Department of Economics

Sport Economics Cluster
Economic Analysis Research Group (EARG)

It's Just Not Cricket: The Uncontested Toss and the Gentleman's Game

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Discussion Paper No. 2020-10

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It's Just Not Cricket: The Uncontested Toss and the Gentleman's Game

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May 2020

Forthcoming chapter in "Advances in Sports Economics"
Agenda Publishing, Ed: R. Butler

Abstract

Cricket offers a wealth of opportunity and potential insights for economists and other researchers. Focusing on the oldest domestic cricket competition, the English County Championship, we discuss issues of demand, home advantage, competitive balance and the importance of winning the pre-match coin toss to determine the playing order. Despite cricket being generally regarded as a sport for traditionalists, the County Championship is remarkable in how often the rule makers have altered its format. We study one recent change, the replacement of the mandatory pre-match coin toss with an uncontested one, whereby the away team could decide whether to bowl first or face a toss to bat instead. In theory, this ought to have reduced home advantage, made the toss matter more when it was contested, and incentivised teams to prepare better pitches leading to longer matches. We found no evidence of the first or the last of these effects, but matches did become more predictable once the toss was decided. This suggests that the rule makers were right to abandon this experimental change after only four seasons.

Keywords: Home advantage, First-mover advantage, Decision making under uncertainty, Coin toss, County Championship, Fist-class cricket

JEL codes: D81, L83, Z22

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We thank Robbie Butler and Mark Casson for helpful comments. The data used in this study are available under subscription from Cricket Archive; https://cricketarchive.com/. The use of these data does not imply the endorsement of the data owners in relation to the interpretation or analysis of the data.

1. Introduction

Cricket is a massive sport. It dominates the attention of sports fans on the Indian Subcontinent. It is a national obsession in India, Pakistan, Bangladesh, Sri Lanka, Afghanistan and Nepal, as well as among these ethnic communities found in large numbers around the world, such as in the Arabian Peninsula. It is also popular in other regions of the former British Empire, such as Southern Africa, Australia, New Zealand and the Caribbean. Cricket remains the dominant sport of the English summer, despite the encroaching influence of football. To put the scale of the demand and interest in cricket into perspective, a 2019 match between India and Pakistan in the World Cup drew an estimated live broadcast audience of one billion.[1] In comparison, the biggest live event in the US annual sporting calendar, the National Football League (NFL) Super Bowl, attracts around 100 million domestic viewers and less than that number again in the rest of the world.[2] Even the 2018 FIFA Football World Cup Final had an estimated average viewership of just over 500 million.[3] In this context, there is a surprising lack of economic literature concerning cricket, at least when compared with the team sports most focused on by economists, such as baseball, basketball, Association football and American football (Gregory-Smith et al., 2019). Like these other sports, cricket is a setting that allows effective economic analysis, with implications not just for this sport and others, but for our wider understanding of economic behaviour.

In this chapter, we focus on the oldest cricket league, the English County Championship (henceforth the CC). The CC is the premier domestic first-class cricket competition in England, with matches played over several days. The competition can be traced back to the 1700s in some form, but it officially began in 1890. From the first match to the most recent, we have complete data not only on final outcomes but also the specifics of what happened within those matches. Despite the increasing popularity of short-form cricket, the CC still makes up most of the professional cricket played in England each season. One reason why the CC is interesting for economists is that its rule makers have continuously tinkered with its design over the past 130 years. We will describe some of the major changes alongside a timeline of how competitive the league has been over time. Generally, the

[1] Source: Dave Richardson, International Cricket Council (ICC) Chief Executive https://www.mirror.co.uk/sport/cricket/one-billion-watch-crickets-biggest-16528033. This estimate may be on the high side, however, as the ICC reports 270 million watched India against Pakistan in the 2019 World Cup. However, similar estimates were also made that a billion people watched the 2015 World Cup match between the same two sides: https://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.

[2] Source: Nielsen, via CNN: https://edition.cnn.com/2020/02/03/media/super-bowl-2020-ratings/index.html

[3] Source: FIFA: https://www.fifa.com/worldcup/news/more-than-half-the-world-watched-record-breaking-2018-world-cup

tinkering appears to have worked in one respect, as in the past two decades the CC was as competitive as it has ever been. We focus on the period since the competition was split into two hierarchical divisions in 2000, documenting the extent of home advantage, i.e., teams playing at their home ground have a higher chance of winning a match.

The main attention of this chapter is on a novel rule change the CC brought in for the four seasons from 2016 to 2019. Before this period, each cricket match started with a mandatory coin toss, with the captain calling it correctly making the decision on whether his team should bat or field first. Given the variable conditions of a CC match over the maximum four days that it can last, the outcome of the toss can be important. It potentially favours the home side, who can prepare the playing conditions, i.e., the pitch, with the expectation that if they were to win the toss, then it would suit their relative strengths and preferences. In 2016, the mandatory coin toss was replaced with what was described as an uncontested toss.[4] Under this system, the away team had the option of whether to bowl first or instead face a toss should they prefer to bat first. The principal aim of this rule change was to counteract the incentive of the home team to prepare a 'poor' pitch, with plenty of grass left on to aid seam movement, which could favour its bowling strengths in the early stages, and thus lead to a match finishing well within the scheduled four days. In other words, the hope was that the uncontested toss would lead to a better balance of competition between bat and ball within the match, as well as increasing the uncertainty of the match outcome through reduced home advantage. We analyse the impact of this rule change over several relevant match outcomes. We find statistically weak evidence that the change increased the extent to which the toss outcome could predict the match result. This unintended consequence is not offset by a reduction in home advantage. There is also no convincing evidence that batting conditions persistently improved in the CC after 2016, through longer first innings, suggesting that home teams did not on average respond to the change by preparing substantially 'better' pitches. The rule makers have decided to revert to the mandatory coin toss from the 2020 season. On balance, this appears to be the correct decision, not least because cricket fans, especially those who follow the CC, are well-known as traditionalists.[5]

[4] Formally, the English Cricket Board referred to this rule change as "no mandatory toss"; https://www.espncricinfo.com/story/_id/20430915/no-mandatory-toss-county-championship. A similar rule was introduced to domestic cricket in Pakistan for the 2019/20 season and called the "no toss" rule; https://www.pcb.com.pk/press-release-detail/pcb-announces-playing-conditions-and-code-of-conduct-for-2019-20-season.html. It is colloquially referred to as an "uncontested" toss as this is what is recorded on match scorecards.

[5] Whenever a new rule change is suggested or the game of cricket revolves, there is typically significant grumbling among what are referred to as 'traditionalists' of the game, be they fans (e.g. https://www.spectator.co.uk/article/cricket-s-traditionalists-should-embrace-the-day-night-test) or past and present players (https://www.telegraph.co.uk/cricket/2017/10/10/players-union-warns-cricketers-traditionalists-unlikely-support/).

The remainder of the chapter proceeds as follows: Section 2 introduces the economics of cricket, including past studies, a brief description of the game and the CC, with its major rule changes over the past 130 years, as well as a description of competitive balance and home advantage in the CC. Section 3 analyses the impact of the uncontested toss on match outcomes. Section 4 concludes the chapter.

2. The Economics of Cricket

2.1 Why should cricket interest economists?

Cricket is of potential interest to economists for several reasons. The game has a long history. It has gone through several rule changes, as well as the development of different forms of the game. Across its history, the sport has experienced numerous innovations, such as the use of technology to aid decision making. The game also involves a series of decisions by teams, players and officials, often made under pressure. These decisions can be easily observed, aided by the discrete nature of the game, i.e., the game comprises a series of innings, played over sessions, which in turn consist of a set of overs and balls bowled. It is easy to collect definitive individual-level performance data, in the form of batting, bowling and fielding statistics. There is a greater scope to explore home advantage, compared with other sports, since match conditions systematically vary across venues, and not only are teams more familiar with some conditions but they can also affect them. Cricket is subject to some clear exogenous factors, such as a coin toss and weather. The longer form of the game especially offers scope to explore a wide set of decisions and outcomes.

2.2 What are cricket and the County Championship?

2.2.1 First-class cricket – a brief description

Cricket is a game involving a bat and ball between two teams of eleven players. It takes place on a field, which has somewhere toward the centre a pitch (twenty-two yards in length) with a wicket at both ends. The game is overseen by two on-field umpires (referees), with some matches (typically at international level) having a third umpire (television match official) and a match referee. In each innings one team bats and one team bowls (fields). In first-class cricket (matches taking place over at least three days), each team has up to two innings, which alternate. An innings normally ends when ten wickets have fallen (ten of a team's eleven batters are given out by the umpire), and the roles are

then reversed in the next innings. An innings may also end if the batting team decides to declare early, usually to try and force a result before the match time runs out, or if a team runs out of batsmen due to injury. Typically, there is a minimum number of overs expected to be bowled in a day, with a set time limit for play. An over consists of six balls bowled to the batting team. In a four-day first-class match that goes to the very end of the fourth day, with no interruptions, 350-380 overs could be expected. In other words, such a match can consist of over 2,000 individual events (balls bowled). A team's aim over the course of a match is to score more batting runs than their opposition before either teams' resources have run out, which are the time remaining in the game and the number of wickets to have fallen (number of players out).[6]

In first-class cricket, there are effectively five possible match outcomes for a team: win, loss, draw, tie or no result. A team wins (loses) if they score more (less) runs than the other team over their two completed innings. A draw takes place when a game does not reach the conclusion of the fourth innings. A tied match occurs when the final wicket falls in the fourth innings and the cumulative numbers of runs scored by both teams are the same. This is rare. A no result outcome is normally declared when weather or other circumstances prevent the first innings from beginning. Weather is often a factor in determining a drawn match, due to time lost because of rain or bad light.

If a captain wins the coin toss, then his or her decision to bat or bowl first will be determined by factors including the interaction of the pitch (both the initial condition and how it is expected to change), expected weather conditions and each team's relative strengths, especially among the bowlers. Whilst they have no control over the weather, the home team has an incentive to produce a pitch that plays to their strengths or suits their purposes. For example, a home team that is ahead in an international series of matches may produce a pitch that is likely to lead to a draw. A team with strong spin bowlers can produce a pitch that is expected to 'take turn' as the match progresses, such that they have a strong advantage in the final innings. Teams may have a financial incentive when preparing a pitch, to attempt to ensure the match lasts the full number of days to maximise revenue, rather than favouring the bowlers too much and producing an early outcome. However, home teams still face an element of risk when producing pitches, as the coin toss still determines who decides on batting first.

