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Uncertainty of outcome or strengths of teams: An economic analysis of attendance demand for international cricket

Abstract

A significant body of theoretical literature has argued that popular interest in sporting contests between teams is heavily influenced by how difficult it is to predict the result ex-ante. Empirical research has, however, been unable to reach a consensus on magnitude of uncertainty on demand. In this paper, we seek to resolve this impasse by distinguishing between uncertainty of outcome in the short run and uncertainty of outcome in the long run. We also show that it is important to control for the independent effect of absolute team strength when testing the uncertainty of outcome hypothesis. Using data on over 380 Test cricket matches played in England, Australia and New Zealand since 1980, we find that short run uncertainty of outcome has a significant impact on attendance demand and that absolute team strength has better explanatory power for attendance demand than does long run uncertainty of outcome. Our results suggest some policy implications for the management and organisation of international cricket.

Keywords: demand, uncertainty of outcome, cricket, fixed effects.
JEL codes: C23, L83, R22

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1 Introduction

In seminal contributions, Rottenberg (1956) and Neale (1964) suggest that the professional sports industry is unique because the success of a professional sports team or firm depends on its competitor also succeeding. Given this dependence, the uncertainty of outcome hypothesis proposes that the closer the competition between professional sports teams, the greater the likelihood of increased spectator attendance due to increased interest in the sport. In contrast to theory, empirical evidence on the relationship between uncertainty of outcome and demand has produced mixed conclusions: Borland and Macdonald (2003) looked at over forty studies on demand for sport and noted a significantly positive effect of uncertainty of outcome on demand (as predicted by the uncertainty of outcome hypothesis) in fewer than half.

One possible explanation for the lack of consensus in the empirical literature is that very few studies have differentiated between the impact of short run, seasonal uncertainty of outcome and longer run uncertainty (see Downward and Dawson, 2002 and Szymanski, 2003 for a review of this literature). A further issue is whether the absolute strength of teams may exert an effect on demand, independent of the relative strength of teams or uncertainty of outcome. Again this is an issue which has received relatively little attention in the literature.

International cricket is a particularly useful context for testing these ideas. First, the structure of international cricket with teams playing each other in extended "series" of matches, allows for an easy distinction between short and long run uncertainty of demand. Further, Test cricket, which is typically played over a period of five days, allows us to measure the effect of a change in the uncertainty of outcome within the course of a match.[1] Further, the topic has pressing relevance for current policy debates regarding the organisation of international cricket. Specifically, there has been a long-running debate over whether to introduce a two tier system for international test matches, in which strong and weak teams would be segregated. This question is frequently debated by in the cricket media and by cricket fans.[2]

[1] A further interesting and unique feature of Test cricket is that matches may reach the end of the allotted time without a result being reached. This is termed a draw. For a weak team, achieving a draw against a stronger team is often perceived as a very attractive outcome.

[2] For instance, see Saltau and Marshallsea (2004) and Vaughan (2013).

Using attendance data that we collected for over 380 Test matches played by home teams in England, Australia and New Zealand between 1980 and 2012, we estimate the effect of short and long run uncertainty of outcome and also absolute team strengths on the demand for Test cricket. We control for a series of other factors previously noted to affect demand for sport including the fixed effect of the venue at which the test was played.

In the next section of the paper, we review some relevant literature, particularly on the effects of uncertainty of outcome and team quality on demand for sport. In section 3, we explain the methodology and data used in this study. In section 4, we present and discuss the descriptive statistics and multivariate regression results. We make some concluding remarks and suggest some policy implications of this research in section 5.

2 Uncertainty of outcome: literature review

Empirical evidence on the impact of uncertainty of outcome on demand for professional sport is mixed. Borland and Macdonald (2003) and Szymanski (2003) found that fewer than half of the studies they reviewed offered strong support for the uncertainty of outcome hypothesis. In football, Wilson and Sim (1995) and Baimbridge et al. (1996) find no significant impact of outcome uncertainty on demand for European football. In contrast, Falter and Perignon (2000) note that rising uncertainty of outcome leads to increases in attendance demand for football in France. Looking at other team sports, Borland (1987) and Peel and Thomas (1997) find similar positive effects of uncertainty of outcome on demand for Australian rules football and rugby league in England, respectively.

Even where a relationship exists between attendance demand and uncertainty of outcome, it is not always linear: for example, Peel and Thomas (1992) noted an "inverted U" shaped relationship between uncertainty of outcome and demand for English league football, with demand rising with uncertainty of outcome till a point and declining thereafter. It is possible that demand for sport is affected differently by small and large differences in team strengths. Welki and Zlatoper (1999) found that small increases in uncertainty raised attendance but very large increases in uncertainty lowered attendance.

What about team quality? Some studies have established a strong effect of home performances on attendance in professional sport: for instance, Buraimo and Simmons (2008)

found that the opposite of the uncertainty of outcome hypothesis holds in the English Premier League (EPL), with fans preferring to watch their team win against an inferior team. On the whole, Borland and Macdonald (2003) note that most studies in their review found a positive and significant effect of home team performances on demand for sport.

The impact of the away team on demand is less clear from the literature. Pawloski and Anders (2012) recently noted a significant effect of "reputation" of away teams on demand in Germany. By contrast, Dobson and Goddard (1992) found that the away team has no significant effect on attendance demand in football. Similarly, Butler (2002) found that the away team had no significant effect on demand for MLB in the USA. In their review, Borland and Macdonald (2003) find that only half of the studies they reviewed found a significant effect of the away team, though the impact was positive in these studies.

Given the lack of clarity on the impact of uncertainty of outcome and team strengths on demand for sport in the extant literature, there is some merit in contrasting different types of uncertainty of outcome from team strengths. It is also worthwhile to use Test cricket for this analysis because Test cricket offers a unique type of uncertainty of outcome (final day uncertainty).

