

Asymmetries in Cricket

The Effects of Winning the Toss on Winning the Match^{*}

Apoorva Lal[†] Derek Willis[‡] Gaurav Sood[§] Avidit Acharya[¶]

August 6, 2022

Abstract

The rules in cricket treat the competing teams asymmetrically, even before the start of physical play. In the one-day version of the game, for instance, which team bats first is determined by the captain that wins the toss. This raises questions about the effects of the asymmetry created by luck. Does the team that wins the toss have an advantage over the other team?

We find that, on average, the effect of winning the toss on winning the match is essentially nil in international limited-overs daytime matches but substantial (3.3 percentage points) in day/night matches. In test cricket, the advantage is even larger (4.9 percentage points). The advantage has exploded in the last decade (to nearly 15 percentage points) after a steady decline. More surprisingly, the effect of the toss does not appear to vary between competitive and noncompetitive pairings of teams. And as for the decision to bat or field first, we find the win-loss differential is significantly larger for the teams that elect to field than those that elect to bat, in which case it is negligible. Lastly, and perhaps most surprisingly, in rain-delayed matches in which the chasing team's total was adjusted by the Duckworth-Lewis formula, we find that teams that elected to bat first did just as well than those that elected to field first.

Key words: cricket, fairness, randomization

^{*}This paper incorporates some of the text and results from Sood & Willis's (2019) working paper: "Fairly Random: The Impact of Winning the Toss on the Probability of Winning." The authors thank Matt Blackwell, Andrew Gelman, Donald Green, Jens Hainmueller, and Daniel Stone for their comments and suggestions. We are grateful to Sajan Mehotra for outstanding research assistance.

[†]Dept. of Political Science, Stanford University; apoorval@stanford.edu.

[‡]News applications developer at ProPublica; dwillis@gmail.com.

[§]Independent researcher; gsood07@gmail.com.

[¶]Dept. of Political Science and Graduate School of Business, Stanford University; avidit@stanford.edu.

1 Introduction

In a competitive sport, every little thing matters. Yet, many sports leave some large levers out of the reach of the teams and in the hands of fate. In cricket, one such lever—the toss—has been the subject of much attention. In many matches, commentators and cricket enthusiasts claim that there is a definite advantage to either bowling or batting first.¹ The advantage is also often pointed to by the captains in the pre-toss interview and by the captain of the losing team in the post-match interview. To wrest the advantage, the captain merely needs to pick the side of the coin that will be left facing the sky after the toss and choose whichever one—batting first or batting second—gives the greater advantage.

In this paper, we measure how well teams have been able to capitalize on any advantage conferred by winning the toss. To answer this question, we collected data on over 35,000 cricket matches across four formats (First Class, ODIs, T20s, and tests) played over the course of more than one hundred fifty years. To our knowledge, this is the most comprehensive professional cricket match dataset to date.

Winning the toss increases the chances of winning the match by 1.8 percentage points: toss winners win 39.2% of the time and lose 37.4% of the time, with the remaining share being draws or ties. The effect of winning the toss is the largest in tests, where it is 4.9 percentage points and is smallest in ODIs and T20s, where it is essentially zero. That being said, in ODIs and T20s that are day/night matches, the effect of winning the toss is 3.3 percentage points, whereas, in the day-time matches, the effect is a precise zero.

The effect of toss in the ODIs has remained relatively stable since the 1980's when the one-day format first became popular. In tests, however, the importance of the toss has varied considerably. The effect of winning the toss in test cricket was a little over five percentage points before 1990. It then dropped to nearly 0 between 1990 and 2010. In the last decade, however, it has exploded, averaging 14.5 percentage points. Counter to conventional wisdom, the effect of winning the toss is relatively similar across continents, though the toss appears less important on European and African wickets than elsewhere. The effect on Aussie and Kiwi wickets (3 percentage points) is not substantially different from its effect on South Asian wickets (2.8 percentage points) but is higher than the effect on European and African wickets (1.1 and 0 percentage points respectively).

In sports like soccer, the conventional wisdom is that the toss is inconsequential (Csató, 2020). In cricket, it is believed that the toss has little significance in lopsided matches that have clear favorites and underdogs. For example, it is thought to be less relevant in an India-Ireland match than in an India-Australia match. For this reason, we look at the effect of the toss separately in subsamples where teams are similarly ranked according to ICC ELO ratings and where their ratings differ more substantially. We find that the effect of the toss doesn't vary by how well matched the teams are. Since ELO ratings are available only for

¹See, for example, the Quora page on “How much does a toss matter to a game of cricket?”

matches played in recent decades, these findings (along with our finding that the influence of the toss has declined over time) suggest that the toss probably has little influence in modern cricket.

An important caveat about the null findings is in order, however. Our empirical approach cannot tell whether the effects are nil because the toss is unimportant or because the toss is important, but that (modern) teams have not been able to capitalize on the advantage. The toss may matter quite a bit in principle, but we would only be able to observe its effect if a team is able to use the information on the conditions of play and how it pairs strategically against the opposing team to be able to make the optimal decision of whether to bat or field first. If teams simply do not have this knowledge and are often choosing poorly, then we would not see any toss effects. So, when we refer to “toss effects” in this paper, what we are measuring is not whether there is an advantage to winning the toss in principle, but whether any such advantage is exploited in practice.

With this, we turn to the batting first decision. When pitch and weather conditions are hard to read, and it is not obvious that fielding first has a clear advantage, many cricket commentators suggest that batting first is the appropriate choice: get runs on the board, and put the opposing team under psychological pressure by having them chase the target, worrying about “required run rates,” etc. We see that the effect of winning the toss on batting first is 13 percentage points. If one team bats, the other team must field, so this translates to saying that among toss winners, 56.5% of the teams elect to bat, and the remaining 43.5% choose to field. Thus, compared to the case where teams are randomly assigned to bat, i.e., the case in which the toss has no effect on the batting decision, toss-winning teams bat an excess of 6.5% of matches.

However, we find that of the toss winners that elected to bat, only 38.1% won the match compared to 37.9% that lost—a small difference of 0.2 percentage points. On the other hand, of the toss winners that elected to field, 40.8% won the match compared to 36.9% that lost—a larger difference of 3.9 percentage points. This means that 94% of the 1.8 percentage point effect of winning the toss can be attributed to instances in which the toss winning team elected to field, and only 6% of the effect can be attributed to the toss winning team electing to bat. This suggests that teams are better able to capitalize on the toss by electing to field when it is advantageous to do so.

We also look at how the toss advantage breaks down between teams that elected to bat versus those that elected to field within the various subgroups mentioned above and others. Perhaps the most striking result from this analysis for many cricket followers is that there does not appear to be the case that toss winners that elect to bat first do better than those that elected to field first in rain delayed matches where the chasing total is adjusted according to the Duckworth and Lewis (1998) formula.