[6] There are currently ten ways in which a wicket can fall in cricket. In brief, the five common ways are: bowled (the stumps are hit directly by the ball from the bowler's delivery or after it strikes any part of the batsman), caught (the ball is caught directly after hitting the batsman's bat or gloves), leg before wicket (the ball would have hit the stumps if it hadn't hit the batsman first, before the bat, and depending on where the ball pitched before), run out (the stumps are broken when a batsman attempts a run but is out of his/her ground), and stumped (a batsman is out of his/her ground following the delivery of the ball and the wicketkeeper breaks the stumps).

In games played over four innings, the general wisdom, at least at the international Test level, is that teams should opt to bat first, owing to the fact it becomes more difficult to bat as the pitch gets older (though not always, e.g. in New Zealand[7]). However, teams may opt to field first if they believe their bowlers can exploit the early match conditions. It is often argued that a pitch allowing a good battle between bat and ball creates a better spectacle, leading to greater interest and demand for the game.[8] The mark of a 'good' pitch is one which results in a win for one of the teams well into the final day of scheduled play, so long as the opposing teams are not completely mismatched in their strengths or play is not significantly interrupted by the weather.

2.2.2 The County Championship

There have been many changes to the CC across its history. This includes the number of teams competing, the structure of the league (a single division versus two), the length of matches in days or overs, the number of matches played by teams each season and how points are awarded. There have also been changes to penalties and other inventions, such as permitting games to be decided on a single innings and allowing day/night matches.

In 1890, there were only eight county teams (Gloucestershire, Kent, Lancashire, Middlesex, Nottinghamshire, Surrey, Sussex and Yorkshire). The CC expanded to nine teams in 1891 (Somerset), to fourteen in 1895 (Derbyshire, Essex, Hampshire, Leicestershire, and Warwickshire), to fifteen in 1899 (Worcestershire), to sixteen in 1905 (Northamptonshire), to seventeen in 1925 (Glamorgan) and finally to eighteen in 1992 (Durham). The competition was a single league until 2000, after which it was divided into two hierarchical leagues of nine teams each, with promotion and relegation at the end of each season. The rationale for introducing two divisions was twofold according to Forrest and Dorsey (2008). First, it reduced the number of "meaningless" matches, with the aim of increasing stadium attendances and revenues. Second, it improved the quality of domestic (home-grown) players, by concentrating talent in a top division, giving teams greater incentives to invest in talent to achieve promotion or avoid relegation. This should then in turn improve the strength of the England Test match team. From 2000 to 2005, three teams were promoted to and relegated from Division One each season. This decreased to two teams from 2006 to 2015 and 2017 to 2018. In 2016, two teams were relegated but only one promoted, as Division One decreased to eight teams. In 2019, only one team

[7] See ESPN Cricinfo (2020) on why Test cricket in New Zealand is different to anywhere else in the world: https://www.espncricinfo.com/story/_/id/28734914/why-test-cricket-new-zealand-unlike-anywhere-else-world.
[8] See ESPN Cricinfo (2017) for a discussion of the balance between bat and ball in ODIs; https://www.espncricinfo.com/story/_/id/27093872/why-bat-ball-balance-now-probably-best-in-odi-history.

was relegated from Division One and three teams were promoted to Division One, increasing the number of teams in Division One to ten. The latter increase in the size of Division One was to reduce incentives toward short-termism for management and coaches in the top division, who would fear the sack if they were relegated.[9]

Since 1993, matches have exclusively taken place over four days, but this has varied in the past. Prior to 1988 all matches were three days, with an experiment of two days in 1919. Between 1988 and 1992 teams predominately played three-day games with some four-day games mixed in. The minimum number of overs expected to be bowled in a day, weather permitting, has varied over time. It is currently 96, with the possibility of adding a further eight overs per day if time was lost to bad weather on previous days. On the final day of a match, captains can agree to finish when sixteen overs are remaining and call it a draw if they wish, which means a minimum of eighty overs bowled.

Throughout the history of the CC, there have been continual tweaks to the number of games played, points systems and, therefore, how final league positions and champions were determined. From 1963, all teams consistently played the same number of games in a season, though that number has varied over time, tending to decrease as the limited overs forms of the game (One Day, normally fifty overs per side, and T20, twenty overs per side) became more financially lucrative. Before 1963, there were seasons where teams played a varying amount of games and, to determine final league positions, the points earned from each match were adjusted by the number of games or possible points. From 1993 to 1999, teams played seventeen matches, i.e. each other team once, with some teams having one fewer home match than others. From 2000, when the CC was split into two divisions, teams played sixteen matches, each other team in the division home and away. This was reduced to fourteen matches in 2017, when the number of teams in each division also changed.

The points system has also altered through time. The first CC in 1890 had a system of one point for a win, minus one for a loss and zero for a draw. Since the matches have been played over four days, there have been several changes to the weighting of points, particularly for wins and draws. Points for a draw (three points) were first introduced in 1996. Win points were reduced from sixteen to twelve in 1999, but then increased to fourteen in 2003 and back to sixteen in 2010. Points for a draw were increased to four in 1999, then reduced back to three in 2010 and increased to five in 2014. Bonus points were first used in the CC in 1957, based on comparative runs scored in the first innings and run rates, until 1962, and then re-introduced in 1968 for both batting and bowling performances

[9] See English Cricket Board: https://www.ecb.co.uk/news/894379/counties-agree-to-men-s-domestic-structure-changes-from-2020

in the first innings over a set number of overs. The idea of bonus points is to encourage and reward teams for more attractive play, to increase fan interest.[10] Bonus points have been used consistently since 1968, although the points system has varied, i.e. the maximum number of batting or bowling points and the time in a match when they are awarded. For example, the number of overs during which bonus points could be accumulated was reduced from 130 to 120 in 2009 and to 110 in 2010, to incentivise faster scoring, more attacking cricket and preparation of good pitches. Currently there are a maximum of 8 bonus points (up to 5 batting points and up to 3 bowling points).

If a lot of wickets fall in a day's play the pitch will be inspected. The umpires can report a 'poor' pitch. The penalty for a poor pitch was originally twenty-five points, one more than the maximum number for a win with full bonus points. Essex were the first team to receive such a penalty in 1989. The exact penalty has varied over time but has generally been reduced. The most recent example was Somerset in 2019, who were deducted twenty-four points, although twelve of these were suspended for two years and the other twelve will be applied in the 2021 season.

2.3 Does competitive balance matter in cricket?

The uncertainty of outcome hypothesis was introduced by Rottenberg (1956) and states that the interest of sports fans, and thus the demand for sport, will be greater when contests are more competitive. Uncertainty of outcome can be separated into three levels (Cairns et al, 1986): match, season and long-run dominance, which Szymanski (2003) termed championship uncertainty. Season-level and long-run dominance can be important for demand. If many teams are in contention to win a championship and in the running for promotion or relegation, or if a variety of teams win a championship and get promoted/relegated over the longer term, then this will maintain interest and demand. In general, there is mixed evidence on whether there is a positive relationship between the uncertainty of outcome and the demand for sport (Borland and Macdonald, 2003; Szymanski, 2003). Studies often do not distinguish between match-level, season-level or long-run dominance (Szymanski, 2003).

In studies relating to cricket, several have focused on the link between uncertainty of outcome and spectator demand. Studies have examined attendances at Test cricket (e.g., Bhattacharya and Smyth, 2003; Blackham and Chapman, 2004; Hynds and Smith, 1994; Sacheti et al., 2014), One Day Internationals (ODIs) (e.g., Sacheti et al., 2016) and domestic matches (e.g., Morley and Thomas,

[10] Whilst there are no studies that have looked at the impact of bonus points in cricket, Lenten and Winchester (2015) focused on their introduction in rugby union, finding that teams scored more tries, but only toward the end of a match when a win was already likely.

2007; Paton and Cooke, 2005; Schofield, 1983). These studies have tended to find that match-specific factors are more important than economic ones. Some examined the impact on attendance of match uncertainty (e.g. whether the result is a foregone conclusion, subjectively determined, going into the final day), series uncertainty for international fixtures (e.g. whether the result of a series of matches is known before the final match) and match and season uncertainty for domestic competitions. They tend to find stronger evidence that series uncertainty has a more significant, negative impact (Bhattacharya and Smyth, 2003; Blackham and Chapman, 2004; Hynds and Smith, 1994). In contrast, Sacheti et al. (2014) found the reverse, with little evidence of any significant impact of series uncertainty, which may relate to tickets for Test matches typically being sold in advance, and some evidence of the impact of match uncertainty, i.e. a certain result on the final scheduled day has a negative impact on demand; tickets for day five are often only sold on the day. At the domestic level, there is the possibility of a wider set of match and season-level uncertainty measures, and the evidence suggests that the latter are important for demand. Morley and Thomas (2007) captured season-level uncertainty using a measure of whether a team was still in contention for the championship, whilst Paton and Cooke (2005) found that matches which were not important in terms of promotion and relegation had reduced attendances. Paton and Cooke (2005) also found that match uncertainty had no significant demand effects in the 2000, 2001 and 2002 English seasons.

A couple of studies have focused on long-term patterns. Sacheti et al. (2014) examined the impact of different measures of uncertainty of outcome on attendance at Test cricket in England, New Zealand and Australia between 1980 and 2011, using differences in official team rankings. Their findings suggested that long-term uncertainty has a limited influence on Test cricket attendances, but the strength of the home and away team in each match does. However, there is some evidence that long-term uncertainty is important for ODI attendance in England but not in Australia (Sacheti et al, 2016). To the best of our knowledge, no studies have examined the effects of long-term measures of uncertainty of outcome on domestic cricket.

2.3.1 Competitive balance in the County Championship

Irrespective of the apparently dubious empirical evidence regarding competitive balance, the history of rule changes in the CC is indicative of governing bodies who were convinced that competitive balance was essential to generate fan interest. Over almost the whole post-war era, attendances at CC matches have been falling, prompting different tweaks in the format of the longer-form game, as well as creating entirely new shorter formats.