Despite being one of the most popular sports in the world[3], research on international cricket is relatively thin, with previous literature (Chapman et al. 1987; Hynds and Smith, 1994; Bhattacharya and Smyth, 2003; Blackham and Chapman, 2004) having looked at whether shorter run measures of uncertainty of outcome (such as final day and series uncertainty of outcome) affect demand for Test cricket. In contrast to many professional sports, the elite level of professional cricket is played between teams representing countries. The nature of Test cricket, which is played over five days, also provides a valuable opportunity for distinguishing two different types of short run uncertainty.

The earliest known academic study on demand for cricket was carried out by Schofield (1983), who looked at demand for the John Player League, a limited overs tournament played domestically in England. He found all economic factors specified as possible explanations of cricket demand to be insignificant. Later, in their study of first-class and domestic one day cricket demand in England, Paton and Cooke (2005) examined the effect of uncertainty of outcome through a "points differences" variable which measured the difference in points

[3] Some estimates put TV viewership of the 2011 cricket World Cup final at over a billion people (Taylor, 2011).

between teams in each match based on the season's point table. This was statistically insignificant. Hynds and Smith (1994) and Bhattacharya and Smyth (2003) studied demand for Test cricket in England and Australia respectively and noted that economic variables were mostly insignificant in explaining attendance demand. Instead, series certainty, venue effects, opposition effects and rain proved stronger influences on Test cricket demand in both England and Australia.

All of the studies above measure the ex-ante uncertainty of outcome by calculating the relative difference in the strength of the teams immediately (or as soon as possible) before they play each other. We label this as "short run uncertainty of outcome".. Yet both the uncertainty of the outcome and popular interest in the contest are likely to be generated over time. A close and uncertain contest between the teams in the past may generate a rivalry that stimulates demand over several periods. Therefore, in addition to the short run uncertainty of outcome we will construct a variable which captures "long run uncertainty of outcome". This is described in the section below. As far we are aware, there has been no work on the impact of long run uncertainty of outcome. In addition, we will also control for the independent effect of team strength on demand when estimating the impact of the two types of uncertainty of outcome on the demand for cricket. .

3 Methodology

3.1 Measuring team quality and longer run uncertainty in cricket

Similar to Hynds and Smith (1994) and Bhattacharya and Smyth (2003), we include short run uncertainty of outcome measures in the present research, but we also include an additional measure that captures longer term uncertainty of outcome by assessing the impact of longer term performances on demand.

To do this, we use the ICC quality ratings which allocate scores to each international team on the basis of previous home and away performance. We create a variable called Ratings Certainty, which models the ratings uncertainty of outcome of each match as the absolute difference in ratings points between the two teams prior to the match. An increase in the variable shows declining uncertainty of outcome and so is expected to lower attendance (for example, ratings certainty of 20 points is expected to produce a more certain contest than ratings certainty of 5 points; a smaller difference is "better"). The historical ratings do not include ratings for

every month in a year (meaning there are some series for which a team rating is unavailable for the very month the series was played in), so in some cases updates take place after a series of games in our sample. We also include a Ratings Certainty Squared variable, which is simply the square of Ratings Certainty, to distinguish impacts of small and large increases in uncertainty of outcome.

Also in contrast to previous literature, we create a variable called Home Strength, which models the quality of the home team, measured by the ICC rating of the team prior to the match. This will show whether the strength of the home team affects demand for international cricket. As noted, previous literature has found that home team success tends to raise attendance demand. Finally, we construct a variable called Opposition Strength, modelling the quality of the opposition team, measured by the ICC rating of the opposition prior to the match. This will show if spectators are attracted to matches played by strong opponents independent of the strength of the home team. Borland and Macdonald (2003) found that the effect of opposition strength on demand for sport is positive where statistically significant.

3.2 A model of attendance demand

Given the discussion above, we present a model of attendance demand for Test cricket:

$$Average\ Daily\ Attendance_{it} = a_i + B_1 Home\ Strength_{it} + B_2 Opposition\ Strength_{it} + B_3 Ratings\ Certainty_{it} + B_4 Ratings\ Certainty\ Squared_{it} + B_5 Final\ Day\ Certainty_{it} + B_6 Series\ Certainty_{it} + C_i \mathbf{X_{it}} + v_{it} \quad \textbf{[1]}$$

The dependent variable is Average Daily Attendance, the average daily attendance during the match. This is obtained by dividing the total number of spectators in the match by the number of days of play. Some studies have also used television viewing figures to measure demand (e.g. Alavy et al. 2010). Television viewing figures are important because of the contribution of television broadcast rights to national board revenues. Attempts were made to collect data on television audiences for this study, but these were unavailable.

However, live attendance is important for two reasons. First, in England and Australia, the two main countries covered in this study, crowd attendances tend to be high for international matches across different formats of cricket. Given this, there are sizable revenues gained from

crowd attendance and the sale of complementarities in stadia, such as food and drink. Second, poorly attended matches may be unattractive to broadcasting companies: venues with persistently poor attendances may find it difficult to gain hosting rights for international games in future.

Thus in our model of Test cricket demand, attendance demand is a function of home team strength (Home Strength); opposition team strength (Opposition Strength); the absolute difference in team strengths (Ratings Certainty); the square of absolute differences in team strengths (Ratings Certainty Squared); uncertainty of outcome before the final day of a Test match (Final Day Certainty); uncertainty of outcome about a series (Series Certainty) and a vector of control variables (X) based on previous literature on demand for cricket. v_{it} is an error term.