Our results are pertinent to debates on how cricket should be governed. One argument is that since the toss is random, no team is advantaged by the format prior to the toss; and in

fact the luck of the toss along with the strategic choice to bat first or second are integral parts of the game— not very different from the luck of weather affecting the teams differently. An alternative argument, however, is that the toss is problematic because it advantages one team over the other even before the first ball is bowled; and care should be taken to mitigate this asymmetry— for example, by making cricket pitches more durable so that they don't deteriorate so much so that batting on the final day of a test match is miserable. Otherwise, the toss-winning team could exploit this advantage by batting first, reducing the chance that it has to endure this misery. Moreover, the fact that no side is advantaged *ex-ante* if the toss is random is not enough to justify not correcting any asymmetry created by the toss. In fact, the rules of cricket already try to correct the asymmetry between teams that bat first and those that bat second in one particular instance: In rain-delayed one-day matches, the Duckworth-Lewis formula is used to set a new target for the chasing team.²

For those who take this latter viewpoint, a straightforward policy prescription that comes out of our analysis is that, at least for ODIs, day-night matches should be avoided. In general, when new formats are introduced (such as the recent introduction of T20s) care should be taken to ensure the toss has little effect. The designers of cricket should always consider ways of leveling the playing field for the competing teams starting from the point at which the game really begins— the moment the first ball is bowled.

We do not address these optimal design questions in this paper, but our results are relevant to these issues depending on what the designers of cricket seek to optimize.

2 Data

2.1 Creating the sample

We obtained data on cricket matches from the ESPN Cricinfo website, which provides coverage of international and many domestic matches, and maintains statistics on a wide variety of matches across formats.³

We focus on four types of formats: T20, ODI, Test, and First Class matches for both men's and women's teams.⁴ The data are a near census of the relevant population, excluding only scheduled matches that were abandoned without the toss being conducted, and a small

²The argument that no side was advantaged *ex-ante* could have been used to justify not doing any correction in such rain-delayed matches, and simply declaring that the team that batted first won the match because the chasing team was unable to reach its target. But the designers of one-day cricket were clearly unwilling to allow the bad luck of weather to have this much influence on the game. If addressing the misfortunes of weather are important, it may also be important to address the misfortune of losing the toss.

³Information on all available matches was downloaded in June 2020 using a purpose-built parsing library available at <https://github.com/dwillis/python-espncricinfo>. The data will be available as a separate repository available at <https://github.com/dwillis/cricket-stats>.

⁴We do not include the List A matches that are not ODIs or T20s, which are often considered a less professional category (with worse data recording) than the formats that we include.

number of limited-overs matches in which the minimum number of overs that must be bowled to establish a result was not met.⁵

Our final sample comprises of 35,357 cricket matches across four formats played over the last 150 years. We report the distribution of matches over time and by type in Figure 1. As the figure shows, the number of matches has exploded over the last two decades, largely due to the introduction of the enormously popular Twenty-20 (T20) format of the game both in both international and domestic tournaments. T20 matches constitute over a quarter of all matches played in the last decade.

2.2 Is the toss random?

Since our analysis will be based on the assumption that the coin toss is random, we start by examining this assumption.⁶ Is there any evidence that the coin toss is somehow rigged—for example, with the home side enjoying the rub of the green more often? In order to study this, we compare the rates at which home teams, teams that won the toss in their last match, and underdogs (defined as the lower-ranked team whenever rankings are available for both teams) win the toss relative to their opponents.

To examine whether the toss is rigged, we compute the odds of seeing as many successes in the same number of draws of a sequence of independent Bernoulli random variables with parameter 0.5. For example, home teams have won 50.81% of tosses in the 6377 matches for which we have data. The likelihood of tossing a fair coin 6377 times and getting at least this percentage of heads is 20.1%. This chances appears low, but not eyebrow-raisingly so. We find that toss wins are even more balanced for teams that won and lost the last toss, and for teams that are underdogs and favorites. Table 1 reports these balance results.

That said, we do see one potential source of concern. We find that teams that share their nationality with at least two of the three umpires of the match win 51.3% tosses in the 4044 international matches for which we have this data. The likelihood that tossing a fair coin 4044 times and getting at least this share of heads is only 10%. This number is certainly low enough to raise some eyebrows. That said, the practice of allowing home-team umpires in international matches ended in 1992, and so these issues are less relevant in recent decades which comprise the bulk of our sample.

⁵In ODIs, for example, each side must bat at least 20 overs for a result to be declared. We have no reason to suspect that the small matches that were excluded because they did not meet this threshold could be biased enough to affect our conclusions. We drop 426 matches recorded as “no result,” 3 matches that are recorded as “abandoned” or “canceled,” and another three that don’t record who bat first. The former constitutes the largest exclusion we make and appears to be comprised of matches canceled for idiosyncratic reasons, ranging from the a team being unable to bat because of the weather to cancellations because of unwanted audience participation. This results in us dropping approximately 0.07% of matches.

⁶Prior work in the sports analytics of cricket by Shafqat (2015) and Dawson et al. (2009) conditions on post-treatment variables, whereas we use only the randomization of the toss to identify toss effects.

In addition, a rigged toss in favor of the home team would bias estimates of the advantage of winning the coin toss to the extent that it is correlated with ability. If stronger teams win more tosses, estimates of the advantage of the coin toss would be inflated upwards. And vice versa, if otherwise. We do not have good reasons to think that there is a correlation. So for now, we proceed as if the toss is random.

3 Do teams exploit the advantage of winning the toss?

To estimate the advantage of winning the toss, we run regressions on a team \times match level dataset. Let i index teams, and j index matches. Y_{ij} is a dummy for team i winning match j , and takes a value of 0.5 for draws. Z_{ij} is a dummy for team i winning the toss in match j . For the main specifications of interest, we estimate regression equations of the form

$$Y_{ij} = \alpha_0 + \tau Z_{ij} + \gamma_i + \delta_t + \psi_k + \varepsilon_{ij} \quad (1)$$

which includes fixed effects for teams γ_i , time δ_t , and match-type ψ_k , so that all variables can be interpreted as residuals from partialing out team, match-type, and time fixed effects. Since unobservable factors are correlated across opposing teams in the same match, we cluster the standard errors at the match level.

We report results in Table 2. We progressively introduce team, match-type, and time period fixed-effects in columns 2, 3, and 4 to make more fine-grained comparisons, and find that results are remarkably stable across specifications. The first column, for example gives the baseline estimate of the toss effect being 1.8 percentage points in all matches. As we mentioned in the introduction, this effect represents toss winners winning 39.2% of the time and losing 37.4% of the time, with the remaining matches being draws. The estimated effect remains at 1.7 percentage points when we progressively add the fixed effects.

We then proceed to examine the effect of the toss withing various subgroups. We report the estimates graphically in Figures 2 - 6 with point estimates and sample sizes as annotations. The results are summarized as follows.

