

Economics lessons from sports during the COVID-19 pandemic

Carl Singleton,^{a,*} Alex Bryson,^{b,c} Peter Dolton,^{c,d} J. James Reade,^a Dominik Schreyer,^e

^a*Department of Economics, University of Reading*

^b*Social Research Institute, University College London*

^c*National Institute of Economic and Social Research*

^d*Department of Economics, University of Sussex*

^e*Center for Sports and Management (CSM), WHU – Otto Beisheim School of Management*

January 2022

Forthcoming chapter in: Pedersen, P. M. (Ed.), Research Handbook on Sport and COVID-19, Edward Elgar Publishing

Abstract

Economists have used Covid-19 as an exogenous shock to improve understanding of sports markets and in doing so gain broader economic insights. These natural experiments have provided partial answers to: how airborne viruses may spread in crowds; how people respond to the risk and information about infection; how the absence of crowds reduces the social pressure that can affect arbitration decisions; and how quickly asset (betting) prices reflect new information. We review this evidence and reflect on how (sports) economics research can continue to be most valuable to policymakers.

Keywords: Coronavirus, Natural experiments, Prediction markets, Referee bias, Social pressure, Sports economics

* c.a.singleton@reading.ac.uk (corresponding author) & j.j.reade@reading.ac.uk, Department of Economics, University of Reading, Whiteknights Campus, RG6 6UA, UK. a.bryson@ucl.ac.uk, UCL's Social Research Institute, UCL, 20 Bedford Way, London, WC1H 0AL. p.dolton@sussex.ac.uk, Department of Economics, University of Sussex, Brighton, BN1 9SL. dominik.schreyer@whu.edu, Center for Sports and Management (CSM), WHU – Otto Beisheim School of Management, Erkrather Str. 224a, 40233 Düsseldorf, Germany.

Sports can offer rare moments of clarity to social scientists within an otherwise complex real world. The competitive environments in sports provide laboratories to study human behaviour, to test theories, and to observe the effects of policy. In this book chapter, we take an editorial cue from a recent special issue of the *Journal of Behavioral and Experimental Economics*: “Ask not what economics can do for sports - Ask what sports can do for economics” (Bar-Eli et al., 2020). In this spirit, economists have been studying the impacts of Covid-19 on sports, and vice versa, addressing research questions that have important implications far beyond the fields of play. We briefly summarize these studies and give our views on where there are knowledge gaps that (sports) economists may try to answer next.

What economists have learned from sports during Covid-19

In this section, we provide an initial overview of empirical studies using (professional) sports as a laboratory to analyze economic behavior during the Covid-19 pandemic. The way we read it, this still-emerging literature has largely centered on answering four different questions: (1) How airborne viruses may spread in crowds; (2) how crowds respond to the risk and information about an infection; (3) how the absence of crowds may reduce social pressure and affect arbitration decisions; and (4) how quickly betting markets respond to this new information.

Mass events and the spread of an airborne virus

Before Covid-19, there was surprisingly little evidence on the causal effects that sports events could have on the spread of an airborne virus. A notable exception used the locations of the National Football League (NFL) Super Bowl, and the home cities of the teams making it there, to estimate the impacts of this annual mass winter gathering of sports fans on seasonal influenza mortality (Stoecker et al., 2016). Using a differences-in-differences design, the study found an 18% increase in influenza mortality in the over 65s in the cities represented in North American sport’s annual showpiece, between 1974 and 2009, compared with the cities that did

not make it to the Bowl. There was no increase in mortality in the cities hosting the Bowl, suggesting that the increased gatherings of people in social settings back home, away from the stadium, could be part of the mechanism spreading the virus.

Also studying seasonal influenza in North America, a more recent study exploited the movement or creation of major sports franchises between 1962 and 2016, as well as the periods when sports stopped, e.g., due to player strikes (Cardazzi et al., 2020). The study found significant increases in influenza mortality of 4-24%, depending on the sport, when franchises arrived in cities, compared with before they arrived and with other cities without franchises. The impact of league stoppages was mixed, with effects on mortality associated with the 1982 NFL and 2011 National Basketball Association (NBA) stoppages, but not the 2004 National Hockey League (NHL) stoppage. The authors also found a parallel with Stoecker et al. (2016), as there was a significant increase in all-cause mortality in over 65s when a new NFL sports franchise arrived in a city. However, neither study could pin this down to fans attending stadiums, as opposed to the general gathering of people to watch sports events, e.g., in their homes or bars.

