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Handbook of Sports Economics

Chapter on

The Economics of Cricket

By

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1. Introduction

Professional cricket is one of the most popular team sports in the world. The game originated in England, where it remains popular, but it is in the Asian subcontinent where the sport is most dominant. Cricket is also widely followed in several other countries in the Commonwealth such as Australia and South Africa. In 2015, an estimated audience of a billion people watched a live broadcast of the match between India and Pakistan in the Cricket World Cup (Berry, 2015). Despite this, economists have generally paid less attention to cricket than to other sports such as football, baseball, basketball or American football.

This chapter argues that cricket has a number of features which make it conducive to economic analysis. The sport is structured in such a way that the public is offered differentiated products, from Test matches between countries which can last up to five days to domestic

[1] We would like to thank Usha Sacheti for kindly assisting with data collection.

competitions comprising games lasting just a few hours. Further, these products have been subject to both product and technological innovation (Borooah, 2016; Shivakumar, 2016). At a micro level, playing the game involves a series of interesting decisions made by both officials and players under varying information sets and with uncertain outcomes. Many of these decisions are discrete in nature and outcomes depend not only on physical performance but also on chance, climatic and ground conditions as well as strategic awareness. As a result, intellectual skills relating to judgement of risk and reward are at a premium. The rapid rate of innovation in the structure of cricket in recent years has also provided researchers with a number of naturalistic experiments within which aspects of decision-making can be analysed (Sacheti et al., 2015). Considering also the amount of data generated by cricket matches, cricket provides a rich context for conducting economic research (Bhaskar, 2009).

The aim of this chapter is to highlight some of the more significant contributions made by economists to the analysis of cricket. In the next section, cricket's historical and institutional background is sketched out. In section 3, an overview of the cricket economics literature is provided. In section 4, the issue of bias amongst cricketing officials (umpires) is explored and some new data are used to analyse recent changes in decision-making technology. Finally, in section 5, some implications for cricket administrators are identified as well as suggestions for future research by economists.

2. Cricket: Overview and developments

Description of cricket

Cricket is a bat and ball game played between two teams of eleven players each. Although the earliest form of cricket is believed to have originated in southeast England in the

thirteenth century, games played in a form recognisable to the current sport can be traced back to the eighteenth century. Birley (2003) provides a full account.

At present, international cricket is played in three formats: the Test format, the One-Day International (ODI) format and the Twenty20 International (T20I) format. Each of these three formats has a counterpart in domestic cricket within the Test playing nations. It is at the domestic level that most cricketers are first able to earn a living playing the sport.

The Test format involves two batting 'innings' per team, and is peculiar in its length of playing time, which has varied between three days and 'timeless' over the history of the sport but is now standardized at five days. Notably, despite the length of playing time, Test matches still frequently end up in a 'drawn' game with neither side victorious. The ODI format was introduced in 1971. ODI games are played only one innings a side, and are designed to be completed within a day (matches typically last between seven and eight hours) and to produce a winner. Over three decades later, the T20I format, an abridged version of ODI cricket lasting three to four hours, was introduced in 2005.

Changes to the structure and regulations of cricket

The International Cricket Council (ICC) is the governing body of international cricket. The ICC is responsible for staging all global tournaments such as the Cricket World Cup and also selects match officials for all sanctioned international matches. The organization of domestic cricket and the national team is the responsibility of national cricket boards, as are all bilateral fixtures between cricket playing countries. National cricket boards are the sole 'buyers' for professional cricketers who wish to 'sell' their services in the market for international cricket selection. This framework has been challenged twice by unsanctioned cricket tournaments (the

World Series Cricket tournament in 1977 and the Indian Cricket League tournament in 2007 (Parker et al., 2008)). In both cases, cricket administrators responded by banning participating players. As a result, both leagues were short lived, but several of their innovations, such as day/night matches and coloured uniforms for players (rather than white clothing) now feature prominently in contemporary cricket.

More recently, officially sanctioned domestic T20 leagues have begun to challenge the dominance of international cricket. Although T20 cricket started with an English county competition in 2003, a significant development took place in 2008 when the Board of Cricket Control in India (BCCI), the governing body of Indian cricket, allowed private ownership of franchisee based teams in a domestic T20 league called the Indian Premier League (IPL). This is not the only novelty. Players are assigned to teams through an auction, and the resulting salaries can at times be in excess of those available from international cricket. The IPL's success has spawned several other leagues with a similar business model, including the Big Bash League (BBL) in Australia, the Bangladesh Premier League (BPL), the Caribbean Premier League (CPL) in the West Indies and the Pakistan Super League (PSL). These leagues are threatening the historical primacy of international cricket, and several commentators have raised concerns that the significant salary differential between T20 leagues and Test cricket could eventually even lead to the demise of Test cricket (White 2010, Fletcher 2017).