Using the final points totals of teams at the end of each season, constructed using the entire history of the CC from CricketArchive.com (see Section 3.1 for more details on this data source), we consider two measures of competitive balance over time. The first is the commonly used Gini coefficient:

$$GiniCC_{ds} = \frac{2\sum_{i=1}^{n_{ds}} ip_{ids}}{n_{ds}\sum_{i=1}^{n_{ds}} p_{ids}} - \frac{n_{ds}+1}{n_{ds}}, \quad with \quad p_{ids} \leq p_{i+1ds}\ , \tag{1}$$

where p_{ids} is the number of points achieved by team i in division d and season s, and n_{ds} is the number of teams in the division that season. To construct this measure for each season and, after 1999, each division, we use the points system applied at the time. That is, over time we track the amount of end-of-season competitive inequality, with a larger Gini coefficient implying that the CC was less competitive. Figure 1 plots these measures for each season since 1890. It shows that the early years of the CC were relatively unequal and that the level of inequality varied dramatically from season to season. This is not a pattern unique to cricket. Association football, whose formal leagues developed in England at around the same time, also displayed high inequality in its early years (Reade, 2020).

After the early years, the distinguishing features of competitive inequality in the CC are a permanent reduction to a new and quite consistent level, after Glamorgan were admitted in 1921. A further reduction occurs in the mid-1960s, shortly before the introduction of the one-day game. This also coincided with an equal number of games being played by all teams in a season, thus plausibly removing any advantages or disadvantages that an uneven fixture list had previously created. The introduction of bonus points in 1968 also appears to have happened alongside the CC becoming more competitive, with teams thereafter earning rewards even if they lost a match. What is distinct about the CC is that a relatively high level of competitive balance has been maintained over such a long period.

Again, making a comparison with English football, competitive balance in that sport deteriorated consistently over the half century after it reached its high point in the 1950s (Reade, 2020). But this has not happened in English cricket. This is despite a myriad of changes being made to the game in the pursuit of improving demand. Whereas the post-war decline in football attendance numbers reversed in the 1980s (Reade, 2020), the same has not happened in cricket, despite relatively high levels of competitive balance.

Figure 2, which focuses in on the split into two divisions in 2000, suggests a slight upward trend in competitive inequality over the past two decades. There is no suggestion that this was reduced by

the introduction of the uncontested toss. If anything, the 2016-2019 seasons were, on average, marginally less competitive than the decade which came before.

A second measure of competitive balance attempts to evaluate the extent to which final championship outcomes change between seasons, i.e. competitive mobility, and can be written as:

$$C_s = \frac{\sum_{i=1}^{n_s} |r_{is} - r_{is-1}|}{n_s}, \quad (2)$$

where r_{is} is the rank of team i in season s, and n is the number of teams. A higher value would generally be regarded as better, and up to the point where the CC split into two divisions, this measure was as high as it had been in the entire history of the competition, as Figure 3 shows. The highest period of competitive mobility appears to have been between the mid-1960s and 2000, coinciding with the era of bonus points, balanced fixtures and a single division. After the split in 2000, this measure of balance in the CC has fallen mechanically because of limited promotion and relegation. The average season-to-season change in a team's rank has been between 1 and 3.5 positions over the past two decades, whereas it reached as high as 7 in 1998. There is no suggestion that competitive mobility was any higher or lower in the 2016-2019 period with the uncontested toss than in the previous fifteen seasons.

2.4 Is there home advantage in cricket?

There is plenty of evidence in the sports economics literature that suggests officials tend to favour home teams, whether consciously or unconsciously (for reviews see Dohmen and Sauermann, 2016; Reade, 2019). Cricket involves umpires who make quick and often subjective judgements, especially in relation to LBW (Leg Before Wicket) decisions. Several studies have looked at LBWs and found that away team batsmen received more decisions (outs) than those on the home team (Crowe and Middeldorp, 1996; Ringrose, 2006; Sacheti et al., 2015), although it is difficult to separate out umpire bias from the pressure of the home crowd. Sacheti et al. (2015) used the switch to neutral umpires in international cricket to disentangle these two factors, with the evidence pointed more toward umpires favouring their own national team. Cricket has used technology for a relatively long time (since approximately 1992) to aid the decisions of officials, when compared with other sports, such as football. More recently the game has introduced a Decision Review System (DRS), first used in 2008 (Gregory-Smith et al., 2019), where players can refer decisions to a third umpire. A small number of

papers have looked at the impact of DRS on decision making and umpiring (e.g., Borooah, 2016; Gregory-Smith et al., 2019; Shivakumar, 2018). Gregory-Smith et al. (2019) showed that DRS can reduce the potential bias of decisions in favour of the home team.

Allsopp and Clarke (2004) identified home advantage in cricket by the number of runs scored in ODIs, with an average of 14 runs more scored by the home team. De Silva and Swartz (1998) also found evidence of home advantage in ODIs. Dawson et al. (2009), in their exploration of day/night ODIs (one team bats in daylight and the other bats under artificial light), found significant home advantage, i.e. if a team was playing at home, then this increased its odds of winning by 69%. In the context of Test matches, Allsopp and Clarke (2004) found a home advantage in terms of runs scored in the first innings. They also found that a significant first innings lead was a good predictor of a winning outcome, and this relationship was stronger for the home team than the away team. Morley and Thomas (2005) examined domestic one-day matches and, consistent with the evidence at international level, found that home teams won 57% of the time, and the advantage of winning the toss was greater for home teams. To the best of our knowledge, there are no studies that have examined the home advantage in CC matches. In none of these studies was home advantage explicitly linked to the issue of how pitches were prepared. Allsopp and Clarke (2004) considered that conditions may vary across countries, but the inclusion of parameters for individual countries or similar conditions, such as in the Indian Subcontinent, did not improve their common home advantage model.

2.4.1 Home advantage in the County Championship

Home advantage is a concept common across many forms of sport. At first glance it appears quite slight in the CC. From Figure 4, the percentage of matches that finished as wins for the home team in a season has only been marginally higher than the percentage that finished as away wins. Home advantage is substantially smaller than is commonly found in football matches (see e.g., Singleton et al. 2019; Reade et al. 2019).

To some extent, the draw disguises the extent of home advantage, and so we also plot over time in Figure 4 the percentage of matches that ended in a home win excluding drawn games. After the uncontested toss rule was introduced in 2016, there is evidence that this slightly mitigated home advantage, since the percentage of non-drawn matches that were won by the home team was falling year-on-year, reaching precisely 50% in 2019.

2.5 First-mover advantage and the toss of a coin

The decision on which team bats first in a cricket match is generally decided by the toss of a coin. The winning captain decides whether their team will bat or field first. Therefore, which team gets to make this decision is randomly determined. Several studies have found limited evidence of an advantage from winning the toss in one-day cricket (Allsopp and Clarke, 2004; Clarke and Allsopp, 2001; Silva and Swartz, 1998) and Test cricket (Allsopp and Clarke, 2004). Bhaskar (2009) found in daytime ODIs that winning the toss and batting first decreased the chances of winning. There is a general wisdom that teams winning the toss, particularly in the longer form, should opt to bat first, and this preference for batting may lead to teams making sub-optimal decisions (Bhaskar, 2009). Allsopp and Clarke (2004) argued that teams' typical preferences for batting first may explain why there is no advantage from winning the toss in Test cricket. Some studies have specifically examined the toss in day/night matches, where an advantage from the conditions is clearer (Bhaskar, 2009; Dawson, 2009). It is typically harder to bat under lights in the second innings, so it is usually more advantageous to bat first. In this context, Dawson (2009) found that in a contest between two evenly matched teams, winning the toss and batting first led to a 57% probability of winning. If the home team won the toss and chose to bat first, then its win probability increased to 69%.

In domestic cricket, there is further evidence that the toss matters. Morley and Thomas (2005) found that winning the toss in domestic one day matches could be an advantage, but other factors such as weather, home advantage, team strength and the importance of the match for the league standing of a team were more important in determining the result. Forrest and Dorsey (2008) showed that the toss was influential in the CC between 1993 and 2006, in matches where there was a winner (i.e. excluding draws and no results). 54.2% of teams winning the toss went on to win, and this was significantly different from 50%. The authors found no evidence that, if the home team won the toss, they subsequently had a greater chance of winning. The importance of winning the toss was the same for both the home and the away team. Forrest and Dorsey (2008) discussed several reasons why the toss may be more important in the CC compared to ODIs or in Test matches. They argued that, compared to limited overs cricket, there are fewer restrictions in the CC, which may allow teams to better exploit favourable conditions and effective bowlers, in addition to the fact that the pitch will deteriorate more in a four-day match, given the longer period of play. However, in Test matches, they argued that there are typically greater resources available and financial incentives to produce a better pitch, which has a better chance of holding up, allowing more even playing conditions and negating the toss advantage.

Figure 5 shows that before 2016 winning the toss in the CC was on average more advantageous to the home team than the away team. Since 2016, the evidence also suggests that the toss became a more important factor in determining the outcome of a match.

3. The Impact of the Uncontested Toss

In 2016, the County Championship introduced the uncontested toss. The mandatory toss was removed over concerns about the state of the pitches being prepared in the CC, especially in Division Two, and the impact that this may have had on the competitiveness of the England Test team, in terms of batting skills (such as patience, 'hanging around at the crease' and shot selection), both the playing and the development of quality spin bowling, fast bowling and the ability to reverse swing the ball.[11] The pitches being prepared in the CC suited English weather conditions, incentivising teams to pick and develop players suited to these, who were likely to be unsuited to the conditions faced in Test cricket overseas, such as in the Indian Subcontinent or Australia (England has only won one of the last eight Test series in Australia, and one of the last seven in India, but has a consistently strong record at home). Unlike in other sports, the primacy of the international game, and the role of the domestic setup to support it, is generally accepted in English cricket, not least because the domestic teams receive a large proportion of their revenues through the broadcasting agreements for international cricket.

Probably reflecting the changing nature of pitch preparation and player skills in the CC, as well as the increasing scheduling of matches in the peripheries of the domestic season in spring and early autumn, if we look at the decision of the team winning the toss since 2000, we can see a marked increase in opting to field first. In 2015, the year before the uncontested toss was introduced, 55% of teams opted to field first (51% in Division One and 58% in Division Two) compared with 28% in 2000 (33% in Division One and 24% in Division Two). Crudely speaking, this would suggest that pitches may have become more friendly to medium-paced bowlers over time, who can extract the most advantage out of a pitch when it is still green and relatively new.