The first study of whether major sports events can cause the spread of Covid-19 focused on North America (Ahammer et al., 2020). By exploiting the variation in the scheduling of NBA and NHL games in a twelve-day period in early March 2020, the study was able to estimate the effects of these large indoor gatherings on the subsequent spread and mortality of Covid-19. The authors concluded that each of these mass gatherings, on average, increased the cumulative number of deaths directly from Covid-19 by 9% up to the end of April 2020, in the areas around where the events took place.

Using a similar empirical design, another study has looked at the impact of English football matches taking place with crowds as the Covid-19 pandemic took hold (Olczak et al., 2020). Even though these events took place outdoors, compared to the indoor events studied in

North America (Ahammer et al., 2020), the authors also concluded that attendance at matches resulted in local increases in the spread of Covid-19. Each match added six Covid-19 cases, two Covid-19 deaths, and three excess deaths per 100,000 local people. However, these, and subsequent, studies typically cannot distinguish the causal effects stemming from attending live matches in a stadium and other related gatherings, including collectively watching sports events in a pub.

More recent studies have corroborated these early findings by exploring data from football in Belarus (Parshakov, 2021), Germany (Fischer, 2021) and Italy (Alfano, 2021). There's also increasing evidence that these effects were robust across different sports, including college sports (Carlin et al., 2020) and motorsports (Dave et al., 2020).

However, an overview by Else (2021) has urged extreme caution in assessing these initial results because it might be too early to calibrate any effects reliably. She suggests that much depends on the extent to which: (1) the event is indoors or outdoors; (2) what the prevailing ventilation is; (3) what measures were taken in public transport to and from the venue; (4) what measures were taken in ticketing, queuing, corridors, drink stands, and toilet conveniences to mitigate risks of transmission. Additional complications arise between studies depending on what stage or variant of the Covid-19 pandemic was being investigated. Further, data collection should be cautious to ensure that the pre-event and post-event testing is truly comparable and controlled for.

Subject to these significant methodological challenges, the emerging literature on the potential of (mass) sports events to spread a virus suggests that extreme caution needs to be applied by policymakers on when and how to reopen sports stadiums to spectators during a pandemic. This is underlined by another literature that suggests social distancing will not happen naturally from large numbers of sports fans voluntarily staying away from stadiums.

Stadium attendance demand and risk taking

The demand for attending sports events during the pandemic may tell us something about how populations respond to a public health emergency, especially one which requires social distancing, under different policy regimes. It may provide more general evidence on how individuals respond to negative risk and uncertainty. The perspective of these effects is potentially different for the individual fan, the sports organization and society at large (see Mastromartino et al., 2020).

Since most governments shut down professional sports quickly in Spring 2020 and subsequently restricted the numbers of fans allowed to return, with massive unmet demand, opportunities to gain novel insights from stadium attendances have so far been limited. Reade and Singleton (2021) used the predetermined scheduling of football matches in early 2020 in Europe's major leagues, to test whether public news about domestic or global virus cases and deaths affected stadium attendances. The study found no association between the global news about the progress of the outbreak and stadium attendance demand. However, in England, Germany and Italy, the previous day's newly confirmed domestic cases or deaths negatively affected attendances (e.g., for every 100 new cases announced, attendances were estimated to have decreased by 5%, 11% and 14%, respectively), though this was not the case in France or Spain – for France, one explanation of this difference could have been the especially competitive nature of the 2019-20 Ligue 1 season also affecting attendances just before it was abandoned.

In the only European professional football league to not temporarily shut down due to Covid-19, Belarussian stadium attendance demand declined significantly in the initial period of maximum uncertainty about the virus and its lethality (Reade et al., 2021a). Demand in this league then slowly recovered, despite the ongoing inherent risk to individuals from going to a match. This is consistent with other research from North America showing that some fans who were surveyed and subject to a discrete choice experiment, in August-September 2020, were

largely still willing to accept Covid-19 risks to attend stadiums, despite being well aware of them, though with some reduced demand (Humphreys et al., 2020). For example, the willingness to pay (WTP) of NFL and NHL fans in the experiment increased by about 50% when told there would be a mask requirement at a stadium limited to 25% capacity, as opposed to no mask requirement and the same capacity limit. The WTP increased by as much as 130% for fans posed with the same scenario in Major League Baseball (MLB) and the NBA. These early findings were mirrored by another study from Japan (Takamatsu, 2021), reporting that spectators visiting home matches of Victorina Himeji, a professional women's volleyball club in Japan, expressed severe health concerns in early 2021, despite health protocols being in place at the venue.