As well as innovations in the formats of the game, regulations affecting decision-making have also changed over the history of cricket. Prior to the 1990s, the match officials (umpires) in all international cricket matches were from the hosting country. However, home umpires from a number of countries faced persistent questions regarding their objectivity and competence[2]. In

[2] Perhaps the most notorious incident was during England's 1987 tour of Pakistan between England captain Mike Gatting and Pakistani umpire Shakoor Rana, see Johnson (1989).

response, the ICC mandated one neutral umpire for Test matches held in the early 1990s and, by 2002, ruled that both umpires should be from neutral countries. ODI cricket continues to feature one home and one neutral umpire. In 2009, the ICC began formally including technology in the decision-making process through the Decision Review System (DRS), which allows teams to challenge a fixed number of umpire decisions by seeking assistance from an off-field umpire (the third umpire, or TV umpire) with access to television replays of the on-field activity.

Other regulatory changes include the pre-match coin toss in which the captain winning the toss has the right to choose whether to bat or field first. The coin toss is thought to play an important role in the outcome of the match, albeit the statistical evidence is somewhat mixed (Bhaskar, 2009, Sacheti et al., 2016b). In 2015, the England and Wales Cricket Board (ECB) ruled that the visiting team would be offered the chance to bowl first and a toss used only if this option is declined.

Many of these decision-making features and innovations have been subject to economic analysis and we now turn to an overview of this academic literature.

3. The cricket economics literature

Much of the work by economists on cricket can be conveniently divided into two lines of inquiry:

1) Demand, structure and organization of cricket
2) Decision making in cricket

Although both areas are surveyed, the focus in this chapter will be on the second. It is argued that it is within the study of decision making where the empirical setting of cricket is particularly favourable relative to other sports. Discrete cricketing decisions are regularly made

by key actors such as leaders (cricket captains) and officials (cricket umpires) under reasonably controlled conditions. As such, it is possible to gain insights into potential biases that may be present in decisions, sometimes by exploiting exogenous rule changes which affect the decisions.

There are also other cricket-related fields of inquiry with a more limited literature which are briefly surveyed at the end of this section.

Demand, structure and organization

While research on cricket has a long history[3], the literature on cricket demand has received relatively little attention. Out of nearly 50 studies on demand for sport reviewed by Borland and Macdonald (2003), only one is on international cricket, this being Hynds and Smith (1994). To the authors' knowledge , there are in fact at least eight other published studies on the demand for international and domestic cricket—Schofield (1983); Chapman et al. (1987); Bhattacharya and Smyth (2003); Blackham and Chapman (2004); Paton and Cooke (2005); Morley and Thomas (2007) and Sacheti, Gregory-Smith and Paton (2014, 2016a).

Estimates of demand have typically employed Ordinary Least Squares (OLS) or Generalised Least Squares (GLS) regressions and have attempted to accommodate the various atypical aspects of cricket demand. First, watching live cricket carries a high opportunity cost in that spectators have to forgo considerable amounts of time, with the exception of T20I (T20 International) matches (Paton and Cooke, 2011). Second, prices for match day attendance can be endogenous to the quality of opposition. For example, cricket authorities in Australia set prices according to the strength of the opposition in order to maximise revenue (Bhattacharya and

[3] Statistical analysis of cricket in the academic literature dates back to, at least, Wood (1945) and Elderton (1945). Sloane (1976) included cricket as part of wider research on team sports. Work on the structure of the professional cricket industry can be traced back to Schofield (1982). An earlier overview of the literature is provided by Preston (2006).

Smyth, 2003). Third, match day attendances can be censored due to venue capacity constraints, as is the case in England (Paton and Cooke, 2005), although this far less likely in countries such as Australia due to the much bigger stadia (Sacheti et al., 2014, 2016a).

Like in other sporting settings, a stream of the cricket demand literature has considered the notion of competitive balance or uncertainty of outcome (e.g. Rocke et al., 2016). International cricket has a history of dominant teams, such as the West Indian team of the 1980s and the Australian team of the 1990s and early 2000s. Debates on team strengths led the ICC to introduce an official ratings system, but consideration of outcome uncertainty has been limited to relatively short-run measures of uncertainty such as match uncertainty and series uncertainty (Hynds and Smith, 1994 and Bhattacharya and Smyth, 2003). Sacheti et al. (2014, 2016a) examine longer run measures of uncertainty and find support for the uncertainty of outcome hypothesis in England but not Australia.

Decision making in cricket

Sporting settings such as the draft in American football (Massey and Thaler, 2013) have been used to examine how actors depart from the axioms of rational decision making. Decision making in cricket is particularly well suited to economic analysis. The decisions are often discrete (out or not out, bat or field), governed by precise rules, repeated numerous times over the course of a season and the outcomes are public knowledge and are feasible to assemble into a dataset. This potentially allows the identification of even quite subtle effects. Decision making in cricket offers analogies to behaviour in wider microeconomic contexts. For example, decision-making by cricket captains parallels the behaviour of corporate leaders. In both settings, agents are making complex decisions under uncertainty on behalf of their organisation and these

decisions draw upon experience, skill, risk preferences and are influenced by the incentives (possibly financial) facing the agent.

The impact of the coin toss and resulting decision by the captain to bat or field first has been analysed with respect to each format of the game, typically by employing logit/probit regression analysis. Identification is achieved by exploiting the random assignment of the decision following the coin toss. Overall, winning the toss appears to marginally increase the probability of winning the match, albeit results vary according to the specific empirical setting. Internationally, de Silva and Schwartz (1998); Bhaskar (2009) and Dawson et al. (2009) analyse the impact of the toss in ODI cricket, with the latter finding a stronger effect by focusing on day/night ODI matches. Allsopp and Clarke (2004) use data from both ODIs and Test matches and find no effect of winning the toss. Sacheti, Gregory-Smith and Paton (2016b) focus on T20I cricket and present evidence to suggest captains do not always choose optimally after winning the toss when under pressure from external commentators. Domestically, Morley and Thomas (2005) and Forrest and Dorsey (2008) find winning the toss increases the probability of winning but to a lesser extent than other variables such as home advantage, the weather and the strengths of the teams.