Format. Toss effects are most pronounced in test matches followed by first class matches, and are statistically indistinguishable from zero in ODIs and T20s. We estimate the effect of the toss on winning a test match to be 4.7 percentage points, allowing for the fact that many tests end in draws. Given that only 65% of test matches end with one team winning, the effect of the toss conditional on the match producing a winner is higher: 7.2 percentage points. The effect of the toss in first class matches is 2.3 percentage points. These results support the conventional wisdom among lay cricket followers that the toss grants the greatest advantage in multi-day affairs. Pitches invariably deteriorate over the course of these matches, and the fourth innings in test match is often the most challenging time to bat. The pitch deteriorates far less over the course of a day, or in the case of T20s, a few hours. Our

null results for limited over matches also extend De Silva and Swartz (1998), who, based on analysis of data from 427 international one-day matches conclude that “winning the toss at the outset of a match provides no competitive advantage.”

International vs. Domestic matches. Toss effects are virtually the same for international and domestic matches (point estimates are 1.7 percentage points in the former, and 1.9 percentage points in the latter). This is a bit surprising given differential use of cricket formats differs in international and domestic matches (for example, there are no domestic tests), and our findings of heterogeneous effects across formats.

Effects over time. Toss effects overall appear to have declined over time from a high of 9.9 percentage points in the second half of the 19th century, to 1.4 percentage points in the last decade. We also look at these trends within format. T20s have not been played long enough for us to draw any conclusions about how toss effects have changed over time. But within the other formats, we find that toss effects follow a similar pattern, except that in test cricket there is a peculiar uptick in in the last decade: the toss effect jumps from 0 in the decade before to 14.5 percentage points now. We investigate potential sources of this variation below but there are some factors that could be important drivers for which we do not have data. For example, cricketers may have become more fit, and able to play for longer periods without tiring as much as they once did. Pitches now may be more resilient to wear than they once were. Teams may have acquired better knowledge on how to play more effectively whether they bat first or second. Etc.

Relative strength. Common sense suggests that the toss should be less important in lopsided matches where there is one dominant team that is expected to win, whether it bats first or second. It should be more important in competitive matches where the opposing teams are more even in cricketing strength. We define competitive matches as those in which the gap in ELO ratings of the two teams is less than 15 points. Since the median ELO rating difference is 17 points, this threshold roughly splits our sample of matches for which we have ELO ratings for both teams in two halves. Surprisingly, we find the toss effect to be nearly the same, and indistinguishable from zero within both competitive and noncompetitive matches even when we look at tests and international ODIs separately (these are the two formats for which ELO ratings apply). Part of the reason for this is that the ELO ratings are available only for recent years, and we saw above that toss effects have declined over time. We also perform an omnibus test of treatment effect heterogeneity by estimating sorted partial effects (Chernozhukov et al., 2018, Chen et al., 2019) with respect to ranking and result history, and find minimal evidence for effect heterogeneity.

Continents. We find that toss effects vary only somewhat across continents, hovering around 2.5 percentage points for matches played in Asia, Oceania, and the Americas (though the estimates for the Americas are noisier in part due to the smaller number of matches played there). In Europe (mainly England) the toss effect is only 1.1 percentage points (though we do not rule out a null effect), and in Africa it is essentially zero. Over-

all, despite there being much talk about the different nature of wickets across the world, with wickets in certain regions being drier, or stickier, or subject to more wear, these differences do not seem to translate into substantial toss effect differences at least when we look coarsely at averages.

Day/Night matches. It is often claimed that the toss is more crucial in day-and-night matches. We find some evidence for this. In the limited overs formats where day/night matches take place (ODIs and T20s), the advantage of winning the toss in a day/night match is 3.3 percentage points, whereas the advantage of winning the toss in a limited overs match played during the day is zero.

Seasonality. Weather is also thought to have a large impact on the playing conditions in cricket. Cool overcast weather, for example, is thought to aid swing bowling, especially in English pitches. More generally, the advantage of winning the toss likely varies by the weather. Although do not have data on the weather, we can proxy it with seasons. In particular, students of the game suspect that the advantage of winning the toss in the early English season is especially significant. There is some evidence of a seasonal pattern for matches played in England, with the advantage of winning the toss growing over the summer, though the trend is weak and broken in the month of July.

Rain delays. Finally, we look at the differential effects of winning the toss in ODI matches that were rain-delayed, causing the number of overs bowled in the second innings to be adjusted down. We examine the subset of matches where rain-delays result in revised targets computed using the Duckworth and Lewis (1998) method. This method has been the subject of much controversy, with many cricket fans suggesting that it is rigged against the chasing team. To our surprise, we find no evidence that toss winners are able to exploit the possibility of second inning rain delays to their advantage. If anything, we see that the toss-winner has a *disadvantage* of 2.4 percentage points in matches subject to the Duckworth-Lewis adjustment, though this point estimate is statistically indistinguishable from zero⁷. This, however, does not mean that the Duckworth-Lewis method is not rigged against the chasing team; that issue will be discussed further in the next section.

4 Batting versus Fielding First

4.1 The Choice to Bat

The first column of Table 3 shows that 49.2% of teams that batted first won the match, while 50.8% of teams that fielded first won. The second column shows that among teams that won the toss and batted first, the “win-loss differential” is small: these teams won only 0.2 percentage points more frequently than they lost, winning 38.1% of matches and losing

⁷Toss-winners won 160 out of 333 ODIs with the Duckworth-Lewis adjustment (i.e. 48%) and 3085 out of 6187 ODIs without the Duckworth-Lewis adjustment (49.9%).

37.9% of matches, as reported in the introduction. This win-loss differential is smaller than it is for teams that won the toss and elected to field. The third column of the table shows that these teams won 3.9 percentage points more frequently than they lost: they won 40.8% of their matches and lost 36.9% of them. Combining this information with the fact that 56.5% of teams that won the toss elected to bat (and only 43.5% elected to field, as implied by the fourth column of the table) this means that 94% ($= .435 \times .039/.018$) of the 1.8 percentage point advantage to winning the toss that we reported in the previous section can be attributed to the success of toss-winning teams that elected to field.

These findings are not surprising given the conventional wisdom that captains who are not sure whether they should bat or field first often choose to bat. If a team wins the toss and elects to field, they often have a good reason to do so. It is interesting to ask what these reasons could be. Although we cannot answer this question fully, comparing the win-loss differentials within subgroups may offer some clues.

Format. In test matches 72.8% of teams that win the toss elect to bat, whereas in T20s and ODIs this share is only about 52.9%. In first class matches it is 56.9%. It appears that teams err heavily on the side of batting first in longer match formats.

International vs. Domestic matches. We see no big differences in propensity to elect to bat first across international versus domestic matches.

Effects over time. Historically, toss-winning teams tilted heavily in favor of batting first, but this declines over the course of the 20th century, and now they show no preference (on average) to bat first. Even for test matches, toss winning teams tend to be tilting less toward batting first than they once did. Pre-1950, more than 90% of teams that won the toss elected to bat, whereas in the last two decades that number is closer to two-thirds. Perhaps players have gotten more fit and are willing to trade-off expecting to have to bat on the final days of the match in favor of taking advantage of playing conditions that are favorable to fielding first. As for ODIs, captains curiously erred heavily on the side of fielding first in the early decades of the format, but in the last thirty years, they have tilted more towards batting first, with just over half of toss-winning teams electing to bat.

