Article

Journal of Sports Economics
2018, Vol. 19(5) 696-724

DOI: 10.1177/1527002516672059
journals.sagepub.com/home/jse
SAGE

Examining the Relationship Between Scheduling and the Outcomes of Regular Season Games in the National Football League

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Abstract

Nontraditional scheduling in the National Football League (NFL) has created variation in the rest/preparation time among opponents. Using data from the 2011 to 2015 NFL seasons, regression analysis examines the impact of differential rest and preparation periods among teams on the probability of the home team winning and on the number of points scored in a particular contest. Results show that the probability of winning a game for the home team and the total number of points scored in a game are impacted by different rest combinations between opponents. These impacts are sensitive to the familiarity among opponents and the travel patterns of the visiting team.

Keywords

win, points scored, scheduling, National Football League

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Introduction and Literature Review

The National Football League (NFL) is currently the most popular of the four major sports leagues in the United States. As evidenced by a recent 2014 Harris poll, approximately one third of U.S. adults surveyed answered that professional football was their favorite sport (Pollock, 2015). The immense popularity of professional football has aided the NFL in leveraging massive television contracts from the major broadcast outlets in the United States. The most recent television contracts signed with the major broadcast networks (NBC, CBS, and FOX) which began in 2013 will bring approximately 28 billion dollars to the NFL by their completion in 2022 (Flint, 2011). Beyond these major television contracts, the NFL has profited from selling the broadcast rights to regular season NFL games that take place outside the traditional Sunday viewing schedule. In 2011, the NFL sold 10 years of broadcasting rights for Monday Night Football games to ESPN for a total of 15.2 billion dollars (Sandomir, 2011). The NFL has also expanded its slate of regular season games that are played on Thursday nights. Beginning in the 2012 NFL regular season, one regular season has been played on Thursday night each week beginning in Week 2 and running through Week 16 of the regular season. Initially, these Thursday night games were broadcast on the NFL's own broadcasting network, but in 2014 the NFL sold broadcast rights to the first 8 weeks of Thursday Night Football games in that particular season to CBS for 275 million dollars (James, 2015). For the upcoming season, NBC and CBS will pay 450 million dollars per year for the next two seasons to broadcast 10 weeks of Thursday Night Football each season (Pallotta & Stelter, 2016).

The financial importance of television contracts for the NFL cannot be understated, and the NFL has continued to respond to this financial incentive by expanding its schedule of regular season games outside of the traditional Sunday afternoon time slots. The recent increase in the number of Thursday Night Football games combined with the continued success of the Monday Night Football schedule will certainly increase current and future streams of revenue for the NFL; however, are there any negative aspects that could impact the quality and outcomes of NFL games due to this increase in scheduling of regular season games outside of the traditional Sunday time slot? The increased number of non-Sunday games scheduled in the NFL creates significant variation and differences in the rest and preparation time between opponents. If differences in rest and preparation time impact the quality or outcome of regular season NFL games, it could potentially impact attendance, fan interest, and perhaps even competitive balance throughout the league. Between the 2011 and 2015 seasons, 1,280 regular season NFL games were played and approximately 55% of those regular season games matched opponents that each had 7 days of rest and preparation time since their last game. The winning percentage among home teams in these contests was approximately 59%. Over that same time period, games where the visiting team had more rest and preparation time than their

opponents (21% of all games) lowered the home team winning percentage to 53.6%. Although having less rest time than their opponent is correlated with a lower winning percentage for the home team, results presented by Coates and Humphreys (2010) suggests that a lessening in the probability of the home team winning could lead to a decrease in game-day attendance which as the authors suggest runs contrary to the Uncertainty of Outcome Hypothesis.[1] Although game day attendance may be negatively impacted, studies have shown that fan interest in NFL games as measured by television and Internet ratings increases as the outcome of the contest becomes more uncertain (Paul, Wachsman, & Weinbach, 2010; Paul & Weinbach, 2007).

Beyond impacting the probability of winning a contest, different amounts of rest and preparation time among opponents might also impact the scoring in NFL regular season games. Between 2011 and 2015, the average total points scored in games that included opponents with equal amounts of rest (44.97 points) were less than the average total points scored in games where the visiting team had more rest than the home team (47.32 points) and in games where the visiting team had less rest than the home team (45.32 points). Several studies have shown a strong connection between increased fan interest in the NFL and more scoring in a game (Paul & Weinbach, 2007; Paul et al., 2010).[2] Increased fan interest due to higher scoring games would lead the NFL to increase revenue and profitability from future media and television contracts.

Empirical analysis on the impact of rest days on performance in major sports leagues has produced mixed results. Leard and Doyle (2011) examine all regular season games during the 2007/2008 National Hockey League (NHL) season and find that a difference in rest days between home and visiting teams does not impact the probability of winning.[3] Contrary to evidence provided by Leard and Doyle, studies focused on the National Basketball Association (NBA) have found strong support that differences in the rest days enjoyed by home and visiting teams between games can impact the outcome of a contest. Entine and Small (2008) used data on regular season NBA games from the 2004/2005 to 2005/2006 seasons and showed that visiting teams with no rest between games have a lower probability of winning their next game. Nutting (2010) examined 17 years of NBA regular season data (1990/1991-2008/2009) and found home teams experienced a greater probability of winning the fewer rest days visiting teams had between games.[4] Unlike the NBA and NHL, studying the impact of differential rest days between home and visiting teams in the context of the NFL has not been extensively studied. Previous research on the relationship between NFL scheduling and competitive balance has focused on estimating the impacts of cross country travel on team performance (Nichols, 2012) and the league-wide changes made to NFL scheduling policy in the 1990s and early 2000s (Uyar & Surdam, 2013).[5]

Work by Karwan, Kurt, Pandey, and Cunningham (2015) is the first paper that has addressed the potential relationship that may exist between regular season scheduling in the NFL and its impact on the quality and outcome of the NFL games.

Although Karwan and his coauthors are not seeking to establish a causal relationship between differential rest days for home and visiting teams and the impacts on winning, they do provide a number of descriptive statistics suggesting that certain teams may be unfairly placed at a disadvantage due to the structure of the NFL schedule.[6]

Similar to the motivation put forth in the Karwan et al. (2015), the goal of this analysis is to investigate the relationship between how differences in opponents rest and recovery time caused by the NFL regular season game scheduling impact the probability of the home team winning and the level of scoring in the game. Using results from over 1,000 regular season NFL games during the 2011-2015 seasons, ordinary least squares (OLS) regression and probit estimation techniques were used to investigate the relationship between differential rest and preparation time for home and visiting teams and the outcomes of regular season NFL games. This article contributes to the literature by providing the first evidence on the impact differential rest and preparation times between opponents in the NFL on the probability of winning a game and the amount of points scored in a game.

Data and NFL Scheduling

To examine how rest and preparation among participants in NFL games impact the competitiveness and outcomes of the aforementioned contests, data were collected for regular seasons NFL games during the 2011-2015 seasons. The structure of the NFL regular season has each of its 32 teams play 16 games over a 17-week regular season schedule. Of the 16 games each team will play, 8 games are played at an individual team's home stadium and the remaining 8 are played at an opponent's home field. Since this analysis uses a comparison of home and visiting team rest days, the data set is limited to focus just on home games for each team; this amounts to 256 regular season games that take place each year, for a total of 1,280 games over the 5-year time period. For each regular season game, information on the game was collected which included the participants in and the location of the game, the final score of the game, the date of the game, and the weather conditions in which the game was played. The majority of this information was elicited from historical NFL data provided by ESPN.com.