The studies on umpire decision making in Test cricket have focused on the Leg Before Wicket (LBW) dismissal decision, and whether this decision is being made optimally or exhibits bias. The LBW decision is particular to cricket, requires a high degree of judgment by the umpire in a very short period of time and can dramatically shift the momentum of a match. The early literature compared whether LBW decisions against home and away teams differ statistically, using data from either one country (e.g. Australia by Sumner and Mobley, 1981; Croucher, 1982 and Crowe and Middeldorp, 1996), several countries (Ringrose, 2006) or

domestic cricket (Jones et al., 2001). Although these studies tend to find that batsmen of home teams are given out LBW less frequently than away teams on average, it proved difficult to distinguish between umpire bias and pressure from home crowds as the cause of the difference. More recent evidence has exploited changes in umpiring regulations and decision-making technology to deepen our understanding of umpiring anomalies and the issue is considered in more detail in section 4.

Other themes in cricket research

A number of other issues have been studied in the context of cricket. Among these are:

1) Studies that assess batting strategy and forecast match outcomes. Of particular note is Duckworth and Lewis (1998)[4], who develop a method to reset targets and determine a winner in rain affected matches. The Duckworth-Lewis method was officially adopted by the ICC in 1998 and remains in use for most one-day games. Other studies include Preston and Thomas (2000), who consider domestic limited overs cricket in England; Brooks et al. (2002), who predict Test cricket outcomes using an ordered response model; Norton and Phatarfod (2008), who look at ODI matches and Akhtar and Scarf (2012), who use logistic regression models to forecast Test match outcomes by session.
2) Studies that provide quantitative measures to assess cricketers' performances. Barr and Kantor (2004) provide a criterion for comparing and selecting batsmen in ODI cricket, while Rohde (2011) applies the concepts of opportunity costs and supernormal profits to batting performance to produce a cardinal ranking system for players. Chedzoy (1997) examines the

[4] After their retirements, Professor Steven Stern became the custodian of the method. In November 2014, it was renamed the Duckworth–Lewis–Stern method (or D/L/S method).

impact of umpiring decisions on player performance. Bullough et al. (2016) look at the impact of central contracts on player performances.

3) Studies that use cricket as a setting to examine wider economic issues. Mandle (1972) provides an overview of the cricket labour market in its early history whilst Aiyar and Ramcharan (2010) attempt to identify the role of fortune in labour markets by separating the impacts of luck and ability on an individual's career progression. Mishra and Smyth (2010) look at the effect of the Indian cricket team's performance in ODI matches on returns on the Indian stock market.
4) Studies that develop models for the structure of international cricket. Preston et al. (2000) presented a model for an international club championship.
5) Studies that use T20 league auctions to draw insights on player valuations and on the economics of auction theory. Parker et al. (2008) assess the IPL auction in the wider setting of the economics of auctions. A small literature has looked at the determinants of player valuations, including Karnik (2010) and Lenten et al. (2012).

4. Decision-making anomalies: the latest evidence

The sports economics literature has identified a tendency for sporting officials to favour home teams (Garicano et al., 2005, Buraimo et al., 2010, Dohmen and Sauermann, 2016). Cricket is a particularly interesting laboratory for studying the issue for two reasons. First, cricket umpires are able to apply a high level of subjective judgement in decisions that can be critical for match outcomes. Second, regulatory changes to the appointment and functioning of umpires over the last two decades provide natural experiments that can help to identify the source of any bias.

In cricket, players first appeal to the umpire for a decision. Umpires face significant incentives to award the correct decision. Aside from the inherent satisfaction associated with making a correct decision, the more decisions umpires get correct, the more likely they are to be retained by the ICC. Nevertheless, umpires may exhibit a conscious or subconscious preference to favour home teams. In other sports, home support from large crowds has been shown to exert pressure on the neutral officials (e.g., Buraimo et al., 2010, find that home teams in the *Bundesliga,* the German football league, receive fewer yellow and red cards when crowds are closer to the field of play). To distinguish between these two sources of bias Sacheti et al. (2015) exploit a regulatory change which required first one and subsequently both umpires to be neutral (i.e., to be of a different nationality to both the playing teams) in Test cricket. Robust evidence is found that favouritism towards home teams was not associated with crowd size and, indeed, could be attributed almost exclusively to the presence of 'home' umpires. The implication is that umpires, on average, display favouritism to the team of their nationality, though it is impossible to know if this bias was conscious or sub-conscious.

A more recent development in officiating allows further insights into anomalies in the decision-making process. As noted above, the use of technology supports umpire decision-making through the DRS. An obvious line of inquiry is whether or not the DRS corrects the bias of home umpires and, if so, how it has achieved this. Although Test matches are now officiated by two neutral umpires, ODIs continue to have one home and one neutral umpire. For this reason, presented below are some preliminary results on a new sample of data on umpiring decisions in ODIs.