Relative strength. We see no notable differences in the toss-winning captain's choice to bat first across matches that are lopsided and those in which the teams are more evenly matched. This is especially true in tests, but also appears to be true in ODIs, though a slightly larger share of toss-winning teams elect to bat in matches that are lopsided (54.6%) in comparison to ones that are less lopsided (51.9%).

Continents. Toss-winning captains show a preference to bat first in matches played in Oceania and Europe, more so than in other pitches. For example, in Europe (mainly England) 64.9% of toss winning teams elect to bat, and in Oceania this number is 59.9%. By contrast, on Asian wickets it is only 50.1%.

Day/Night matches. The ball being harder to see at night afflicts both the night-time batting team, as well as the fielding team, making it prone to dropping catches. But the dif-

difficulty for batsmen is probably greater than it is for fielders. Indeed, within the shorter formats, the variation between day matches and day/night matches is greatest when it comes to the choice to bat first. In day/night matches, 59% of toss-winning teams elect to bat first, whereas in day matches just about only half of them do.

Seasonality. The preference to bat first in England follows a broadly similar trend to the toss effect over the course of the year— rising steadily over the summer, and drops in September. At its peak in August, top-winning captains choose to bat first 71.9% of the time. At its lowest in April, they choose to bat 57.4% of the time.

Rain delays. Remarkably, there is an overall preference to field first in matches that ended up using the Duckworth-Lewis adjustment: only 43.5% of toss winning teams elected to bat in these matches. If captains are at all able to predict rain (and other) delays, they seem to show a preference to bat a fewer number of overs and chase the adjusted target.

4.2 The Difficulty in Estimating the Advantage to Electing to Bat/Field First

Despite having reported the ‘reduced form’ and ‘first stage’ effects of the toss, we cannot not interpret the ratio of these effects as the causal effect of batting first. If we used the toss as an instrument for batting first, say, we could at best hope to estimate the local average treatment effect (LATE) of electing to bat on winning the match (Angrist et al., 1996). This is because in our setting treatment effects likely vary across groups: some teams in some circumstances will be better able to capitalize on the ability to bat or field first.

However, even the conditions under which the LATE is known to be identified are probably not satisfied in our setting. To see why, first note that our setting has two-sided non-compliance: there are teams that win the toss that bat first, and those that lose the toss that bat first as well. Then, recall that under two-sided noncompliance, the LATE is identified under a monotonicity assumption that rules out defiers. However, defiers are likely to be present in our setting: they correspond to dyads of opposing teams that walk on to the pitch, both intending to field first if they win the toss. In such a setting, the team that wins the toss will chose to field first and the team loses the toss will be compelled to bat first. If these defiers are present, which they likely are, the monotonicity assumption does not hold, and so we cannot assert that the IV estimates are giving us the LATE.

We make these points a bit more concrete. Recall that we saw that 56.5% of teams that won the toss elect to bat, which corresponds to an excess of 6.5 percentage points over the benchmark case in which the toss has no effect on the batting/fielding decision. In addition, the reduced form estimated effect of winning the toss on winning the match was 1.8 percentage points, implying that toss winners win an excess of 0.9 percent of matches over parity. The instrumented effect of batting first would then be estimated as $0.9/6.5 = 13.9$ percentage points.⁸ Can we interpret this as the average rate at which the complier teams

⁸Since the choice to field first is the perfectly colinear inverse of the choice to bat first, flipping the sign of this number gives the estimated instrumented effect of electing to field first.

that won the toss and elected to bat generated the excess wins? Not really, because these excess wins could have been generated by the defiers making good decisions to field. Since we saw that teams that win the toss and elect to field first have a higher win-loss differential than those that elect to bat first, it would be irresponsible to rule out this possibility. Consequently, it is unlikely the LATE can be identified in our setting.

5 Summing Up

When the toss is unimportant, the game is fair: neither the batting side nor fielding side has an advantage derived simply from the luck of the toss prior to the first ball being bowled. The toss appears to be unimportant in some settings, but important in others, like day/night matches. Although day/night matches are enjoyable, if we care about eliminating the influence of the toss, they should be avoided. Cricket pitches should be made durable, and with an eye to not disadvantaging teams that bat first or second. As for the much maligned Duckworth-Lewis formula, it looks as though there is no need to change it for now. We have no evidence that it is helping or harming teams that bat second.

Since the start of cricket, the toss has been used to determine which team gets to make the decision to bat first. But it is not the only way to make this determination. For example, we could instead run an auction in which each team bids how many runs to give the other team for free at the start of their innings for the right to decide whether to bat or field first. We could also specify more elaborate mechanisms that attempt to elicit both the willingness to pay and the willingness to accept a number of starting runs, for each team separately. Such ways of resolving who has the right to make the choice to bat or field first could make games more competitive, and thus more enjoyable to many viewers. Cricket could benefit from our willingness think outside the box.

References

- ANGRIST, J., G. W. IMBENS, AND D. B. RUBIN (1996): "Identification of causal effects using instrumental variables," *Journal of the American statistical Association*, 91, 444–455.
- CHEN, S., V. CHERNOZHUKOV, I. FERNÁNDEZ-VAL, AND Y. LUO (2019): "SortedEffects: sorted causal effects in R," *arXiv preprint arXiv:1909.00836*.
- CHERNOZHUKOV, V., I. FERNÁNDEZ-VAL, AND Y. LUO (2018): "The sorted effects method: discovering heterogeneous effects beyond their averages," *Econometrica*, 86, 1911–1938.
- CSATÓ, L. (2020): "A comparison of penalty shootout designs in soccer," *4OR*, 1–16.
- 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, 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," *New Zealand Statistician*.
- DUCKWORTH, F. C. AND A. J. LEWIS (1998): "A fair method for resetting the target in interrupted one-day cricket matches," *Journal of the Operational Research Society*, 49, 220–227.
- SHAFQAT, S. (2015): "Analysis: How many ODIs are decided by the toss of a coin?" *The Telegraph*.