Taken together, the evidence suggests that sports fans are cognizant of the health risks associated with Covid-19. Those perceived risks have reduced demand for sports events, but only to a limited extent, and demand rises when fans are reassured about safety protocols to mitigate those risks.

Behavior, bias and social pressure: sports behind closed doors

The social environment has the potential to affect individuals' decisions and choices (e.g., Becker and Murphy, 2000). This has been demonstrated for the referees of sporting contests. There is widespread evidence that they are affected by social pressure (see the survey by Dohmen and Sauermann, 2016). The substantial advantage that football teams normally have when playing at home, mostly in front of their own supporters, has been partly attributed to the impact the crowd can have on refereeing decisions.

The Covid-19 pandemic has induced worldwide natural experiments on the effects of crowds. We exploited one of these experiments that took place over several countries in almost identical settings: professional football matches played behind closed doors within the 2019/20 league seasons (Bryson et al., 2021). Although a decline in seasonal home advantage in

professional football competitions worldwide began some time ago (e.g., Peeters and van Ours, 2021), it has become more pronounced since Covid-19, when most matches were played without crowds. Still, when focusing on the 2019/20 football seasons for the 17 countries and 23 leagues in our study, we noted a lot of heterogeneity in whether home advantage increased or decreased after Covid-19 when measured in terms of goal difference, but a clear and widespread diminution in the home advantage in referee card-giving for player offences.

Before Covid-19, professional football behind closed doors, without a crowd, was rare, and was usually a punishment inflicted on clubs for their fans' poor behavior. Studies of these one-off events have found that the referees tended to favor the home team relatively less when handing out punishments for foul play, but this was not enough to significantly affect the final match outcomes (Pettersson-Lidbom and Priks, 2010; Reade et al., 2021b).

Addressing team and referee heterogeneity, we found average effects of playing behind closed doors in the 2019/20 season that were consistent with the aforementioned pre-Covid-19 estimates, which had relied on much smaller samples of matches: no significant general impacts on match outcomes or score lines, but fewer yellow cards awarded to away teams (Bryson et al., 2021). There have been several other studies of these patterns since Covid-19, either using sub-samples of our data (e.g., Endrich and Gesche, 2020) or alternative empirical approaches (e.g., Benz and Lopez, 2021; Scoppa, 2021), finding largely similar results (see also the summaries in Leitner et al., 2022; Reade et al., 2021b).

Football referees can be unfairly biased against away teams by the presence of a crowd and the social pressure it creates. This has implications for the judging and citing of any competitive event or outcome, when it is anticipated that the audience could be partisan, for example, in the Olympics, reality TV contests or even jury trials. More generally, any contest with adversaries and a crowd needs to be set up in such a way as to minimize the potential biases arising from the partiality of adjudicators who may be influenced by the crowd.

Betting markets and information efficiency

To gain insights on the informational efficiency of financial markets and the behavioral biases of the participants, a large literature has studied prediction or betting markets, typically those relating to sports events (e.g., Levitt, 2004; Snowberg and Wolfers, 2010; Croxson and Reade, 2014; Angelini et al, 2021). Unlike conventional financial markets, sports betting provides ‘real world laboratories’ in which to test the Efficient Market Hypothesis and study the departures from it. This is because participants are generally regarded as being well-informed, motivated, experienced and, most importantly, breaking news is usually reported cleanly, in a way that is easy for the participants to share and process. It is also an advantage that the assets (bets) in these markets have defined end points upon which their values become certain, which is typically not the case when evaluating financial securities pricing (Thaler and Ziemba, 1988).