The Decision Review System: Context and Literature

International cricket has been one of the leaders in the use of technology in the umpire decision making process (other sports such as football have later adopted technology). Following a trial of the system in 2008, the DRS has been gradually introduced into the majority of international cricket matches. The system was welcomed at a relative early stage in its history by most Test playing countries, the one exception being India, who refused to allow the use of DRS in their matches until late 2016 (Hoult, 2016). Some observers retain doubts about the quality and accuracy of the technology used, which includes computerized projections of the path of the ball and a device that detects noise to try to identify whether the ball hit the bat. Using a Bayesian approach, Borooah (2016) argues that rather than taking the DRS decision as infallible, umpires should recognise it as a tool for updating their prior belief as to whether the batsman was out or not out. Borooah concludes that in its current format, the marginal improvement to decision making from DRS is not justified by the large set up costs.

Shivakumar (2016) analyses 912 LBW DRS referrals in Test matches between 2009 and 2014. The preliminary analysis below, although presently on a much smaller scale, advances Shivakumar's analysis in two important directions. First, since Sacheti et al. (2015) provide evidence that decision-making varies between neutral and home umpires, data are collected separately for on-field home and neutral umpires. Second, Shivakumar restricts his analysis to on-field decisions that are challenged, while data on all appeals, including those that are not reviewed, are collected here.

Data

We have data, collected by hand, on LBW decisions in ODIs played since 2015. Our sample comprises 20 matches where DRS was used and 20 where it was not. All matches are between Test-playing countries. For each match, we record the details of the match (e.g. venue, date, home and away teams, total runs scored and total overs bowled in each innings etc.) and data relating to umpiring decisions. These include data on all 57 LBW wickets, at what stage each LBW decision occurred and which umpire made the decision along with their nationality. For the DRS matches, we also have data on every LBW appeal, 135 in total, as well as whether the appeal was given out or not out, whether this decision was reviewed and, finally, whether the review was upheld. In each case we also record the bowler and batsman involved.

Neutral umpires and DRS

Table 1 reports the data on LBW appeals in DRS matches along with whether the appeal was reviewed and, if so, whether it was upheld or overturned. Separate reports for decisions made by home and neutral umpires and also whether the decision concerned a home or away batsman are provided. In Table 2, data on LBW wickets broken down by DRS and non-DRS games are presented. Decisions are reported separately for home and neutral umpires by whether a home or away batsman was given out.

The first item of note in Table 1 is that the overwhelming majority of appeals are not reviewed. Of the 135 appeals, only 28 (21%) were reviewed. Further, nearly 80% of appeals (106 of 135) are given 'not out' by the on-field umpires and only 12 of the 106 (11%) were reviewed. In contrast, 'out' decisions are reviewed more frequently with 16 of 29 (55%) 'out' decisions reviewed. It is the bowling side that initiates the appeal and there is no limit on the

number of appeals that can be made. As a result, many appeals will be of little merit and it is unsurprising that a relatively large proportion of the 'not-out' decisions go uncontested.

Moving to review success rates, 'out' decisions are reviewed with much greater frequency than 'not-out' decisions. 10 of the 16 on-field 'out' decisions were overturned on review while only 1 of the 12 'not-out' decisions were overturned. To some extent, this reflects the informational differences between a batting and bowling team at the moment when a decision to review is being made. For example, a batsman will be almost certain whether or not he has edged the ball prior to striking the pads which automatically overturns an LBW. In contrast, reviews of 'not-out' decisions are more likely cast in hope than expectation.

However, there could be other factors at play. Of particular interest is the high frequency of successful reviews in this small sample; 62.5% 'out' decisions are successful compared to 28% (119 of 420) of decisions found in Test matches by Shivakumar (2016). An important difference between this empirical setting of ODIs and Shivakumar's is that on-field decisions are made by one home umpire and one neutral umpire whereas in Shivakumar's sample both umpires are neutral. Two additional variables are thus brought to the analysis: one, whether the on-field decision was given by the home umpire, and two, whether the decision is in favour of the home team.

An important question is whether this sample displays the same evidence of home favouritism as that found in previous work such as Sacheti et al. (2015). To answer this, the differences between games where DRS operated and where it did not are considered (see Table 2). Home batsmen are given out less often by on-field home umpires but only when DRS is not available. Away batsmen are given 'out' more often by the on-field home umpire than the on-field neutral umpire but the effect is much larger where DRS is not available. Together, this

suggests that the presence of DRS could constrain the favouritism of home umpires towards home teams.

However, we do find some evidence of favouritism even in DRS games. It appears that decisions by on-field home umpires are overturned with greater frequency than neutral umpires. If the post-DRS decision is the correct one (noting the objection by Borooah (2016) above), the original decisions of home umpires were correct 89% of the time (64 of 72) while neutral umpires were correct 95% (60 of 63) of the time. Furthermore, looking more closely at the times when home umpires 'got it wrong', 3 of these decisions were against home teams whereas 5 of these decisions were against away teams. In contrast, neutral umpires made a mistake against the away team only once. Of course, whether these differences hold up in a larger sample remains to be seen. To be clear, other explanations for the differences are not ruled out. It may be neutral umpires are simply better umpires. Neutral umpires are selected by the ICC from a pool of umpires known as the "Elite Panel of ICC Umpires", which is considered the pinnacle of the profession for professional cricket umpires and hence they may make fewer mistakes.