3.3 Empirical modelling

The data used in this study are in panel form, as they comprise both time series and cross sectional elements: a number of venues host matches annually over the sample period. In contrast to Hynds and Smith (1994) and Bhattacharya and Smyth (2003), we formally choose between a venue fixed effects or random effects model by running a Hausman test. Schofield (1983) explains that using log-linear models enables interaction effects amongst independent variables and provides direct estimates of elasticities. Given this, we use a log-linear specification in addition to a linear specification. Test match attendance in England is slightly constrained as the first three days of Tests are often sold out (Hynds and Smith, 1994). However, the final two days, should the Test go that far, are not similarly constrained.

3.4 Variables

The discussion above suggests a number of variables expected to influence demand for Test cricket matches, apart from uncertainty of outcome and team quality. This list of variables and their expected signs are provided in Table 1.

Similar to Hynds and Smith (1994) and Bhattacharya and Smyth (2003), we include two dummy variables for short run uncertainty of outcome. The first is a dummy for final day uncertainty of outcome (Final Day Certainty), which controls for matches in which the outcome on the final day of the Test could be easily predicted. Second, we include a dummy variable for

series uncertainty of outcome (Series Certainty): this equals 1 if the series result was decided prior to the match. It should be noted that the variables show certainty of outcome. Based on the uncertainty of outcome hypothesis, the sign on their coefficients is expected to be negative rather than positive (as it would be if the variable was defined as uncertainty). This makes a difference only to the direction, not magnitude of the coefficients.

Although previous literature has mostly found a negative effect of ticket prices on demand for sport (Borland and Macdonald, 2003), data on ticket (admission) prices were not available in this study. However, data on match revenues are available for most matches played in England during the sample period. Given this, one possibility is to follow Hynds and Smith (1994) and calculate a proxy measure for real price of attendance for each match in England by dividing the match revenue by the total attendance for the match, adjusting for inflation.

Inclusion of such a variable is likely to be problematic. Ticket prices are likely to be endogenous in the opposition, as English venue authorities likely set ticket prices according to perceived interest in the opposition. This is a pricing strategy that maximizes revenue and affects attendance demand. Given this, inclusion of a real price variable is unlikely to capture the true effect of price on demand for cricket in England, as prices are likely to reflect this underlying phenomenon. A similar problem is also noted by Bhattacharya and Smyth (2003) in their study of demand for Test cricket in Australia. However, it can be argued that there exists a degree of inertia in price setting by cricket venue authorities. They are not profit maximisers in the same way that commercial firms might be. As such, the results of this study may not be as strongly affected by this pricing behaviour as they would be for most firms..

Nevertheless, given the difficulty of interpreting the impact of price on demand, we do not include a real price variable in this study. Instead, we include a dummy variable for each opposition team. These dummy variables capture opposition fixed effects and indirectly model the impact of price on demand for international cricket. In the case of Test matches, this method cannot overcome the problem of variation in prices over the days of a match, particularly on the final day. The venue fixed effects will capture any fixed price differentials between venues.

Apart from their use in indirectly capturing the impact of price on demand, opposition fixed effects can also control for the impacts of historical rivalries between some countries, independent of changes in team strengths. In this study, the Ashes rivalry between England and Australia is particularly important in this regard.

We include two economic explanations of demand more directly into the regression model. First, we include Real Income, measured by average weekly earnings in the region the match is held in. This is adjusted for inflation by the monthly national Retail Price Index (RPI) in England, quarterly regional Consumer Price Index (CPI) in Australia and quarterly national Consumer Price Index (CPI) in New Zealand. The expected sign for Real Income is ambiguous as professional sport can be either a normal or inferior good. We also include a Substitutes variable which equals 1 if a notable event in another major professional sport simultaneously took place (such as the Australian Open in tennis or European Championships in football).

The venue of the match is used as the base unit for the fixed effects model. This is because demand is likely to differ at each venue for reasons that cannot be captured by the other explanatory variables. These reasons include differences in market size, attractiveness of the stadium[4] and local interest in watching live international cricket at each venue. As discussed, venue fixed effects can capture any fixed price differentials between venues.

We include a dummy variable called Rain to control for the effect of weather. The variable is set equal to 1 if at least forty scheduled overs were lost to rain or poor light[5] on any day of the match. Rain is expected to have a negative coefficient. We also include a dummy variable called Holiday which equals 1 if the match period contained at least one public holiday. Its expected sign is positive. We do not include population as an explanatory variable as the venue fixed effects are likely to capture the market size, particularly in Australia, where venues are rarely supply constrained.

3.5 Data

For Test matches, the England data include total match attendance for each Test played by the English cricket team between January 1980 and December 2011, with the exception of the match against West Indies at Chester-Le-Street in 2007, providing 196 observations. For Australia, the data contain total match attendance for each Test played by the Australian cricket team between November 1984 and January 2012, with the exception of the Tests against West Indies at Adelaide in 1984 and 2009, providing 153 observations. For New Zealand, the data include total match attendance for each Test played by the New Zealand cricket team between December

[4] This can be affected by facilities at the venue, travel time and viewing pleasure.
[5] For the rest of this study, rain will refer to both rain and poor light.

2001 and April 2009, providing 32 observations. In total, there are 381 Test matches in the sample.

Data on match attendances were collected from *Wisden Cricketers' Almanack* annual editions between 1981 and 2012 and from cricket New Zealand. In a minority of cases, match attendances were unavailable from the *Wisden Cricketers' Almanack*, so data for these matches were collected from venue authorities instead. Attendance figures for Test matches were not available on a day by day basis, so the total attendance and the number of days of play in each Test were noted instead, in order to estimate average daily attendance. Match related data, including dates, venue, opposition and series and final day uncertainty were collected from the ESPNcricinfo web site. Data on rain, including which days were affected and how many overs were lost, were collected using the ESPNcricinfo web site and match reports in various Wisden *Cricketers' Almanack* editions.

