million-dollar lotteries, or suffered sudden crippling accidents life is much like the chess game. We make hundreds of choices among the alternative paths that lie before us and, as the result of those choices, find ourselves pursuing particular, perhaps highly specialized, careers, married to particular spouses, and living in particular towns. Even if we point to a single event as the "cause" of one of these outcomes, closer scrutiny of the path we have trod would reveal prefatory or preparatory events and choices that made the occurrence of the critical event possible (p. 113).

Pioneers of AI such as Allen Newell, Herbert Simon, and others realized that chess could be used as a vehicle to try simulating thought processes via computer programming[8]. A good example is Allen Newell's (1954) paper *The Chess Machine: An Example of Dealing with Complex Task by Adaptation*. He was interested in the problem of playing good chess as an ultra-complicated problem which requires thinking about mechanisms and programs necessary to handle such problems. His approach was to use a broad collection of rules of thumb (e.g., chess principles to follow, measurements to make, what to do next, how to interpret those rules

[7] See Tromp and Farnebäck (2016) Combinatorics of Go. Working Paper p.22 (Table 4). Accessed from https://tromp.github.io/go/gostate.pdf

[8] For a discussion on pioneering work on computer chess by Claude Shannon, Alan Turing, Alex Bernstein, and his authors, see Newborn (1975).

of thumb etc.) and focus on describing how such a set of rules is defined and organized to achieve solutions: "the intent to see if in fact an organized collection of rules of thumb can pull itself up by its bootstraps and learn to play good chess" (p. 23). Newell and Simon (1972) also derived insights from how individuals played chess, using a protocol in which persons were asked to talk aloud, mentioning moves considered and aspects of the situation. Out of that problem-behaviour they generated graphs that show the person's searches in a space of chess positions. They were fascinated to discover what an experienced chess player was able to see or perceive when looking at a chess position. Chase and Simon (1973) concluded in their analysis that superior performance is achieved from the ability to encode positions into larger perceptual chunks, which consisted of familiar sub-configuration of pieces. Thus, selective search guided by heuristics can compensate for being subjected to bounded rationality (Simon 1996).

Adriaan de Groot's (1965) *Thought and Choice in Chess*[9] was a pioneering book on the cognitive processes of chess; outlining an attempt to understand the thought processes underlying skilled chess playing by also using thinking aloud protocols with experimental sessions already held between 1938 and 1943:

> [A] subject was presented with an unfamiliar position taken from an actual tournament or match game and asked to find and play a move as though he were engaged in a tournament game of his own. The verbal report was to be as full and explicit a rendering of the subject's thoughts as possible, to include his plans, calculations, and other considerations leading to the move decision (p. v).

Rasskin-Gutman (2009) acknowledges that de Groot's research helped us understand that grand masters have a larger amount of chess knowledge that helped them to focus better on general patterns of the position and identify particular characteristics.

[9] For follow up books see, e.g., Avni (2004) or Aagard (2004).

Herb Simon (1996) also stresses in his autobiography that he always celebrated December 15, 1955 as the birthday of heuristic problem solving by computer, because it was

> the moment when we knew how to demonstrate that a computer could use heuristic search methods to find solutions to difficult problems. According to Ed Feigenbaum, who was a graduate student in a course I was then teaching in GSIA, I reacted to this achievement by walking into class and announcing, "Over the Christmas holiday, Al Newell and I invented a thinking machine." We were not slow in broadcasting our success. In a letter to Adriaan de Groot, on January 3, 1956, I reported: You will be interested to learn, I think, that Allen Newell and I have made substantial progress on the chess-playing machine except that at the moment it is not a chess-playing machine but a machine that searches out and discovers proofs for theorems in symbolic logic. The reason for the temporary shift in subject matter is that we found the human eye and the portions of the central nervous system most closely connected with it to be doing too much of the work at the subconscious level in chess-playing, and we found this aspect of human mental process (the perceptual) the most difficult to simulate. Hence, we turned to a problem-solving field that is less "visual" in its content. Two weeks ago, we hit upon a procedure that seems to do the trick, and although the details of the machine coding are not yet worked out, there seem to be no more difficulties of a conceptual nature to be overcome. By using a human (myself) to simulate the machine operating by rule and without discretion this simulated machine has now discovered and worked out proofs for the first twenty five or so theorems in Principia Mathematica. The processes it goes through would look very human to you, and corroborate in many respects the data you obtained in your chess studies (p. 2006).