Total matches by type over time

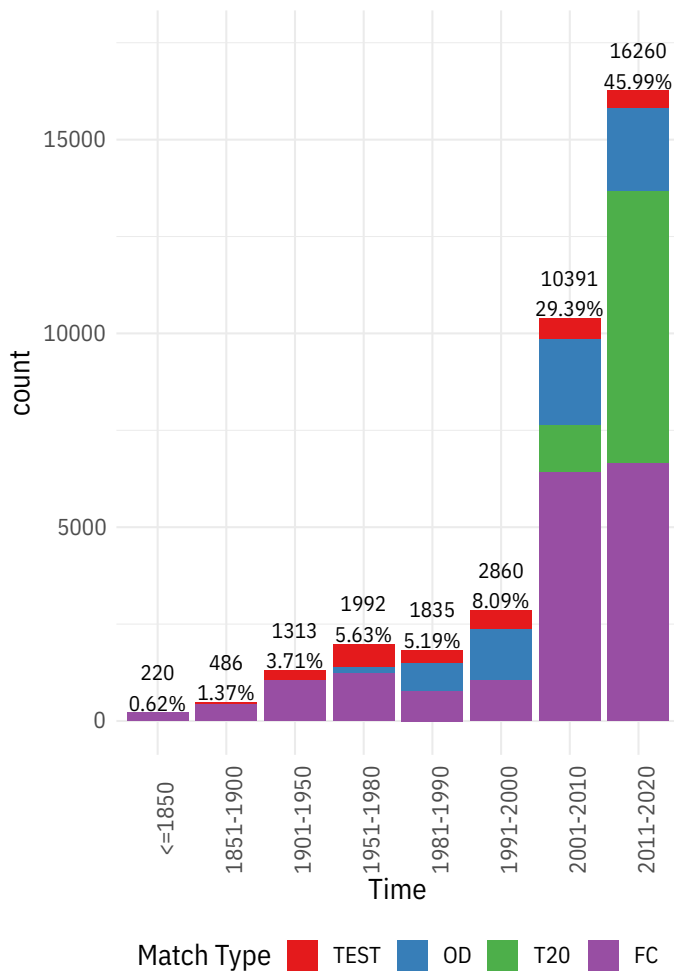


Figure 1: Number of matches by format over time

	Toss Wins	Matches	<i>p</i> value
Home team	3240	6377	0.201
Last toss winners	17189	34283	0.611
Underdog	2001	4054	0.423
Home Umpire	2075	4044	0.098

Table 1: Balance

Table 2: Reduced Form Effect of Toss on win probability

	(1)	(2)	(3)	(4)
Win Toss	0.018*** (0.005)	0.017*** (0.005)	0.017*** (0.005)	0.017*** (0.004)
Constant	0.491*** (0.002)			
Team FE		✓	✓	✓
Match-Type FE			✓	✓
Time FE				✓
Number of Matches	35357	35357	35357	35357

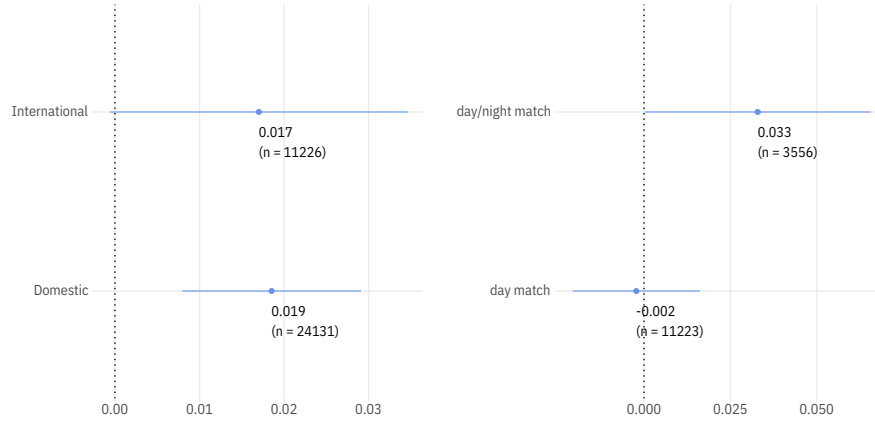
Table 3: Batting first and win probability

	(1)	OLS (2)	(3)	First-Stage (4)	(5)	IV (6)	(7)
Bat First	-0.016*** (0.005)	0.002 (0.006)	-0.039*** (0.007)				
Win Toss				0.130*** (0.005)			
Bat First (IV)					0.139*** (0.036)	0.134*** (0.036)	0.134*** (0.036)
Constant	0.508*** (0.002)	0.499*** (0.003)	0.519*** (0.004)	0.435*** (0.003)	0.430*** (0.018)		
Sample	All	TW bats	TW fields	All	All	All	All
FS F-Stat						604.71	579.95
Team FE						✓	✓
Match-Type FE						✓	✓
Decade FE							✓
Number of Matches	35357	19971	15386	35357	35357	35357	35357

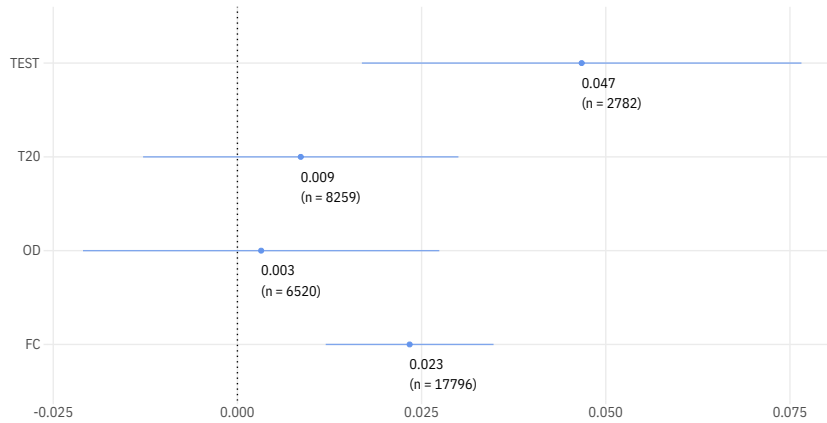
Heterogeneous Treatment Effects of the Toss on Win Probability

Intl / Domestic

Day / Night



match type



by continent

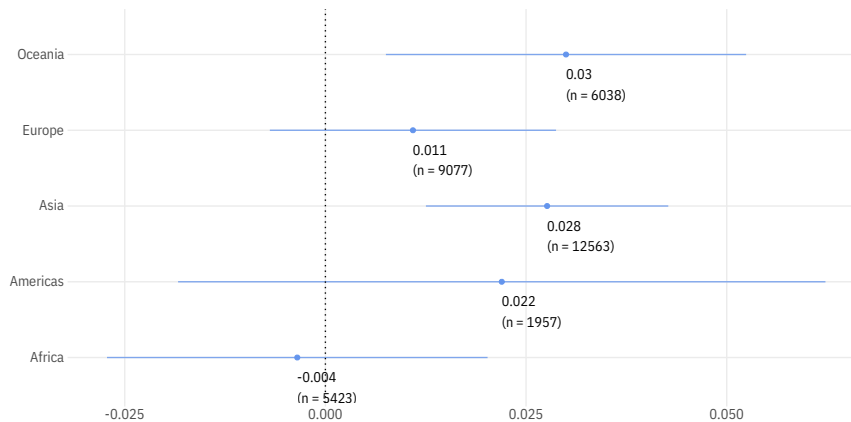
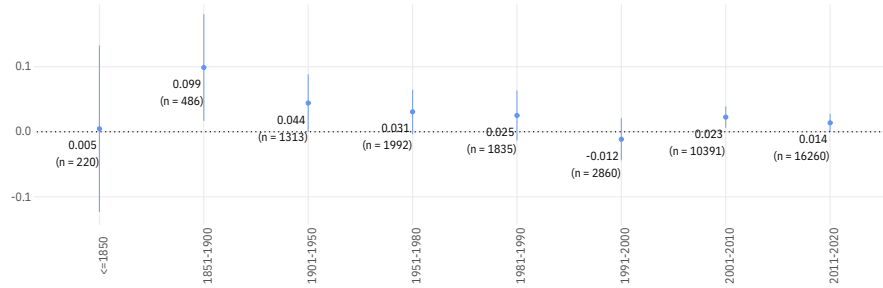