When football returned after its brief shutdown in Spring 2020, the change in home advantage in professional sports represented new information for markets. Some first studies have looked at the accuracy and speed by which this was reflected in prices (e.g., Deutscher et al., 2021; Fischer and Haucap, 2020; Meier et al., 2020). The first two of these studies found that prices were slow to adapt for the early German so-called Ghost Games, indicating a lack of market efficiency, and thus providing profitable opportunities for bettors (Deutscher et al., 2021; Fischer and Haucap, 2020). The third study also showed this pattern in the other European leagues when they returned, with it taking up to 30 days since the first German games for the inefficiencies to vanish (Meier et al., 2020). As such, it seems consequential that a fourth study (Hegarty, 2021) found that removing crowd-induced home advantage might have, in turn, improved betting market prediction efficiency in the long run. Further studies (e.g., Qureshi and Zaman, 2021) from college sports in the USA have also found significant measurable effects on the inefficiency of betting markets during the pandemic. De Angelis and Reade

(2022) consider European basketball, a sport played indoors, and find a significantly decreased home advantage in terms of win ratios during the pandemic, noting that this effect is not reduced as teams became familiar with playing without crowds. Moreover, the authors find that bookmakers immediately and effectively priced in this reduced home advantage, contrary to what Deutscher et al. (2021) and Fischer and Haucap (2020) found.

Given that the Covid-19 literature on football home advantage without fans suggests mixed evidence across the world's leagues, but a significant reduction in Germany's top-tier football competition (e.g., Fischer and Haucap, 2021), it could be that bettors and bookmakers just viewed what was happening in the Bundesliga as a plausible outlier. Nonetheless, these initial studies add to some previous literature demonstrating how betting markets can offer abnormal returns for participants who react quickly to major structural changes in the nature of the events, or temporal inefficiencies – in this case, markets were slow to adjust away from their long-held beliefs about the scale of home advantage in football. It is important to caveat that these inferences are only relevant for other financial markets in so far as the participants' behavior is comparable to sports bettors. Still, in essence, this new stream of economic literature can help us better understand what happens to betting markets when the signal-noise ratio of information gets upset.

What might economists look at next in sports?

Policy makers around the world need more evidence on if, when and how it is safe to open sports stadiums as Covid-19 rages. While the results in Olczak et al. (2020) and Alfano (2021) suggest caution in re-opening outdoor stadiums, they were based on fan behavior pre-Covid-19, without the subsequent adoption of social distancing, the wearing of face coverings, vaccines, or the redesign of public spaces to remove potential pressure points where people may congregate. Those results also come from the early (unawareness) stage in the spread of the virus. This may help to explain the different results in a study of the mass outdoor gatherings

during the Black Lives Matters (BLM) protests in the summer of 2020, which found no growth in Covid-19 cases or deaths in the weeks following these substantial relaxations of outdoor social distancing (Dave et al., 2020). There is a lot of heterogeneity in sports stadiums, as well as in how spectators normally experience a matchday. For example, BLM marchers were typically on the move, whereas sports crowds are largely static for up to two hours. These issues could be studied more closely, to understand whether there are restrictions short of a complete shutout that are manageable alongside Covid-19. The focus so far has been on how safe it is for the consumers of sport to return, with little attention given to the participants or staff involved with putting on these events and what employers can reasonably expect of them. It is quite possible that these effects will be very different depending on the different waves of Covid-19, which makes it essentially heterogenous and not a uniform treatment (see Dolton, 2021).

There are many unanswered questions about how the demand for spectator sports will recover to pre-pandemic levels and trends. We expect there will be a flurry of research on this in the coming year(s). One important distinction for this research will be the issue of stated versus revealed preferences and demand. Most studies of stadium attendance demand in sports shy away from this distinction, as it is often unclear whether the reported attendances in part reflect tickets purchased well in advance (i.e., season tickets; c.f., Schreyer and Ansari, 2021). This matters, as one study demonstrated when describing the behavioral response of German football fans to the 2015 Paris terrorist attacks, which would have otherwise been largely concealed when exploring such stated preferences (Frevel and Schreyer, 2020) – a lot of information can be revealed by studying the composition of stadium attendance demand, especially the no-shows for pre-purchased tickets (e.g., Schreyer, 2021). It will also be important to distinguish between casual and loyal sports fans in future demand research, with the latter group being more likely to purchase season tickets and the former group either

purchasing them on or near the day of an event. In a different but comparable context, Becker and Rubinstein (2005) demonstrated that the demand responses for goods and services affected by terrorism in Israel were solely accounted for by the occasional spectators; frequent spectators, i.e., season ticket holders, did not change their demand for bus travel or coffee shops following related terrorist activity in the country. Sports could also reveal what types of information about the risk of Covid-19 infection can predict significant demand responses for different types of consumers.