Deepmind's[10] solution was to adopt an AI strategy with the development of AlphaGo, and its ability to beat the best human player in the world was not programmed – AlphaGo learned how to play and win by itself. This is machine learning AI at its best: the system was not programmed in any way to play Go. Instead, it started by watching thousands of games and

[10] Deepmind is a London based AI lab that is a subsidiary of internet juggernaut Google.

learnt the game through observation. Thus, AlphaGo is classified as a General AI. It was not programmed or taught to do a task; it used its own ability to learn in order to gain information about the game. This AI revolution demonstrated that not only can machines learn to imitate human behaviours but can also anticipate them, and because it is a General AI it can potentially learn to do anything that it is presented with.

What happens next should also be very interesting for behaviouralists. If General AI can learn to play any game (once we provide it with some framework) then the scope for its interaction with humans and our response may be astounding. One of the general issues we have had running experimental economics was the absence of realism (the abstractness) and our inability to create realistic experimental conditions where we could elicit real human responses and behaviours. The use of computing in experiments (over pen and paper) means that we can observe every aspect of an experiment. By adopting General AI, we could start to run experiments that might be otherwise impossible with real people. For example, high-cost, high-risk, or life-and-death situations experiments that would be too dangerous or stressful for humans to undertake could be replaced with AI participants. Additionally, we could observe the impact of any number of changes to how sports are played using AI players (e.g., rules changes) or learn human behaviours that are difficult for most of us to understand.

Poker AI

Poker is often thought of as simply a game of probabilities or risk, and as such it should be easy to generate unbeatable computer players. However, much like the game of Go, it is the human elements of the game that make it so hard to emulate human players. One of the central skills of the game is bluffing (misleading opponents), which is not only about the players' ability to control tells (ticks that give away the bluff) but also the correct betting sequences. As early as 1998, Billings et al. (1998) flagged poker as a potential testbed for AI describing it as:

> a game of imperfect knowledge, where multiple competing agents must deal with risk management, agent modelling, unreliable information and deception, much like decision-making applications in the real world (p. 228).

This prediction become a reality when the poker program dubbed 'Pluribus' learned to play six-player no-limit Texas Hold'em and performed significantly better than humans over the course of 10,000 hands of poker (Brown and Sandholm 2019). This demonstrated that a General AI is able to learn just about everything we can think of throwing at it; thus, the question for us is, what do we want to do with it in the future?

AI and eSport

While the idea of eSport is relatively new to most people, it has been around in some form since at least 1972, through a Space Invaders tournament with over 10,000 contestants (Picknell 2019)[11]. eSports are one of the few sports not based on physical attributes such as strength, but on reflex speed and mental acuity. This means that size and strength are no longer factors, and everyone, regardless of age or gender, can compete on an even playing field. Even so, there still is some inherent bias as computer games have long been seen as something that boys do rather than girls, resulting in a much higher pool of male players versus female on a competitive level. There also appears to be a fundamental difference in the type of games preferred by male and female players. While the economics of the business (prize money, sponsorships, viewership, etc.) have been explored, the players and their decision making have remained relatively untouched. eSport represents an untapped field for analysis and potentially the running of experiments – as these computer-based environments lend themselves to the development of specific types of choices and behaviours made by players. That is, modules

[11] Accessed from https://learn.g2.com/esports

and game designs could be specifically set up to test decision-making, collaboration, altruism, and a broad range of other human insights.

Another major advantage of eSport tournaments is that they are played live or live streamed players are seen, while the online version of the games are played anonymously. This results in a comparable environmental difference; because in one the player is an anonymous avatar, and in the other the player is an identifiable person. This poses some interesting questions about how decision-making, and behaviour could be impacted by information and identity, i.e., do players change behaviour if all they know is an avatar? Some previous research has indicated that players endow their avatars with their own beliefs and social norms, but there is also a likelihood that some players use their avatar as an aspirational representation of themselves (Praetorius and Görlich 2020, Ratan 2020, Wiederhold 2013). This could include choosing avatars of a different gender or race or choosing to behave in a matter that they would like to in the real world but feel for whatever reason they are unable. Running experiments in such an environment would enable participants to be much more invested in the outcomes and may elicit a more realistic response than we would observe in purely laboratory experiments.

Another advantage of eSports is what Slovic (2010) describes as the 'feeling of risk'. These digital environments are able to manipulate and measure sensory input and alter the perceived and actual levels of risk faced by players. Just like experimentalists do in a laboratory setting, programmers would be able to test the perceptions of risk versus actual risk by control or set the probability of certain events occurring and explore player reactions and decision-making.