Following Hynds and Smith (1994), data on earnings were collected from national income surveys (a list of sources for all variables is provided in Table 2). The measure used was the average weekly wage for all workers, and where unavailable, all male workers in the catchment area for the match venue. The wage data were adjusted for inflation using relevant price indices. Data on venue capacities were collected from venue authorities. In some cases, the accuracy of obtained estimates was questionable, so we made a judgement on actual capacity by observing attendance data over a number of years.

Data on competing sports events and public holidays in all three countries were collected using widely available public sources. Exchange rates were used to convert earnings into the same currency (pounds sterling) for all three countries. Exchange rate data were obtained from widely available public sources.

4 Results and discussion

4.1 Descriptive statistics

We first present some summary statistics of English, Australian and New Zealand Test attendances over the last thirty years in Tables 3a-3c below. The average daily attendance is defined as the total match attendance divided by the number of days of play. Standard deviations are also provided for each venue and opposition team in order to show how spread the data are. Throughout this section, N indicates the number of matches.

The average attendance figures reveal that Lord's was the best attended venue in England during the sample period, with an average daily attendance that is over 27% higher than the next best attended venue, the Oval. Amongst venues that have hosted at least five Tests in the sample period, Nottingham had the lowest average daily attendance with fewer than 10,700 spectators per day.

Australia was the most popular opposition team, attracting over 16,200 spectators per day, on average, confirming interest in the historic Ashes series. However, Test attendance against four other opposition teams averaged over 14,000 spectators per day: South Africa, West Indies, Pakistan and India. By contrast, Tests against New Zealand, Sri Lanka, Zimbabwe and Bangladesh averaged fewer than 13,000 spectators per day. Interestingly, during the sample period, these latter four countries also played fewer Tests combined in England (44) than Australia (46), suggesting the scheduling of Test matches in England already reflects underlying demand for different opposition teams. This difference can indirectly help in understanding pricing strategies at Test venues.

In Australia, Melbourne has the highest average daily attendance for Test matches, with almost 50% more spectators than Sydney, on average. Hobart, Darwin and Cairns average fewer than 5,000 spectators per day. In Australia, the impact of different opposition teams on demand is even stronger then it is in England. Matches against England, West Indies, Pakistan, South Africa and India average over 13,000 spectators per day, whereas matches against New Zealand, Sri Lanka, Zimbabwe and Bangladesh average fewer than 8,100 spectators per day. It should be noted that stadium capacities in some Australian venues are much higher than in England.

Finally, in New Zealand, average daily attendances are much lower than in England and Australia, on average. England is the most popular opposition team and Auckland the most popular venue. The sample sizes are small, however, with only one venue (Wellington) having hosted more than six Tests during the sample period.

Clearly, the descriptive statistics suggest that England, Australia, South Africa, West Indies, Pakistan and India are the most popular international cricket teams in England, Australia and New Zealand. However, it is not clear what impact the relative strengths of these teams and uncertainty of outcome had on attendance demand during the sample period. In order to identify these impacts, we conduct fixed effects analysis.

4.2 Fixed effects estimates

Given the likely bias that would exist in OLS estimates of the data , we present fixed effects estimates for Test matches in England in Table 4. This treats the unobserved heterogeneity between venues as fixed over time. We use both linear and log-linear specifications given there is no consensus on the appropriate functional form for demand for sport. In the first two models, we do not include the six outcome uncertainty and team strength variables (Ratings Certainty, Ratings Certainty Squared, Series Uncertainty, Final Day Uncertainty, Home Strength and Opposition Strength). Instead, we include only opposition dummy variables and the control variables (Real Income, Rain, Substitutes and Holiday). This is a phased approach in which we first isolate the impact of other factors on demand for sport before attempting to identify the impacts of outcome uncertainty and team strengths, the variables of interest in this study.

In the first set of estimates (Models 1 and 2), Real Income is statistically very significant and has a positive coefficient, suggesting Test cricket in England is a normal good: fans choose to watch more Test cricket as their incomes rise. Rain and Substitutes have no significant effect in the linear estimates, but Rain has a significantly negative impact in the log-linear estimates. Some teams have been traditionally popular in England, particularly Australia, so to consider opposition fixed effects and also to indirectly control for the impact of price, we include opposition dummy variables as well.

Amongst opposition teams, Australia, South Africa, Pakistan, New Zealand, West Indies and India significantly raise attendance relative to Sri Lanka in the linear estimates. In the log-linear estimates, New Zealand does not significantly raise attendance, but the other opposition teams mentioned above raise attendance. Holiday is statistically insignificant in all but one of the four models, but surprisingly has a negative coefficient. As the public holidays in the sample fall on a Monday (Bank Holiday), which is usually the final day of a Test match in England, it is likely that the negative effect is capturing declining attendance towards the end of Test matches in England.

In Models 3 and 4, we also include uncertainty of outcome and team strength variables. Ratings Certainty and Ratings Certainty Squared are not statistically significant in either set of estimates, but Home Strength and Opposition Strength are very significant and have positive coefficients. Given the inclusion of opposition dummy variables in the model, the positive coefficient on Opposition Strength suggests that, for each opposition country, a relatively

stronger team attracts more fans than a weaker team. This result is of particular interest because if opposition fixed effects were not controlled for, the strength of the opposition team could have reflected other characteristics of traditionally strong teams such as Australia (for example, the historic Ashes rivalry). Including only Ratings Certainty, rather than both the linear and squared ratings certainty terms leaves its significance unchanged, and also leaves the significances and magnitudes of the other coefficients unchanged.