The studies of sports without the social pressure of a crowd have so far only scratched the surface. There are opportunities for deeper insights and more convincing descriptions of how the different participants and agents involved in contests are affected. For example, keeping the focus on football, the evidence so far is not entirely convincing that it is only referee bias that is affected by the lack of a crowd, rather than the different match outcomes being a result of changes to player behavior also. Future studies could disentangle this by looking more carefully at the in-play match context when referees made their decisions. For example, do referees “level things up” less with no crowd? Are they less likely to award a penalty or red card to one team after awarding one to the other team? Alternatively, without a crowd, do referees add on less stoppage time at the end of the game per substitution made when the home team is losing? Association football was the first sport to return after the initial Covid-19 hiatus with large numbers of events, making it a natural first sporting environment to exploit, with only a few notable exceptions looking at other major spectator sports (e.g., for NHL see Guérette et al., 2021; for MLB see Losak and Sabel, 2021; for European rink hockey see Arboix-Alió et al., 2022). However, there are also opportunities from studying the lack of social pressure on behavior and outcomes in other sports, including individual sports played in very different environments to football (e.g., darts, golf, and snooker).

There are detailed studies waiting to be done on how the uses of technologies in sports have changed from their introduction prior to Covid-19 and over the period from March 2020. For example, has the time taken to reach a decision in football using the video assistant referee (VAR) been reduced by the absence of a crowd, and have on-field decisions been more correct during the lockdown period? There is also the largely unaddressed question on whether the observed (modest) reduction in home advantage from an absent crowd was moderated by its normal pre-Covid-19 composition, in terms of the relative numbers of home and away fans. It is further worth testing whether fans returning to stadiums reversed the evidently robust effects of them emptying (c.f., Singleton et al., 2021), as well as the general dynamics of the ‘ghost games’ effects. For instance, as the decrease in home advantage was the subject of extensive public debate, referees might have adapted their behavior accordingly. After media attention on economists’ results demonstrating significant racial bias among officials in American sports, this bias reduced (see Price and Wolfers 2010, followed by Pope et al., 2018). Finally, it might be interesting to look at international football competitions, which typically include more travel, and, during tournaments such as the European Championships, and more balanced crowds.

There remain uncertainties about the effects of ‘long-Covid’ on exercise and sporting performance (e.g., Dores and Cardim, 2020). Throughout 2021, there have been large numbers of sports fixtures postponed because of players contracting Covid-19. This will lead to fixture backlogs within league competitions, which may disadvantage some teams more than others. In one of the first analyses, Fischer et al. (2021) studied the effects of COVID-19 infections on workplace productivity using German and Italian football data, noting that player performance dropped significantly after infection, with the resulting performance decline still evident after six months. Soon there will be enough data to analyze the potential long-term effects of infection within sports, drawing out insights for other markets and contexts as well. Some

professional teams have had players out of action for many weeks with long-Covid. The lasting effects on a team's performance could be studied, of what can be treated as random draws on the amount of talent available. As we move to a situation where the postponement of matches is determined by local conditions relating to the number of players in a club who have contracted the virus, we may be concerned about the verifiability and moral hazard issues involved. But, as a by-product, if matches are called off (as if) at random, then the uneven times between matches could be used to determine effects on performances due to match fatigue and overcrowded fixture lists. Somewhat related, the inevitable absences of head coaches and managers from matches following Covid-19 cases and exposure could be used to estimate the value of their leadership from the touchline.

Finally, another area of importance is the distributional effects of Covid-19 on sports. As in so many other areas, those at the top of the pile have done well whilst those at the bottom have fared badly. In English football, for example, the incomes of the smaller non-Premier League clubs have been much more adversely affected, as their shares of television broadcast rights are much lower (Reade and Singleton, 2020). This raises questions about the extent to which the bigger and richer sports firms should subsidize or bankroll the poorer and smaller firms because of Covid-19. Quite rightly, the richer firms point to the fact that in no other industry is it the case that some suppliers are forced to bankroll their failing competitors. However, this rhetoric ignores two important facts. First, a competitive sport fixture can only be produced if there are viable rivals to play against. Second, the big firms benefit from the small firms as nurseries for young talent coming through. This all relates to questions of competition within sports, and specifically whether having a concentration of success in a very few firms is sustainable. For example, one factor keeping the NFL and other North American sports alive and fascinating every season is the draft system; if a team finishes bottom of the rankings one season, it gets the first pick of new talent to potentially reverse its fortunes in the

next or following seasons. If European football leagues go on being won from among a select few teams, then they could limit or destroy their own appeal sometime in the future. Covid-19, through its distributional effects, may very well have exacerbated these problems.