During the 2011-2015 seasons, the structure of the NFL consisted of 2 conferences each comprised of 16 teams. Each conference had four divisions with four teams in each division. An individual team played the other three teams within their division twice, once at home and once as a visiting opponent. Teams would also face all of the teams from another division within their conference and all the teams from another division in the opposing conference. Each year an individual team would rotate which division (in both conferences) they played against ensuring that within a 4-year time span an individual team would play against all the teams in the league at least once. The remaining two games on an individual team's regular season schedule were played against teams within their own conference outside of their

own division who ended the last regular season in the same position in their divisional standings.[7] Lenten (2015) provides a more detailed discussion of current and historical scheduling in the NFL.[8]

The majority of regular season games, approximately 86%, during the 2011-2015 NFL seasons were played on Sunday afternoon and Sunday evenings. The remaining 14% of games were played on Monday night (7%) and Thursday night (6%) along with a handful of games played on Saturday afternoon and Saturday evening. During the 2012 season, the NFL expanded its Thursday Night Football scheduling to include one Thursday night game a week beginning in Week 2 of the NFL season and ending Week 16 of the NFL season. Prior to 2012, the Thursday Night Football schedule (which began in 2006) had only eight scheduled games which began in early November. The combination of this expanded Thursday night schedule with the traditional Thanksgiving Day NFL games ensured that every NFL team played at least one Thursday night game each season during the 2012-2015 season.[9] In contrast to the Thursday Night Football schedule, the Monday Night Football schedule does not guarantee equal exposure among all the teams in the NFL. Often the matchups on Monday Night Football are chosen to promote television ratings by scheduling teams from larger cities and media markets or classic rivalry matchups instead of ensuring every team receives equal opportunity to play on Monday night. As an example, the Chicago Bears participated in 10 Monday Night Football games during the 2011-2015 seasons while over the same time period the Buffalo Bills and Cleveland Browns each participated in only a single Monday Night Football game. In addition, teams that are scheduled to play on Monday Night Football are on average of higher quality. Between the 2011 and 2015 NFL seasons, 85 Monday Night Football Games were played and the average previous season's winning percentage of the participants in those games was equal to 0.564. If all teams were to be given equal exposure on Monday Night Football, we should expect the average previous season's winning percentage to be closer to 0.500.

Although most of the regular season games in the NFL take place on Sunday, the increased scheduling of games outside of normal Sunday time slots combined with the bye week that each team is entitled to at one point during the season has created a significant amount of variation in the amount of rest and preparation teams are able to have between games. As shown in Table 1, home teams had the normal 7 days of rest between games for 69% of all regular season games, while 16% and 15% of games featured home teams with more than and less than 7 days of rest, respectively. Although these differences in winning percentages are not statistically significant, home teams have lower winning percentages with both more than and less than 7 days of rest as compared to having the normal 7 days of rest between games. Home teams with fewer than 7 days of rest are statistically significantly more likely to allow more points which lead to higher scoring contests.

When comparing the rest and preparation times for both home and visiting teams, approximately 66% of all regular season games featured opponents that

Table 1. Mean Winning Percentages, Points Scored by Team, and Total Points per Game.

Rest/Preparation Combinations	Number of Games	Winning Percentage for Home Team	Points Scored by Home Team	Points Allowed by Home Team	Total Points Scored in Game
All games (1,280)					
All games	1,280	.568	24.034	21.463	45.498
Rest for home team					
Seven days	882	.579	23.921	21.322	45.243
More than 7 days	206	.553	24.053	20.495	44.549
Less than 7 days	192	.531	24.536	23.151**	47.688**
Home team rest compared to opponent					
Same rest as opponent	847	.581	23.845	21.123	44.968
More rest than opponent	170	.553	24.024	21.3	45.324
Less rest than opponent	263	.536	24.65	22.665**	47.316**
Common rest combinations (1,163 games)					
Home = 7 days; away = 7 days	697	.588	23.94	21.072	45.011
Home = 6 days; away = 7 days	77	.481*	25.364	25.61***	50.974***
Home = 4 days; away = 4 days	73	.575	22.247	21.11	43.356
Home = 7 days; away = 10 days	63	.508	25.19	23.032	48.222
Home = 7 days; away = 14 days	59	.542	21.695*	21.203	42.898
Home = 7 days; away = 6 days	53	.585	24.679	22.679	47.358
Home = 8 days; away = 8 days	52	.577	24.096	20.596	44.692
Home = 10 days; away = 7 days	45	.556	24.644	20.333	44.978
Home = 14 days; away = 7 days	44	.523	21.386*	19.613	41**

Note. Means that are accompanied by any significance signs in the top portion of the table indicate that the variable in question for that specific rest combination is statistically different from the mean value of that variable when the home team has 7 days of rest. Means that are accompanied by any significance signs in the bottom portion of the table indicate that the variable in question for that specific rest combination is statistically different from the mean value of that variable when both home and away teams have 7 days of rest (home = 7 days; away = 7 days). The top portion of the table is constructed using data from 1,280 regular season National Football League games (2011-2015); while the bottom table contains 1,163 of the aforementioned 1,280 games. The 117 games dropped in the bottom portion of the table exhibit rest combinations between home and away teams that were not that common during the 5-year period in question. Please see Appendix Table A1 for a more detailed breakdown of the rest combinations for all 1,280 games.

*Significance at 10%. **Significance at 5%. ***Significance at 1%.

had the same amount of rest and preparation time before their game and furthermore, 21% of games featured visiting opponents that had more rest and recovery time compared to their home team counterparts. The winning percentage for the home team declines in games where the home teams have a different amount of rest/preparation as compared to their opponent (both more and less rest/preparation). Total points scored in games where the rest/preparation time differs between the home team and visiting team increases and this increase is attributable to both an increase in home team scoring and visiting team scoring. For games where the home team has less rest than its opponent, the increase in opponent scoring and overall increase in total points scored in the game is statistically significantly larger than games where both the home and away team have the same amount of rest.

To further explore the correlations documented in the top portion of Table 1, the bottom portion of Table 1 presents data on home team winning percentages and scoring for nine of the most common rest/preparation combination for home and away teams in the NFL. These nine rest combinations represent 1,163 (90.8%) of the 1,280 regular season games played between 2011 and 2015. The 117 games not included in the bottom portion of Table 1 exhibit rest combinations that are not common in NFL scheduling and are therefore not considered. For a more detailed breakdown of the rest days for home and visiting teams for the 2011-2015 NFL regular seasons, please refer Appendix Table A1. The rest combinations shown in the bottom portion of Table 1 can be thought of as interactions between the actual amount of rest a home team receives and differences in the relative rest a home team has compared to its opponent. The most common rest combination has both home and away teams playing with 7 days of rest/preparation between games (60%); this is essentially teams playing their games on subsequent Sundays. Games in which the home team has only 6 days of rest while the visiting team has 7 days of rest are most likely the consequence of the home team playing on Monday Night Football the week previously and are subjected to a shortened week of rest and preparation. The impact of Monday Night Football is also seen when both teams have 8 days of rest, which represents the extra day each team receives in preparation for the actual game played on Monday night. Games played on Thursday night feature 4 days of rest for both teams. For teams that played a Thursday night game the week before, the amount of time between the Thursday night game and their next regular game (on Sunday of the following week) equals 10 days. Rest combinations that include 10 days of rest for a team indicate that the team had played on Thursday the week before. Finally, each team in the NFL is allowed one bye week per season which gives them an additional 7 days off (for a total of 14 days) between games.

