Outcome Uncertainty, Attendance, and Television Audience in NASCAR

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Abstract

This paper investigates whether, and to what extent, outcome uncertainty influenced NASCAR race attendance and television viewership during the 2007 and 2008 seasons. It is shown that while race-level competiveness was positively related to both attendance and the television audience, only the television audience responds to season-level competitiveness. Furthermore, variables that describe the macroeconomic environment and the characteristics of the broadcast and the race are not statistically related to NASCAR attendance but are related to the television audience. The estimates are used for out-of-sample predictions of attendance and viewership for the first five races of the 2009 season. It is shown that the model correctly predicted a decline in attendance but did not predict the decline in television viewership.

JEL* Classifications*: D23, L83, L25

Keywords*:* competitiveness, adjusted churn, motor sports, uncertainty of outcome

1. Introduction

The National Association for Stock Car Auto Racing (NASCAR) Sprint Cup Series, hereafter NASCAR, has been one of the fastest growing sports over the past fifteen to twenty years, primarily caused by the transformation of NASCAR from a regional into a national sport.[1] This increased popularity manifested in greater race attendance and national television viewership, both of which led to more lucrative sponsorships for the teams and media contracts for NASCAR.[2] This paper investigates to what extent race outcome uncertainty or in-race competitiveness, along with race and broadcast characteristics, and macroeconomic conditions influence race attendance and television viewership.

Investigating how outcome uncertainty impacts NASCAR is appropriate for a number of reasons. First, unlike other sports, NASCAR has no home team as forty-three teams compete simultaneously during a given race. This removes the potentially confounding issue of home-team bias but makes measuring outcome uncertainty a bit more difficult than in normal head-on-head competition. Second, at the end of the 2008 and early in the 2009 NASCAR seasons there was a noticeable decline in attendance and television audiences for NASCAR. While there have been a number of potential reasons offered to explain the decline, including changes in macroeconomic conditions, increasing competition for leisure time, and changes in competitive balance, there has been no empirical study of these various claims. Third, NASCAR continuously adjusts the rules so that driver skills and not technological advantages determine race outcomes, i.e., the rules changes ostensibly aim to improve competitive balance. Whether attendance and television viewership responds to any changes in competitiveness, either at the race or season level, is therefore an interesting empirical question.

In 2004 NASCAR changed the way the sport crowns its season champion by introducing the "Chase for the Cup." [3] As argued by Depken and Hasen (2009), after the Chase field is determined driver incentives change,

[1] NASCAR is a family owned and operated race sanctioning and sponsoring firm founded in 1947 by Bill France. By the late 2000s more than half of the sport's races were held outside of the six states that comprised the historic home for the sport (Virginia, North Carolina, Tennessee, Georgia, Alabama, and Florida). NASCAR itself fields ten different racing circuits, the three most popular being the Sprint Cup Series, the Nationwide Series, and the Camping World Truck Series.

[2] The first live-broadcast of a NASCAR event was the 1979 Daytona 500. In 1999 NASCAR signed a six-year $2.4 billion broadcasting package with Fox Sports, FX, NBC, and TNT. In 2005, NASCAR signed an eight-year $4.8 billion broadcast package with Fox/SPEED Channel, ABC/ESPN, and TNT. The sports lower series, including the Nationwide and Camping World Truck Series, are now included in this arrangement. The nation-wide broadcasting was coincident with a nation-wide expansion of NASCAR to new tracks from California to Kansas City to Chicago.

[3] The Chase for the Cup originally involved the top ten drivers in terms of performance points at the end of the 26th race of the 36 race season. As of 2008, the Chase was expanded to include the top 12 drivers with a $1 million price for the driver who finishes thirteenth in season-end performance points; the $1 million prize is to provide sufficient incentive for drivers not in the Chase to continue to race at or near their peak performance.

which might influence the expected competitiveness of the final ten races of the season. Finally, NASCAR races most often occur during the weekend and the NASCAR season ends in November. Thus, although NASCAR's biggest race, the Daytona 500, occurs in February, the season champion is determined while NASCAR competes with college and professional football, the end of the professional baseball season, the end of the professional golf season, and the beginning of professional hockey, which might further influence attendance and viewership beyond the competitiveness of the NASCAR events.

Using data from the 2007 and 2008 NASCAR seasons, we test whether race outcome uncertainty, measured by the adjusted churn developed by Mizak, et al. (2007), and the overall competitiveness of NASCAR's Sprint Cup Series, as measured by dispersion of season-total performance points, influences attendance, television viewership, and television ratings; the latter two measured by Nielsen and the former reported by NASCAR. We find evidence that race-level uncertainty influences both attendance and the television audience. However, season-level competitiveness only influences the television audience. Furthermore, variables that describe the macroeconomic environment, the specifics of the broadcast network, the specifics of the race, and whether there is another high-profile sporting event on the day of the race, do not share a statistically meaningful relationship with race attendance yet have a statistically significant relationship with television viewership. Using the estimation results, out-of-sample predictions for the television viewership for the first five races of the 2009 NASCAR season are generated. The model specified here correctly predicted a decline in NASCAR attendance but not in television viewership.

2. The Related Literature

The Literature Concerning Outcome Uncertainty

Knowles, Sherony, and Haupert (1992) offered the following definition for the "uncertainty of outcome hypothesis":

> Uncertainty of outcome hypothesis (UOH) is predicated on the assumption that fans receive more utility from observing contests with an unpredictable outcome, and posits that the more evenly team playing abilities are matched the less certain the game's outcome and the greater the game's attendance will be.