References

- Ahammer, A., Halla, M., & Lackner, M. (2020). Mass gatherings contributed to early Covid-19 spread: Evidence from US sports. *Covid Economics*, 30, 44–62.
- Alfano, V. (2021). Covid-19 diffusion before awareness: The role of football match attendance in Italy. *Journal of Sports Economics*, Forthcoming. <https://doi.org/10.1177/15270025211067786>
- Angelini, G., De Angelis, L., & Singleton, C. (2022). Informational efficiency and behaviour within in-play prediction markets. *International Journal of Forecasting*, 38(1), 282–299. <https://doi.org/10.1016/j.ijforecast.2021.05.012>
- Arboix-Alió, J., Trabal, G., Peña, J., Arboix, A., & Hileno, R. (2022). The behaviour of home advantage during the Covid-19 pandemic in European rink hockey leagues. *International Journal of Environmental Research and Public Health*, 19(1), 228–240. <https://doi.org/10.3390/ijerph19010228>
- Bar-Eli, M., Krumer, A., & Morgulev, E. (2020). Ask not what economics can do for sports – Ask what sports can do for economics. *Journal of Behavioral and Experimental Economics*, 89. <https://doi.org/10.1016/j.socec.2020.101597>
- Benz, L. S., & Lopez, M. J. (2021). Estimating the change in soccer's home advantage during the Covid-19 pandemic using bivariate Poisson regression. *AStA Advances in Statistical Analysis*, Forthcoming. <https://doi.org/10.1007/s10182-021-00413-9>
- Becker, G. S., & Murphy, K. M. (2000). *Social economics: Market behavior in a social environment*. Harvard University Press.
- Becker, G. S., & Rubinstein, Y. (2011). *Fear and the response to terrorism: An economic analysis*. Centre for Economic Performance (CEP) Discussion Papers 1079.
- Bryson A., Dolton, P., Reade, J. J., Schreyer, D. & Singleton, C. (2021). Causal effects of an absent crowd on performances and refereeing decisions during Covid-19. *Economics Letters*, 198. <https://doi.org/10.1016/j.econlet.2020.109664>
- Cardazzi, A., Humphreys, B. R., Ruseski, J. E., Soebbing, B. & Watanabe, N. (2020). Professional sporting events increase seasonal influenza mortality in US cities. *SSRN Electronic Journal* (3628649). <https://doi.org/10.2139/ssrn.3628649>
- Croxson, K., & Reade, J. J. (2014). Information and efficiency: Goal arrival in soccer betting. *The Economic Journal*, 124(575), 62–91. <https://doi.org/10.1111/eoj.12033>