Summary

This preliminary exploration of ODIs by umpire nationality suggests that on-field home umpires have a tendency to give the away team out more frequently than on-field neutral umpires. This is consistent with home favouritism as found in Sacheti et al. (2015) in the context of Test matches. When available, DRS appears to help correct this bias. In the final reckoning, the away team and the home team have the same number of dismissals by LBW. This provokes an interesting question. Why would home umpires favour home teams in a setting where they

know they can be found out? Perhaps this suggests that the favouritism exhibited by home umpires occurs subconsciously.

Another question that emerges from the analysis is whether the teams adjust their decision to review based on their beliefs as to whether a particular umpire is likely to be unbiased. Indeed, the preliminary results suggest that away batsman review the decision of the home umpire more than they do that of the neutral umpire. 11 out of 15 'out' decisions given by the home umpire were reviewed. In 8 out of these 11 cases, it was the away team that instigated the review. This compares to a review of only 5 of 14 'out' decisions given by the neutral umpire, of which only 3 were instigated by the away team. In other words, the away batsmen use their reviews to challenge the home umpire vs the neutral umpire at a ratio of 8:3.

There are other interesting questions that could be explored. The decision to initiate a review has not been theorised in the literature. An unsuccessful review carries an opportunity cost since the number of reviews is finite but the cost diminishes as the innings approaches an end (or 80 overs in Test matches). Also, the value of overturning a decision is increasing in the expected score of the batsman. Both these factors may influence the original decision of the umpire but exactly how is currently unknown. It may be that umpires are more willing to give a star batsman out, now they are supported by DRS. Alternatively, they may be less willing to give a star batsman out, knowing that a 'not-out' is less likely to be reviewed and overturned than an 'out' decision.

5. Policy implications and suggestions for future research

The cricket economics literature offers several insights for the ICC, national cricket boards and other key stakeholders in the sport. For example, the coin toss has been abolished in

domestic cricket in England by giving the away team the choice to bat or field first (to prevent home teams from deliberately preparing favourable pitches). However, the empirical evidence reviewed above suggests that such a policy change is unlikely to improve competitive balance substantially because winning the toss only marginally increases the probability of winning.

On the demand side, the finding that interest in ODI cricket in England benefits from longer run uncertainty of outcome suggests English administrators could prioritize matches against teams likely to provide a close contest. However, these findings need to be set against the argument that a more equitable structure of the sport requires presently weaker teams to receive exposure to better teams in order to develop in the future. This is of particular significance given protracted discussions between the ICC and national boards on the appropriate revenue sharing model for international cricket as well as debates on the inclusion of non-Test playing nations in global tournaments such as the World Cup and Champions Trophy, as well as the proposed inclusion of cricket in the Olympic Games.

Looking at decision-making technology, there are several interesting implications of the existing research for the ICC. For one, the use of home umpires in ODIs post-DRS could offer insight to inform the debate over whether or not to re-introduce home umpires in Test matches. The preliminary analysis of ODIs post-DRS in this chapter suggests that home teams receive an advantage when DRS is not in place, suggesting the ICC should not allow teams the choice of whether to use DRS. Finally, it is important for the ICC to carefully review the statistical evidence on the extent to which the DRS helps improve decisions, such as by reducing anomalies between home and neutral umpires, especially in light of setup costs for DRS.

To conclude the chapter some suggestions for areas of cricket research which are likely to be fruitful for economists are offered. Recent upheavals in the revenue sharing arrangements

from shared television rights for international cricket matches (in the last three years, two significantly different revenue sharing models have been put forward at the ICC[5] (ESPNcricinfo, 2017; Gollapudi, 2017; BBC, 2017) highlight the need for an academic study that provides a comprehensive analysis of the drivers of revenues from international cricket and the various domestic T20 leagues.

The literature on demand for cricket has focused predominantly on datasets recording attendance in England and Australia. This is at odds with the popularity of the sport in the Asian subcontinent. While data can sometimes be difficult to obtain in these countries, it is not reasonable to assume past results generated with English and Australian data will automatically carry over to other countries. In particular, the IPL affords new opportunities for research on competitive balance, as it has now been played for nine completed seasons and six different teams have won the IPL championship at the time of writing. The IPL uses a franchisee model with shared revenues from television rights so there is also scope for research on optimal revenue sharing arrangements.

The IPL and other T20 leagues could also offer other interesting avenues for research in terms of their impact on product quality (how does participation in T20 leagues affect player performances in international cricket, particularly T20I cricket?) and product demand (have attendances and consumption of other media offering international cricket changed after the introduction of T20 leagues?).

[5] The first model was proposed in 2014. It involved distributing a significantly higher proportion of ICC revenues to India, England and Australia. In 2017, the ICC put forward an alternative approach which reduced the contributions to India and England in percentage terms, whilst making more provision for non-Test playing countries.