These results suggest that whilst longer run uncertainty of outcome does not affect demand for Test cricket in England, strong home and opposition teams raise attendance. An increase in one ratings point for the opposition increases average daily attendance by around 55 spectators, whilst an increase in one ratings point for the home team increases average daily attendance by around 141 spectators in the linear estimates. Interestingly, Final Day Certainty is negative and very statistically significant, suggesting a certain final day outcome reduces attendance by over 1800 spectators, other things being equal. This impact likely underestimates the true impact of final day certainty because when the outcome is certain before the final day, it is possible spectators can gain entry into the venue at a reduced price. This finding about final day certainty provides some evidence that short run uncertainty of outcome impacts demand.

By contrast, Series Certainty is positive and statistically insignificant. One explanation for the positive coefficient is that tickets for the initial days of Test matches in England tend to be sold several months in advance, so spectator demand is not very elastic to the series state. Tickets for the final days of Test matches are still available after the match begins, so ticket sales for those days are more vulnerable to match state. This result contrasts from Hynds and Smith (1994), but our dataset considers a larger number of years and we use average daily attendance in the Test match as the dependent variable rather than attendance on each day of the Test. Real Income is still statistically significant. The log-linear estimates are similar.

Home Strength, Opposition Strength, Real Income and Final Day Certainty are thus the strongest explanations of demand for Test cricket in England, though the impact of price on attendance is not explicitly considered in this analysis. Six opposition teams also raise attendance: Australia, South Africa, Pakistan, New Zealand, India and West Indies. However, ratings uncertainty of outcome has not affected demand for Test matches in England over the last three decades. As such, Test attendance in England is mostly determined by the average earnings

in the region the match is being played in; the strength of the home and away teams; some opposition teams and certainty of outcome before the final day of the Test match.

Referring back to the question of whether team strengths or outcome uncertainty drives demand, it appears that in England, Test cricket fans prefer watching matches in which their team is strong or in which they can expect to see high quality cricket from the opposition. Long run uncertainty of outcome has no significant impact on attendance decisions of Test cricket fans in England, all other things being equal, though short run uncertainty does have some impact. Our empirical analysis allows identification of the impact of these different factors on demand for Test cricket in England.

Next, we present fixed effect estimates for demand for Test cricket in Australia in Table 5. Similar to the England estimates, we include the outcome uncertainty and team strength variables in Models 3 and 4.. Real Income is clearly positive and significant across specifications, suggesting that, similar to England, Test cricket is a normal good in Australia. Home Strength and Opposition Strength are positive and significant, also similar to the England estimates, implying demand for Test cricket in Australia increases with the quality of the home and opposition teams.

Coming to the long term uncertainty variables, Ratings Certainty and Ratings Certainty Squared are both significant in the linear estimates, though not in the log-linear estimates. Ratings Certainty Squared is positive, suggesting longer run uncertainty of outcome initially raises attendance, but after a point it lowers attendance. However, excluding the squared term alters the results. Ratings Certainty is no longer statistically significant, nor is Opposition Strength. The inclusion of a squared ratings certainty term was motivated by the rationale that small and large increases in uncertainty of outcome may impact demand differently.

Given this, to further test the robustness of this second effect we specified the impact of large ratings differences in other ways. First, we included dummy variables for groups of ratings differences (e.g. ratings differences of 0-10 points, 10-20 points, 20-30 points and so on) and second, we used a piecewise linear regression. These were more flexible specifications but less precise than a squared ratings certainty term. The alternative specifications produced contrasting results, as they showed insignificant impacts of ratings differences. The insignificance of the log-linear estimates and the fact that the linear estimates are not robust to alternative specifications suggest the significant impacts of Ratings Certainty and Ratings Certainty Squared are doubtful.

Final Day Certainty is also significant and negative, similar to the England estimates, but by contrast, Series Certainty is significant and positive in the linear estimates, suggesting uncertainty of outcome lowers attendance (as certainty raises attendance). An explanation is as follows. The Australian team was very strong during much of the sample period and frequently won series with one or two Tests to spare. These final two Tests were usually held at Melbourne and Sydney over the Christmas and New Year period, which are traditional sporting attractions in Australia.

Rain is significant in the log-linear estimates with and without uncertainty and strength variables included and in the linear estimates without uncertainty and strength variables included. The effect of rain is to lower attendance, as expected. Interest in the Ashes is confirmed with Test matches against England significantly raising average daily attendance by over 9,800 spectators relative to Sri Lanka, on average, in the linear estimates with uncertainty and strength effects included. These fixed effects estimates suggest that income; final day certainty; rain and team strengths (both home and opposition) are strong predictors of demand for Test cricket in Australia. Longer run ratings certainty has some apparent impact on Australian Test attendance, but this result is not robust to alternative specifications.

Table 6 provides the fixed effects estimates with and without uncertainty and team strength effects for all Test matches in England, Australia and New Zealand in the sample combined. Real Income is adjusted into pound sterling from Australian and New Zealand dollars using annual exchange rates. Opposition Strength, Home Strength, Real Income, Final Day Certainty, Holiday and Rain are all very significant but Ratings Certainty and Ratings Certainty Squared are insignificant. In the linear estimates, Series Certainty is also statistically significant and positive, similar to the Australia estimates. Excluding Ratings Certainty Squared has no significant impact on Ratings Certainty or the other variables, suggesting there is no real impact of longer run uncertainty of outcome on demand for Test cricket in these three countries combined.

Having examined Test demand in England; Australia and finally England, Australia and New Zealand together, we can state some observations. One, ratings uncertainty of outcome has very limited power in explaining demand for Test cricket. There is tentative evidence that certainty of outcome lowers Australian Test attendance where small differences exist and that attendances tend to rise as differences become larger. However, this finding is not robust to

alternative specifications, while there is no significant relationship between ratings certainty and demand in either the England estimates or the estimates for England, New Zealand and Australia combined.