Conclusions

Throughout this book chapter we have tried to show how powerful sports data can be in understanding questions that are at the core of behavioural economics. We sought to show how

scholars have advanced knowledge by finding new avenues through which they might improve on previous papers that used sports data, by finding other areas of exploration within the sports environment. We have also tried, without searching for completeness, to discuss throughout the paper what else can be explored in the future in more detail. When exploring biases Camerer and Weber (1999) raise an important point:

> First, establishing systematic mistakes using naturally occurring data is very difficult. Of course, this does not mean we should avoid such hard work and exploit the superior control of the lab; it just means that the standard of proof for mistakes outside the lab is high, and should be. It is also likely that important field anomalies will not be established by a single study, but by a series of studies which build on earlier results. Behavioral economists have learned that the best way to win an argument about the existence of systematic mistakes is to take complicated rationalizations offered by critics seriously (no matter how cockamamie they are), and collect more data to test them (p. 81).

Using sports data is a strategy to move towards that direction when working with naturally occurring data. Sports data allow us to use a variety of different datasets and look at different sport disciplines when exploring aspects in the area of behavioural economics. Our aim was to show that sports data are a valuable tool of thought and exploration in the interplay between speaking to theorists and searching for facts, which is particularly important when challenging the status quo in a particular scientific field.

References

Aagaard, J. (2004). *Inside the Chess Mind: How Players of All Levels Think about the Game*. Gloucester Publishers plc.

Allen, R. D., Hitt, A. M. and Greer, C. R. (1982) Occupational stress and perceived organizational effectiveness in formal groups: An examination of stress level and stress type, *Personal Psychology*, 35, 359–70.

Allison, P.D. (1999). *Multiple Regression: A primer*. Pine Forge Press.

Alter, A. L., and Oppenheimer, D. M. (2006). From a fixation on sports to an exploration of mechanism: The past, present, and future of hot hand research. Thinking & Reasoning, 12(4), 431-444.

Arkes, H. R., and Blumer, C. (1985). The psychology of sunk cost. O*rganizational Behavior and Human Decision Processes*, 35(1), 124-140.

Avni, A. (2004). *The Grandmaster's Mind: A Look Inside the Chess Thinking-Process*. Gambit Publications Ltd.

Bar-Eli, M., Azar, O. H., Ritov, I., Keidar-Levin, Y., and Schein, G. (2007). Action bias among elite soccer goalkeepers: The case of penalty kicks. *Journal of Economic Psychology*, 28(5), 606-621.

Baumeister, R. F. (1984) Choking under pressure: Self-consciousness and paradoxical effects of incentives on skill performance, *Journal of Personality and Social Psychology*, 46, 610–20.

Baumeister, R. F. and Showers, C. J. (1986) A review of paradoxical performance effects: Choking under pressure in sports and mental tests, *European Journal of Social Psychology*, 16, 361–83.

Beilock, S. L. and Carr, T. H. (2001) On the fragility of skilled performance: What governs choking under pressure? *Journal of Experimental Psychology: General*, 130, 701–25.

Bem, D. J., Wallach, M. A., and Kogan, N. (1965). Group decision making under risk of aversive consequences. *Journal of Personality and Social Psychology*, 1(5), 453–460.

Bénabou, R. (2013). Groupthink: Collective Delusions in Organizations and Markets, *The Review of Economic Studies*, 80(2), 429–462.

Billings D., Papp D., Schaeffer J., Szafron D. (1998). Poker as a testbed for AI research. In: Mercer R.E., Neufeld E. (Eds.), *Advances in Artificial Intelligence. Canadian AI 1998*. Lecture Notes in Computer Science (Lecture Notes in Artificial Intelligence), vol 1418. Springer, Berlin, Heidelberg.

Borland, J., Lee, L., and Macdonald, R. D. (2011). Escalation effects and the player draft in the AFL. *Labour Economics*, 18(3), 371-380.

Bourne, L. E., & Yaroush, R. A. (2003). Stress and Cognition: A Cognitive Psychological Perspective, *National Aeronautics and Space Administration* (N.A.S.A.).

Brouwer, T., and Potters, J. (2019). Friends for (almost) a day: Studying breakaways in cycling races. *Journal of Economic Psychology*, 75, 102092.

Brown, N. and Sandholm, T. (2019). Superhuman AI for multiplayer poker. *Science*, 365(6456), 885-890.

Bryson, A., Dolton, P., Reade, J. J., Schreyer, D., and Singleton, C. (2021). Causal effects of an absent crowd on performances and refereeing decisions during Covid-19. *Economics Letters*, 198, 109664.

Burns, B. D. (2004). Heuristics as beliefs and as behaviors: The adaptiveness of the "hot hand". *Cognitive Psychology*, 48(3), 295-331.

Butler, J. L., and Baumeister, R. F. (1998). The trouble with friendly faces: Skilled performance with a supportive audience. *Journal of Personality and Social Psychology*, 75(5), 1213-1230.