The winning percentage for the home team is lower for every single rest combination that deviates from the traditional 7 days of rest for both the home and away teams; however, only the rest combination of 6 days of rest for the home team and 7

days of rest for the away team is statistically significantly lower. Although deviations from the traditional 7 days of rest for both home and visiting team lead to a lower probability of winning for the home team in all cases, the same cannot be said for the impact of rest on total points scored in a game. For the eight rest combinations that differ from the 7 days of rest for both teams, three of these rest combinations lead to an increase in the total number of points scored in a game. The increase in total points scored is a combination of increased home team and visiting team scoring depending on the rest combination considered. For those home teams playing the week after a Monday Night Football game (6 days of rest compared to 7 days of rest for the opponent), the increase in total points comes from an increase in home team scoring and an increase in visiting team scoring that is statistically significantly larger than the level of opponent scoring in games where both teams have 7 days of rest between games. Although no pattern seems to exist for points scored by the home team and relative rest days as compared to one's opponent, it does appear that as a home team has a greater relative rest period as compared to its opponent the fewer points opposing teams are likely to score.

In order to more rigorously investigate the relationship between different rest/preparation periods between home and away teams and the outcomes of NFL games, regression analysis using the five seasons' worth of NFL data (2011-2015) will be necessary. Of the initial 1,280 games, this analysis will focus on the 9 most common rest combinations as shown in the bottom portion of Table 1. In addition, games that ended in a tie score or were played on a neutral field are excluded from this analysis.[10] Finally, all games that took place during the first week of the season are not included, as measures of team quality require using past performance within a given season (average points scored per game, average points allowed per game, and winning percentage) within a season. The final data set consists of 1,069 regular NFL games played during the 2011-2015 regular seasons.

Method

The correlations presented in Table 1 provide suggestive evidence that differential rest/preparation time between home and visiting teams may impact not only the probability of winning the game but also the overall level of points scored within a particular contest. In order to isolate the causal impact of rest/preparation time on these aforementioned outcomes, the following model, Equation 1, is estimated,

$$Y_{iowt} = \text{Rest}_{iowt}\beta + X_{iowt}\gamma + \lambda_t + \theta_w + \delta_i + \mu_o + \varepsilon_{iowt}. \quad (1)$$

The dependent variable in Equation 1, Y_{iowt}, represents an outcome of interest for an individual regular season NFL game featuring home team i and visiting team o in week w and in year t. Outcomes of interest explored in this article include the total

number of points scored in a game (total points), points scored by the home team, points scored by the visiting team (points allowed by home team), and the probability of the home team winning the game (win). All of the outcomes with the exception of the probability of the home team winning are estimated using OLS; due to the dichotomous nature of winning a game, a probit model is used to estimate the probability of the home team winning a game. The structure of the error term, ε_{iowt}, is assumed to be independent and identically distributed with a standard normal distribution.

Variables that account for differences in rest and preparation time are encapsulated in the vector of variables labeled Rest_{iowt}. All of the components of Rest_{iowt} are dummy variables that identify a situation where the rest and preparation time for either (or both) teams deviates from a normal rest period of 7 days. The rest variables can be plausibly considered exogenous as the schedule is determined by the NFL league office well in advance of the season and cannot be influenced by the actions on or off the field by an individual team. The point estimates generated from the estimation of Equation 1 for these variables are to be interpreted as differences in the outcome variable associated with deviating from a normal rest period of 7 days for each team. If deviations from the standard 7 days of rest for both teams do not impact the outcomes of NFL regular season games, one would expect all of the coefficients on the Rest_{iowt} variables to equal 0.

The explanatory variables included in X_{iowt} control for team quality measures, game day weather characteristics, familiarity among opponents, and the impact of traveling across time zones for the visiting team in question. Controlling for the quality of a team and its opponent is necessary in order to ensure an unbiased estimate of the rest variables mentioned above. Following the work of Coates and Humphreys (2010), three measures of team quality are included for both the home team and visiting team. These measures include the average points scored per game, average points allowed per game and winning percentage in all previous games played within a particular season. Using past performance within a season forces the estimation to drop all of the games played in Week 1 as discussed earlier in the article. Controls for game day temperature, wind conditions, and precipitation are included in Equation 1.[11] Borghesi (2007, 2008) found that temperature and precipitation conditions impacted the amount of points scored in a game which could then impact the probability of winning a game. Along with temperature controls, dummy variables for wind speed and whether a game is played inside a dome are included in the analysis. The evolution of the NFL has seen more teams attack with more frequency by passing instead of rushing. Changing wind conditions will impact the efficiency of a team's passing game. Dummy variables for whether the teams are in the same conference or same division are included as well to control for the potential impact of playing opponents that a team is more/less familiar with. Controls for visiting teams traveling across time zones are included; prior research showed that traveling across time zones impacted the probability of winning for home teams (Nichols, 2012).

Due to the pooling of regular season game results across four seasons, time effects are included in the estimation of Equation 1 in the form of year dummy variables, λ_t. These time effects will account for changes in rules, salary caps, or other league-wide phenomenon that impact all teams in the league and could potentially impact the outcomes of interest examined in this analysis. For example, for the 2015 regular season the NFL changed its rule regarding the extra point attempt after a touchdown is scored. The extra point attempt was moved from approximately the 2 yard line to the 15 yard line. This rule change theoretically could lead to lower scoring games across the NFL, something the time effects will account for. Week dummy variables, θ_w, are included as well to account for the time of the regular season a game takes place. Games played later in the regular season may hold more importance due to their potential playoff implications. Finally, Equation 1 includes home team, δ_i, and visiting team, μ_o, dummy variables that capture time-invariant characteristics about individual home and visiting teams over the entire time span of the data set. Inclusion of home and visiting team dummy variables controls for issues related to team-specific home field advantage effects such as fan attendance and fan noise along with team quality measures that are constant over the time period in question.

Results

Table 2 presents descriptive statistics for the explanatory variables and outcomes of interest examined in this analysis. The average total points scored per game over the 1,069 games used in this analysis is equal to 45.13 with 23.85 points per game scored by the home team and the remaining 21.28 points per game scored by the visiting team. The overall winning percentage for the home team is equal to 57.10%. The explanatory variables that control for the rest and preparation of both home and away teams can be broken into two categories: condensed and detailed. The rest variables in the condensed category can further be broken into two general categories. The first category contains three variables that account of the absolute rest for the home team while the second category contain three variables that track whether the home team has more, less, or the same rest as compared to its opponent. Home teams have 7 days of rest approximately 73% of the time and have the same amount of rest as their opponent 68.2% of the time. The detailed scheduling and rest combinations can be thought of as interactions between the two categories of condensed rest variables. These detailed rest combinations are the same combinations presented in Table 2 and contain information on both the absolute rest for the home and away team along with the difference in rest and preparation days between the opponents. The most common detailed rest combination is the traditional 7 days of rest for both the home team and away team (56.5% of all games) followed by a home team having 6 days of rest (most likely the week after a Monday Night Football game) and the away team having 7 days of rest (7.2%).

Table 2. Descriptive Statistics.