Stronger teams attract more spectator interest, with one Test ratings point increase in opposition team strength leading to nearly 70 more spectators per Test day, on average and one Test ratings point increase in home team strength leading to over 200 more spectators per Test day, all other things being equal in the combined estimates. Also, Test cricket is a normal good, with increasing earnings leading to greater demand for the sport. Rain lowers attendance, whilst playing during a public holiday boosts demand. A certain outcome of a match lowers attendance on the final day, providing some support for the uncertainty of outcome hypothesis in the short run. Amongst opposition teams, Australia, England, West Indies, South Africa and India most significantly raise demand for Test cricket.

Our research thus suggests that short run uncertainty of outcome is a stronger explanation of demand for Test cricket than long run uncertainty of outcome. In terms of team strengths, both home and away team strengths have a significantly positive impact on Test demand, even after controlling for opposition fixed effects over time. In contrast to previous literature on demand for international cricket, we are thus able to identify the impact of absolute strengths of teams on attendance decisions of Test cricket fans.

4.3 Discussion of results

Our results provide only limited evidence that long run uncertainty of outcome (measured as the difference in team quality) has an impact on demand for Test cricket. Whilst there is some suggestion of a mixed effect of longer run uncertainty of outcome in Test matches in Australia (with uncertainty of outcome raising attendance till a turning point), this impact is not robust to alternative specifications. No significant impact of long run outcome uncertainty is observed in Test matches in England, or in Test matches in Australia, New Zealand and England all combined.

In contrast, we find strong evidence that absolute team strengths (both for home and away teams) raise demand. The result is largely consistent with previous literature (Borland and Macdonald, 2003) and the effect is found in each of the Australia and England samples as well as the combined estimates for three countries (Australia, England and New Zealand).

The two measures of short run uncertainty of outcome, included in line with previous literature, are final day uncertainty and series uncertainty. Final day uncertainty raises demand, as shown by the fact that a certain final day outcome lowers attendance in the Test estimates. Series uncertainty is found to have a negative effect on both demand for Test cricket in Australia and all of Australia, England and New Zealand combined. This result differs from Hynds and Smith (1994) and Bhattacharya and Smyth (2003). However, neither of these earlier studies used a panel data framework. Further, our estimates control both for absolute team strengths and for longer run uncertainty of outcome. . Like all work in this area, the effect of ticket prices is not explicitly considered in this study. As discussed earlier in the article, the impact of ticket prices on demand may be captured to some extent by the venue fixed effects and opposition dummy variables, but these are not perfect proxies for price.

5 Concluding remarks

In contrast to much of the previous literature on the demand for professional sport, we consider that the absolute strength of home and away teams may be a more satisfactory explanation of differences in the demand for sport than simple uncertainty of outcome. Outcome uncertainty relies on the fact that fans prefer watching close contests between teams. However, fans may well prefer watching strong teams, particularly their own team, as it means they are more likely to see victory (a strong home team) or high levels of skill and quality (a strong away team). Building on this, our model suggests that demand for international cricket is influenced by the strength of the home team; the strength of the opposition team; ratings uncertainty of outcome; short run uncertainty of outcome and a host of other economic and match specific factors.

Using attendance data for over 380 Test cricket matches played in England, Australia and New Zealand over the last thirty years, we find that, controlling for a series of economic and match specific factors, long run uncertainty of outcome has only limited impact on demand for Test cricket, whereas short run uncertainty and absolute team strengths have a more significant impact on demand. Fans of Test cricket in both England and Australia have an interest in watching their team succeed but also in watching a strong away team: these findings suggest Test cricket fans prefer watching high quality cricket. The insignificant impact of ratings uncertainty in England, Australia and New Zealand combined suggests that Test cricket fans do not have as much interest in watching close contests. We also find that very short run

uncertainty of outcome has an effect on demand for Test cricket, as a certain outcome for the final day of a Test match lowers attendance.

Previous literature on demand for sport has noted the ambiguous effect of uncertainty of outcome on demand for sport (Borland and Macdonald, 2003). Our study finds that whilst there is evidence that spectators choose not to attend outcome-certain final days of Test matches, there is only limited evidence that longer term uncertainty of outcome (based on relative performances of teams over a number of years) matters as much for Test cricket demand.

The perception of rising imbalance in international cricket team strengths has led to frequent discussion about the merits of a two tiered system for Test match cricket. We can use the results in this paper to speculate as to the likely impact of such a change. In the first place, we can expect an increase (on average) in the uncertainty of outcomes as there will be fewer contests between very strong and very weak teams. However, absolute team strength will (again, on average), increase for matches in the upper tier but reduce for matches in the lower tier. An implication would be an increase in the average attendance for matches in upper tier countries but a decrease for matches played in lower tier countries. In other words, our results suggest a divergence in the impact on attendances in matches played countries with stronger and weaker teams. Overall, there is little in our results to suggest that the two-tier system would significantly increase test match attendance on average.

An important caveat to this is that our results focus on sports attendances. It is possible that long run uncertainty of outcome may be more important for broadcast viewing figures. Collecting better evidence on the determinants of the broadcasting demand for sport would be a useful venture for future research.