- Dave, D., McNichols, D., & Sabia, J. J. (2021). The contagion externality of a superspreading event: The Sturgis Motorcycle Rally and Covid-19. *Southern Economic Journal*, 87(3), 769–807. <https://doi.org/10.1002/soej.12475>
- Dave, D. M., Friedson, A. I., Matsuzawa, K., Sabia, J. J., & Safford, S. (2020). *Black Lives Matter protests, social distancing, and Covid-19*. National Bureau of Economic Research (NBER) Working Paper No. 27408. <https://www.nber.org/papers/w27408>
- De Angelis, L., & Reade, J. J. (2022). *Home advantage and mispricing in indoor sports' ghost games: the case of European basketball*. University of Reading Discussion Paper Number 2022-01.
- Deutscher C., Winkelmann, D., & Ötting, M. (2021). Bookmakers' mispricing of the disappeared home advantage in the German Bundesliga after the Covid-19 break. *Applied Economics*, 53(26), 3054–3064. <https://doi.org/10.1080/00036846.2021.1873234>
- Dohmen, T., & Sauermaun, J. (2016). Referee bias. *Journal of Economic Surveys*, 30(4), 679–695. <https://doi.org/10.1111/joes.12106>
- Dolton, P. (2021). The statistical challenges of modelling Covid-19. *National Institute Economic Review*, 257, 46–82. <https://doi.org/10.1017/nie.2021.22>
- Dores H., & Cardim, N. (2020). Return to play after Covid-19: A sport cardiologist's view. *British Journal of Sports Medicine*, 54, 1132–1133. <https://doi.org/10.1136/bjsports-2020-102482>
- Else, H. (2021). COVID and mass sport events: early studies yield limited insights. *Nature*. <https://doi.org/10.1038/d41586-021-02016-5>
- Endrich, M., & Gesche, T. (2020). Home-bias in referee decisions: Evidence from “ghost matches” during the Covid-19 pandemic. *Economics Letters*, 197. <https://doi.org/10.1016/j.econlet.2020.109621>
- Fischer, K. (2021). Thinning out spectators: Did football matches contribute to the second Covid-19 wave in Germany? *Covid Economics*, 71, 137–172.
- Fischer, K., & Haucap, J. (2021). Does crowd support drive the home advantage in professional football? Evidence from German ghost games during the Covid-19 pandemic. *Journal of Sports Economics*, 22(8), 982–1008. <https://doi.org/10.1177/15270025211026552>
- Fischer, K., & Haucap, J. (2020). Betting market efficiency in the presence of unfamiliar shocks: The case of ghost games during the Covid-19 pandemic. *SSRN Electronic Journal* (3692914). <http://doi.org/10.2139/ssrn.3692914>
- Fischer, K., Reade, J. J., & Schmal, W. B. (2021). *The long shadow of an infection: Covid-19 and performance at work*. Düsseldorf Institute for Competition Economics (DICE) Discussion Paper 369.

- Frevel, N., & Schreyer, D. (2020). Behavioral responses to terrorist attacks: Empirical evidence from professional football. *Applied Economics Letters*, 27(3), 244–247.
<https://doi.org/10.1080/13504851.2019.1613490>
- Guérette, J., Blais, C., & Fiset, D. (2021). The absence of fans removes the home advantage associated with penalties called by National Hockey League referees. *PLOS ONE*, e0256568.
<https://doi.org/10.1371/journal.pone.0256568>
- Hegarty, T. 2021. Information and price efficiency in the absence of home crowd advantage. *Applied Economics Letters*, 28(21), 1902–1907. <https://doi.org/10.1080/13504851.2021.1883525>
- Humphreys, B., Wagner, G. A., Whitehead, J. C., & Wicker, P. (2020). *Beyond ghost games: The value of avoiding Covid-19 with masking and social distancing in us professional sports*.
<https://www.youtube.com/watch?v=zND-c6LMSV4>
- Leitner, M. C., Daumann, F., Follert, F., & Richlan, F. (2022). The cauldron has cooled down: A systematic literature review on home advantage in football during the Covid-19 pandemic from a socio-economic and psychological perspective. *Management Review Quarterly*, Forthcoming.
<https://doi.org/10.1007/s11301-021-00254-5>
- Losak, J. M., & Sabel, J. (2021). Baseball home field advantage without fans in the stands. *International Journal of Sport Finance*, 16(3), 148–162.
<https://doi.org/10.32731/IJSF/163.082021.04>
- Levitt, S. D. (2004). Why are gambling markets organised so differently from financial markets? *The Economic Journal*, 114(495), 223–246. <https://doi.org/10.1111/j.1468-0297.2004.00207.x>
- Mastromartino, B., Ross, W. J., Wear, H., & Naraine, M. (2020). Thinking outside the ‘box’: A discussion of sports, fans and teams, and the environment in the context of Covid-19. *Sport in Society*, 23(11), 1707–1723. <https://doi.org/10.1080/17430437.2020.18041087>
- Meier, P. F., Flepp, R., & Franck, E. P. (2020). *Are sports betting markets semi strong efficient? Evidence from the Covid-19 pandemic*. UZH Business Working Paper No. 387.
<https://doi.org/10.2139/ssrn.3676515>
- Olczak, M., Reade, J. J., & Yeo, M. (2020). Mass Outdoor Events and the Spread of an Airborne Virus: English Football and Covid-19. *Covid Economics*, 47, 162–183.
- Parshakov, P. (2021). The Spread of Covid-19 and attending football matches: Lesson from Belarus. *SSRN Electronic Journal* (3764404). <https://doi.org/10.2139/ssrn.3764404>
- Peeters, T., & van Ours, J. (2021). Seasonal home advantage in English professional football; 1974–2018. *De Economist*, 169(1), 107–126. <https://doi.org/10.1007/s10645-020-09372-z>