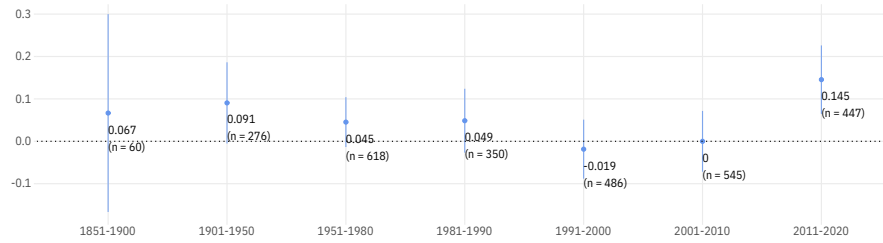
Figure 2: Effect of winning the toss on win probability decomposed across different match types, over time, and by continent.

Heterogeneous Treatment Effects of the Toss on Win Probability by Format over time

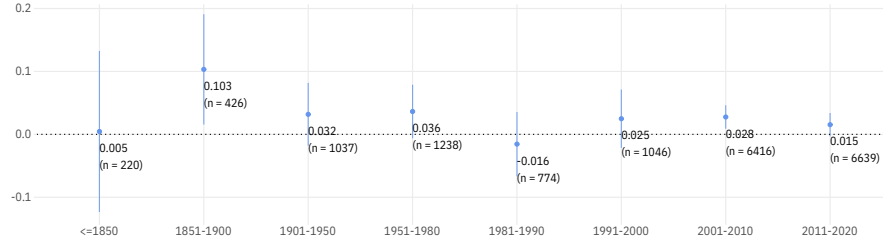
All matches



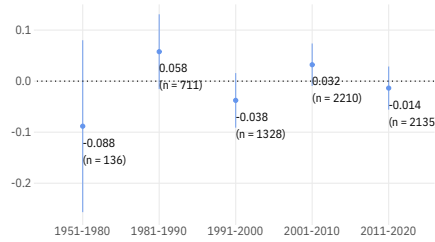
TEST over time



FC over time



ODI over time



T20 over time

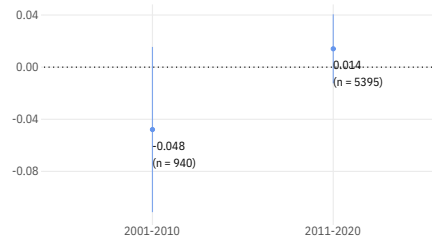
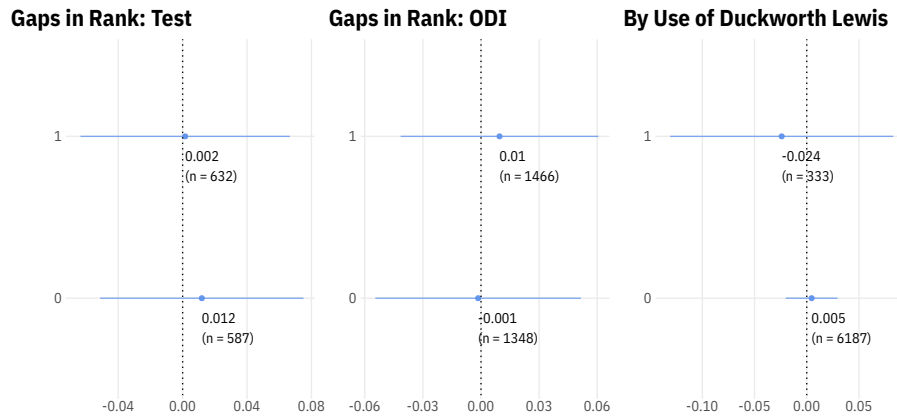


Figure 3: Effect of winning the toss on win probability decomposed by format over time

Heterogeneous Treatment Effects of the Toss by Rank, Rain Interruptions, and Seasonality



Month of the year (in England)

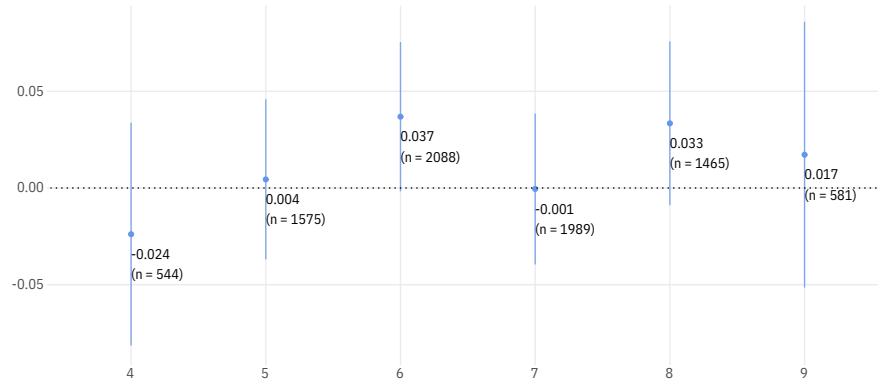


Figure 4: Effect of winning the toss on win probability decomposed by competitiveness, use of DL, and Seasonality

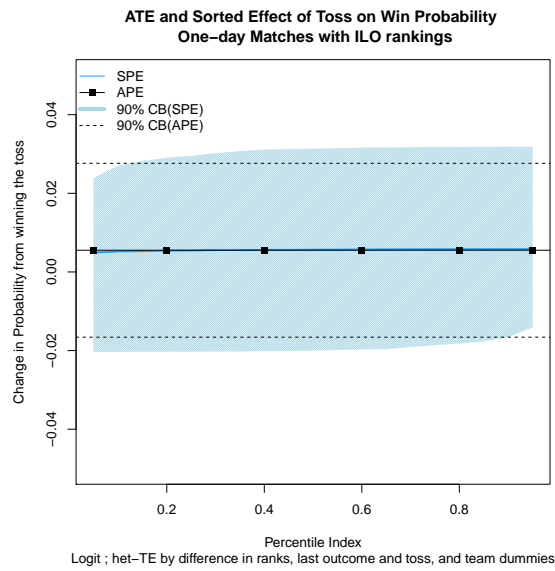


Figure 5: Treatment effect heterogeneity by ranking, toss and win history, and team dummies. Minimal evidence of effect heterogeneity