Camerer, C. F., and Weber, R. A. (1999). The econometrics and behavioral economics of escalation of commitment: A re-examination of Staw and Hoang's NBA data. *Journal of Economic Behavior & Organization*, 39(1), 59-82.

Cao, Z., Price, J., and Stone, D. F. (2011). Performance under pressure in the NBA. *Journal of Sports Economics*, 12(3), 231-252.

Caruso, R., Di Domizio, M., and Savage, D. A. (2017). Differences in National Identity, Violence and Conflict in International Sport Tournaments: Hic Sunt Leones! *Kyklos*, 70(4), 511-545.

Chan, H. F., Savage, D. A., and Torgler, B. (2019). There and back again: Adaptation after repeated rule changes of the game. *Journal of Economic Psychology*, 75, 102129.

Chase, W. G., and Simon, H. A. (1973). Perception in chess. *Cognitive Psychology*, 4(1), 55-81.

Christakis, N. A. (2019). *Blueprint: Evolutionary Origins of A Good Society*. Little, Brown Spark.

Coates, J. (2012). *The Hour Between Dog and Wolf: Risk-taking, Gut Feelings and the Biology of Boom and Bust*. Penguin Books.

Coates, D., and Oguntimein, B. (2010). The length and success of NBA careers: Does college production predict professional outcomes. *International Journal of Sport Finance*, 5(1), 4-26.

Cohen-Zada, D., Krumer, A. and Shtudiner, Z. (2017). Psychological momentum and gender, *Journal of Economic Behavior & Organization*, 135, 66-81. https://doi.org/10.1016/j.jebo.2017.01.009

Cohen-Zada, D., Krumer, A., Rosenboim, M., and Shapir, O. M. (2017). Choking under pressure and gender: Evidence from professional tennis. *Journal of Economic Psychology*, 61, 176-190.

Coleman, J. S. (1998). Social Capital in the Creation of Human Capital, *American Journal of Sociology*, 94, S95-S120.

Cooper, J. (1989). The military and higher education in the USSR. The ANNALS of the American *Academy of Political and Social Science*. 502: 108–119.

Darcy, S., Maxwell, H., Edwards, M., Onyx, J. and Sherker, S. (2014). More than a sport and volunteer organisation: Investigating social capital development in a sporting organisation, *Sport Management Review*, 17(4), 395-406.

Dasgupta, P. (1999), Economic progress and the idea of social capital, in Dasgupta, P. and Serageldin, I. (Eds), *Social Capital: A Multifaceted Perspective*, World Bank.

de Groot, A. (1965). *Thought and Choice in Chess*. Mouton Publishers.

Diamond, J. (2019) The 'Moneyball' A's Find a New Inefficiency: Other Teams' Players, in the *Wall Street Journal*, August 20, 2019. Available at https://www.wsj.com/articles/the-moneyball-as-find-a-new-inefficiency-other-teams-players-11566322019.

Dobelli, R. (2013). *The art of thinking clearly: better thinking, better decisions*. Hachette UK.

Dohmen, T. J. (2008a). Do professionals choke under pressure?. *Journal of Economic Behavior & Organization*, 65(3-4), 636-653.

Dohmen, T. J. (2008b). The influence of social forces: Evidence from the behavior of football referees. Economic inquiry, 46(3), 411-424.

Dohmen, T., and Sauermann, J. (2016). Referee bias. *Journal of Economic Surveys*, 30(4), 679-695.

Duggan, M. and Levitt, S. D. (2002). Winning isn't everything: Corruption in sumo wrestling. *American Economic Review*, 92(5):1594–1605.

Dulleck, U., Ristl, A., Schaffner, M., and Torgler, B. (2011). Heart rate variability, the autonomic nervous system, and neuroeconomic experiments. *Journal of Neuroscience, Psychology, and Economics*, 4(2), 117-124.

Dulleck, U., Schaffner, M., and Torgler, B. (2014). Heartbeat and economic decisions: observing mental stress among proposers and responders in the ultimatum bargaining game. *PLoS One*, 9(9), e108218.

Dulleck, U., Fooken, J., Newton, C., Ristl, A., Schaffner, M., and Torgler, B. (2016). Tax compliance and psychic costs: Behavioral experimental evidence using a physiological marker. *Journal of Public Economics*, 134, 9-18.

Elias, N., and Dunning, E. (1966). Dynamics of sports groups with special reference to football. *British Journal of Sociology*, 17(4), 388-402.

Elster, J. (1998). Emotions and economic theory. *Journal of Economic Literature*, 36(1), 47-74.

Emerson, J. W., Seltzer, M., and Lin, D. (2009). Assessing judging bias: An example from the 2000 Olympic Games. *The American Statistician*, 63(2), 124-131.