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Table 1: Definitions of variables and expected signs for model of Test cricket demand

	Definition	
Dependent variable		
Average Daily Attendance	Total match attendance divided by number of days of play	
Explanatory variables		**Expected Sign**
Ratings Certainty	Absolute difference in ICC Test ratings prior to match	*Negative*
Ratings Certainty Squared	Square of absolute difference in ICC Test ratings prior to match	*Ambiguous*
Home Strength	ICC Test rating of home team prior to match	*Positive*
Opposition Strength	ICC Test rating of opposition team prior to match	*Ambiguous*
Series Certainty	1 if series result was decided prior to Test; 0 otherwise	*Negative*
Final Day Certainty	1 if match result was certain prior to final day; 0 otherwise	*Negative*
Real Income	Real weekly earnings in region match played in	*Ambiguous*
Rain	1 if at least 40 overs lost due to rain or bad light on any day of match; 0 otherwise	*Negative*
Opposition	Dummy variables for opposition teams	*Ambiguous*
Substitutes	1 if match was played as competing sporting event took place; 0 otherwise	*Negative*
Holiday	1 if match period included at least one public holiday; 0 otherwise	*Positive*

Table 2: Data sources

Variable	Source
Average Daily Attendance	Wisden Cricket Almanacks; Cricket New Zealand and Test match venue authorities
Ratings Certainty	International Cricket Council (ICC)
Ratings Certainty Squared	ICC
Home Strength	ICC
Opposition Strength	ICC
Series Certainty	ESPNcricinfo
Final Day Certainty	ESPNcricinfo
Real Income	Australian Bureau of Statistics; Office of National Statistics and Statistics New Zealand
Rain	ESPNcricinfo and Wisden Cricket Almanacks
Opposition	ESPNcricinfo
Substitutes	Various
Holiday	Various

Table 3a: Average daily attendance by venue and opposition in Test matches in England, 1980-2011

Venue	Average	Std. Dev.	N
Lord's	19444	5750	53
Oval	15259	4411	32
Birmingham	14483	4780	27
Manchester	12126	4091	25
Leeds	11971	2441	27
Cardiff	11184	5542	2
Nottingham	10692	4101	26
Southampton	9242	-	1
Chester-Le-Street	7081	1614	3
All	**14628**	**5607**	**196**

Opposition	Average	Std. Dev.	N
Australia	16258	5172	46
South Africa	16066	5179	17
West Indies	14973	5484	40
Pakistan	14889	5568	26
India	14326	6419	23
New Zealand	12256	5627	23
Sri Lanka	12247	4849	13
Zimbabwe	11584	6276	4
Bangladesh	10773	5154	4

Table 3b: Average daily attendance by venue and opposition in Test matches in Australia, 1984-2012

Venue	Average	Std Dev.	N
Melbourne	33435	14645	28
Sydney	22368	9384	30
Adelaide	15008	5471	26
Perth	10936	4703	27
Brisbane	10580	6648	28
Hobart	4545	1203	10
Darwin	4536	120	2
Cairns	3726	416	2
All	**17326**	**12483**	**153**

Opposition	Average	Std. Dev.	N
England	25339	15345	36
South Africa	23325	9732	15
India	20949	12123	22
West Indies	15558	8672	29
Pakistan	13693	9715	15
New Zealand	8007	5046	22
Sri Lanka	7777	5727	10
Zimbabwe	4700	155	2
Bangladesh	4026	840	2

Table 3c: Average daily attendance by venue and opposition in Test matches in New Zealand, 2001-2009

Venue	Average	Std. Dev.	N
Auckland	5435	1297	4
Dunedin	3558	783	2
Wellington	3483	1295	13
Christchurch	3176	1016	3
Hamilton	2714	1244	6
Napier	2536	1210	4
All	**3440**	**1421**	**32**

Opposition	Average	Std. Dev.	N
England	5099	987	6
Australia	3721	2363	3
India	3550	910	5
West Indies	3293	1192	5
Bangladesh	3090	1282	4
South Africa	2818	1085	3
Sri Lanka	2220	723	4
Pakistan	2213	1096	2

Table 4: Fixed effects estimates of attendance demand for Test cricket in England, 1980-2011

Dependent variable: AVERAGE DAILY ATTENDANCE				
	Model 1	***Model 2***	***Model 3***	***Model 4***
Variable	***Linear***	***Log-linear***	***Linear***	***Log-linear***
Ratings Certainty			-25.23 (46.26)	-0.002 (0.004)
Ratings Certainty Squared			0.15 (0.79)	$-3.33 * 10^{-6}$ (0.00006)
Home Strength			141.71 (28.61)***	0.02 (0.002)***
Opposition Strength			54.767 (17.82)***	0.003 (0.001)**
Series Certainty			78.33 (778.00)	0.01 (0.06)
Final Day Certainty			-1807.32 (484.55)***	-0.13 (0.04)***
Real Income	52.44 (4.79)***	0.004 (0.0004)***	37.70 (4.84)***	0.003 (0.0004)***
Rain	-590.68 (527.57)	-0.08 (0.04)**	-631.28 (467.81)	-0.008 (0.04)**
Substitutes	-797.78 (687.45)	-0.072 (0.05)	-183.13 (619.31)	-0.019 (0.05)
Holiday	-1462.51 (859.81)*	-0.009 (0.07)	-400.39 (784.95)	-0.02 (0.06)
Australia	6874.70 (1139.44)***	0.50 (0.09)***	5637.48 (1064.85)***	0.42 (0.08)***
South Africa	4170.18 (1319.08)***	0.30 (0.10)***	3915.03 (1213.40)***	0.30 (0.09)***
Pakistan	4086.78 (1209.99)***	0.29 (0.09)***	3234.60 (1088.03)***	0.22 (0.08)***
New Zealand	2362.88 (1214.26)*	0.14 (0.09)	2225.90 (1109.75)**	0.13 (0.09)
India	3390.79 (1227.19)***	0.22 (0.09)**	2425.72 (1105.77)**	0.14 (0.08)*
Zimbabwe	-556.70 (1967.54)	-0.03 (0.15)	2432.78 (1883.07)	0.18 (0.14)
West Indies	5435.30 (1160.24)***	0.39 (0.09)***	4602 (1088.14)***	0.34 (0.08)***
Bangladesh	-2928.36 (1945.55)	-0.22 (0.15)	777.87 (4289.24)	0.13 (0.33)
Overall R^2	*0.61*	*0.58*	*0.61*	*0.60*
Hausman test	*42.55***	*36.29***	*62.61***	*56.75***
N	*196*			

Notes:
(i) Standard errors in brackets.
(ii) * Significant at the 10% level. ** Significant at the 5% level. *** Significant at the 1% level.
(iii) Hausman test presents the chi-square statistics for fixed effects.