Rest/Preparation Combinations	Mean	Minimum	Maximum	Standard Deviation
Dependent variables				
Total points	45.128	9	101	13.659
Home points scored	23.851	0	62	10.491
Visiting points scored	21.277	0	56	9.810
Home team win	0.571	0	1	0.495
Condensed scheduling and rest combinations				
Same rest as away team	0.682	0	1	0.466
More rest than away team	0.132	0	1	0.339
Less rest than away team	0.186	0	1	0.389
Seven days of rest for home teams	0.729	0	1	0.445
More than 7 days rest for home team	0.131	0	1	0.338
Less than 7 days rest for home team	0.140	0	1	0.347
Detailed scheduling and rest combinations				
Home = 7; away = 7	0.565	0	1	0.496
Home = 4; away = 4	0.068	0	1	0.252
Home = 6; away = 7	0.072	0	1	0.259
Home = 7; away = 6	0.050	0	1	0.217
Home = 7; away = 10	0.059	0	1	0.236
Home = 7; away = 14	0.055	0	1	0.228
Home = 8; away = 8	0.049	0	1	0.215
Home = 10; away = 7	0.042	0	1	0.201
Home = 14; away = 7	0.040	0	1	0.197
Performance/quality (based on past performance during the season in question)				
Home points scored per game	22.741	3	46	5.397
Home points allowed per game	23.072	2	49	5.051
Home winning percentage	48.65	0	100	26.56
Away points scored per game	23.142	2	49	5.686
Away points allowed per game	22.956	6	44.5	5.124
Away winning percentage	50.984	0	100	26.680
Team familiarity/travel				
Teams in same division	0.375	0	1	0.484
Teams in same conference	0.376	0	1	0.485
Teams in different conferences	0.249	0	1	0.433
Away team did not change time zones	0.405	0	1	0.491
Away team traveled across time zones west to east	0.299	0	1	0.458
Away team traveled across time zones east to west	0.296	0	1	0.457
Game day conditions				
Dome	0.227	0	1	0.419
Precipitation	0.064	0	1	0.244
Temperature under 50°	0.206	0	1	0.404

(continued)

Table 2. (continued)

Rest/Preparation Combinations	Mean	Minimum	Maximum	Standard Deviation
Temperature between 50° and 60°	0.170	0	1	0.376
Temperature between 60° and 70°	0.201	0	1	0.401
Temperature over 70°	0.196	0	1	0.397
Wind at 0 mph	0.091	0	1	0.287
Wind between 1 and 5 mph	0.227	0	1	0.419
Wind between 6 and 10 mph	0.290	0	1	0.454
Wind above 10 mph	0.165	0	1	0.371

Note. $N = 1{,}069$.

The increased prevalence of Thursday Night Football can be seen when both teams play on 4 days of rest (6.8% of all games).

Beyond the explanatory variables devoted to capturing different rest and preparation times, opponents were equally likely to be from the same division (37.5%) or from different divisions inside of the same conference (37.6%). Only 24.9% of games featured opponents from different conferences. The majority of visiting teams did not travel across time zones (40.5%), but if away teams did travel they were equally likely to travel from the west coast to the east coast (29.9%) as they were to travel from the east coast to the west coast (29.6%). The final set of explanatory variables controls for weather conditions on the day of the game in question. A set of dummy variables is created for both temperature and wind speed categories. For easier interpretation of the weather dummy variables (temperature, precipitation, and wind speed), the dummy variables have been constructed to included games played in a dome as not being impacted by weather conditions. Therefore, all of the temperature, wind, and precipitation variables can be thought of as being conditional on the game being played outside of a dome.

Initial results from the estimation of Equation 1 are presented in Table 3. Estimates presented in this table use the condensed rest variables discussed in the preceding paragraphs. Table 3 contains results from four separate regressions. The first three columns present OLS results where the dependent variables are total points scored, points scored by the home team, and points allowed by the home team (scored by the visiting team). Column 4 of results, estimated using a probit model, presents the marginal effects of the explanatory variables on the probability of the home team winning the game. Results for total points scored show that the rest and preparation variables do matter.

According to the results, games featuring home teams with less rest than their opponents see a statistically significant increase of 2.253 points over games where both opponents have the same amount of rest. As it relates to home teams, a home team with more than 7 days of rest (regardless of what the opponent has for rest days) is likely to decrease the total points scored in the game by −2.941 as compared to

games were the home team has 7 days of rest. The quality of teams matter when it comes to determining the total amount of points scored in a contest. Both point estimates on the points per game scored by each team are positive and statistically significant at the 5% level; one would expect that better offensive teams would lead to higher scoring games. The same logic does not hold for defense, as better defensive teams do not have an impact on the total points scored in a game. Teams from the same division are likely to produce lower scoring games most likely due to the increased knowledge opponents have of each other's strengths, weakness, and strategies due to the high frequency of playing one another. Games played in colder weather (below 50°) and those played in windy conditions (winds above 10 mph) show a statistically significant drop in the total number of points scored.

Columns 2 and 3 of Table 3 provide insight into where the changes in total points scored are originating from. It appears the impact the home team having less rest than the away team leads to an increase in the points allowed by the home team. More specifically, when a home team has less rest and preparation time as compared to its opponent, the away team increases its scoring output by 1.999 points (significant at the 5% level). When a home team has more than 7 days of rest, there is not a individually statistically significant decline in points scored for the home team or points allowed by the home team, but the combination of these point estimates leads to an overall decline in total points which is statistically significant. The amount of points a home team scores increases with the quality of the home team's offense as measured by the points per game in previous games, while a similar effect is found when examining the impact of points scored per game for a visiting team in previous games on the points allowed by a home team during the game in question. As it relates to scoring for the home team, the remained of the explanatory variables included in the analysis do not statistically significantly change the number of points scored with the exception of games played outdoors in temperatures above 70° which decreases points scored by the home team by 2.606 points as compared to games played outdoors with temperatures between 60° and 70°. Home teams allow fewer points to visiting teams outside of their own division but within their same conference (−1.367) as compared to opponents from a different conference, while visiting teams have a harder time scoring in conditions where the wind is above 10 mph (−2.733).

The final results reported in Table 3 (Column 4) are the marginal effects from the probit estimation of the probability of the home team winning on the condensed rest variables and additional explanatory variables. In terms of rest and preparation variables, having a game where the home team has less rest than the visiting team lowers the probability of the home team winning by 10.4 percentage points. This estimate suggests that the probability of a home team winning a game drops by 17% if the home team plays an opponent with more rest and preparation as compared to a similar opponent that has the same rest and preparation time as the home team does. Additionally, a home team's probability of winning decreases as the quality of its

Table 3. OLS and Probit Estimation Results—Condensed Rest and Preparation Variables.

Dependent Variables	Total Points Scored (Combined Home and Away)	Points Scored by Home Team	Points Allowed by Home Team	Probability of Home Team Winning
Rest/preparation				
More rest than away team	2.336 (1.545)	0.800 (1.174)	1.535 (1.100)	−0.043 (0.062)
Less rest than away team	2.253* (1.174)	0.254 (0.850)	1.999** (0.856)	−0.104** (0.048)
More than 7 days rest for home team	−2.941* (1.657)	−1.421 (1.178)	−1.520 (1.154)	−0.042 (0.064)
Less than 7 days rest for home team	0.691 (1.180)	−0.688 (0.964)	1.379 (0.896)	−0.028 (0.052)
Performance/quality				
Home points scored per game	0.265** (0.125)	0.180** (0.086)	0.085 (0.086)	0.004 (0.005)
Home points allowed per game	−0.030 (0.130)	−0.096 (0.095)	0.066 (0.090)	−0.016*** (0.005)
Home winning percentage	0.0003 (0.031)	0.021 (0.021)	−0.021 (0.022)	−0.00001 (0.001)
Away points scored per game	0.309** (0.125)	0.061 (0.083)	0.247*** (0.089)	−0.010* (0.005)
Away points allowed per game	−0.087 (0.119)	0.049 (0.091)	−0.136 (0.091)	0.009* (0.005)
Away winning percentage	−0.047 (0.031)	−0.026 (0.021)	−0.021 (0.022)	0.001 (0.001)
Team familiarity/travel				
Teams in same division	−2.081* (1.152)	−0.916 (0.838)	−1.166 (0.846)	−0.060 (0.046)
Teams in same conference	−0.474 (1.062)	0.892 (0.813)	−1.367* (0.776)	0.040 (0.044)
Away team traveled across time zones west to east	2.723 (1.940)	2.066 (1.419)	0.657 (1.329)	0.021 (0.074)
Away team traveled across time zones east to west	−1.793 (2.029)	−2.061 (1.502)	0.268 (1.397)	0.002 (0.076)
Game day conditions				
Precipitation	0.895 (1.697)	0.646 (1.369)	0.249 (1.244)	0.090 (0.073)
Dome	−4.497 (2.843)	−2.038 (2.120)	−2.459 (2.030)	−0.156 (0.112)
Temperature under 50°	−2.659* (1.557)	−1.920 (1.186)	−0.739 (1.135)	−0.142** (0.068)
Temperature between 50° and 60°	−2.129 (1.384)	−1.630 (1.033)	−0.498 (1.049)	−0.118** (0.060)
Temperature over 70°	−2.672 (1.638)	−2.606** (1.213)	−0.067 (1.207)	−0.147** (0.064)
Wind between 1 and 5 mph	0.196 (1.652)	−0.841 (1.220)	1.037 (1.236)	−0.133* (0.069)