In the 2016 season, the first year of the uncontested toss, just 39% of away teams opted to field first rather than face a toss, suggesting that batting first was generally preferred, in contrast to the previous few seasons. However, by the 2018 and 2019 seasons, over half of the away teams opted to

[11]See ESPNcricinfo, among various other media or official sources: https://www.espncricinfo.com/story/_/id/20430915/no-mandatory-toss-county-championship. See also the ECB in 2017 discussing the reasons why they decided to keep the rule change in place after the first season: https://www.ecb.co.uk/news/123373/toss-changes-retained-after-positive-spin.

field first. This suggests that despite the rule change initially having the intended effects of favouring batting and longer matches, teams may have reverted quickly toward preparing pitches that favoured their players' domestic bowling skills and thus shorter matches.

Despite these patterns, and the intentions of the ECB when introducing the uncontested toss, it is not *a priori* obvious what to expect from the response by teams and match outcomes. Home teams should have had a decreased incentive to prepare pitches which suited their strengths, conditional on a 50:50 chance of winning the toss. This should have reduced home advantage overall. In matches where the toss was uncontested, we should expect a clear reduced home advantage, as without having to win a toss, an away team had a chance to exploit conditions that favoured bowling first over batting. But, if a toss was contested, then we should expect that its outcome mattered more. A contested toss would generally imply that match conditions did not suit the away team bowling first, suggesting that the home team had a clear advantage if they could make them do this. In other words, when a toss happened, we should expect its outcome to have had a greater impact on determining the match outcome in the 2016-2019 seasons than before. This should have increased the incentive for a home team to prepare pitches which favoured batting first. Therefore, we should expect to see longer first innings in 2016-19 than before.

The rationale of the uncontested toss was as follows. Giving the away team the option of putting the home team in to bat first would encourage counties to produce better pitches. These pitches would allow matches to last longer and encourage more spin and reverse swing bowling, as well as giving batsmen more practice at batting long and playing such bowling. However, the uncontested toss was scrapped from 2020 after just four years, due to the English Cricket Board (ECB) believing that tougher penalties for a poor pitch would lead to improvements, and that a change in the seam of the Dukes cricket ball used in CC would improve the balance between bat and ball.[12]

3.1 Data

As above, the data used to analyse the impact of the uncontested toss rule change are extracted from CricketArchive.com, using scorecards of every CC match ever played. The entire dataset covers 22,237 matches in total since 1890, which are used to derive some of our variables and the figures described above. However, the focus of the analysis is on the twenty seasons in 2000-2019, after the

[12] How pronounced the seam is on a cricket ball affects the ability of a bowler to generate movement off the pitch, thus affecting how likely a ball bowled will result in a wicket because the batsman misjudges its line by the time it gets to him/her. See Wisden in 2019 summarising the ECB's decision: https://www.wisden.com/stories/county-cricket/uncontested-toss-scrapped-for-2020-county-championship.

CC split into two divisions, with promotion and relegation. We ignore the 161 matches which had no result, typically because the match was abandoned before any play due to weather or pitch conditions, leaving 2,809 matches to focus on since the beginning of the 2000 season.

We focus on five different outcome variables of cricket matches:

1. Whether the home team won, conditional on the match not ending in a draw;
2. Whether the home team avoided defeat, i.e., they won or drew the match;
3. Whether the away team avoided defeat;
4. The combined total number of runs scored in both the home and away teams' first innings, conditional on both teams having completed their first innings.
5. The combined total number of overs bowled in both the home and away teams' first innings, conditional on both teams having completed their first innings.

We study outcomes 1-3 to assess whether the uncontested toss rule change affected the ultimate outcomes of cricket matches, on average. We consider these three binary outcomes to simplify the model estimation and interpretation of the results. We study outcomes 4 & 5 to assess whether the nature of matches was affected by the uncontested toss, i.e. whether the length of the first innings increased, implying that pitches prepared that were more friendly to batting earlier in the match.

Scorecards tell us the outcome of the toss in each match, as well as whether it was contested or not from 2016 onwards. We also construct time-varying measures of the teams' relative strengths. To do this, we use the entire history of CC results. We generate dynamic Elo (1978) ratings, which are updated using a recursive algorithm after every match result. The original application of this rating system was applied to Chess players and leagues, but it has since been used widely in the sports economics literature as a way to capture the relative abilities of teams throughout a season, depending on the relative strengths of the opponents they have played up to that point in time (e.g. Hvattum and Arntzen, 2010).[13] Figure 6 plots these ratings for the eighteen CC teams since 1890. Like the Gini coefficient in Figure 1, the pattern of Elo ratings over time represents reduced competitive inequality, through reduced variance, especially in the past two decades, implying that teams' relative strengths have narrowed.

[13] To apply the rating system to cricket, we score a win as 1, a draw as 0.5 and a loss as 0. We choose an updating factor of 40.

3.2 Estimation

To assess the impact of the uncontested toss on the outcomes of CC matches, we estimate the following (logistic) regression model using data from all matches since the beginning of the 2000 season:

$$y^*_{ms} = \alpha_m + \lambda_1 HToss_{ms} + \lambda_2 HToss16'19_{ms} + \lambda_3 Uncon_{ms} + \boldsymbol{x'_{ms}}\beta + \varepsilon_{ms} \ , \qquad (3)$$

$$\varepsilon_{ms} \sim \text{Logistic}(0,1) \quad ,$$

$$y_{ms} = \begin{cases} 1; & y^*_{ms} > 0 \\ 0; & otherwise \end{cases} \quad ,$$

where m refers to the distinct matchup between a home and an away team, e.g., Surrey playing at home against Yorkshire, and s is the season. In our preferred specifications, we include fixed effects in the model, α_m, such that we identify the impacts of the rule change from variation over the seasons in outcomes within matchups. The outcome variables, y^*_{ms}/y_{ms}, are the five listed above. $HToss_{ms}$, $HToss16'19$ and $Uncon_{ms}$ are dummy variables, taking a value of one if the home team won the toss, if the home team won the toss in the period 2016-2019, and if the toss was uncontested, respectively (i.e. the excluded category is the away team winning a toss that was contested). Therefore, λ_1 estimates the effect of the home team winning the toss, λ_2 estimates the added effect of the home team winning the toss during the 2016 to 2019 seasons and λ_3 measures the impact of the away team choosing not to contest the toss from 2016 to 2019 (i.e. they chose to bowl first). The combination of these three effects maps to all possible outcomes of the toss over the 20 seasons examined, allowing an assessment of whether this matters for each outcome. We also include control variables in $\boldsymbol{x_{ms}}$, with corresponding coefficient vector β. This includes the ELO ratings of both home and away teams before each match to capture their time-varying relative strengths in the CC, as well as fixed effects for the season and the month in which the matchup took place. ε_{ms} gives the (latent) model error term, representing all other unspecified heterogeneity in match outcomes.

For outcomes 1-3, we use conditional likelihood estimation when admitting the matchup fixed effects. The standard logistic regression model estimates of such models are inconsistent (Chamberlain, 1980). For outcomes 4 & 5, we estimate the equivalent model as stated above by ordinary least squares. In the versions of these models without the matchup fixed effects, we estimate standard errors robust to home-team-season clusters, to account for heteroskedasticity across the different teams and how they performed or prepared their pitches within seasons. When including the

matchup fixed effects, we estimate standard errors robust to these matchup clusters. We exclude from the analysis all matches which had no result.

3.3 Results

Table 1 presents the results of estimating Equation (3) for the first three outcomes that we focus on, using all CC matches since the beginning of the 2000 season. Columns (I) and (II) consider only those matches that did not end in a draw and whether the home team won. Columns (III) and (IV) consider the effect of the toss on whether the home team avoided losing the match. Similarly, columns (V) and (VI) look at whether the away team avoided defeat. Columns (I), (III) and (V) omit the matchup fixed effects from the regression model, whereas the other columns include them and are our preferred specifications, since they address any bias from not accounting for the fixed unobserved heterogeneity of CC matches. For example, Somerset may have a particularly strong home advantage when winning the toss, since they normally prepare pitches which favour their spin bowling strengths, which some of their opponents have been generally weaker against. The estimated models in Table 1 all exclude season and month fixed effects, as these were found to be generally statistically insignificant. In other words, conditional on the other factors controlled for, the general extent of home advantage in the CC has remained unchanged since 2000. The ELO rating regressors for both home and away teams are generally significant predictors of match results, and have the expected signs, though these effects are weaker when the matchup fixed effects are included in the models.

In all six regressions summarised in Table 1, the effect of winning a toss improves a team's likelihood of achieving a positive result. However, these effects are not statistically significant at standard levels, unlike the results for the CC in Forrest and Dorsey (2008), who did not control for relative team strengths nor fixture heterogeneity, and who estimated less conservative standard errors. During the 2016 to 2019 seasons, an away team choosing not to contest a toss is associated with a decreased likelihood of home success, but not significantly so. If a toss did take place in this period, then the importance of winning it increases with regards the final match result, as hypothesised. However, when we consider whether a home team wins or avoids defeat, this effect is not statistically significant. If an away team loses a toss, having chosen to contest it, then their likelihood of avoiding defeat is 69% of what it was if they had lost a toss before 2016 in the same fixture. This effect is marginally statistically significant (p-value<0.1). In general, these results are consistent with the expected effects of the uncontested toss rule change: an away team gains an advantage when it chooses

not to contest a toss and a toss matters more when it is contested. In other words, what happened before the first ball was bowled in a match had a bigger impact on the eventual result than it did before the uncontested toss was introduced. However, the general uncertainty of cricket match outcomes means that these model estimates are imprecise, and the conclusions are not statistically convincing.

Table 2 summarises the ordinary least squares estimates of Equation (3) for two more cricket match outcomes: the total collective number of runs scored (columns I & II) and overs bowled (columns III & IV) in both teams' first innings. As before, the preferred model specification includes matchup fixed effects (columns II & IV). Across all these estimates, there is no evidence that winning the toss significantly affects these outcomes for either team. This holds over the entire period, both before and after the uncontested toss rule change. However, a team deciding to not contest a toss and to bowl first in the 2016-2019 seasons is associated with 42 fewer runs scored (p-value<0.1) and 13 fewer overs bowled (p-value<0.05) in the first two completed innings of a match. These effects are reduced compared with model estimates which omit the matchup fixed effects, highlighting the importance of controlling for fixture heterogeneity. The results should not be a surprise, since an away team deciding to bowl first would typically imply that conditions favoured their bowlers early in a match, with the consequence of lower scores and wickets falling more frequently.