When measuring the demand for cricket, studies have limited themselves to attendance demand. Ideally, wider measures such as television viewing figures should be used. Viewership could even be examined in real time to help explore the extent to which demand varies according to the state of play in a match. Such analysis will become more feasible as streaming services of international cricket matches over the Internet become commonplace. How do these different modes of consuming cricket interact? Are Internet streaming services complements or substitutes to live attendance?

Future work on decision-making would benefit from a better appreciation of the influence of live crowds and TV audiences on officials. In addition, there have been a number of recent instances of corruption in professional cricket, including several in T20 leagues. These have not yet been the subject of academic research and an obvious avenue to explore is any links between corruption and anomalies in decision-making by officials.

There are already signs in the past few years of a growing interest in cricket amongst economists. Potential exists for economists to derive significant insights which will be of interest not only to sports economics but also to the more general field of the microeconomics of behaviour and decision making.

6. References

Aiyar, S. and Ramcharan, R. (2010). What can international cricket teach us about the role of luck in labor markets? *International Monetary Fund Working Papers*, 10/225, pp. 1-29.

Akhtar, S. and Scarf, P. (2012). Forecasting test cricket match outcomes in play. *International Journal of Forecasting*, 28 (3), pp. 632-643.

Allsopp, P.E. and Clarke, S.R. (2004). Rating teams and analysing outcomes in one-day and test cricket. *Journal of the Royal Statistical Society Series A,* 167 (4), pp. 657-667.

Barr, G.D.I. and Kantor, B.S. (2004). A criterion for comparing and selecting batsmen in limited overs cricket. *Journal of the Operational Research Society*, 55 (12), pp. 1266-1274.

Berry, S. (2015) India beat Pakistan by 76 runs as estimated one billion viewers tune in to World Cup clash. The Telegraph, 15th February 2015, www.telegraph.co.uk/sport/cricket/cricket-world-cup/11413995/India-beat-Pakistan-by-76-runs-as-estimated-one-billion-viewers-tune-in-to-World-Cup-clash.html.

Bhaskar V. (2009). Rational Adversaries? Evidence from randomised trials in one-day cricket. *The Economic Journal* 119 (534), pp. 1-23.

Bhattacharya, M. and Smyth, R. (2003). The game is not the same: The demand for test match cricket in Australia. *Australian Economic Papers*, 42 (1), pp. 77-90.

Birley, D. (2003). *A Social History of English Cricket*. London: Aurum Press.

Blackham J. and Chapman B.J. (2004). The value of Don Bradman: Additional revenue in Australian Ashes tests. *Economics Papers: A journal of applied economics and policy*, 23 (4), pp. 369-385.

Borland, J. and Macdonald, R., (2003). Demand for Sport, *Oxford Review of Economic Policy*, 19 (4), pp. 478-502.

Borooah, V.K. (2016) Upstairs and Downstairs. The imperfections of cricket's Decision Review System, *Journal of Sports Economics,* 17 (1), pp. 64-85.

BBC (2017). India's share of ICC global revenues adjusted after initial vote. *BBC*, 22nd June 2017, http:/www.bbc.co.uk/sport/cricket/40374596.

Brooks, R.D., Faff, R.W. and Sokulsky, D. (2002). An ordered response model of test cricket performance. *Applied Economics*, 34 (18), pp. 2353-2365.

Bullough, S., Ramchandani, G., Coleman, R. and Miller, R. (2016). Central contracts in Test cricket: a model of best practice? *Managing Sport and Leisure*, 21 (5), pp. 338-352.

Buraimo, B., Forrest, D. and Simmons, R. (2010). The twelfth man? Refereeing bias in English and German soccer. *Journal of the Royal Statistical Society Series A*, 173 (2)**,** pp. 431-449.

Chapman, B., Fischer, A. and Maloney R. (1987). *An analysis of the determinants of English-Australian Test cricket crowds: estimating the value of Don Bradman.* Mimeo, Centre for Economic Policy Research, Research School of Social Sciences. Australian National University.

Chedzoy, O.B. (1997). The effect of umpiring errors in cricket. *The Statistician*, 46 (4), pp. 529-540.

Croucher, J.S. (1982). Anglo-Australian test cricket dismissals 1946-80. *Bulletin in Applied Statistics*, 9 (2), pp. 179-193.

Crowe, S.M. and Middeldorp, J. (1996). A comparison of leg before wicket rates between Australians and their visiting teams for Test cricket series played in Australia, 1977-94. *The Statistician*, 45 (2), pp. 255-262.

Dawson, P., Morley, B., Paton, D. and Thomas D. (2009). To bat or not to bat: An examination of match outcomes in day-night limited overs cricket. *Journal of the Operational Research Society,* 60 (12), pp. 1786-1793.

de Silva, B.M. and Swartz, T.B. (1998). Winning the coin toss and the home advantage in one-day international cricket matches. *Department of Statistics and Operations Research, Royal Melbourne Institute of Technology.*

Duckworth, F. and Lewis, A. (1998). A fair method for resetting the target in interrupted one-day cricket matches. *Journal of the Operational Research Society,* 49 (3), pp. 220–227.

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

Elderton, W.P. (1945). Cricket scores and some skew correlation distribution. *Journal of the Royal Statistical Society Series A*, 108 (1-2), pp. 1-11.