Rottenberg (1956) was the first to apply the concept to the sports industry and Sloane (1971) and El-Hodiri and Quirk (1971) discuss the importance of the UOH to the economics of sport. Sloane (1971) distinguished between long run uncertainty of outcome, characterized by the variation in championship teams over an extended period of time, and short run uncertainty of outcome, characterized by the uncertainty of particular games and by extension for a particular season's championship. Szymanski (2003) provides a more developed

taxonomy by distinguishing between game uncertainty, season uncertainty and championship uncertainty. While early references to the UOH were primarily theoretical, there is a large literature that empirically tests the hypothesis in various sports including professional baseball, football, rugby, cricket, and college football.[4]

When investigating outcome uncertainty, attendance has generally been the variable of focus.[5] Szymanski (2003) reviews twenty-two different tests of the UOH at all levels of uncertainty, finding general support for the impact of outcome uncertainty on attendance. The UOH literature has, however, focused on sports in which two teams compete head-to-head and there are clearly delineated home and visiting teams. Unfortunately, any home team bias can be a confounding factor making an accurate test of the UOH difficult. NASCAR differs from other sports in which the UOH has been tested: there is no home driver (team) and each race has forty-three drivers (teams) competing simultaneously.

The Literature of NASCAR

With NASCAR's increased popularity, economists have used NASCAR to look at a variety of economic questions. The research involving NASCAR falls into three areas: investigation of the reward structure in NASCAR, the relationship between team performance and sponsor stock returns, and the impact of safety on driver behavior. Highly nonlinear payoffs are often used in rank-order tournaments to encourage risk taking and greater individual effort. However, in a motorsport such as NASCAR risky behavior can impose considerable negative externalities on other drivers. Thus NASCAR utilizes a much flatter reward structure than traditional rank-order tournaments. Becker and Huselid (1992) find that greater disparity between the highest and lowest reward in NASCAR and the International Motor Sports Association (IMSA) is correlated with increased hazardous behavior. Von Allmen (2001) argues that NASCAR's relatively flat reward structure might have three underlying motivations: increasing sponsorship exposure, reducing reckless behavior or "sabotage," and that the high cost of fielding a NASCAR team requires the sport to have a more egalitarian reward system. Depken and Wilson (2004) empirically find support for reduced "sabotage" but no evidence to support the cost

[4] For professional baseball see Knowles, Sherony and Haupert (1992) and Woodland and Woodland (1994); for professional basketball see Berri, Schmidt and Brook (2004); for professional football see Welki and Zlatoper (1999), Putsis and Sen (2000), and Paul and Weinbach (2007); for rugby see Peel and Thomas (1997); for Australian Rules Football see Borland (1987) and Borland and Lye (1992); for cricket see Paton and Cooke (2005); for soccer see Forrest and Simmons (2002), Peel and Thomas (1998), and Jennet (1984); for college football see Depken and Wilson (2006), Fizel and Bennett (1989), and Price and Sen (2003).

[5] Forrest, Simmons and Buraimo (2005) and Alavy, et al. (2006) analyze the impact of outcome uncertainty on television ratings for the English Premier League (soccer). Paul and Weinbach (2006) investigate the impact of outcome uncertainty on the ratings for the NFL's Monday Night Football.

argument. Schwartz, Isaacs and Carilli (2007) argue against von Allmen's "sabotage effect" by showing that once driver-skill differences are taken into account the linear point system does not reduce aggressive behavior.

Groothius, Groothius, and Rothoff (2009) suggest that while the distribution of the race purse might be relatively linear, the payoff structure becomes considerably more non-linear when including the value of "time on camera," which is generally greater for those drivers near the front of the pack. This suggests that the structure of the total rewards earned in NASCAR may be closer to traditional tournament theory than previously suggested. In a similar vein, Depken and Mackey (2009) show that multi-car teams have an advantage over single-car teams which leads to greater real dollar earnings. They show that multiple cars might allow team owners to circumvent the flatter payoff structure in NASCAR but that this advantage experiences diminishing returns.

Mahar, Paul, and Stone (2005) find that a NASCAR team sponsor's stock performance on the first trading day after a race is positively correlated with the sponsored car's performance. However, this correlation only holds for sponsors that sell directly to consumers or for sponsors that sell products in the auto industry; the relationship does not hold for sponsors that sell primarily to businesses. Durr, Eaton and Broker (2009) create and study a portfolio of corporations that sponsor NASCAR cars and show that it consistently outperforms the S&P 500. However, the authors conclude that sponsorship does not directly cause higher stock returns but is a signal of financial stability, which indirectly results in higher returns.

The third area focuses on the behavioral impact of NASCAR's safety regulations. This strain of research builds on the work of Peltzman (1975), who argues that drivers tend to drive more aggressively when they feel safer in their vehicles. In the years following the death of Dale Earnhardt, Sr. in the 2001 Daytona 500, NASCAR implemented a series of safety enhancements including the Haans head-restraint system, impact-absorbing walls, and new aerodynamics built into the "Car of Tomorrow," which was introduced in 2008. These additional safety systems, combined with changes in how NASCAR penalizes drivers for overly aggressive driving, have correlated with zero fatalities in NASCAR's three premier series since 2001 despite hundreds of accidents. These changes provide a natural test of whether professional drivers respond the same as previous theories predict. Sobel and Nesbit (2007) found clear support for the conclusion that drivers act more reckless after improvements in safety. O'Roark and Wood (2004) found that restrictor-plate races, which should result in a safer race because top speeds are reduced, tend to have more accidents that eliminate cars from the race but

which do not result in an increase in driver injuries.[6] This suggests that drivers behave more reckless when safety improves, consistent with Peltzman's original theory.

3. Outcome Uncertainty in NASCAR

Whether race outcome uncertainty influences NASCAR attendance is not immediately clear. While there are thirty-six races during the year, most tracks host only one or two races each season.[7] As a result, many NASCAR fans decide long in advance whether to attend the race and for how long they will stay in the race area; many fans stay at the race site for the week preceding the race to participate in multiple preliminary events, such as driver practice, race qualifying, concerts, and interaction with drivers and other fans. The dedication required by these long-distance travelers might mitigate the impact of the outcome uncertainty on NASCAR attendance relative to other sports.