Eremin, O., Walker, M. B., Simpson, E., Heys, S. D., Ah-See, A. K., Hutcheon, A. W., Ogston, K. N., Sarkar, T. K., Segar, A. and Walker, L. G. (2009). Immuno-modulatory effects of relaxation training and guided imagery in women with locally advanced breast cancer undergoing multimodality therapy: A randomised controlled trial. *Breast*, 18(1), 17-25.

Flessas, K., Mylonas, D., Panagiotaropoulou, G., Tsopani, D., Korda, A., Siettos, C., Di Cagno, A., Evdokimidis, I. and Smyrnis, N. (2015). Judging the judges' performance in rhythmic gymnastics. *Medicine & Science in Sports & Exercise*, 47(3), 640-648.

Frank, R. H. and Cook, P. J. (1995). *The Winner-Take-All Society*. The Free Press.

Frank, R. H. (1984). Interdependent preferences and the competitive wage structure, RAND Journal of Economics, 15(4), 510-520.

Frey, B. S., Schaffner, M., Schmidt, S. L., and Torgler, B. (2013). Do employees care about their relative income position? Behavioral evidence focusing on performance in professional team sport. *Social Science Quarterly*, 94(4), 912-932.

Fukuyama, F. (2003). Social capital and civil society.In Ostrom, E. and Ahn, T.K. (Eds.), *Foundations of Social Capital*. Edward Elgar.

Garicano, L., Palacios-Huerta, I., and Prendergast, C. (2005). Favoritism under social pressure. *Review of Economics and Statistics*, 87(2), 208-216.

Gauriot, R. and Page, L. (2018). Psychological momentum in contests: The case of scoring before half-time in football, *Journal of Economic Behavior & Organization*, 149, 137-168.

Gigerenzer, G. (1996). On narrow norms and vague heuristics: A reply to Kahneman and Tversky. *Psychological Review*, 100, 592-596.

Gigerenzer, G. (2000). *Adaptive thinking: Rationality in the real world*. Oxford University Press.

Gigerenzer, G. (2004). Striking a blow for sanity in theories of rationality. In: M. Augier and J. G. March (Eds.), *Models of a man: Essays in memory of Herbert A. Simon*. MIT Press, 389-409.

Gilovich, T., Vallone, R., & Tversky, A. (1985). The hot hand in basketball: On the misperception of random sequences. *Cognitive Psychology*, 17(3), 295-314.

Goff, B. L., and Tollison, R. D. (Eds.). (1990). *Sportometrics*. Texas A&M University Press.

Groothuis, P. A., and Hill, J. R. (2004). Exit discrimination in the NBA: A duration analysis of career length. *Economic Inquiry*, 42(2), 341-349.

Groysberg, B., Nanda, A., and Nohria, N. (2004). The risky business of hiring stars. *Harvard Business Review*, 82(5), 92-101.

Hackinger, J. (2019). Ignoring millions of euros: Transfer fees and sunk costs in professional football. *Journal of Economic Psychology*, 75, 102114.

Hamilton, D. R. (2018). How Your Mind Can Heal Your Body, Hay House.

Harb-Wu, K., and Krumer, A. (2019). Choking under pressure in front of a supportive audience: Evidence from professional biathlon. *Journal of Economic Behavior & Organization*, 166, 246-262.

Heiniger, S., and Mercier, H. (2019). Judging the judges: A general framework for evaluating the performance of international sports judges. arXiv preprint arXiv:1807.10055.

Hickman, D. C., and Metz, N. E. (2015). The impact of pressure on performance: Evidence from the PGA TOUR. *Journal of Economic Behavior & Organization*, 116, 319-330.

Hill, A. (2018). Why groupthink never went away. *Financial Times*, May 7th, 2018. Available from https://www.ft.com/content/297ffe7c-4ee4-11e8-9471-a083af05aea7

Hill, R. A., and Barton, R. A. (2005). Red Enhances Human Performance in Contents. *Nature* 435, 293–293.

Howell, R. (1975). The USSR: Sport and politics intertwined. *Comparative Education*, 11(2): 137–145.

Humphreys, B. and Ruseski, J. (2011). Socio-Economic Determinants of Adolescent Use of Performance Enhancing Drugs: Evidence from the YRBSS, *The Journal of Socioeconomics*, 40(2), 208–216.

Ilie, A., Ioan, S., Zagrean, L. and Moldovan. M. (2008). Better to be Red Than Blue in Virtual Competition. *Cyber Psychology and Behaviour,* 11(3), 375–377.