(continued)

Table 3. (continued)

Dependent Variables	Total Points Scored (Combined Home and Away)	Points Scored by Home Team	Points Allowed by Home Team	Probability of Home Team Winning
Wind between 6 and 10 mph	−1.013 (1.653)	−0.654 (1.241)	−0.360 (1.196)	−0.050 (0.067)
Wind above 10 mph	−4.762*** (1.744)	−2.028 (1.331)	−2.733** (1.310)	−0.089 (0.078)
N	1,069	1,069	1,069	1,069
R^2	.244	.2817	.2500	—
F-statistic	2.18	2.76	2.46	—
Pseudo-R^2	—	—	—	.2221
Wald test	—	—	—	288.68
Log pseudolikelihood	—	—	—	−568.08509
Predicted probability	—	—	—	0.595
Observed probability	—	—	—	0.571

Note. *N* = 1,069 for all regression results presented in the table. Robust standard errors are calculated. OLS = ordinary least squares.
*Significance at 10%. **Significance at 5%. ***Significance at 1%.

defense (as measured by points allowed per game) decreases and as the quality of the visiting team (as measure by points scored per game and points allowed per game by the visiting team) increases. The impact of temperature changes in outdoor games has a significant impact on the probability of winning for the home team. Any deviation of temperature below 60° or above 70° leads to a decline in the probability of winning for the home team (the comparison category is temperatures between 60° and 70°).

Analysis of condensed rest and preparation variables is constructive; however, understanding the interactions of the level of rest home teams receive and the relative amount of rest teams have compared to one another is something the results presented in Table 3 cannot fully show. For instance, it might be important to know if having less rest than your opponent impacts a home team differently if that team has less than 7 days of rest between games or more than 7 days of rest between games. To that end, regression results presented in Table 4 mirror those found in Table 3 in presentation with the sole difference being the detailed rest and preparation combination variables are used in lieu of the condensed rest and preparation variables. Analysis of Table 4 will be limited to the impact of the detailed rest and preparation variables on the four dependent variables of interest as the remaining explanatory variables all impact the dependent variables in a similar fashion to the results presented in Table 3.

The point estimates for all of the detailed rest combination variables should be interpreted as differences (or changes) from the situation where both teams (home and away) have 7 days of rest and preparation. The results for total points show that games played on Thursday night (Thursday Night Football) generate fewer total points (−2.846) mostly due to a decline in the points scored by the home team (−2.482). In contrast, when away teams have a full week of rest and home teams are playing with only 6 days of rest (the majority of the time due to having played on the previous Monday night), the total amount of points scored in the game increases by 5.406 points (significant at the 1% level). This increase in point total is almost completely attributable to an increase in visiting team scoring of 4.618 points. The only other rest combination that produces a statistically significant change involves the situation where the home team is coming off of a bye week (14 days of rest) and the away team has the normal 7 days of rest. In this case, the total amount of points scored in the game declines by 3.497, but the individual decline in points scored by the home team and points scored by the away team is not statistically significant. Home teams on 7 days of rest that are facing away teams coming off of a bye (14 days of rest) score fewer points (2.718) compared to home teams that face opponents that have the more common 7 days of rest. As it relates to impacting the probability of the home team winning, only home teams that have 6 days of rest compared to 7 days of rest for their opponents are at a decided disadvantage. For home teams with 6 days of rest and 1 less day of rest compared to their opponent, the probability of winning declines by 14.8 percentage points (approximately 25%).

Table 4. OLS and Probit Estimation Results: Detailed Rest and Preparation Variables.

Dependent Variables	Total Points Scored (Combined Home and Away)	Points Scored by Home Team	Points Allowed by Home Team	Probability of Home Team Winning
Rest/preparation				
Home = 4; away = 4	−2.846* (1.524)	−2.482* (1.309)	−0.363 (1.220)	0.003 (0.071)
Home = 6; away = 7	5.406*** (1.592)	0.788 (1.276)	4.618*** (1.091)	−0.148** (0.068)
Home = 7; away = 6	2.870 (1.867)	0.981 (1.577)	1.889 (1.284)	−0.0004 (0.078)
Home = 7; away = 10	1.789 (1.997)	0.668 (1.336)	1.120 (1.441)	−0.094 (0.076)
Home = 7; away = 14	−2.160 (1.814)	−2.718** (1.210)	0.557 (1.319)	−0.067 (0.080)
Home = 8; away = 8	−2.161 (2.424)	−1.133 (1.570)	−1.027 (1.635)	0.005 (0.085)
Home = 10; away = 7	0.115 (2.160)	−0.149 (1.357)	0.264 (1.797)	−0.128 (0.097)
Home = 14; away = 7	−3.497* (2.068)	−2.137 (1.735)	−1.360 (1.582)	−0.063 (0.096)
Performance/quality				
Home points scored per game	0.270** (0.123)	0.183** (0.085)	0.087 (0.085)	0.004 (0.005)
Home points allowed per game	−0.034 (0.129)	−0.100 (0.095)	0.066 (0.089)	−0.016*** (0.005)
Home winning percentage	−0.001 (0.030)	0.020 (0.021)	−0.022 (0.022)	-8.63×10^{-6} (0.001)
Away points scored per game	0.304** (0.124)	0.057 (0.083)	0.247*** (0.090)	−0.010** (0.005)
Away points allowed per game	−0.070 (0.120)	0.057 (0.092)	−0.127 (0.091)	0.009* (0.005)
Away winning percentage	−0.043 (0.030)	−0.024 (0.021)	−0.019 (0.022)	0.0009 (0.001)
Team familiarity/travel				
Teams in same division	−1.330 (1.181)	−0.485 (0.852)	−0.845 (0.866)	−0.062 (0.047)
Teams in same conference	−0.544 (1.058)	0.873 (0.812)	−1.417* (0.775)	0.042 (0.044)
Away team traveled across time zones west to east	3.140 (1.941)	2.312 (1.436)	0.827 (1.326)	0.017 (0.074)
Away team traveled across time zones east to west	−2.049 (2.011)	−2.203 (1.503)	0.154 (1.391)	−0.001 (0.076)
Game day conditions				
Precipitation	0.843 (1.689)	0.550 (1.379)	0.294 (1.244)	0.088 (0.073)
Dome	−4.076 (2.807)	−1.775 (2.100)	−2.300 (2.044)	−0.151 (0.112)

(continued)

Table 4. (continued)

Dependent Variables	Total Points Scored (Combined Home and Away)	Points Scored by Home Team	Points Allowed by Home Team	Probability of Home Team Winning
Temperature under 50°	−2.611* (1.554)	−1.855 (1.189)	−0.755 (1.131)	−0.144** (0.068)
Temperature between 50° and 60°	−2.171 (1.360)	−1.610 (1.023)	−0.561 (1.044)	−0.118** (0.060)
Temperature over 70°	−2.557 (1.626)	−2.486** (1.209)	−0.071 (1.202)	−0.148** (0.065)
Wind between 1 and 5 mph	0.448 (1.660)	−0.719 (1.238)	1.167 (1.266)	−0.127* (0.070)
Wind between 6 and 10 mph	−0.926 (1.667)	−0.597 (1.253)	−0.329 (1.231)	−0.043 (0.068)
Wind above 10 mph	−4.852*** (1.768)	−2.078 (1.350)	−2.774** (1.343)	−0.080 (0.078)
N	1,069	1,069	1,069	1,069
R^2	.2552	.2880	.2546	—
F-statistic	2.24	2.84	2.48	—
Pseudo-R^2	—	—	—	.2229
Wald test	—	—	—	289.15
Log pseudolikelihood	—	—	—	−567.4992
Predicted probability	—	—	—	0.595
Observed probability	—	—	—	0.571

Note. *N* = 1,069 for all regression results presented in the table. Robust standard errors are calculated. OLS = ordinary least squares.
*Significance at 10%. **Significance at 5%. ***Significance at 1%.