It is perhaps more likely that the television audience is more sensitive to changes in the competitiveness of NASCAR. First, watching a NASCAR race on television does not require planning weeks or months in advance and does not incur considerable direct costs. Furthermore, by its very nature the costs of switching from the NASCAR broadcast to other entertainment options on television is very low; in contrast, once an individual is in attendance at a NASCAR race it is very costly to substitute entertainment. To the extent that the television audience anticipates the race to be competitive, whether because of the nature of the race, e.g., a restrictor-plate race, or because of the way the season-level competitiveness is evolving, and these expectations are not met, the television audience would seem more likely to switch away from the NASCAR race into an alternative activity.

In the literature, at least three levels of outcome uncertainty have been defined: event-level, season-level and inter-season uncertainty. In the case of NASCAR, the first two seem to be of most concern to fans and are therefore the focus of analysis here. Yet it is not immediately clear what outcome uncertainty actually applies in the case of NASCAR. Each NASCAR race entails 43 drivers on a closed course, most often an oval track with four turns but occasionally on a triangular track and twice a year on road courses. Television broadcasts

[6] Currently two tracks require restrictor plates: Talladega (Alabama) and Daytona (Florida). A restrictor plate is a small piece of metal installed on the engine's intake that restricts the airflow into the engine and therefore lowers the engine's output and the top speed the car can obtain. Restrictor plate races in NASCAR are notorious for "grouping," that is large numbers of cars driving in a group. In these situations even small mistakes can lead to accidents that "collect" a large number of cars.

[7] Lowe's Motor Speedway, *nee* Charlotte Motor Speedway, is the only track that hosts three events: the Coca-Cola 600 and the All-star Race in May and the NASCAR Banking 500 in October. In the 2009 season Watkins Glen (NY), Sonoma (CA), Las Vegas (NV), Kansas City (KS), Homestead (FL), Chicago (IL), Indianapolis (IN), and Darlington (SC) all hosted one race.

naturally focus on the several cars near the front of the race or the season standings, but those in attendance often focus on cars that are not near the front of the field. The so-called races-within-the-race, say between two drivers in positions 21 and 22, are not often displayed on the television but can be of intense interest to the fans in attendance.

Traditional measures of competitive balance, such as the idealized standard deviation (Fort and Quirk, 1995), the Normalized Herfindahl-Hirschman Index (Depken, 1999), or the Competitive Balance Ratio (Humphreys, 2002), do not seem appropriate for a NASCAR race. Thus, an alternative measure is needed. One possibility is margin of victory. Of the 322 Sprint Series races from 2000 through 2008, the average margin of victory reported by NASCAR was 1.43 seconds, yet this only measures the "competitiveness" between the winner and second place; it does not indicate anything about the competitiveness of the remainder of the field. An alternative might be the number of lead changes in a given race. From 2000 through 2008 the average race had 10.27 lead changes. Yet this measure does not reflect how much of the race is run between lead changes or how much passing has occurred by the end of the race. Ultimately, these measures and others are not very satisfying given the nature of a NASCAR race.

Because of the large number of participants and the rank-order reward system of NASCAR, any measure of competitiveness within a NASCAR race would ideally reflect the difference between the starting and finishing positions of the drivers and would encompass the entire field of drivers. Such a measure would reflect each driver's (in)ability to advance during the race. The "adjusted churn" measure developed by Mizak, et al. (2007) would seem to be an instrument that captures these two desirable characteristics of a measure of uncertainty of outcome. The churn was originally defined to quantify the change in finishing position of the teams in a league from one year to the next. We apply it here to measure competitiveness within a race. The adjusted churn (C) for race *i* is measured as:

$$C_i = \sum_{d=1}^{N} \frac{| p_{d,f} - p_{d,s} |}{N},$$

where $p_{d,f}$ is the finishing position of driver *d* and $p_{d,s}$ is the starting position of driver *d* in race *i* and *N* is the number of drivers participating. The maximum churn possible in an N driver field is N/2 if N is even or $(N^2 - 1)/2N$ if N is odd. The so-called adjusted churn, which falls between zero and one, is calculated by normalizing the churn by the maximum churn.

An adjusted churn of zero (one) would indicate that all drivers finished in the same (reverse) position they started, which would suggest minimum (maximum) uncertainty of outcome. Either extreme is unlikely to happen in a NASCAR race, but in general, more competitive races would have an adjusted churn closer to one

and less competitive races closer to zero. The adjusted churn is calculated for each race in the sample and the adjusted churn for the previous three races at a particular track is used to proxy for NASCAR fans' expected competitiveness of a particular race.[8]

Another question is how to measure uncertainty of outcome at the season level. At the end of each race, performance points are awarded to each starting driver based on finishing position at the end of the race. The race winner receives 185 points with the distribution of points following a relatively flat gradient through the forty-third position, which receives 34 points.[9] The purpose of the season-total points system is two-fold. First, it is intended to reward consistency in performance, perhaps reducing the incentive to engage in risky behavior undertaken to gain an additional one or two positions and their associated increase in performance points and race earnings. Second, the points system helps determine who wins the season-level championship. At the end of the 26th race, the top twelve drivers in performance points qualify for the "Chase for the Cup," which takes place during the last ten races of the season. The drivers in the Chase have their accumulated points "reset" for the purposes of determining the season champion, although they are awarded race points in the same manner as non-Chase drivers.[10] For those drivers who do not qualify for the Chase, there is a $1 million bonus for the driver who finishes thirteenth in points, that is, the driver who finishes the season with the most performance points among non-Chase drivers.