Iso-Ahola, S. E., and Dotson, C. O. (2016). Psychological Momentum-A Key to Continued Success. *Frontiers in Psychology*, 7, 1328.

Jamal, M. (1984). Job stress and job performance controversy: An empirical assessment, *Organizational Behavior and Human Performance*, 33, 1–21.

Janis, I. L. and Mann, L. (1977) Decision Making, The Free Press.

Janis, I. L. (1972). *Victims of groupthink: A psychological study of foreign-policy decisions and fiascos.* Houghton Mifflin.

Kahn, L. M. (2000). The sports business as a labor market laboratory. *Journal of Economic Perspectives*, 14(3), 75-94.

Kahneman, D., and Tversky, A., (1979). Prospect theory: An analysis of decision under risk. *Econometrica* 47(2), 263–291.

Kawachi I., Subramanian S., and Kim D. (2008). Social Capital and Health. In: Kawachi I., Subramanian S., Kim D. (Eds.) *Social Capital and Health. Springer*. New York.

Kausel, E. E., Ventura, S., and Rodríguez, A. (2019). Outcome bias in subjective ratings of performance: Evidence from the (football) field. *Journal of Economic Psychology*, 75, 102132.

Kay, T. and Bradbury, S. (2009) Youth sport volunteering: developing social capital?, *Sport, Education and Society*, 14(1), 121-140.

Keefer, Q. A. (2015a). Performance feedback does not eliminate the sunk-cost fallacy: Evidence from professional football. *Journal of Labor Research*, 36(4), 409-426.

Keefer, Q. A. (2017). The sunk-cost fallacy in the National Football League: Salary cap value and playing time. *Journal of Sports Economics*, 18(3), 282-297.

Keltner, Da. and Lerner, J. S. (2010). Emotion. In: D. Gilbert, S. Fiske, and G. Lindsey (Eds.). *The Handbook of Social Science*, Vol. 1. Wiley, pp. 317-352.

Keinan, G. (1987) Decision making under stress: Scanning of alternatives under controllable and uncontrollable threats, *Journal of Personality and Social Psychology*, 52, 639–44.

Kho, A. Y., Liu, K. P., Chung, R. C. (2014). Meta-analysis on the effect of mental imagery on motor recovery of the hemiplegic upper extremity function. *Australian Occupational Therapy Journal*, 61(2), 38-48.

Kim, A. C. H., Ryu, J., Lee, C. et al. (2021) Sport Participation and Happiness Among Older Adults: A Mediating Role of Social Capital. *Journal of Happiness Studies*, 22, 1623-1641

Koehler, J. J., & Conley, C. A. (2003). The "hot hand" myth in professional basketball. *Journal of Sport and Exercise Psychology*, 25(2), 253-259.

Kraus, S., Meier, F., Niemand, T., Bouncken, R. B. and Ritala, P. (2018). In search for the ideal coopetition partner: an experimental study. *Review of Managerial Science,* 12, 1025–1053.

Krumer, A. (2020). Pressure versus ability: Evidence from penalty shoot-outs between teams from different divisions. *Journal of Behavioral and Experimental Economics*, 89, 101578.

Kumar, H., Manoli, A. E., Hodgkinson, I. R. and Downward, P. (2018). Sport participation: From policy, through facilities, to users' health, well-being, and social capital, *Sport Management Review*, 21(5), 549-562.

Leeds, D. M., Leeds, M. A., and Motomura, A. (2015). Are sunk costs irrelevant? Evidence from playing time in the National Basketball Association. *Economic Inquiry*, 53(2), 1305-1316.

Lehner, P., Seyed-Solorforough, M., O'Connor, M. F., Sak, S. and Mullin, T. (1997) Cognitive biases and time stress in team decision making, *Transactions on Systems, Man, and Cybernetics Part A: Systems and Humans*, 27, 698–703.

Levitt, S. D. (2002). Testing the economic model of crime: The national hockey league's two-referee experiment. *Contributions in Economic Analysis & Policy*, 1(1).

Lewis, M. (2017). *The Undoing Project: A Friendship that Changed Our Minds*. W. W. Norton & Company.

Lewis, M. (2004). *Moneyball: The Art of Winning an Unfair Game*. W. W. Norton & Company.

Locke, E. A. (1968). Toward a theory of task motivation and incentives. Organizational Behavior and Human Performance, 3(2), 157–189.

Locke, E. A., Latham, G. P., Smith, K. J. and Wood, R. E. (1990). *A Theory of Goal Setting & Task Performance*. Prentice Hall.

Loewenstein, G. (2005). Hot-cold empathy gaps and medical decision making. *Health Psychology*, 24(4), S49–S56.

Nowak, M., and Highfield, R. (2011). *Supercooperators: Altruism, evolution, and why we need each other to succeed*. Simon and Schuster.