The regression models summarised in Table 2 include season fixed effects. These estimates are displayed with confidence intervals in Figure 7 for runs scored and Figure 8 for overs bowled. These provide, for each season, the conditional estimates of the mean number of total runs scored or overs bowled in the first two completed innings of matches. There is suggestive evidence that in the first season where the uncontested toss was introduced, the length of the first two innings increased relative to the few seasons before, though they were no longer than in the early 2000s. Furthermore, this initial effect did not persist during the 2017 to 2019 seasons. Therefore, there is no clear evidence that the uncontested toss led to better pitches that favoured batting and longer matches.

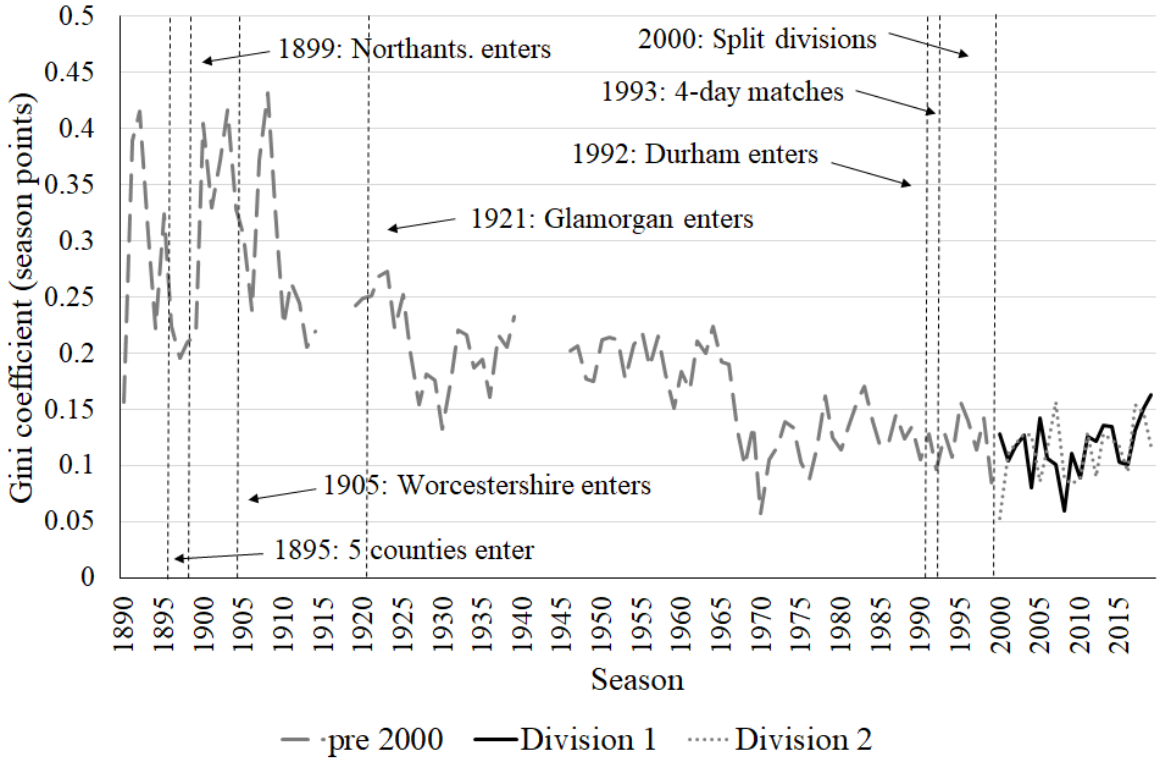
4. Conclusion

The County Championship is one of the longest running annual leagues in professional sport. Over the past 130 years, there have been many changes to how this competition is administered, with the rule makers consistently tinkering with the format to achieve their objectives. In this chapter, we focused on the recent introduction of a novel rule in cricket, whereby the away team could choose

whether to bowl first or face a coin toss, to instead possibly have the option of batting. Previously, a mandatory coin toss determined who got the decision on whether to bowl or bat first. Although the duration of this experiment was too short to yield a definitive answer on its effects, we found some statistically weak evidence that it increased the impact on match results from whichever team made the decision to bat or bowl first. This is potentially to the detriment of the demand and revenues for the CC, given that there is evidence from previous studies that the uncertainty of match outcomes negatively affects cricket attendances (e.g., Sacheti et al., 2014). We find no evidence that the uncontested toss consistently increased the length of the first two completed innings in a match, which was the primary objective of the rule makers. Taken together, this suggests that the right decision, to abandon this experiment from the end of the 2019 season, has probably been made by English cricket's administrators.

The game of cricket offers substantial opportunities for further economic research. Technology continues to creep into the game, either in terms of assisting or evaluating both umpire and player decision making. While there have been some studies on the impacts of this already (e.g. Borooah, 2016), there are opportunities to look closer at the effects that decision review systems have, and whether their use should be extended, given both the fixed setup costs and the incremental costs of their use, in terms of playing time lost and fan patience tried. Although there have been a few widely publicised corruption and match-fixing scandals in cricket, the proliferation of new T20 leagues around the world, and the betting markets which follow, deserve greater attention (see Jewell and Reade, 2014, for further discussion of this issue). A casual look at the world's largest betting exchange, Betfair Exchange, will show that cricket matches attract significant amounts of gambling interest. For instance, recent matches in the T20 Indian Premier League have many times more bet on match outcome markets than contemporary English Premier League football games. Yet, there have been next to no studies of whether these markets are efficient, and the discrete nature of a cricket match lends itself well to the detection of unusual betting patterns and corruption. The nature of play within a cricket match also affords interesting research opportunities. For example, Papps and Bryson (2019) recently used Major League Baseball to detect and investigate the mechanisms driving peer effects and spillovers in production. The structure of cricket suggests that such an analysis could be valuable, given the extended and variable amount of time that two batsmen spend together on the pitch. Despite cricket being a game where each event within a match involves one batsman facing one bowler, even the most casual followers will recognise the adages spoken frequently by commentators about a team's need to "build (break) a partnership" or to "bowl in tandem". Whether partnerships do matter in cricket and, if so, why do they matter, are questions that deserve the attention of economists.

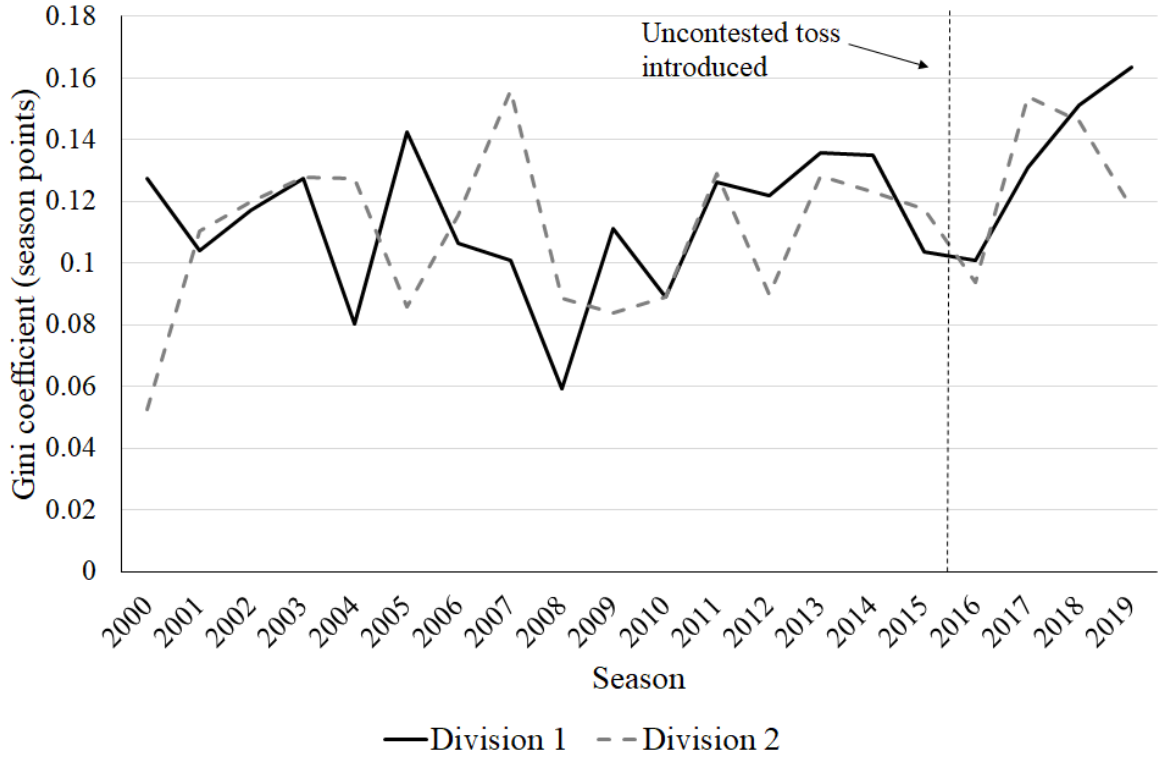
FIGURE 1: Competitive inequality within seasons of the English County Championship, 1890-2019



Notes: Gini coefficient computed over all teams in English County Championship using the division final points tables, after removing any penalties which had been applied. From 2000, results show coefficients in each of the CC divisions.