The performance points reward system lends itself to using the standard deviation amongst all drivers as a measure of overall competitiveness over the course of the NASCAR season. The lower the standard deviation, the more egalitarian the distribution of performance points across drivers over multiple races. This could occur if Driver A (Driver B) performs well (poorly) in Race #1 but then poorly (well) in Race #2. As the change in performance points across all drivers from race to race is zero-sum, a smaller standard deviation in performance points would indicate a more competitive season up to that point in time. The accumulated points earned for

[8] This assumption requires that the measurement error on the part of the fans is not correlated with any of the explanatory variables in the econometric models. This does not seem to be a strong assumption. We experimented using the average competitiveness of the past two and past four Sprint Cup Series races at the particular track but obtained qualitatively similar results as reported here.

[9] Under the current system which began in 2004, the winner receives 180 points. The runner-up receives 170 points and the next four finishers are separated by five points each. Then, the seventh through tenth place finishers are separated by four points and everyone else is separated by three points thereafter. Five additional points are awarded to those that lead a lap and the driver that leads the most laps. From 1975 through 2003, the winner received 175 points with the remainder of the field receiving the same as the current system.

[10] Starting in 2008, the top twelve drivers have their season point total "reset" to 5,000 plus ten points for every race victory. The bonus points are intended to provide incentive for those drivers at or near the top of the points standings to pursue race victories rather than reducing effort going into the Chase. Those drivers not in the Chase retain the points they have earned through the first 26 races of the season.

each driver up to a particular race are calculated and used to determine the standard deviation in performance points for each race in the sample.

4. Data and Empirical Methodology

To test whether outcome uncertainty is important in NASCAR's Sprint Cup series, three measures of fan interest are employed: race attendance, Nielsen television ratings, and Nielsen television viewership. Attendance is reported by NASCAR after each race but is rather lumpy and potentially misleading. In seventy of the seventy-two races from the 2007 and 2008 seasons reported attendance figures rounded to the thousands, e.g., 191,000 or 100,000. Furthermore, as NASCAR is a private firm with little oversight, the reported attendance data might suffer from self-serving measurement errors that make the data less likely to be systematically related to exogenous variables. The Nielsen television ratings reflect the estimated percentage of televisions turned on during the broadcast that were tuned to the NASCAR race; this variable measures the relative demand for the NASCAR broadcast as it depends on what else is on television at the time. The Nielsen television viewership measures the estimated nationwide television audience for the race and measures the absolute level of interest in the broadcast. While Nielsen measures likely suffer from measurement error, it is more likely random and thus expected to only influence estimate precision.[11]

We relate three dependent variables to the same set of right-hand side variable in the following estimating equation:

$$DEP_i = \beta_0 + \beta_1 ADJCHURN_i + \beta_2 SDPTS_i + \beta_3 GASPRICE_i + \beta_4 UNEMP_i + \beta_5 SUNDAY_i + \beta_6 SEVENPM_i + \beta_7 CHASE_i + \beta_8 ROAD_i + \beta_9 CAUTIONS_i + \beta_{10} ESPN_i + \beta_{11} ABC_i + \beta_{12} FOX_i + + \beta_{13} TVEVENT_i + \varepsilon_i,$$

where the dependent variable, DEP_i, is either attendance, Nielsen ratings, or Nielsen viewership, the β's are parameters to be estimated, and ε is a zero-mean error term. Each variable is defined and summary statistics are listed in Table 1. The first two variables are proxies for expected competitiveness of race *i*; one related to the racing characteristics of the track and the other of current season standings of driver performance. The variable *ADJCHURN* is the average adjusted churn of the last three Sprint Cup Series races held at race *i*'s track. *SDPTS* is the standard deviation of season level performance points coming into race *i*. It is anticipated that the parameter on *ADJCHURN* will be positive and that on *SDPTS* will be negative, that is, improved

[11] Nielsen defines ratings as the estimated number of TV households tuned to a particular program in the average minute during which the program is on the air. Nielsen calculates the size of the television audience by estimating the percentage of people using television who are tuned to the program during a specific period of time. The Nielsen ratings do not include Internet and cell-phone streaming, and might undercount the number who record the broadcast for later viewing.

competitiveness at the race and season level both increase relative and absolute demand for the NASCAR broadcast and attendance to the NASCAR race.

Variables reflecting the prevailing macroeconomic environment from when each NASCAR race was held are also included. As many people drive a considerable distance, the price of gasoline (*GASPRICE)* is included to control for a primary cost of attending the event. The national unemployment rate (*UNEMP)* is also included to control for additional potential opportunity cost of attending a NASCAR race. Since ticket decisions are often made months in advance, both variables are lagged three months from the week of the race. A higher gasoline price increases the cost of attending a NASCAR event and is therefore expected to reduce attendance. On the other hand, both variables may induce people to substitute watching the event on television for attending the race in person.

The characteristics of the NASCAR broadcast and the NASCAR race itself are also included. To control for possible differences across the four networks that televise NASCAR races, three network-specific dummy variables are included: *ESPN*, *ABC*, and *FOX* (NBC is the reference broadcaster). If one or more broadcasters provide coverage that is preferred by the television audience, we expect an increase in the level of relative and absolute television viewership associated with that network but expect no impact on attendance.[12] Most NASCAR Sprint Cup Races take place on Sunday, although several races during the season take place on Saturday. We include a dummy variable that takes a value of one if the race takes place on Sunday (*SUNDAY)*. The parameter on this variable will be positive if television audiences are greater on Sunday than otherwise. We also include a dummy variable that takes a value of one if the race occurs at night, generally starting at seven at night in the Eastern Time Zone (*SEVENPM*). If night racing is more popular with television fans, we expect a positive parameter on this variable; we do not expect a significant impact of this variable on race attendance.