- Pettersson-Lidbom, P., & Priks, M. (2010). Behavior under social pressure: Empty Italian stadiums and referee bias. *Economics Letters*, 108(2), 212–214.
<https://doi.org/10.1016/j.econlet.2010.04.023>
- Pope, D. G., Price, J., & Wolfers, J. (2018). Awareness reduces racial bias. *Management Science*, 64(11), 4988–4995. <https://doi.org/10.1287/mnsc.2017.2901>
- Price, J., & Wolfers, J. (2010). Racial discrimination among NBA referees. *The Quarterly Journal of Economics*, 125(4), 1859–1887. <https://doi.org/10.1162/qjec.2010.125.4.1859>
- Qureshi, K. & Zaman, T. (2021). *The impact of Covid-19 on sports betting markets*.
<https://arxiv.org/abs/2109.07581>
- Reade, J. J., & Singleton, C. (2021). Demand for public events in the COVID-19 pandemic: A case study of European football. *European Sport Management Quarterly*, 21(1), 391–405.
<https://doi.org/10.1080/16184742.2020.1841261>
- Reade, J. J., & Singleton, C. (2020). European football after COVID-19. In M. Billio and S. Varotto (Eds.), *A new world post COVID-19: lessons for business, the finance industry and policy makers*, (pp. 349–358). Ca' Foscari University Press. <http://doi.org/10.30687/978-88-6969-442-4/028>
- Reade, J. J., Schreyer, D. & Singleton, C. (2021a). Stadium attendance demand during the COVID-19 crisis: early empirical evidence from Belarus. *Applied Economics Letters*, 28(18), 1542–1547.
<https://doi.org/10.1080/13504851.2020.1830933>
- Reade, J. J., Schreyer, D. & Singleton, C. (2021b). Eliminating supportive crowds reduces referee bias. *Economic Inquiry*, Forthcoming. <https://doi.org/10.1111/ecin.13063>
- Schreyer, D. (2021). Moving toward behavioral stadium attendance demand research: First lessons learned from exploring football spectator no-show behavior in Europe. In H. J. R. Altman, M. Altman and B. Torgler (Eds.), *Behavioural Sports Economics: A Research Companion*, (pp. 264–286). Routledge.
- Schreyer, D., & Ansari, P. (2021). Stadium attendance demand research: A scoping review. *Journal of Sports Economics*, Forthcoming. <https://doi.org/10.1177/15270025211000404>
- Scoppa, V. (2021). Social pressure in the stadiums: Do agents change behavior without crowd support? *Journal of Economic Psychology*, 82. <https://doi.org/10.1016/j.joep.2020.102344>
- Singleton, C., Reade, J. J., & Schreyer, D. (2021). A decade of violence and empty stadiums in Egypt: When does emotion from the terraces affect behaviour on the pitch? *SSRN Electronic Journal* (3967464). <https://doi.org/10.2139/ssrn.3967464>

- Snowberg, E., & Wolfers, J. (2010). Explaining the favorite-long shot bias: Is it risk-love or misperceptions?" *Journal of Political Economy*, 118(4), 723–746. <https://doi.org/10.1086/655844>
- Stoecker, C., Sanders, N. J., & Barreca, A. (2016). Success is something to sneeze at: Influenza mortality in cities that participate in the Super Bowl. *American Journal of Health Economics*, 2(1), 125–143. https://doi.org/10.1162/AJHE_a_00036
- Takamatsu, S. (2021). Spectators' worries and attitudes during the Covid-19 pandemic: A case of a women's volleyball match in Japan. *International Journal of Sport and Health Science*, Forthcoming. <https://doi.org/10.5432/ijshs.202118>
- Thaler, R., & Ziemba, W. T. (1988). Anomalies: Parimutuel betting markets: Racetracks and lotteries. *Journal of Economic Perspectives*, 2(2), 161–174. <https://doi.org/10.1257/jep.2.2.161>