Source: Author calculations using CricketArchive.com

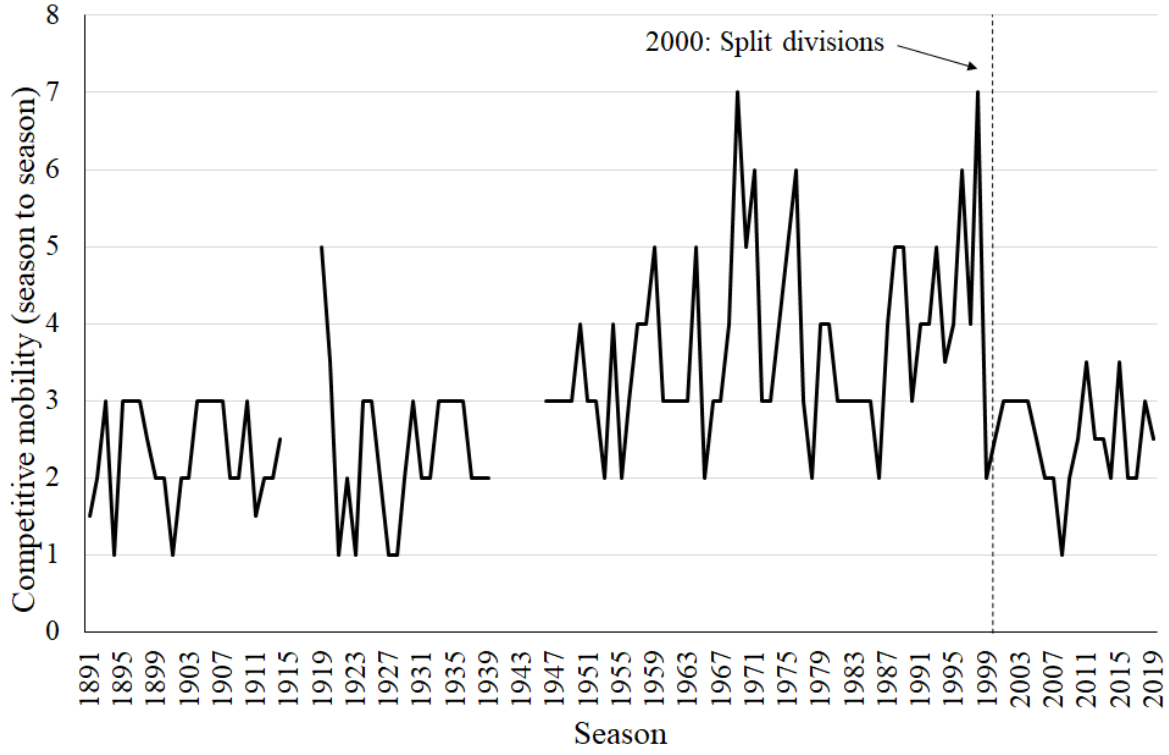
FIGURE 2: Competitive inequality within seasons of the English County Championship Divisions One and Two, 2000-2019



Notes: Gini coefficient computed over all teams in English County Championship using the division final points tables, after removing any penalties which had been applied.

Source: Author calculations using CricketArchive.com

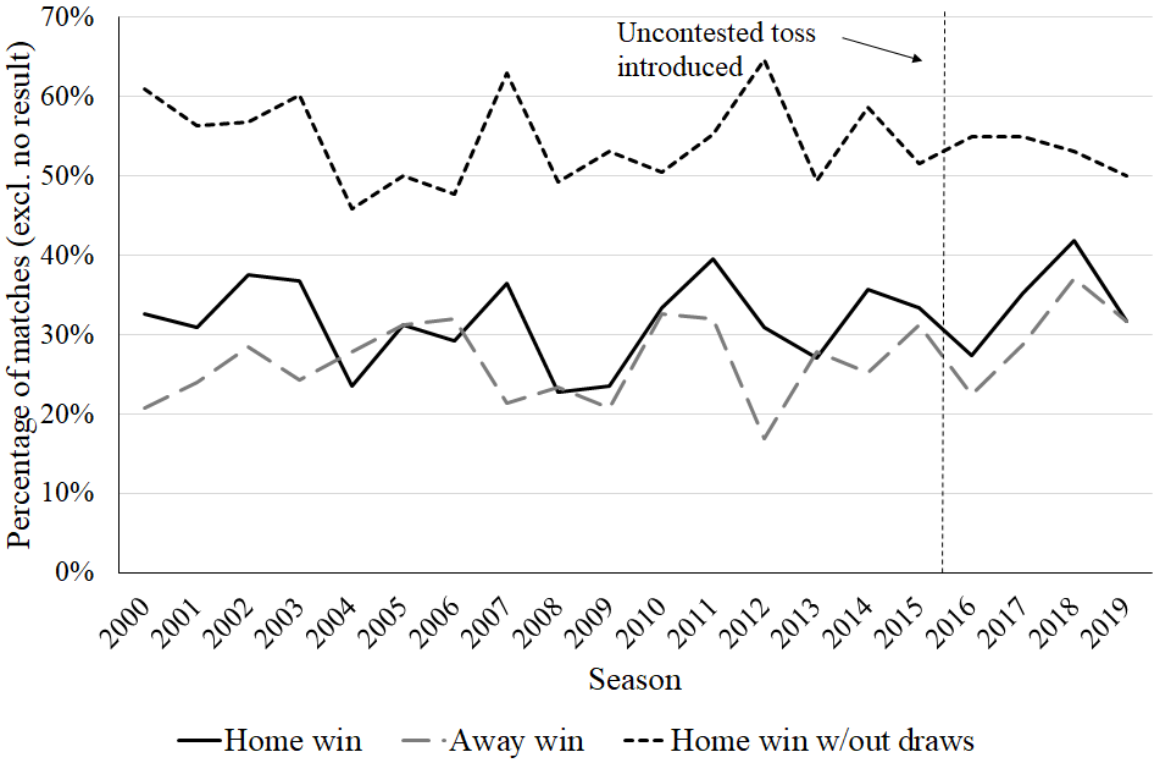
FIGURE 3: Competitive mobility between seasons of the English County Championship, 1890-2019



Notes: Shows the mean absolute change in rank between consecutive seasons for all teams in the CC. Teams are consistently ranked over the competition hierarchy before and after the division split in 2000.

Source: Author calculations using CricketArchive.com

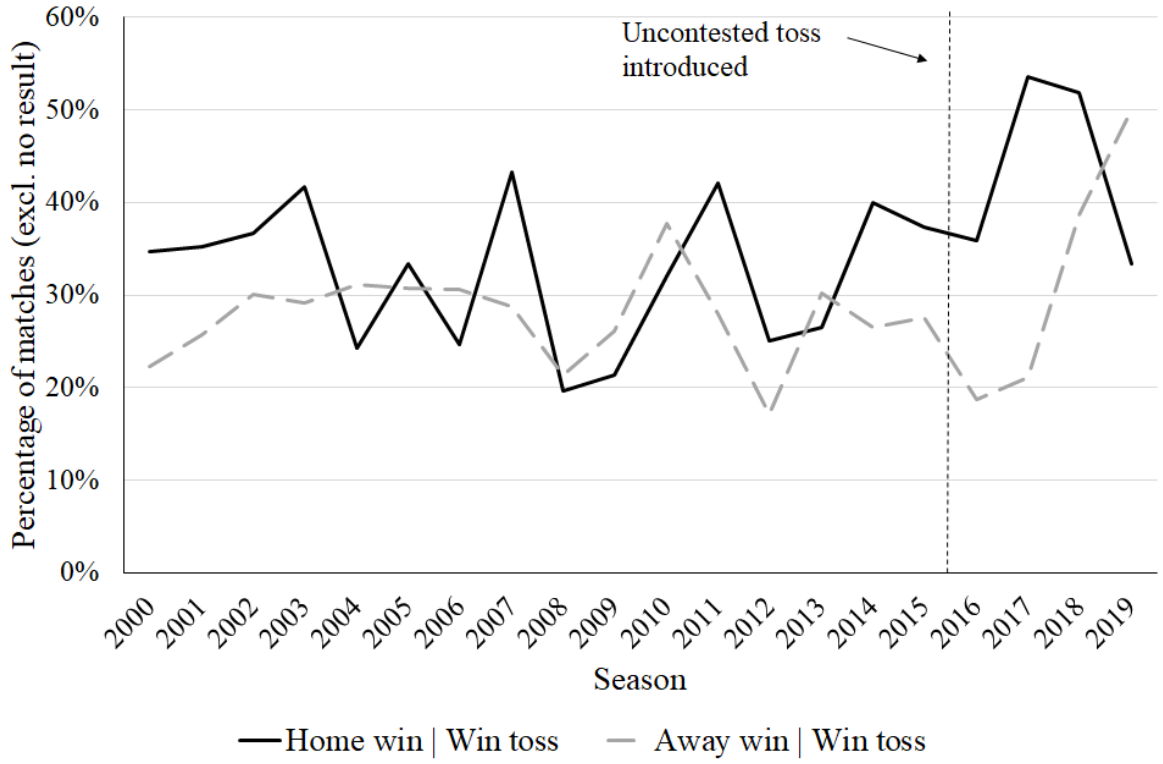
FIGURE 4: Home advantage in the English County Championship, 2000-2019



Notes: Shows the percentage of all matches in each season which ended in a result where either the home of the away side won, with the residual being drawn matches. Also shows the percentage of these matches won by the home team when excluding drawn matches.

Source: Author calculations using CricketArchive.com

FIGURE 5: Advantage of winning the toss in the English County Championship, 2000-2019

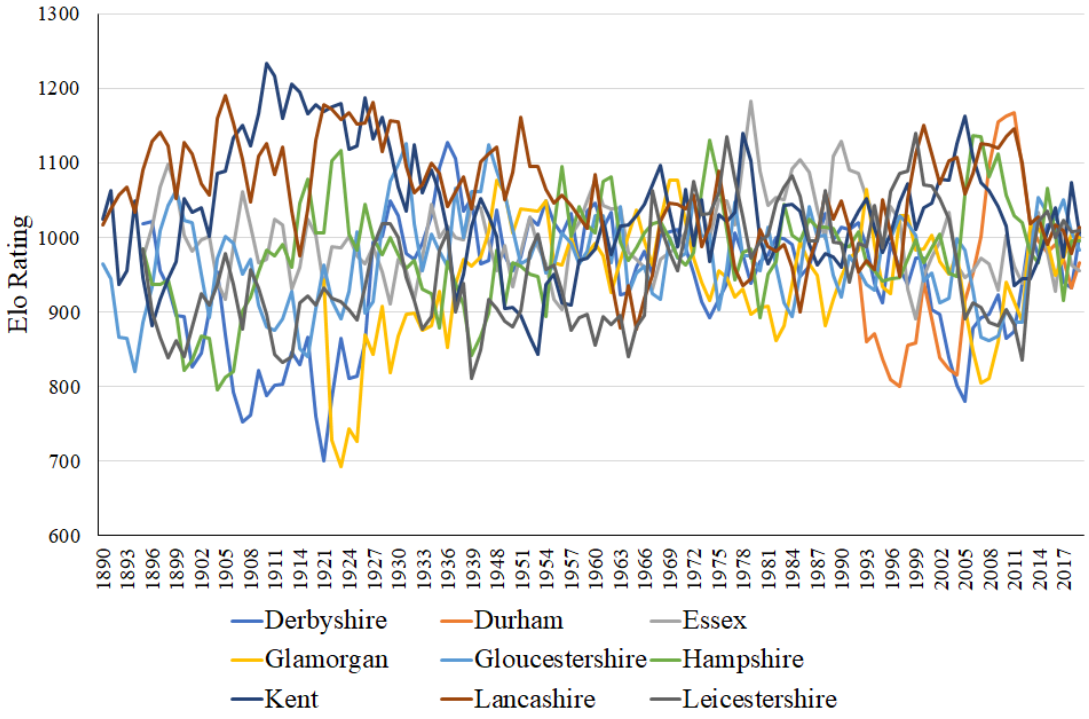


Notes: Shows the percentage of all matches in each season where the home or away side went on to win the match after having won the toss.