We also include a dummy variable that takes a value of one if the race is part of the "Chase for the Cup," that is, it is one of the last ten races in the season (*CHASE*). If Chase races draw a larger television audience, ceteris paribus, then we expect a positive parameter on *CHASE*. NASCAR races twice a year on road courses that have unique viewing characteristics. A dummy variable for road course races is included to capture the uniqueness of these tracks (*ROAD*). Races that have more cautions flags, whether caused by accident or mechanical failure, might be of less interest to the television audience. On the other hand, if the marginal television viewer is attracted by the prospect of a crash, races at tracks with a history of more cautions might draw a larger television

[12] The network dummy variables are jointly insignificant in the attendance equation and are therefore dropped from the final specifications reported in Table 3.

audience. To test this possibility, the average number of cautions during the previous three races held at the current track is included (*CAUTIONS).*

NASCAR's propensity to race on either Saturday or Sunday often pits the event and its broadcast against other high-profile sporting events, such as the World Series or the Masters Golf Tournament. When NASCAR races compete with these other events the viewership for the NASCAR broadcast might decrease, notwithstanding the competitiveness of the event. Therefore, we include a dummy variable that takes a value of one if another high-profile sporting event occurred on the same day as the NASCAR race (*TVEVENT*). To the extent that competing sporting events draw individuals away from the NASCAR broadcast, ceteris paribus, we expect a negative parameter on the variable *TVEVENT*.

The primary data employed in this study were gathered from Nielsen Ratings Company and reflect the absolute and relative viewership of NASCAR Sprint Cup Series races for the 2007 and 2008 seasons. The data include the estimated total number of viewers, which we interpret as an absolute measure of viewership, and the percentage of televisions tuned to the NASCAR event, which we interpret as a relative measure. The ability to test the Uncertainty of Outcome Hypothesis in relative terms is an improvement over studies that use attendance or other measures of direct interest in the event.

The Nielsen ratings data are available for sixty-seven of the seventy–two races held during the 2007 and 2008 NASCAR seasons, the attendance data is available for all seventy-two races. The average reported attendance to NASCAR races was approximately 120,000 people, with a minimum of 40,000 and a maximum of 270,000 people. The average ratings during this period was 4.57, that is, 4.57% of all televisions turned on during the NASCAR broadcast were tuned to the event, with a minimum of 3.0 and a maximum of 10.2. The estimated average total number of viewers was approximately 7.1 million people, with a minimum of 3.9 million and a maximum of 17.75 million.

The previous-three-race average adjusted churn for the seventy-two races was 0.53, with a minimum of 0.33 and a maximum of 0.73.[13] The standard deviation of performance points averaged 626 with a minimum of zero (coming into the first race of the season) and a maximum of 1413. Of the macroeconomic variables, the average price of a gallon of gasoline was 322 cents, with a minimum of 221 cents and a maximum of 426 cents, and the average national unemployment rate during the sample period was 5.42 with a minimum of 4.4 and a maximum of 8.5.[14] Approximately 80% of the races took place on Sunday, approximately 12% of the races started at night,

[13] A higher adjusted churn measure indicates more competitiveness.
[14] Both the price of gasoline and the unemployment rate reflect the values lagged three months from the week of the race.

36% of the races were broadcast on FOX, 29% were broadcast on ABC, and 18% were broadcast on ESPN, 30% of the races were part of the "Chase for the Cup" and 30% of the races competed with another high-interest sporting event.

Table 2 lists the dates and high-interest sporting events against which NASCAR broadcasts competed during the sample period. While there are sporting events broadcast on every day a NASCAR broadcast takes place, e.g., a regular PGA tour stop or a regular season basketball game, the variable TVEVENT intends to control for increased opportunity costs of watching the NASCAR broadcast when another high-profile sporting event will be broadcast during the same day, regardless of when the other event is actually aired. During the two seasons, twenty-three race days shared the day with at least one other high-interest sporting event such as an NBA Conference Finals or the Masters Golf Tournament.

5. Empirical Results

The primary empirical results are reported in Table 3. The various specifications differ by the dependent variable. The first specification uses reported attendance as the dependent variable, the second uses the Nielsen ratings, and the third uses the Nielsen viewership. These specifications control for unspecified heteroscedasticity by employing the Huber-White-Sandwich estimator to provide robust standard errors.

Generally speaking, the explanatory variables included in the specification do not have a statistically significant relationship with reported attendance to NASCAR races. The only variables that are statistically significantly in the attendance model are the average adjusted churn from the previous three races at the current track and races on road courses (although the number of caution flags falls just beyond conventional weak significance with a p-value of 0.103). The more competitive the previous three races at a particular race site, the greater is attendance. However, road races (of which there are only two during the season) are considerably less well attended than races at traditional oval tracks, most likely caused by the relatively poor sight lines at road courses.

The remaining explanatory variables are all statistically insignificant which in many cases is not surprising; certain variables might be expected to impact television viewership but not attendance, e.g. the variable *TVEVENT*. However, neither the lagged price of gasoline nor the lagged unemployment rate has a statistically meaningful relationship with attendance.[15] This is somewhat surprising given that many NASCAR fans travel

[15] We estimated all the models using the contemporaneous values of the explanatory variables ADJCHURN, GASPRICE, UNEMP, and CAUTIONS. The results are not qualitatively different than those presented here and are available from the authors upon request.

long distances to attend races and often purchase tickets months in advance. While changing macroeconomic conditions would be expected to influence attendance, this is not borne out in this sample.[16]

Model (2) in Table 3 uses the Nielsen ratings as the dependent variable. We interpret the market share of the NASCAR broadcast as a measure of relative demand as it reflects the percentage of all televisions turned on during the broadcast. This specification behaves more consistent with intuition than the attendance model. As the adjusted churn for the previous three races for a particular track increases, that is previous races have been more competitive, television ratings increase. On the other hand, the more disparate is the distribution of performance points (*SDPTS*), the lower the television ratings. These findings suggest that the relative demand for NASCAR broadcasts does respond to the uncertainty of the race's outcome: the more competitive the particular event and the entire season, the more interest fans display towards the sport's events.