ESPNcricinfo (2017). Revealed: The ICC's new financial model. *ESPNcricinfo*, 9th February 2017, http://www.espncricinfo.com/story/_/id/18650019/revealed-icc-new-financial-model.

Forrest, D.K. and Dorsey, R. (2008). Impact of weather and toss on County Cricket Championship outcomes. *Journal of Sports Sciences*, 26 (1), pp. 3-13.

Fletcher, T (2017). Cricket: more Twenty20 may sow seeds of demise for the quintessential English game. *The Conversation,* 6th April 2017, http://theconversation.com/cricket-more-twenty20-may-sow-seeds-of-demise-for-the-quintessential-english-game-75520.

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

Gollapudi, N. (2017). BCCI, ICC broker peace over financial model. *ESPNcricinfo*, 22nd June 2017, http://www.espncricinfo.com/story/_/id/19704972/bcci,-icc-broker-peace-financial-model.

Hoult, N. (2016). India finally give in and agree to use DRS in England Test series. *The Telegraph*, 21st October 2016, http://www.telegraph.co.uk/cricket/2016/10/21/india-finally-give-in-and-agree-to-use-drs-in-england-test-serie/.

Hynds, M. and Smith, I. (1994). The demand for test match cricket. *Applied Economics Letters*, 1 (7), pp. 103-106.

Johnson, M. (1989) Pakistan v England 1987 in “Wisden Anthology 1978-2006: Cricket's Age of Revolution”, editor Moss S, A and C Black.

Jones, M.V., Bray, S.R. and Bolton, L. (2001). Game location and officiating bias in English club cricket. Perceptual and Motor Skills, 93 (2), pp. 359-362.

Karnik, A. (2010). Valuing cricketers using Hedonic price models. *Journal of Sports Economics*, 11 (4), pp. 456-469.

Lenten, J.A., Geerling, W. and Kónya, L. (2012). A hedonic model of player wage determination from the Indian Premier League auction: further evidence. *Sport Management Review*, 15 (1), pp. 60-71.

Mandle, W.F. (1972). The professional cricketer in England in the nineteenth century. *Labour History*, 23, pp. 1-16.

Massey, C. and Thaler R. H. (2013). The loser's curse: decision making and market efficiency in the National Football League draft. *Management Science,* 59 (7), pp. 1479-1495.

Mishra, V. and Smyth, R. (2010). An examination of the impact of India’s performance in one-day cricket internationals on the Indian stock market. *Pacific-Basin Finance Journal*, 18 (3), pp. 319-334.

Morley, B. and Thomas, D. (2005). An investigation of home advantage and other factors affecting outcomes in English one-day cricket matches. *Journal of Sports Sciences,* 23 (3)*,* pp. 261-268.

Morley, B. and Thomas, D. (2007). Attendance demand and core support: evidence from limited-overs cricket. *Applied Economics*, 39 (16-18), pp. 2085-2097.

Norton, P. and Phatarfod, R. (2008). Optimal strategies in one-day cricket. *Asia-Pacific Journal of Operational Research*, 25 (4), pp. 495-511.

Parker, D., Burns, P. and Natarajan, H. (2008). Player valuations in the Indian Premier League. *Frontier Economics*, pp. 1-17.

Paton, D. and Cooke, A. (2005). Attendance at County Cricket: an economic analysis. *Journal of Sports Economics*, 6 (1), pp. 24-45.

Paton, D. and Cooke, A. (2011). The changing demands of leisure time: the emergence of Twenty20 cricket, ch. 18, pp. 602-39, in Cameron, S (Ed.) *Handbook on the Economics of Leisure.* London: Edward Elgar.

Preston, I. (2006). The economics of cricket, ch. 61, pp. 585-93 in Andreff, W. and Szymanski, S (Eds.) *Handbook on the Economics of Sport* London: Edward Elgar.

Preston, I., Ross, S.F. and Szymanski, S. (2000). Seizing the moment: a blueprint for reform of world cricket. *ESRC Study Group, Economics of Sport, Arts and Leisure*, 13.

Preston, I. and Thomas, J. (2000). Batting strategy in limited overs cricket. *The Statistician*, 48 (1), pp. 95-106.

Ringrose, T.J. (2006). Neutral umpires and leg before wicket decisions in test cricket. *Journal of the Royal Statistical Society: Series A (Statistics in Society)*, 169 (4), pp. 903-911.

Rocke, K.D., Ramkissoon, B.I., Iton, A. and Khan, M. (2016). The global trend of competitive balance of domestic Twenty20 Cricket competitions: a survey of the 2010-2015 seasons. *International Journal of Sports Studies*, 6 (2), pp. 81-89.

Rohde, N. (2011). An "economic" ranking of batters in test cricket. *Economic Papers: A journal of applied economics and policy*, 30 (4), pp. 455-465.

Sacheti, A., Gregory-Smith, I. and Paton, D. (2014). Uncertainty of outcome or strengths of teams: an economic analysis of attendance demand for international cricket. *Applied Economics*, 46 (17), pp. 2034-2046.

Sacheti, A., Gregory-Smith, I. and Paton, D. (2015). Home bias in officiating: evidence from international cricket, *Journal of the Royal Statistical Society Series A (Statistics in Society)*, 178 (3), pp. 741-55.