Macintyre, Alison, Ho Fai Chan, Markus Schaffner, and Benno Torgler (2021). National Pride and Tax Compliance: A Laboratory Experiment Using a Physiological Marker. CREMA Working Paper No. 2021-07. Center for Research in Economics, Management and the Arts (CREMA).

McCormick, R. E., and Tollison, R. D. (1984). Crime on the court. *Journal of Political Economy*, 92(2), 223-235.

Meglino, B. M. (1977) Stress and performance – are they always incompatible, *Supervisory Management*, 22, 2–13.

Meichenbaum, D. (2007), Stress inoculation training: a preventative and treatment approach. In: Lehrer, M., Woodfolk, R.L. and Slime, W.S. (Eds), *Principles and Practices of Stress Management*. Guilford Press.

Merkel, S., Chan, H. F., Schmidt, S. L., and Torgler, B. (2021). Optimism and positivity biases in performance appraisal ratings: Empirical evidence from professional soccer, forthcoming in: *Applied Psychology*.

Myers, T. D., Balmer, N. J., Nevill, A. M., and Al Nakeeb, Y. (2006). Evidence of nationalistic bias in muaythai. Journal of Sports Science & Medicine, 5(CSSI), 21-27.

Nalebuff, B. J., and Brandenburger, A. M. (1997). Co-opetition: Competitive and Cooperative Business Strategies for the Digital Economy. *Strategy & Leadership,* 25(6), 28–33.

Newborn, M. (1975). *Computer Chess*. ACM Monograph Series. Academic Press.

Newell, Al. (1954). The Chess Machine: An Example of Dealing With a Complex Task by Adaptation, P-620, Rand Corporation.

Newell, A., and Simon, H. A. (1972). *Human problem solving*. Prentice-Hall, Inc.

Paldam, M. (2000). Social capital: One or many? Definition and measurement, *Journal of Economic Surveys*, 14(5), 629-653.

Page, L., & Coates, J. (2017). Winner and loser effects in human competitions. Evidence from equally matched tennis players. *Evolution and Human Behavior*, 38(4), 530-535.

Pedace, R., and Smith, J. K. (2013). Loss aversion and managerial decisions: Evidence from major league baseball. *Economic Inquiry*, 51(2), 1475-1488.

Pettersson-Lidbom, P., and Priks, M. (2010). Behavior under social pressure: Empty Italian stadiums and referee bias. *Economics Letters*, 108(2), 212-214.

Piatti, M., Savage, D. A. and Torgler, B. (2012), The Red Mist? Red shirts, success and team sports, *Sport in Society*, 15(9), 1209-1227.

Picknell, D. (2019). What Is Esports and How Did it Become a $1 Billion Industry? Learning Hub Article August 20th, 2019. Accessed from https://learn.g2.com/esports

Pollak, R. A. (1976). Interdependent Preferences. *The American Economic Review*, 66(3), 309-320.

Portes, A. (1998). Social capital: its origins and applications in contemporary sociology, *Annual Review of Sociology*, 24, 1-24.

Postlewaite, A. (1998). Social Status, Norms and Economic Performances: The social basis of interdependent preferences, *European Economic Review*, 42, 779–800.

Praetorius, A. S. and Görlich, D. (2020) How Avatars Influence User Behavior: A Review on the Proteus Effect in Virtual Environments and Video Games, FDG '20: International Conference on the Foundations of Digital Games 49, 1–9.

Rasskin-Gutman, D. (2009). *Chess metaphors: Artificial intelligence and the human mind*. MIT Press.

Ratan, R., Beyea, D., Li, B. J. and Graciano, L. (2020). Avatar characteristics induce users' behavioral conformity with small-to-medium effect sizes: A meta-analysis of the proteus effect, *Media Psychology*, 23(5), 651-675.

Riordan, J. (1993). The rise and fall of soviet Olympic champions. *Olympika: The International Journal of Olympic Studies*. 2: 25–44.

Savage, D. A. and Torgler, B. (2012). Nerves of steel? Stress, work performance and elite athletes. *Applied Economics*. 44(19): 2423–2435.

Schaffner, M., and Torgler, B. (2008). Meet the Joneses: An Empirical Investigation of Reference Groups in Relative Income Position Comparisons. CREMA Working Paper No. 2008-13. Center for Research in Economics, Management and the Arts (CREMA).

Schmidt, S. L. (Ed.). *21st Century Sports: How Technologies Will Change Sports in the Digital Age*. Springer.

Schultz, D. P. (1966) An experimental approach to panic behavior, Group Psychology Branch.