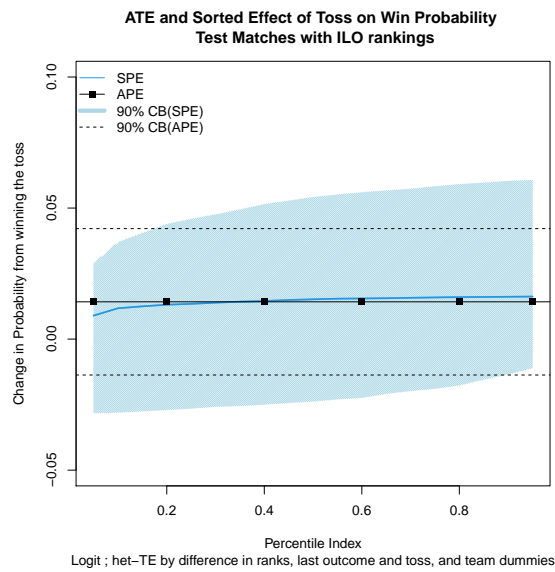
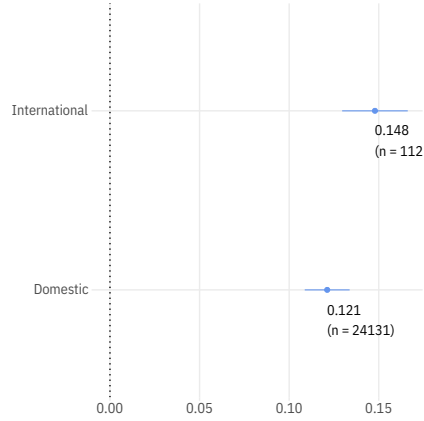


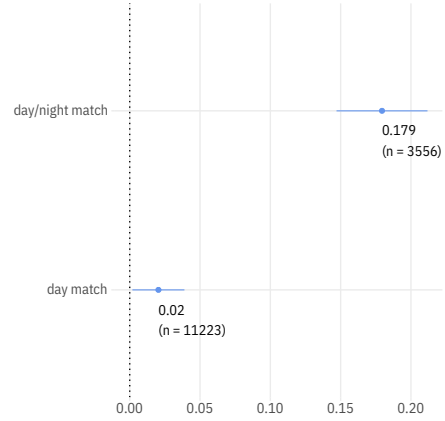
Figure 6: Treatment effect heterogeneity for test matches by ranking, toss and win history, and team dummies. Minimal evidence of effect heterogeneity

Heterogeneous Treatment Effects of the Toss on Choice to Bat First

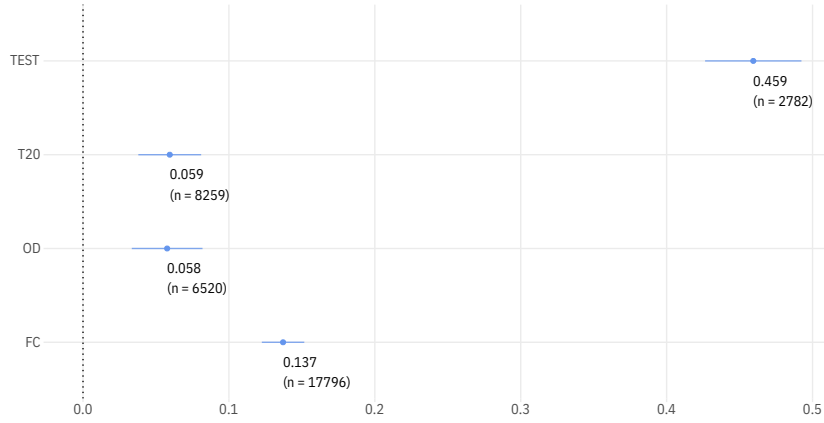
Intl / Domestic



Day / Night



match type



by continent

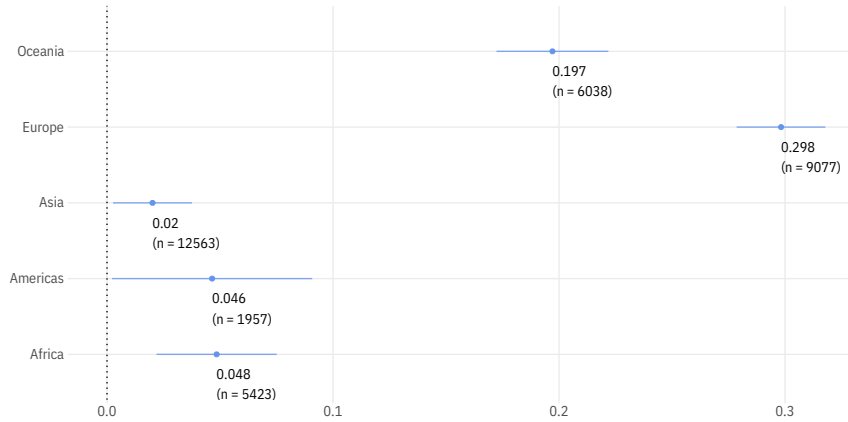
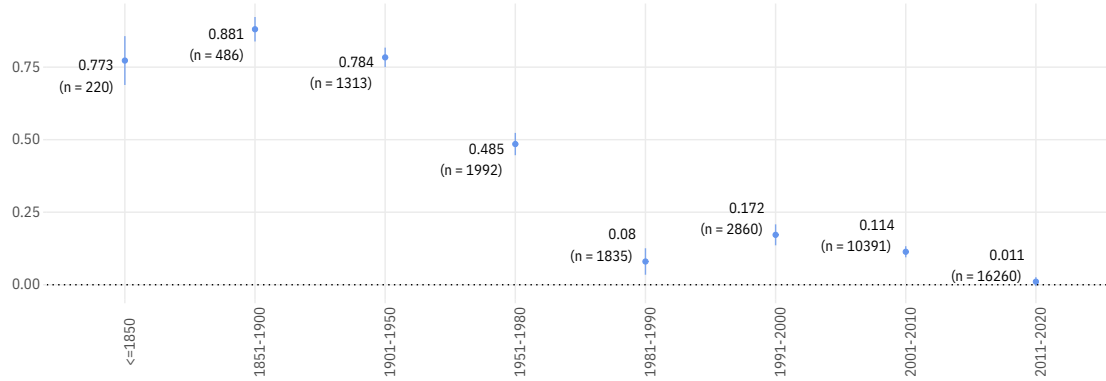


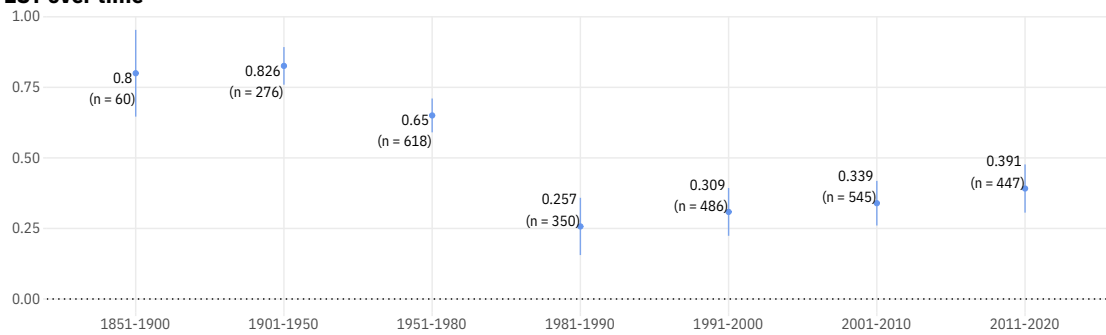
Figure 7: Toss effects on choice to bat decomposed across different match types, timing, and continent.