Of the remaining explanatory variables, several are not statistically related to television ratings, including the price of gasoline, unemployment, and whether the race is part of the "Chase for the Cup." The last result is counter to NASCAR's intention for implementing "The Chase" as these races were expected to add to the viewership interest late in the season.[17] On the other hand, several variables are statistically significantly related to television ratings. Races held on Sunday enjoy an approximately 0.4 point increase in ratings and races held at night enjoy an increase of approximately 0.6 ratings points. On the other hand, road races experience ratings approximately 0.66 points lower than races at traditional oval tracks and each caution reduces ratings by 0.09 points, suggesting that viewers are not necessarily attracted to crashes *per se*. Races broadcast on ESPN and ABC enjoy a ratings advantage over races broadcast on FOX and TNT. When NASCAR shares the time slot with a high-interest sporting event such as the NBA Finals or the PGA's US Open, ratings suffer a reduction of 0.9 percentage points. On the other hand, when NASCAR does not compete with big-time sporting event viewers seem attracted to the race on television. [18]

Model (3) in Table 3 reports the estimation results using the estimated number of television viewers of the NASCAR broadcast. In this case the measure of fan interest is interpreted as an absolute measure of demand. The results are consistent with those in Model (2), suggesting that the absolute demand and the relative demand

[16] Another explanation is that the reported attendance data are not fully accurate.
[17] Interpretation of the parameter on *CHASE* requires a bit of caution. The negative parameter indicates that viewership is for Chase races is not statistically different than non-Chase races *in the sample*. However, we do not have the data to test whether the Chase for the Cup has increased viewership of the last ten races relative to the pre-Chase period.
[18] The Chase races are not correlated with lower viewership, *ceteris paribus*, which suggests that the competition NASCAR faces for viewers is not dramatically different between the beginning and the end of the NASCAR season, notwithstanding the perception of an increased number of sporting events at the end of the NASCAR season. As an additional test the interaction of *TVEVENT* with the month of the year in which the race took place was included in each specification but was consistently insignificant.

for NASCAR broadcasts are positively correlated and that NASCAR broadcasts do not necessarily lose relative interest as the television audience increases or decreases. As the expected competitive balance at the race level improves, the number of television viewers increases, whereas when competitive balance at the season level falls, the number of television viewers decreases. It is true that for both variables the level of significance falls slightly, however there is likely to be more measurement error in the Nielsen estimation of audience rather than ratings which would reduce precision in the estimates.

As was the case for ratings, the absolute demand for NASCAR broadcasts is not statistically impacted by the price of gasoline, the level of unemployment, or a race being in The Chase. NASCAR viewership is positively influenced by races held on Sunday and run at night, road races and cautions reduce absolute viewership, and ESPN and ABC both enjoy higher viewership relative to the other networks that broadcast the races. Television viewership declines when the NASCAR broadcast competes against another high-interest televised sporting event and when the race is run on a road course. The results suggest that competition with another high-profile sporting event might cost the NASCAR broadcast 1.7 million viewers.

The three specifications reported in Table 3 provide evidence of segmentation in the NASCAR market; attendance does not respond to the same influences as the television audience. This segmentation might arise from the geographic distances, relatively high opportunity costs of attending a NASCAR race, or the general environment of a NASCAR race. On the other hand, many of the variables used to explain the variation in television audience might be expected to contribute to explaining the variation in attendance. For example, as many people who attend a NASCAR event drive long distances to attend the event, the price of gasoline is expected to be inversely related to attendance. Our results show that attendance during the sample period was non-responsive to the price of gasoline, *ceteris paribus*.

Although the theoretical impact of outcome uncertainty on NASCAR race attendance is ambiguous, we find a systematic and meaningful relationship between expected outcome uncertainty and Nielsen television ratings and estimated viewership. Specifically, the greater the expected competitiveness of a particular race the greater the absolute and relative television audience. On the other hand, the less competitive the NASCAR season, as measured by distribution of overall performance points, the lower the absolute and relative viewership of a race, all else equal.

The models reported in Table 3 use data from the 2007 and 2008 NASCAR seasons. Late in the 2008 NASCAR season coincided with the increasingly bad economic news at the national level. This in turn raised concerns about the attendance to NASCAR events, which seemed noticeably down using visual inspection of the

grandstands and infields of the races late in the 2008 season but was not reflected in the reported attendance figures released by NASCAR. Early in the 2009 season there was additional concern expressed about the falling ratings of the NASCAR broadcasts relative to the recent seasons. Several different explanations were offered in the general press including the macroeconomic situation, the increasing competition for leisure time, and NASCAR's introduction of the "Car of Tomorrow" in the 2008 season which is blamed by some for "dumbing down" NASCAR races.[19] Using the results presented in Table 3, data from the first five races of the 2009 NASCAR Sprint Cup Series were used to generate out-of-sample predictions for attendance, ratings and the total television audience.

One concern with out-of-sample prediction is that the parameters used to generate the predictions might not be constant over time. This would present a problem in using the parameters, generated using historical data, to predict future values, using "future" data. For each of the dependent variables, a Chow Test for parameter suggests there is no problem with parameter constancy, as reported in Table 4. Table 5 lists the races, actual and predicted values for the first five races of the 2009 NASCAR season. The attendance model consistently under-predicts attendance. On the other hand, the ratings and viewership models generally over-predict relative to what actually occurred in early 2009. This suggests that some variable(s) not included in the empirical models reported in Table 3 caused the dramatic drop in NASCAR ratings and viewership during the 2009 season. Future research into explaining the decline in viewership will be of interest.