Schwert, G. W. (2003). Anomalies and Market Efficiency (Chapter 15). In: G. M. Constantinides, M. Harris, and R. M. Stulz (Eds.), *Handbook of Economics of Finance*. Elsevier, pp. 939-974.

Simon, H. (1983). *Reason in human affairs*. Stanford University Press.

Simon, H. A. (1996). *Models of my life*. MIT press.

Skinner, J., Zakus, D. H. and Cowell, J. (2008). Development through Sport: Building Social Capital in Disadvantaged Communities, *Sport Management Review*, 11(3), 253-275.

Slovic, P. (2010). The feeling of risk: New perspectives on risk perception. Routledge.

Staw, B. M., and Hoang, H. (1995). Sunk costs in the NBA: Why draft order affects playing time and survival in professional basketball. *Administrative Science Quarterly*, 40, 474-494.

Stoner, J. A. (1959). A comparison of individual and group decisions involving risk, Master's Thesis, Antioch College, https://dspace.mit.edu/bitstream/handle/1721.1/11330/33120544-MIT.pdf

Sullivan, S. E. and Bhagat, R. S. (1992) Organizational stress, job satisfaction and job performance: where do we go from here? *Journal of Management*, 18, 353–74.

Thaler, R. H. (2015*). Misbehaving: The Making of Behavioral Economics*. W. W. Norton and Company.

Thaler, R. H., Johnson, and E. J., (1990). Gambling with the house money and trying to break even: The effects of prior outcomes on risky choice. *Management Science,* 36(6), 643–660.

Toma, M. (2017). Missed shots at the free-throw line: Analyzing the determinants of choking under pressure. *Journal of Sports Economics*, 18(6), 539-559.

Torgler, B. (2004). The economics of the FIFA Football Worldcup. *Kyklos*, 57(2), 287-300.

Torgler, B. (2009). Economics of sports: A note to this special issue. *Economic Analysis and Policy*, 39(3), 333.

Torgler, B. (2016). Can Tax Compliance Research Profit from Biology?, *Review of Behavioral Economics*, 3, 113-144, 2016.

Torgler, B. (2019). Opportunities and challenges of portable biological, social, and behavioral sensing systems for the social sciences. In G. Foster (Ed.), *Biophysical measurement in experimental social science research*. Academic Press, pp. 197-224.

Torgler, B. (2020). Big Data, Artificial Intelligence, and Quantum Computing in Sports. In: S. L. Schmidt (Ed.), *21st Century Sports*: *How Technologies Will Change Sports in the Digital Age*. Springer, pp. 153-173,

Torgler, B. (2021a). Symbiotics> Economics? CREMA Working Paper No. 2021-15. Center for Research in Economics, Management and the Arts (CREMA).

Torgler, B. (2021b). The Power of Public Choice in Law and Economics. CREMA Working Paper No. 2021-04. Center for Research in Economics, Management and the Arts (CREMA).

Van Ours, J. C., and Van Tuijl, M. A. (2016). In-season head-coach dismissals and the performance of professional football teams. *Economic Inquiry*, 54(1), 591-604.

Wiederhold, B.K. (2013). Avatars: Changing Behavior for Better or for Worse? *Cyberpsychology, Behavior, and Social Networking*, 16(5), 319-320.

Walseth, K. (2008). Bridging and bonding social capital in sport – experiences of young women with an immigrant background, *Sport, Education and Society*, 13(1), 1-17.

Wilson, D. S. (2019). *This view of life: Completing the Darwinian revolution*. Pantheon Books.

Witt, R. (2005). Do players react to sanction changes? Evidence from the English Premier League. *Scottish Journal of Political Economy*, 52(4), 623-640.

Woolcock, M. and Narayan, D. (2000), Social capital: Implications for development theory, research and policy, *The World Bank Research Observer*, 2, 225-249.

Wright, P. (1974) The harassed decision maker: Time pressures, distractions and the use of evidence, *Journal of Applied Psychology*, 59, 555–61.

Yerkes, R. and Dodson, J. D. (1908) The relationship of stimuli to rapidity of habit formation, *Journal of Comparative Neurological Psychology*, 18, 459–82.

Zeelenberg, M., Van den Bos, K., Van Dijk, E., and Pieters, R. (2002). The inaction effect in the psychology of regret. *Journal of Personality and Social Psychology*, 82(3), 314-327.

Zitzewitz, E. (2006). Nationalism in winter sports judging and its lessons for organizational decision making. *Journal of Economics & Management Strategy*, 15(1), 67-99.

Zitzewitz, E. (2014). Does transparency reduce favoritism and corruption? Evidence from the reform of figure skating judging. *Journal of Sports Economics*, 15(1), 3-30.