Heterogeneous Treatment Effects of the Toss on Bat Choice by Format over time

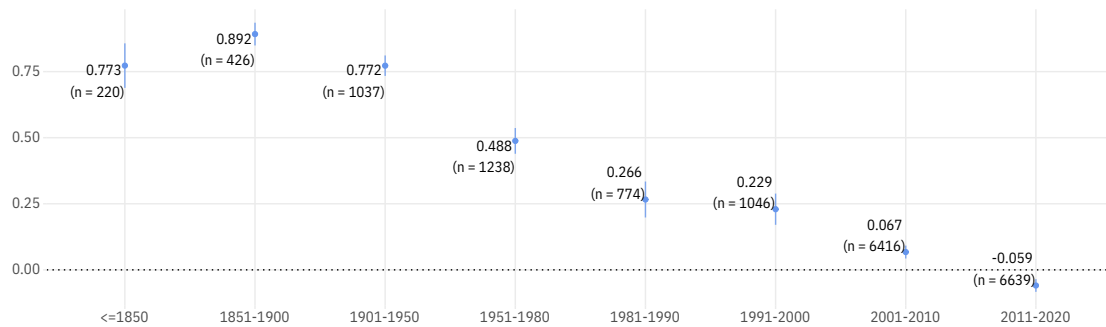
All matches



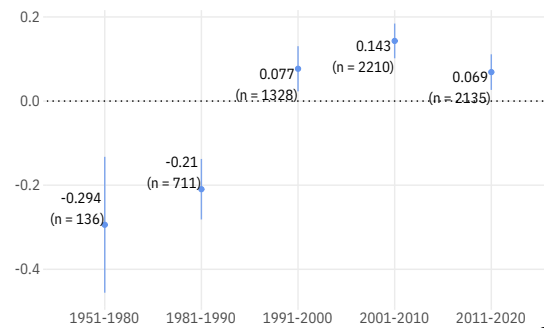
TEST over time



FC over time



ODI over time



T20 over time

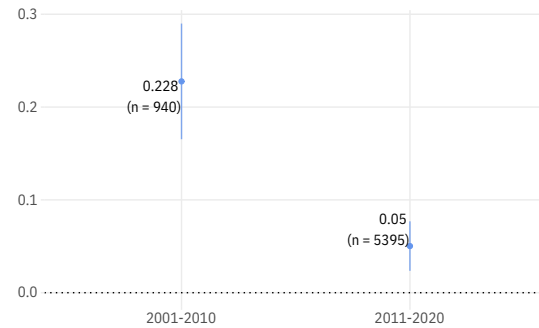


Figure 8: Toss effects on choice to bat decomposed across different formats over time

Heterogeneous Treatment Effects of the Toss on bat choice

by Rank, Rain Interruptions, and Seasonality

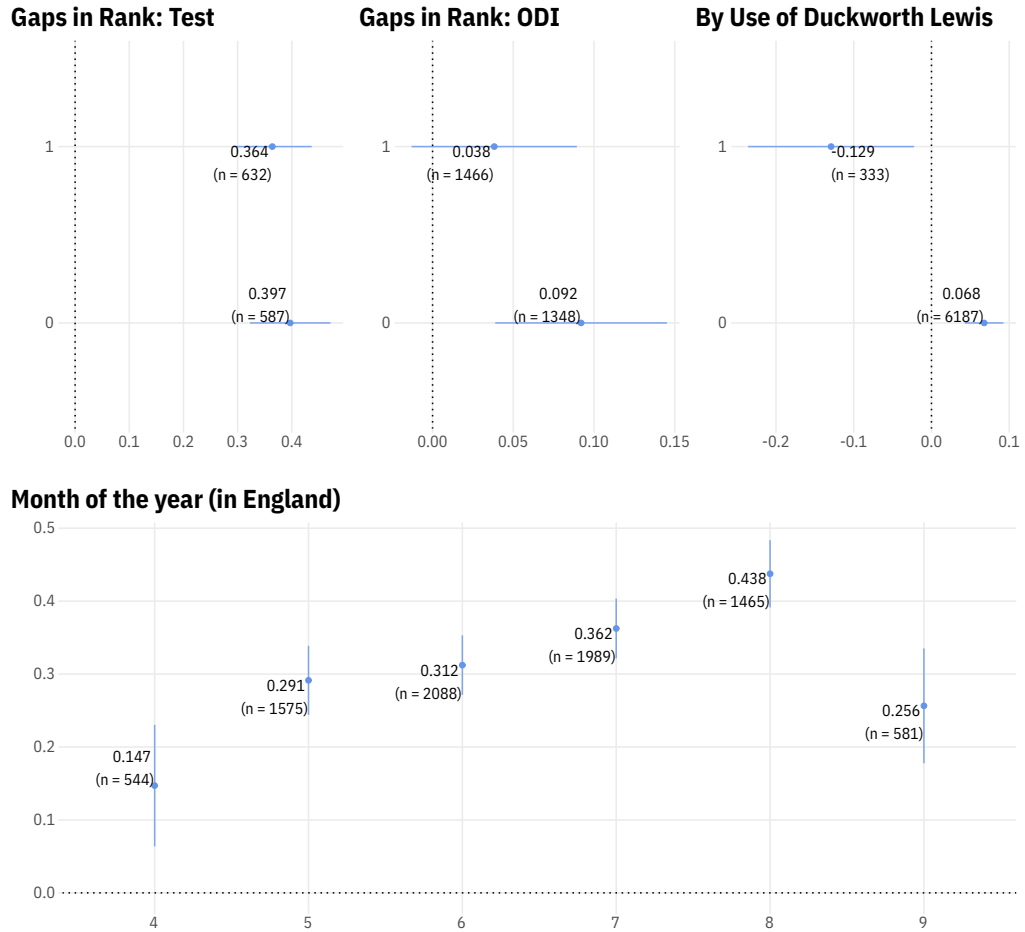


Figure 9: Toss effects on choice to bat decomposed by ranking differences, rain-interruptions, and season (in England)