6. Conclusions

This paper investigates the influence of outcome uncertainty on three measures of fan interest in NASCAR events: attendance, television ratings, and television viewership. This paper fills a gap in the established literature documenting the impact of outcome uncertainty on fan interest in a number of sports, by applying the hypothesis to NASCAR. The application is somewhat unique in that there is no "home team" in a NASCAR race and there are 43 different teams competing simultaneously during the event and throughout the season. The rank-order reward system of NASCAR suggests that measuring outcome uncertainty is a bit more complicated than in other contexts.

[19] The Car of Tomorrow was introduced for select races in the 2007 season and was used for all races in 2008. A dummy variable identifying races using the Car of Tomorrow was included in the specifications reported in Table 3 but in all cases the parameter on the dummy variable was insignificant. This does not preclude the possibility that over time people are responding negatively to the Car of Tomorrow; the data we employ may not encompass a long enough time period to identify fan dissatisfaction.

To address this problem, two measures of competitive balance are proposed. The first measures expected uncertainty of outcome for a particular race using the adjusted churn developed by Mizak, et al (2007). To measure uncertainty of outcome at the season-level, the standard deviation of season-level performance points is used. Using data from the 2007 and 2008 NASCAR Sprint Cup Series seasons, and combining the two uncertainty measures with a variety of other variables describing the macroeconomic environment and the characteristics of the race and the broadcast, the empirical evidence indicates that the influence of competitive balance on fan interest in NASCAR events is consistent with the stylized result from the literature. The higher the expected competitiveness, i.e., greater uncertainty, of individual NASCAR races, fan interest reflected in attendance, ratings, and television viewership all increase. On the other hand, as the disparity in season-long performance points increases, suggesting less competitive balance over the course of the season, fan interest falls in television ratings and viewership; attendance is not statistically influenced by season-level competitive balance.

It seems that the television audience and the attending audience in NASCAR are somewhat segmented. This is suggested by television ratings and television viewership being inversely related with a competing high-interest sporting event while attendance is not. Only viewership is positively related to races held on Sunday and races held at night. Road races are significantly less popular with NASCAR fans, both at the track and on television. Races with more cautions, and hence less full-speed racing, are less popular with the television audience but not statistically so with the attending audience. We find evidence of greater television audience for races broadcast on ABC and higher ratings for races broadcast on ESPN and ABC.

The empirical evidence suggests that NASCAR's efforts to improve competitive balance, especially during the races, yield benefits in both attendance and the television audience. For example, in an attempt to increasingly homogenize the cars being raced NASCAR introduced the so-called "Car of Tomorrow" during the 2007 season and all drivers have driven the homogenized vehicle since the 2008 season. Proponents have credited the Car of Tomorrow with improving the safety of the drivers and making the races more dependent on driver skill and strategy. Detractors have argued that the Car of Tomorrow has made it more difficult to pass and has increased safety to the point where drivers can be more aggressive leading to more accidents, both of which reduce the excitement of the sport. To the extent that rules changes and the Car of Tomorrow increase outcome uncertainty, then attendance and television audiences are expected to increase. However, a formal test of the impact of the Car of Tomorrow on race attendance and television viewership awaits more data.

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Table 1: Descriptive Statistics of the Data

Variable	Description	Mean	Std. Dev.	Min	Max
ATTENDANCE	Reported attendance	121,271	43,390	40,000	270,000
RATINGS [a]	Nielsen television ratings (percentage of households)	4.575	1.289	3.000	10.200
VIEWERS [a]	Nielsen television viewership (thousands)	7074.179	2470.84	3974	17752
ADJCHURN	Average adjusted churn for the previous three races held at the current race track.	0.528	0.059	0.392	0.670
SDPTS	Standard deviation of season level performance points	626.815	386.491	0.000	1413.039
GASPRICE	Three month lagged value of price of gasoline (all grades average)	314.522	56.830	221.3	426.4
UNEMP	Three month lagged value of U.S. unemployment rate	4.91	0.49	4.4	6.2
SUNDAY	Race occurred on Sunday (1=Yes)	0.792	0.409	0	1
SEVENPM	Race occurred at night (1=Yes)	0.125	0.333	0	1
CHASE	Race is part of the “Chase for the Cup” (1=Yes)	0.305	0.463	0	1
ROAD	Race occurred on a road course (1=Yes)	0.055	0.230	0	1
CAUTIONS	Average number of cautions for the previous three races held at the current race track.	9.54	2.60	6	17.67
ABC	Race broadcast on ABC Network (1=Yes)	0.291	0.457	0	1
ESPN	Race broadcast on ESPN Network (1=Yes)	0.181	0.387	0	1
FOX	Race broadcast on Fox Network (1=Yes)	0.361	0.483	0	1
TVEVENT	Another high-interest sporting event held on day of race (1=Yes)	0.319	0.469	0	1
Notes: Sample is comprised of 72 observations. [a] Based on 67 observations; five observations are dropped because of missing Nielsen data.					