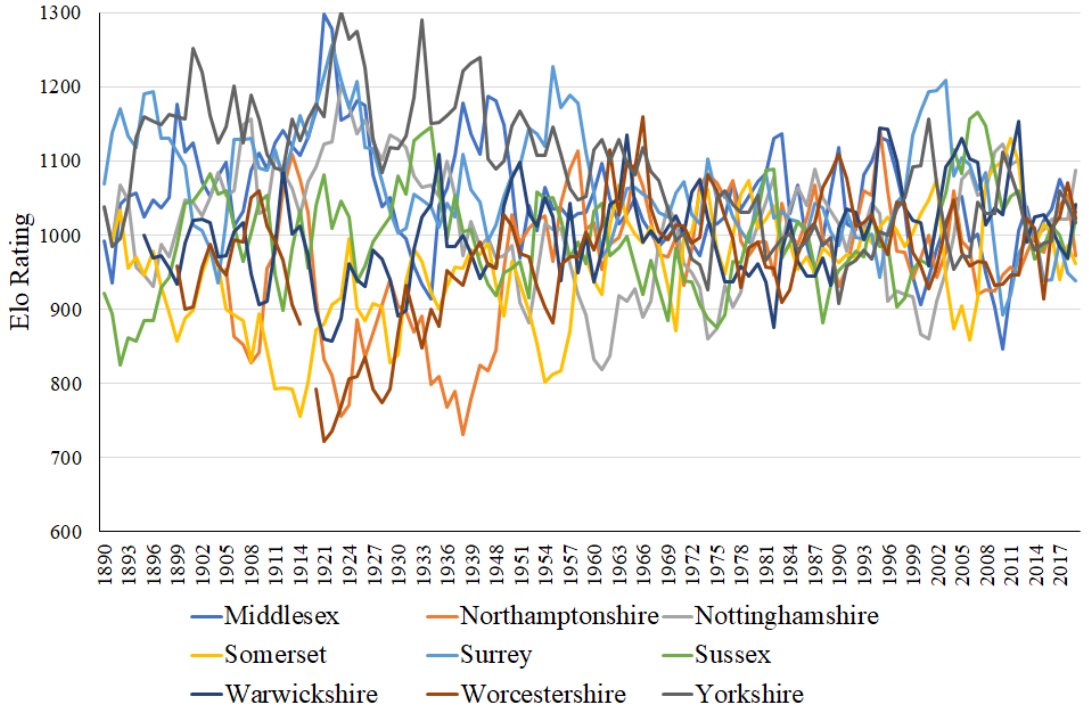
Source: Author calculations using CricketArchive.com

FIGURE 6: Elo Ratings of County Championship teams, 1890-2019

(A)



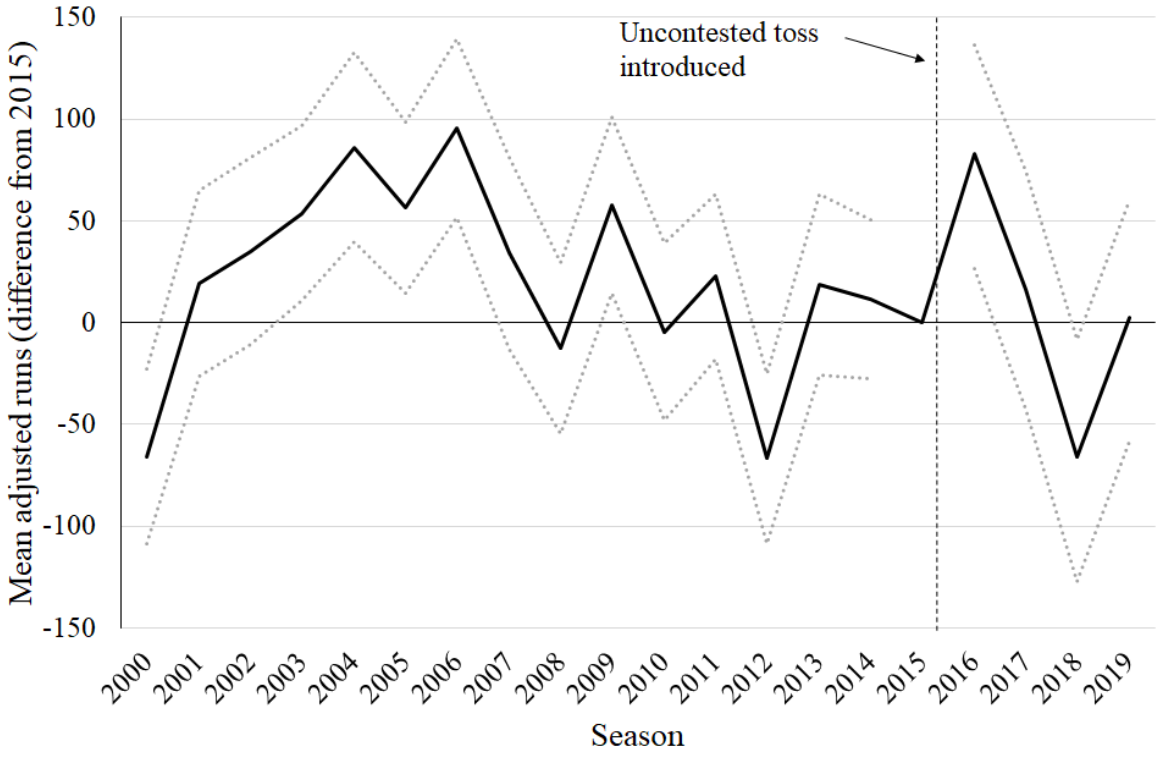
(B)



Notes: Shows derived Elo ratings of teams throughout the history of the CC. Two sub-figures are used to make the patterns easier to observe, with alphabetical order defining which team appears where. Values shown are season averages over matches played for each team.

Source: Author calculations using CricketArchive.com

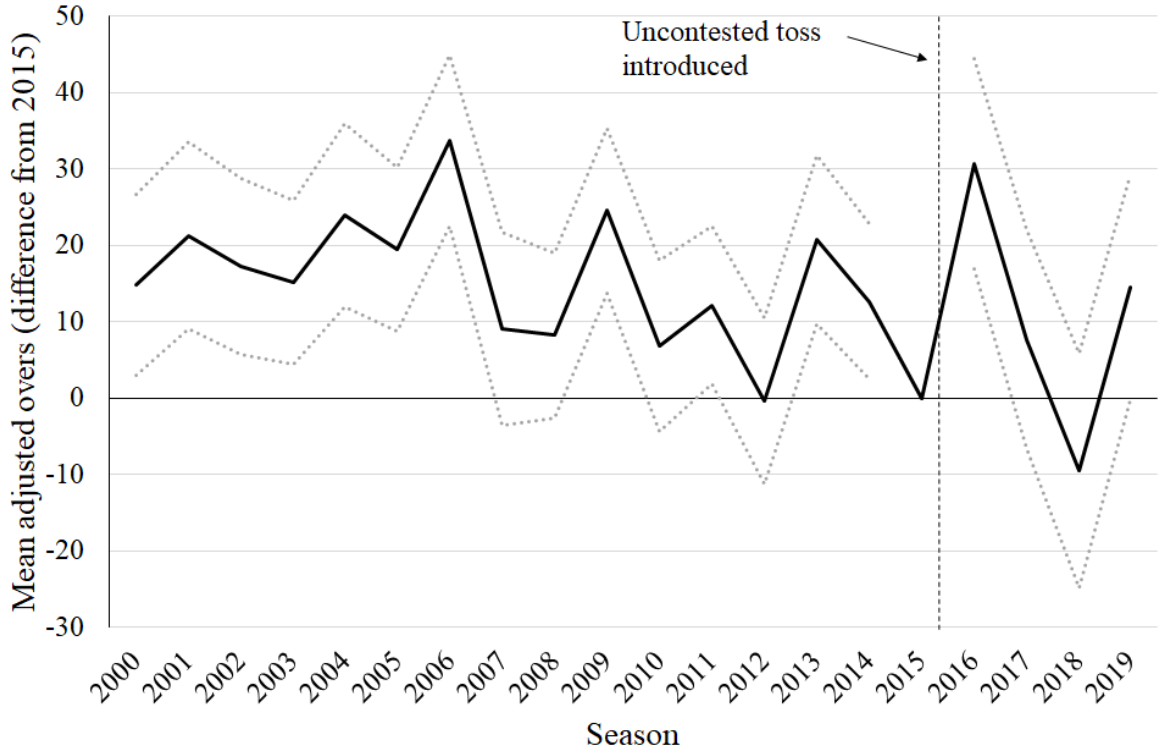
FIGURE 7: Mean sum of home and away first innings runs scored, regression adjusted, relative to 2015.



Notes: Shows estimates of the season fixed effects from Table 2, column (II), i.e. adjusted mean total runs scored by the home and away team in the first innings of matches, with 2015 as the excluded season.

Source: Author calculations using CricketArchive.com

FIGURE 8: Mean sum of home and away first innings overs bowled, regression adjusted, relative to 2015.