Results presented in Table 4 show that common scheduling practices in the NFL can lead to changes in home team and visiting team scoring along with the probability of winning for the home team. Although Equation 1 controls for the relationship between opponents as it relates to the division and conference affiliation of both teams, the results presented in Table 4 assume that the impact of being in the same division or being in a different division in the same conference have the same impact no matter the rest combination examined. Therefore, the impact of playing a divisional rival on a Thursday night (4 days of rest for each team) would be the same as playing a divisional rival after coming off a bye week (14 days of rest). On a similar note, the impact of teams traveling across time zones could potentially be different depending on the rest and preparation days that both teams receive. In order to better capture the differential impacts of team familiarity (division and conference) and visiting team travel, interaction effects between the detailed rest combinations and "same division" and "same conference" variables were included along with interactions between the detailed rest combinations and "away team travel across time zones east to west" and "away team traveled across time zones west to east."

Reporting results with the inclusion of the interaction effects mentioned above in a similar fashion to the regression results presented in Tables 3 and 4 did not seem possible given the sheer number of interaction effects (32).[12] Instead, Table 5 presents the total estimated impact of different combinations of rest variables, team familiarity, and visiting team travel. Table 5 should be considered four separate tables or panels. Each panel represents one of the four dependent variables examined during the course of this analysis. The top panel shows results for total points scored by both teams in a game, the second panel shows points scored by the home team, the third panel shows points allowed by the home team, and the final panel shows the probability of winning for the home team. Each panel shows the estimated change in the dependent variable from a situation where both teams had 7 days of rest and both teams were from different conferences and the visiting team did not have to change time zones when traveling. Consider Panel 1 where the rest combination has the home team and away team with 4 days of rest and both teams are from the same division in the same time zone. The estimated impact of −6.091 which is statistically significant at the 5% level corresponds to a 6.091 decline in total points scored in this environment as compared to the case where both teams have 7 days of rest, are from different conferences, and in the same time zone. Results for team familiarity (same division, same conference, and different conference) are only presented for situations where the teams are always in the same time zone; because the estimation technique did not interact team familiarity variables with visiting team travel variables, the impacts of team familiarity are the same regardless of the time zone. The same logic holds for the impact of time zones on team familiarity; the effects of time zone are the same regardless of whether teams are from the same division or conference.

Table 5. Calculated Impacts of Differential Rest and Preparation Times by Team Familiarity and Time Zone Interactions.

Rest/Preparation Combinations	Different Conference in Same Time Zone	Same Division in Same Time Zone	Same Conference in Same Time Zone	Travel West to East in Different Conference	Travel East to West in Different Conference
Panel 1: Total points scored (combined home and away)					
Home = 7; away = 7	—	−0.242 (.881)	−0.680 (.632)	2.389 (.289)	−1.511 (.510)
Home = 4; away = 4	−0.425 (.926)	−6.091** (.019)	−2.180 (.625)	3.125 (.531)	1.150 (.836)
Home = 6; away = 7	8.622** (.043)	4.477 (.200)	7.122** (.039)	13.285*** (.010)	−0.706 (.884)
Home = 7; away = 6	4.091 (.319)	−6.005 (.217)	−1.812 (.625)	12.555*** (.002)	5.741 (.211)
Home = 7; away = 10	−2.683 (.574)	0.126 (.971)	2.517 (.644)	3.994 (.376)	−3.895 (.503)
Home = 7; away = 14	−7.439 (.122)	−1.344 (.690)	−3.230 (.374)	−2.549 (.625)	−9.599* (.065)
Home = 8; away = 8	−1.727 (.747)	−9.410* (.091)	−1.792 (.706)	6.267 (.259)	−5.586 (.305)
Home = 10; away = 7	3.692 (.559)	−0.423 (.911)	0.951 (.816)	8.519 (.177)	−6.211 (.284)
Home = 14; away = 7	0.896 (.833)	−1.908 (.625)	−4.588 (.352)	5.921 (.240)	−10.534** (.037)
Panel 2: Points scored by home team					
Home = 7; away = 7	—	−0.098 (.934)	0.654 (.565)	1.553 (.346)	−2.178 (.208)
Home = 4; away = 4	−1.693 (.659)	−4.673** (.047)	−0.744 (.876)	2.155 (.531)	−2.733 (.544)
Home = 6; away = 7	0.766 (.818)	2.521 (.390)	1.544 (.572)	4.489 (.183)	−5.813* (.077)
Home = 7; away = 6	1.229 (.766)	−6.483* (.091)	−1.162 (.698)	6.607* (.055)	2.977 (.473)
Home = 7; away = 10	−3.179 (.366)	−0.835 (.720)	1.807 (.628)	2.548 (.463)	−4.819 (.213)
Home = 7; away = 14	−5.096* (.099)	−1.760 (.431)	−2.015 (.371)	−1.312 (.690)	−9.033*** (.006)
Home = 8; away = 8	−3.318 (.294)	−5.883* (.076)	−0.052 (.987)	1.921 (.571)	−5.202 (.165)
Home = 10; away = 7	3.247 (.387)	−0.743 (.755)	2.804 (.201)	2.847 (.510)	−3.553 (.395)
Home = 14; away = 7	−0.836 (.800)	−2.218 (.496)	−4.171 (.381)	6.371 (.204)	−7.576** (.027)
Panel 3: Points allowed by home team (scored by away team)					
Home = 7; away = 7	—	−0.144 (.899)	−1.334 (.194)	0.835 (.584)	0.667 (.676)
Home = 4; away = 4	1.268 (.750)	−1.418 (.491)	−1.435 (.680)	0.970 (.804)	3.883 (.379)
Home = 6; away = 7	7.856*** (.008)	1.956 (.372)	5.579** (.021)	8.796** (.019)	5.108 (.146)
Home = 7; away = 6	2.862 (.389)	0.478 (.889)	−0.650 (.845)	5.947* (.054)	2.764 (.294)

(continued)

Table 5. (continued)