Table 2: High-Interest Sporting Events in Competition with NASCAR Broadcasts (2007 and 2008 Seasons)

	2007			2008		
Competing Event	Date	Day	Race (Site)	Date	Day	Race (Site)
MLB Opening Weekend	4/15/2007	Sunday	Samsung 500 (Texas Motor Speedway)	4/6/2008	Sunday	Samsung 500 (Texas Motor Speedway)
PGA Masters				4/12/2008	Saturday	Subway Fresh Fit 500 (Phoenix International Speedway)
NHL Conference Quarterfinals	4/15/2007	Sunday	Samsung 500 (Texas Motor Speedway)	4/12/2008	Saturday	Subway Fresh Fit 500 (Phoenix International Speedway)
	4/21/2007	Saturday	Subway Fresh Fit 500 (Phoenix International Raceway)			
NBA Conference Quarterfinals	4/21/2007	Saturday	Subway Fresh Fit 500 (Phoenix International Raceway)	4/27/2008	Sunday	Aaron's 499 (Talladega Superspeedway)
	4/29/2007	Sunday	Aaron's 499 (Talladega Superspeedway)			
NHL Conference Semifinals	5/6/2007	Sunday	Jim Stewart 400 (Richmond International Speedway)	5/3/2008	Saturday	Dan Lowry 400 (Richmond International Speedway)
NBA Conference Semifinals	5/6/2007	Sunday		5/3/2008	Saturday	Dan Lowry 400 (Richmond International Speedway)
				5/10/2008	Saturday	Dodge Challenger 500 (Darlington Raceway)
NHL Conference Finals	5/13/2007	Sunday	Dodge Challenger 500 (Darlington Raceway)	5/10/2008	Saturday	Dodge Challenger 500 (Darlington Raceway)
NBA Conference Finals	6/10/2007	Sunday	Pocono 500 (Pocono Raceway)	5/25/2008	Sunday	Coca Cola 600 (Lowe's Motor Speedway)
				6/8/2008	Sunday	Pocono 500 (Pocono Raceway)
NBA Finals	6/17/2007	Sunday	Citizen's Bank 400 (Michigan International Speedway)	6/15/2008	Sunday	Lifelock 400 (Michigan International Speedway)
PGA US Open	8/5/2007	Sunday	Pennsylvania 500 (Pocono Raceway)	8/3/2008	Sunday	Sunoco Red Cross Pennsylvania 500 (Pocono Raceway)
				8/10/2008	Sunday	Centurion Boats at the Glen (Watkins Glen)
1st NFL Preseason Game				8/17/2008	Sunday	3M Performance 400 (Michigan International Speedway)
Beijing Olympics				8/23/2008	Saturday	Sharpie 500 (Bristol Motor Speedway)
NFL Opening Weekend				9/7/2008	Sunday	Chevy Rock & Roll 400 (Richmond International Speedway)
US Open Tennis	9/8/2007	Saturday	Chevy Rock & Roll 400 (Richmond International Speedway)	8/31/2008	Sunday	Pepsi 400 (Infineon Raceway)
				9/7/2008	Sunday	Chevy Rock & Roll 400 (Richmond International Speedway)

Table 3: Impacts on NASCAR Attendance and Television Ratings

	(1)	(2)	(3)
	Attendance [a]	Ratings	Viewership
ADJCHURN	337,187.635***	4.772**	7,357.780*
	(58,912.425)	(1.996)	(3,800.548)
SDPTS	-0.647	-0.003**	-5.789*
	(26.859)	(0.002)	(3.072)
GASPRICE	82.214	-0.006	-10.234
	(194.979)	(0.007)	(14.115)
UNEMP	-18,973.323	0.670	1,269.027
	(22,672.255)	(0.716)	(1,365.100)
SUNDAY	26,899.561*	0.358*	706.165**
	(15,088.840)	(0.206)	(344.842)
SEVENPM	16,707.632	0.646*	1,436.897**
	(23,051.180)	(0.371)	(660.575)
CHASE	-7,948.463	-0.250	76.092
	(21,394.896)	(0.349)	(660.150)
ROAD	-37,900.278**	-0.661**	-1,098.387**
	(16,728.928)	(0.263)	(472.197)
CAUTIONS	-776.611	-0.089**	-168.900**
	(2,018.173)	(0.039)	(73.915)
ESPN		0.942**	1,596.327*
		(0.429)	(825.509)
ABC		1.074**	2,353.923**
		(0.534)	(986.883)
FOX		0.149	1,393.176
		(0.680)	(1,291.623)
TVEVENT	5,056.616	-0.898***	-1,708.200***
	(10,208.578)	(0.224)	(413.096)
Constant	-2,200.826	2.989*	3,775.796
	(66,727.457)	(1.636)	(3,028.792)
Observations	72	67	67
R-squared	0.272	0.687	0.708
F-test	5.63***	8.97***	9.90***

Notes: Dependent variables listed in first row. Explanatory variables defined in Table 1. [a] The network dummy variables (ESPN, ABC, and FOX) are dropped from Model (1) as they have no joint statistical relationship with attendance (F=0.459, p=0.88). Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4: Chow Tests for Parameter Constancy

	ATTENDANCE	RATINGS	VIEWERS
H_0: Parameter Constancy between In-Sample and Out-of-Sample Observations	0.181	0.864	0.854
Notes: The Chow (1960) test for parameter constancy is calculated as $CHOW = \frac{(RSS_2 - RSS_1)/m}{RSS_1/n-k} \sim$ F[m,n-k], where RSS_1 is the residual sum of squares for the n in-sample observations and RSS_2 is the residual sum of squares for $n+m$ observations, m is the number of out-of-sample observations, and k is the number parameters are estimated (including the intercept term). The critical value is 2.36 for the attendance prediction and 2.388 for the ratings and viewers predictions.			

Table 5: Out of Sample Predictions for Early 2009 NASCAR Sprint Cup Series Races

Date	Race Site	Actual Attendance	Predicted Attendance	Actual Ratings	Predicted Ratings	Actual Viewers	Predicted Viewers (thousands)
Feb. 15, 2009	Daytona (FL)	180000	99981	9.2	8.8	15958	15148
Feb. 22, 2009	Fontana (CA)	78000	60758	6	8.1	10206	14021
March 1, 2009	Las Vegas (NV)	140000	86603	6.5	8.9	11123	15397
March 8, 2009	Atlanta (GA)	94400	51255	5.5	8.3	8877	14343
March 22, 2009	Martinsville (VA)	160000	64214	4.5	8.54	7365	14755