Notes: Shows estimates of the season fixed effects from Table 2, column (IV), i.e. adjusted mean total overs bowled by the home and away team in the first innings of matches, with 2015 as the excluded season.

Source: Author calculations using CricketArchive.com

TABLE 1: Logistic regression estimates for English County Championship match result outcomes, effects of winning the toss, 2000-2019 (odds ratios)

	Home win, excl. draw		Home avoid loss		Away avoid loss	
	(I)	(II)	(III)	(IV)	(V)	(VI)
Home toss ($\hat{\lambda}_1$)	1.163	1.199	1.162	1.178	0.923	0.926
	(0.137)	(0.152)	(0.114)	(0.118)	(0.086)	(0.089)
Home toss, 16-19 ($\hat{\lambda}_2$)	1.352	1.203	1.021	1.058	0.644**	0.687*
	(0.342)	(0.339)	(0.234)	(0.266)	(0.125)	(0.139)
Uncontested ($\hat{\lambda}_3$)	0.898	0.899	0.803	0.825	0.939	0.995
	(0.160)	(0.190)	(0.115)	(0.135)	0.149)	(0.169)
Home Elo rating (100s)	1.346***	1.207***	1.249***	1.094	0.811***	0.898*
	(0.090)	(0.086)	(0.070)	(0.064)	(0.045)	(0.050)
Away Elo rating (100s)	0.766***	0.906	0.862***	0.963	1.269***	1.115**
	(0.047)	(0.053)	(0.041)	(0.055)	(0.062)	(0.057)
Constant	0.816		1.246		1.713	
	(0.556)		(0.684)		(0.943)	
Match-up fixed effects	No	Yes	No	Yes	No	Yes
Log-likelihood	-1,121	-642	-1,622	-1,104	-1,742	-1,204
N	1,654	1,480	2,809	2561	2,809	2,708

Notes: ***, **, * indicate significance from one at 1%, 5% and 10% levels, respectively, two-sided tests. Cluster robust standard errors are displayed in parentheses. Columns (I) & (II): whether the home side wins or loses the match (drawn matches and non-results excluded from the sample). Columns (III) & (IV): whether the home team avoids defeat (i.e. home wins or draws, non-results excluded). Columns (V) & (VI): whether the away team avoids defeat (i.e. away wins or draws, non-results excluded). Columns (I), (III) & (V): 360 season-home-team clusters. Columns (II), (IV) & (VI): fixed effects (conditional) logit (e.g. Chamberlain, 1980), with 247, 265, and 286 match-up clusters, respectively (i.e., 59, 41, and 20 of the total 306 matchups were dropped due to no outcome variation within them, respectively).

TABLE 2: Linear regression estimates for English County Championship first innings outcomes, effects of winning the toss, 2000-2019

	Runs scored		Overs bowled	
	(I)	(II)	(III)	(IV)
Home toss ($\hat{\lambda}_1$)	-2.96	-8.37	-0.11	-1.40
	(8.12)	(8.94)	(2.05)	(2.25)
Home toss & 2016-19 ($\hat{\lambda}_2$)	-3.38	1.14	-1.95	3.31
	(24.18)	(28.27)	(6.26)	(7.31)
Uncontested ($\hat{\lambda}_3$)	-50.99**	-41.94*	-15.93***	-13.08**
	(20.02)	(22.45)	(5.06)	(5.64)
Home Elo rating (100s)	1.15	-4.95	0.38	-1.53
	(4.82)	(4.73)	(1.15)	(1.18)
Away Elo rating (100s)	7.49*	11.68**	2.04*	2.36*
	(4.31)	(4.62)	(1.12)	(1.22)
Month fixed effects	Yes	Yes	Yes	Yes
Season fixed effects	Yes	Yes	Yes	Yes
Match-up fixed effects	No	Yes	No	Yes
R^2 (within match-up)	0.069	0.075	0.062	0.068
N	2,604	2,604	2,604	2,604

Notes: ***, **, * indicate significance from one at 1%, 5% and 10% levels, respectively, two-sided tests. Cluster robust standard errors are displayed in parentheses. Excludes matches where two innings were not completed. Columns (I) & (II): total runs scored in the first completed innings by both the home and away teams. Columns (III) & (IV): total overs bowled in the first completed innings by both the home and away teams. Columns (I) & (III): 360 season-home-team clusters. Columns (II) & (IV): 306 match-up clusters.

References

Allsopp, P., and S. Clarke. 2004. “Rating Teams and Analysing Outcomes in One-Day and Test Cricket.” *Journal of the Royal Statistical Society: Series A (Statistics in Society)*, 167(4): 657–667.

Bhaskar, V. 2009. “Rational Adversaries? Evidence from Randomised Trials in One Day Cricket.” *The Economic Journal*, 119(534): 1–23.

Bhattacharya, M., and R. Smyth. 2003. “The Game is Not the Same: The Demand for Test Match Cricket in Australia.” *Australian Economic Papers*, 42(1): 77–90.

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

Borland, J., and R. MacDonald. 2003. “Demand for Sport.” *Oxford Review of Economic Policy*, 19(4): 478–502.

Borooah, V. K. 2016. “Upstairs and Downstairs: The Imperfections of Cricket’s Decision Review System.” *Journal of Sports Economics*, 17(1): 64–85.

Cairns, J., N. Jennett, and P. Sloane.1986. "The Economics of Professional Team Sports: A Survey of Theory and Evidence." *Journal of Economic Studies*, 13(1), 3-80.

Chamberlain, G. 1980. “Analysis of Covariance with Qualitative Data.” *Review of Economic Studies*, 47(1): 225–238.

Clarke, S. R., and P. Allsopp. 2001. “Fair measures of performance: the World Cup of cricket.” *Journal of the Operational Research Society*, 52(4): 471–479.

Crowe, S. M., and J. Middeldorp. 1996. “A Comparison of Leg Before Wicket Rates Between Australians and Their Visiting Teams for Test Cricket Series Played in Australia, 1977-94.” *Journal of the Royal Statistical Society. Series D (The Statistician)*, 45(2): 255–262.

Dawson, P., B. Morley, D. Paton, and D. Thomas. 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): 1786–1793.

De Silva, B. M., and T. B. Swartz. 1998. “Winning the Coin Toss and the Home Team Advantage in One-day International Cricket Matches.” *The New Zealand Statistician*, 32(1): 16–22.

Dohmen, T., and J. Sauermann. 2016. “Referee Bias.” *Journal of Economic Surveys*, 30(4): 679–695.

Elo, A. E. 1978. The rating of chessplayers, past and present. London: Batsford.

Forrest, D., and R. Dorsey. 2008. “Effect of toss and weather on County Cricket Championship outcomes.” *Journal of Sports Sciences*, 26(1): 3–13.

Gregory-Smith, I., D. Paton, and A. Sacheti. 2019. “The Economics of Cricket.” in *The SAGE Handbook of Sports Economics*, Paul Downward, Bernd Frick, Brad R. Humphreys, Tim Pawlowski, Jane E. Ruseski, Brian P. Soebbing (eds.)

Hvattum, L. M., and H. Arntzen. 2010. “Using ELO ratings for match result prediction in association football.” *International Journal of Forecasting*, 26(3): 460–470.

Hynds, M., and I. Smith. 1994. “The Demand for Test Match Cricket.” *Applied Economics Letters*, 1(7): 103–106.

Jewell, S., and J.J. Reade. 2020. “On Fixing International Cricket Matches.” *The Journal of Gambling Business and Economics,* 13(2): 37-82.

Lenten, L. J., and Winchester, N. (2015). “Secondary behavioural incentives: Bonus points and rugby professionals.” *Economic Record*, 91(294): 386-398.

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

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

Papps, K. L., and A. Bryson. 2019. “Spillovers and Substitutability in Production.” IZA Discussion Papers 12252, Institute of Labor Economics (IZA).

Paton, D., and A. Cooke. 2005. “Attendance at County Cricket: An Economic Analysis.” *Journal of Sports Economics*, 6(1): 24–45.

Reade, J.J. 2019, “Officials and Home Advantage”, in *The SAGE Handbook of Sports Economics*, Paul Downward, Bernd Frick, Brad R. Humphreys, Tim Pawlowski, Jane E. Ruseski, Brian P. Soebbing (eds.)

Reade, J.J. 2020. “Football Attendance Over the Centuries.” Economics Discussion Papers em-dp2020-08, Department of Economics, Reading University.

Reade, J.J., C. Singleton, and A. Brown. 2019. “Evaluating Strange Forecasts: The Curious Case of Football Match Scorelines.” Economics Discussion Papers em-dp2019-18, Department of Economics, Reading University.

Ringrose, T. 2006. “Neutral umpires and leg before wicket decisions in Test cricket.” *Journal of the Royal Statistical Society: Series A (Statistics in Society)*, 169(4): 903–911.

Rottenberg, S. 1956. “The Baseball Players’ Labor Market.” *Journal of Political Economy*, 64(3): 242–258.

Sacheti, A., I. Gregory-Smith, and D. Paton. 2014. “Uncertainty of Outcome or Strengths of Teams: An Economic Analysis of Attendance Demand for International Cricket.” *Applied Economics*, 46(17): 2034–2046.

Sacheti, A., I. Gregory-Smith, and D. Paton. 2015. “Home bias in officiating: evidence from international cricket.” *Journal of the Royal Statistical Society: Series A (Statistics in Society)*, 178(3): 741–755.

Sacheti, A., D. Paton, and I. Gregory-Smith. 2016a. “An Economic Analysis of Attendance Demand for One Day International Cricket.” *Economic Record*, 92(296): 121–136.

Schofield, J. 1983. “The Demand for Cricket: The Case of the John Player League.” *Applied Economics*, 15(3): 283–296.

Schofield, J. 1988. “Production functions in the sports industry: an empirical analysis of professional cricket.” *Applied Economics*, 20(2): 177–193.

Shivakumar, R. 2018. “What Technology Says About Decision-Making: Evidence From Cricket’s Decision Review System (DRS).” *Journal of Sports Economics*, 19(3): 315–331.

Singleton, C., J. J. Reade, and A. Brown. 2020. “Going with your gut: The (In)accuracy of forecast revisions in a football score prediction game.” *Journal of Bahavioral and Experimental Economics*, 89, 10152.

Szymanski, S. 2003. “The economic design of sporting contests.” *Journal of Economic Literature*, 41(4): 1137–118.