Rest/Preparation Combinations	Different Conference in Same Time Zone	Same Division in Same Time Zone	Same Conference in Same Time Zone	Travel West to East in Different Conference	Travel East to West in Different Conference
Home = 7; away = 10	0.495 (.896)	0.961 (.664)	0.709 (.845)	1.446 (.694)	0.923 (.818)
Home = 7; away = 14	−2.343 (.562)	0.416 (.855)	−1.215 (.668)	−1.237 (.765)	−0.565 (.890)
Home = 8; away = 8	1.591 (.627)	−3.527 (.443)	−1.740 (.616)	4.346 (.246)	−0.385 (.907)
Home = 10; away = 7	0.445 (.923)	0.320 (.927)	−1.853 (.610)	5.672 (.205)	−2.657 (.543)
Home = 14; away = 7	1.732 (.557)	0.310 (.931)	−0.417 (.901)	−0.450 (.916)	−2.959 (.458)
Panel 4: Probability of home team winning					
Home = 7; away = 7	—	−0.037 (.563)	0.037 (.530)	−0.033 (.697)	−0.056 (.520)
Home = 4; away = 4	−0.057 (.799)	−0.220* (.077)	0.170 (.385)	0.098 (.579)	0.005 (.958)
Home = 6; away = 7	−0.385** (.026)	−0.188 (.233)	−0.234* (.086)	−0.214 (.325)	−0.343* (.066)
Home = 7; away = 6	0.014 (.943)	−0.309 (.163)	−0.054 (.769)	0.099 (.568)	0.105 (.521)
Home = 7; away = 10	−0.220 (.252)	−0.154 (.313)	−0.014 (.974)	−0.156 (.422)	−0.299 (.121)
Home = 7; away = 14	0.190 (.352)	−0.229 (.125)	0.081 (.598)	0.368* (.069)	−0.023 (.998)
Home = 8; away = 8	−0.321* (.098)	−0.110 (.775)	−0.001 (.719)	−0.183 (.460)	−0.317 (.147)
Home = 10; away = 7	−0.059 (.807)	−0.081 (.648)	−0.163 (.391)	−0.203 (.466)	−0.106 (.687)
Home = 14; away = 7	0.137 (.438)	−0.301 (.101)	−0.256 (.229)	0.389* (.054)	0.000 (.963)

Note. $N = 1{,}069$ for all regression results presented in the table. Robust standard errors are calculated. Point estimates and p values (in parenthesis) shown above are calculated from estimating Equation 1 with the detailed rest/preparation variables similar to the estimation used to produce Table 4. In addition, regression used to produce these results interacted the detailed rest variables with team familiarity variables ("same division" and "same conference") along with interactions between the detailed rest variables and the travel variables for the visiting team ("away team traveled across time zones west to east" and "away team traveled across time zones east to west").

*Significance at 10%. **Significance at 5%. ***Significance at 1%.

Results from Panel 1 of Table 5 show that playing an opponent from the same division leads to statistically significant lowering of total points scored in games played on Thursday (6.091; both teams have 4 days of rest) and Monday Night Football games (9.410; teams both have 8 days of rest). For games played on Monday and Thursday nights featuring nondivision opponents (either in the same conference different division or different conference all together), the drop in total points scored is not statistically significant. The catalyst behind both the drop in total points scored in the abovementioned scenarios is almost solely driven by a drop in points scored by the home team as shown in Panels 2 and 3 of Table 5. Interestingly enough, when considering both Monday Night Football games (8 days of rest each) and Thursday Night Football games (4 days of rest each) the decrease in total points and points scored by the home team decline in absolute value and are not statistically significant when the opponents are less familiar with each other (play in different conferences or different divisions in the same conference). A repercussion of Monday Night Football is the disadvantage the teams playing on Monday face with one less day of rest and preparation the following week (only 6 days) as compared to their opponents (7 days). When facing a team, the home team is less familiar with (outside of their division within the conference or completely outside of the conference) total points scored in the game increase in a statistically significant way (7.122 points and 8.622 points, respectively) and the main source of this increase comes from the home team allowing the visiting team to score more frequently. Panel 4 of Table 5 indicates that the probability of the home team winning a game decreases for games played on Thursday by 22 percentage points when facing a divisional rival. When a home team plays an away team with 7 days of rest compared to just six for the home team, the probability of winning drops by 38.5 percentage points when facing an opponent from the other conference and by 23.4 percentage points when facing a conference rival from another division in the conference. Results also indicate that home teams facing an opponent from a different conference on Monday Night Football (8 days of rest each) sees a marginally statistically significant drop of 32.1 percentage points in their probability of winning the game.

Beyond understanding how familiarity among opponents changes the overall impact of rest and preparation days, traveling across the country for a visiting team may also impact rest and preparation differently depending on the amount of time a team has to rest as compared to their competition. Nichols (2012) shows that a visiting team in the NFL traveling from the west coast to the east coast increases the probability of the home team winning the game. This analysis finds evidence to support Nichols' findings when the home team is coming off of a bye (14 days rest) and the away team has normal rest (7 days) or vice versa. When traveling from the east to the west, visiting teams lower the probability of a home team winning in situations where the home team has 6 days of rest and the away team has 7 days of rest. In terms of total points scored, games featuring teams

traveling from the west coast to the east coast increase the number of points scored in a game where the home team has 6 days of rest and the away team has 7 days of rest and vice versa. This increase in points is attributable to an increase in the away team scoring when the home team has 7 days of rest and the away team has 6 days of rest; however, when the away team has 7 days of rest and the home team has 6 days of rest both teams will increase their scoring. Statistically significant declines in total points scored occur in games where the visiting team is traveling from the east coast to the west coast during each of their respective bye weeks while the opposing team has the normal 7 days of rest. The decline in total points scored is directly attributable to a decline in the points scored by the home team in the abovementioned scenarios.

Conclusions

Driven by the immense popularity of the sport, the NFL has expanded its scheduling of regular season games to time slots outside of the traditional Sunday afternoon schedule. Regular season games on Monday and Thursday nights have become must watch television for millions of fans. The financial incentive for scheduling these games is obvious but the impact on the quality and excitement of the game, as measure by points scored, and the overall outcome of the game (probability of winning) due to these scheduling practices has not been completely understood. Construction and estimation of a model using 5 years of data from regular season NFL games isolated the impact of differential rest and preparation periods among opponents on the total points scored, scoring for the home and visiting teams individually, and the overall probability of the home team winning the game. The main results of the analysis concluded that games played on Thursday nights had a lower number of total points scored (2.8 points) which was attributable to a decrease in scoring from the home team (2.4 points). In addition, home teams playing games with only 6 days of rest (likely due to playing on Monday Night Football the week previous) against an opponent with the normal 7 days of rest are likely to concede an additional 4.6 points and the total number of points scored in a game will increase by 5.4 points more than a game where both teams had 7 days of rest. Additionally, home teams playing with a day less of rest as compared to their opponent with 7 days rest are approximately 25% less likely to win as compared to a home team with 7 days of rest in the comparable situation.

The scheduling impact of having a home team with only 6 days of rest after playing on Monday night the week prior competing against a visiting team with a whole week of rest is quite dramatic. To potentially mitigate the large decrease in the probability of a home team winning a game the week after playing a Monday Night Football game, the NFL might consider placing a team's bye week in the week right after a team takes part in a Monday Night Football game. Results show

that the benefits of a bye week in terms of increasing or decreasing the probability of winning for a home team are not statistically different from having a normal week of rest. When looking at the timing of team bye weeks over the past five seasons, only 9% of teams that played on Monday Night Football who were eligible to receive their bye, received a bye the following week after playing on Monday Night Football.[13] Conversely, a potentially unexplored benefit of playing on a short week of rest (6 days) after a Monday Night Football game might (at least marginally) be the creation of more competitive balance in the league. Teams are largely awarded appearances on Monday Night Football due to successful performances the season before among other reasons. The average winning percentage the previous season for a team playing on Monday Night Football was 0.564. The additional burden of playing on a short week due to Monday Night Football might increase the difficulty of attaining continued success of franchises across years and allow for the opportunity for other franchises to benefit creating a more competitive balanced league.