Sacheti A., Gregory-Smith I. and Paton D. (2016a). An economic analysis of attendance demand for One Day International cricket. *Economic Record* 92 (296), pp. 121-36.

Sacheti A., Gregory-Smith I. and Paton D. (2016b). Managerial decision making under uncertainty: the case of Twenty20 cricket. *Journal of Sports Economics*, 17 (1), pp. 44-63.

Schofield, J. (1982). The development of first-class cricket in England: an economic analysis. *The Journal of Industrial Economics*, 30 (4), pp. 337-360.

Schofield, J.A. (1983). The demand for cricket: the case of the John Player League. *Applied Economics*, 15 (3), pp. 283-296.

Shivakumar, R. (2016). What technology says about Decision-Making: evidence from cricket's Decision Review System (DRS). *Journal of Sports Economics*. Published on-line 11 July 2016.

Sloane, P.J. (1976). Restriction of competition in professional team sports. *Bulletin of Economic Research*, 28 (1), pp. 3-22.

Sumner, J. and Mobley, M. (1981). Are cricket umpires biased? *New Scientist*, 91 (1260), pp. 29-31.

White, J. (2010), Twenty20 will kill Test cricket within 20 years, says West Indian great Michael Holding, *The Telegraph*, 1st June 2010, http://www.telegraph.co.uk/sport/cricket/twenty20/7790638/Twenty20-will-kill-Test-cricket-within-20-years-says-West-Indian-great-Michael-Holding.html.

Wood, G.H. (1945). Cricket scores and geometrical progression. *Journal of the Royal Statistical Society Series A*, 108 (1-2), pp. 12-40.

Table 1: summary of LBW appeals in DRS matches

		All			Home umpire			Neutral umpire		
		Total	Home bat	Away bat	Total	Home bat	Away bat	Total	Home bat	Away bat
Given out	All	29	12 (41.4%)	17 (58.6%)	15	6 (40.0%)	9 (60.0%)	14	6 (42.9%)	8 (57.1%)
	Not reviewed	13	7 (53.8%)	6 (46.2%)	4	3 (75.0%)	1 (25.0%)	9	4 (44.4%)	5 (55.6%)
	Reviewed	16	5 (31.3%)	11 (68.8%)	11	3 (27.3%)	8 (72.7%)	5	2 (40.0%)	3 (60.0%)
	Upheld	*6*	*1 (16.7%)*	*5 (83.3%)*	*4*	*1 (25.0%)*	*3 (75.0%)*	*2*	*0 (0.0%)*	*2 (100.0%)*
	Overturned	*10*	*4 (40.0%)*	*6 (60.0%)*	*7*	*2 (28.6%)*	*5 (71.4%)*	*3*	*2 (66.7%)*	*1 (33.3%)*
Given not out	All	106	42 (39.6%)	64 (60.4%)	57	21 (36.8%)	36 (63.2%)	49	21 (42.9%)	28 (57.1%)
	Not reviewed	94	36 (38.3%)	58 (61.7%)	48	15 (31.3%)	33 (68.8%)	46	21 (45.7%)	25 (54.3%)
	Reviewed	12	6 (50.0%)	6 (50.0%)	9	6 (66.7%)	3 (33.3%)	3	0 (0.0%)	3 (100.0%)
	Upheld	*11*	*5 (45.5%)*	*6 (54.5%)*	8	*5* (62.5%)	*3* (37.5%)	3	*0* (0.0%)	*3* (100.0%)
	Overturned	*1*	*1 (100.0%)*	*0 (0.0%)*	*1*	*1 (100.0%)*	*0 (0.0%)*	*0*	*0*	*0*

Notes:
(i) Data is derived from 20 ODIs in January and February 2017.
(ii) Source is match commentary and scorecards from www.espncricinfo.com with some supplementary information taken from www.cricbuzz.com

Table 2: summary of LBW wickets

		All			DRS			Non-DRS		
		Total	Home ump	Neutral ump	Total	Home Ump	Neutral ump	Total	Home Ump	Neutral ump
Original decision	Out - all	57	30 (52.6%)	27 (47.4%)	29	15 (51.7%)	14 (48.3%)	28	15 (53.6%)	13 (46.4%)
	Out - home bat	28	12 (42.9%)	16 (57.1%)	12	6 (50.0%)	6 (50.0%)	16	6 (37.5%)	10 (62.5%)
	Out - away bat	29	18 (62.1%)	11 (37.9%)	17	9 (52.9%)	8 (47.1%)	12	9 (75.0%)	3 (25.0%)
Final decision	Out - all	48	24 (50.0%)	24 (50.0%)	20	9 (45.0%)	11 (55.0%)	28	15 (53.6%)	13 (46.4%)
	Out - home bat	25	11 (44.0%)	14 (56.0%)	9	5 (55.6%)	4 (44.4%)	16	6 (37.5%)	10 (62.5%)
	Out - away bat	23	13 (56.5%)	10 (43.5%)	11	4 (36.4%)	7 (63.6%)	12	9 (75.0%)	3 (25.0%)

Notes:
(i) Data is derived from 20 ODIs using DRS and 20 in which DRS was not used. The non-DRS matches took place between March 2015 and October 2016.
(ii) Source is match commentary and scorecards from www.espncricinfo.com with some supplementary information taken from www.cricbuzz.com