Table 5: Fixed effects estimates of attendance demand for Test cricket in Australia, 1985-2012

Dependent variable: AVERAGE DAILY ATTENDANCE				
	Model 1	***Model 2***	***Model 3***	***Model 4***
Variable	***Linear***	***Log-linear***	***Linear***	***Log-linear***
Ratings Certainty			-233.00 (93.71)**	0.00005 (0.004)
Ratings Certainty Squared			3.60 (1.13)***	0.00006 (0.00005)
Home Strength			167.67 (42.88)***	0.009 (0.002)***
Opposition Strength			116.16 (46.19)**	0.005 (0.002)**
Series Certainty			2989.41 (1463.00)**	0.040 (0.07)
Final Day Certainty			-1997.17 (1063.54)*	-0.019 (0.05)***
Real Income	82.16 (15.33)***	0.005 (0.0007)***	55.52 (15.52)***	0.003 (0.0007)***
Rain	-3676.30 (1835.29)**	-0.245 (0.09)***	-2514.00 (1711.35)	-0.180 (0.08)**
Substitutes	-1416.76 (1819.56)	0.010 (0.09)	-2306.49 (1683.37)	0.004 (0.08)
Holiday	8232.12 (1739.79)***	0.404 (0.08)***	7777.99 (1615.25)***	0.364 (0.07)***
England	10622.55 (2583.49)***	0.684 (0.12)***	9826.41 (2653.71)***	0.703 (0.12)***
South Africa	3365.04 (2968.46)	0.387 (0.14)***	-203.41 (3022.95)	0.290 (0.14)**
Pakistan	1376.25 (2846.40)	0.205 (0.14)	-181.66 (2877.67)	0.168 (0.13)
New Zealand	1366.53 (2663.92)	0.060 (0.13)	3410.71 (2663.56)	0.120 (0.12)
India	2940.47 (2791.33)	0.288 (0.13)**	3594.26 (2730.62)	0.295 (0.12)**
Zimbabwe	-6585.90 (5182.31)	-0.710 (0.25)***	-8488.33 (4830.94)*	-0.890 (0.22)***
West Indies	3940.37 (2591.97)	0.407 (0.12)***	3407.66 (2593.74)	0.372 (0.12)***
Bangladesh	-1094.83 (6307.96)	-0.011 (0.30)	-20543.80 (10523.41)*	-0.443 (0.47)
Hausman test	*43.69***	*55.93***	*50.99***	*68.50***
Overall R^2	*0.63*	*0.70*	*0.63*	*0.71*
N	*153*			

Notes:
(i) Standard errors in brackets.
(ii) * Significant at the 10% level. ** Significant at the 5% level. *** Significant at the 1% level.
(iii) Hausman test presents the chi-square statistics for fixed effects.

Table 6: Fixed effects estimates of attendance demand for Test cricket in England, Australia and New Zealand, 1980-2012

Dependent variable: AVERAGE DAILY ATTENDANCE				
	Model 1	***Model 2***	***Model 3***	***Model 4***
Variable	***Linear***	***Log-linear***	***Linear***	***Log-linear***
Ratings Certainty			-28.92 (39.48)	0.001 (0.002)
Ratings Certainty Squared			0.49 (0.53)	-0.0000 (0.00003)
Home Strength			200.64 (22.85)***	0.013 (0.001)***
Opposition Strength			68.62 (19.92)***	0.002 (0.001)**
Series Certainty			1515.04 (841.83)*	0.05 (0.05)
Final Day Certainty			-1522.96 (550.38)***	-0.15 (0.03)***
Real Income	37.22 (5.70)***	0.002 (0.0003)***	29.50 (5.14)***	0.002 (0.0003)***
Rain	-1558.75 (724.50)**	-0.12 (0.04)***	-1575.42 (630.36)**	-0.12 (0.04)***
Substitutes	-1252.89 (899.45)	-0.07 (0.05)	-447.23 (799.42)	-0.006 (0.05)
Holiday	3802.26 (960.89)***	0.21 (0.06)***	3325.21 (855.60)***	0.18 (0.05)***
Australia	6808.62 (1406.63)***	0.53 (0.08)***	4868.88 (1300.50)***	0.43 (0.07)***
England	11715.53 (1454.38)***	0.81 (0.09)***	10605.88 (1322.84)***	0.75 (0.07)***
South Africa	5535.82 (1484.56)***	0.46 (0.09)***	3114.45 (1364.83)**	0.33 (0.08)***
Pakistan	3436.89 (1415.20)**	0.31 (0.08)***	1823.47 (1269.67)	0.21 (0.07)***
New Zealand	1733.83 (1400.57)	0.12 (0.08)	1987.48 (1246.37)	0.13 (0.07)*
India	4277.70 (1381.35)***	0.36 (0.08)***	2971.87 (1225.33)**	0.28 (0.07)***
Zimbabwe	-1394.09 (2556.19)	-0.14 (0.15)	-186.25 (2283.41)	-0.09 (0.13)
West Indies	4763.66 (1313.06)***	0.42 (0.08)***	3566.07 (1187.22)***	0.34 (0.07)***
Bangladesh	173.44 (2155.68)	0.03 (0.13)	2474.28 (3179.52)	0.29 (0.18)
Hausman test	*41.82****	*49.34****	*40.47****	*93.62****
Overall R^2	*0.40*	*0.36*	*0.46*	*0.42*
N	*381*			

Notes:
(i) Standard errors in brackets.
(ii) * Significant at the 10% level. ** Significant at the 5% level. *** Significant at the 1% level.
(iii) Hausman test presents the chi-square statistics for fixed effects.