Equally as important as the probability of a home team winning, different rest and preparation combinations among teams have impacts on the scoring of points in NFL regular season games. Since fan interest is positively impacted by increased scoring (Paul & Weinbach, 2007; Paul et al., 2010), a higher scoring affair is good business for the NFL. The interaction of rest variables with team familiarity variables (same conference, same division, other conference) helped to highlight the importance of the impact of rest and preparation time differs based on the knowledge and information opponents have on one another. Teams that are in the same division play each other twice a season and are more familiar with each other's personnel, strengths, and weaknesses. The interactions explored in Table 5 showed for both games played on Thursday night (both teams have 4 days of rest) and games where the home team has only 6 days of rest compared to the opponent's 7 days of rest, the total number of points scored was lower when opponents were from the same division as compared to when opponents were less familiar with each other. Approximately 72% of Thursday Night Football games in the data set examined in this analysis scheduled opponents within the same division. On the opposite end of the spectrum, only 32% of games where the home team has 6 days of rest and the away team has 7 days of rest matched opponents within the same division. The remaining 68% of games pitted teams that were less familiar with one another and therefore led to higher total points scored mostly due to the inability of the home team to stop the offense of the visiting team. Should the NFL want to increase the popularity of Thursday Night Football games even more, it may be beneficial to schedule teams that are less familiar with one another in the hopes that it translates into more scoring and more fan interest.

Appendix

Table A1. Frequency Table Showing the Combinations of Rest Days for Both Home and Visiting Teams: 2011-2015 NFL Seasons.

		Away Team Rest Days										
		4	5	6	7	8	9	10	11	13	14	15
Home team rest days	4	***73***	0	0	0	0	0	0	0	0	0	0
	5	0	***0***	1	0	0	0	0	0	0	0	0
	6	0	1	***16***	77	2	1	10	0	0	11	0
	7	0	0	53	***697***	7	0	63	1	2	59	0
	8	0	0	0	6	***52***	0	1	14	0	0	6
	9	0	0	0	0	0	***0***	0	0	0	0	0
	10	0	0	3	45	1	0	***1***	0	0	3	0
	11	0	0	0	1	4	0	0	***0***	0	0	3
	13	0	0	1	3	0	0	0	0	***0***	2	0
	14	0	0	0	44	0	0	3	0	0	***8***	0
	15	0	0	0	0	4	0	0	1	0	0	***0***

Note. $N = 1{,}280$ (256 games each season for five seasons). Values that are both italicized and bold represent games where both the home and away teams had the same number of rest days.

Acknowledgments

I acknowledge and thank participants at the 2014 Eastern Economic Association Conference for their helpful comments and suggestions. I would also like to thank members of the Fairfield University Economics Department for their valuable advice and support.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Notes

1. Buraimo and Simmons (2008) find similar results for English premier soccer matches. The authors find that an increase in the uncertainty in the outcome of the match leads to a decrease in game day attendance, which runs counter to the uncertainty of outcome hypothesis.
2. Evidence supporting the relationship between increased fan interest and increased scoring at sporting events is provided by Coates and Humphreys (2012). The authors show that

increased scoring in National Hockey League (NHL) games is positively associated with increased attendance.

3. Doyle and Leard (2012) extend the analysis of Leard and Doyle (2011) by examining all NHL seasons from 2005/2006 to 2010/2011. Results from this analysis confirm the results reported in Leard and Doyle (2011).
4. Ashman, Bowman, and Lambrinos (2010) examine the impact of differential rest for home and visiting teams in the National Basketball Association (NBA) by focusing on performance of home teams as compared to point spreads. Using 19 years of regular season NBA data (1990/1991-2008/2009), the authors show home teams underperformed established point spreads when playing the second game in two nights when the visiting team had 1–2 days rest between games.
5. Uyar and Surdam (2013) examined the impact of National Football League (NFL) scheduling changes between the 1991 and 2006 regular seasons. The authors focused on the opponents that a particular team was scheduled to play and not when the game was played during a particular week (e.g., Sunday, Monday, and Thursday). Results showed that scheduling changes made during this time period did not have any impact on the competitive balance in the league. Nichols (2012) analyzed NFL betting markets between the 1981 and 2004 regular seasons. Nichols showed that the probability of the home team winning increased when the opponent had to travel across time zones. The time zone effect was largest for teams traveling from the west coast to the east coast.
6. Karwan, Kurt, Pandey, and Cunningham (2015) establish a mixed integer linear program to help more evenly distribute the number of occasions that teams will have to face opponents whom have had more days to rest. This article does not try to prove a causal relationship suggesting that more rest for opponents will lead to a decreased probability in winning the game for a home team. This article was presented at the Massachusetts Institute of Technology Sloan Sports Analytics Conference in February 2015.
7. As an example of how the NFL scheduling works consider the schedule for the 2014 New England Patriots. The New England Patriots play in the American Football Conference East Division and therefore played each of the following opponents twice: Miami Dolphins, Buffalo Bills, and New York Jets. For the 2014, all teams in the AFC East faced every team in the AFC West Division (Denver Broncos, San Diego Chargers, Oakland Raiders, and Kansas City Chiefs) along with every team in the NFC North (Chicago Bears, Minnesota Vikings, Green Bay Packers, and Detroit Lions). The final two games scheduled for the New England Patriots were the Cincinnati Bengals and the Indianapolis Colts. Both the Indianapolis Colts and Cincinnati Bengals are in the AFC and each team finished first in their respective divisions in 2013. Since the Patriots finished first in their division in 2013, they were scheduled to face the first place team from the AFC North Division (Cincinnati Bengals) and first place team from the AFC South (Indianapolis Colts) from the 2013 season.
8. Lenten (2015) provides this description of scheduling in the NFL to lay the groundwork for discussing how to correct of the biases inherent in an unbalanced schedule (like the NFL has) and how measures of competitive balance change once correcting for those biases. After correcting for the aforementioned biases, Lenten shows the NFL in recent years (2002-2011) was more competitively balanced than first thought.

9. Beginning in the 2012 NFL regular season, the expanded Thursday Night Football coverage combined with the traditional Thanksgiving Day games and the regular season opener (normally played on Thursday) resulted in all teams playing at least one regular season game on Thursday night. All teams during the 2012 season only played once on Thursday night. During the 2013 season, the Baltimore Ravens and Denver Broncos each played twice on Thursday night while every other team only played once. During the 2014, all the teams in the NFL played once on Thursday night with the exception of the following four teams that played twice: Chicago Bears, Dallas Cowboys, Green Bay Packers, and Seattle Seahawks. During the 2015 season, each team played one game on Thursday with the exception of the Detroit Lions and Green Bay Packers who each played twice on Thursday during the regular season.
10. A total of 1,280 regular games were played during the 2011-2015 NFL regular seasons. Focusing on the nine most frequency rest combinations eliminates 117 games for the analysis. The three games that ended in a tie during this time period were dropped from the sample. Also dropped from the sample were the 10 games played internationally in London and Toronto. Additionally, in 2014 a Week 12 regular season game between the New York Jets and Buffalo Bills which was moved from Buffalo to a neutral site in Detroit was excluded from the analysis. Lastly, due to the construction of certain explanatory variables which necessitates using previous performance within a season, all Week 1 games (16 per year for a total of 80 games) are excluded from the analysis.
11. Information on game day weather conditions was compiled from http://nflweather.com and http://profootballreference.com.
12. Regression results similar to those presented in Table 4 for the Equation 1 augmented with interaction effects for team familiarity with rest and visiting team travel with rest are available upon request.
13. Each team in the NFL is given a single bye week each season. For the 2013, 2014, and 2015 NFL regular seasons bye weeks for all teams fell somewhere between Week 4 and Week 12. For 2012 the bye weeks feel between Week 4 and Week 11, and for the 2011 season the bye weeks feel between Week 5 and Week 11. After compiling all of the teams that played Monday Night Football games where their next possible game fell during the bye week portion of the season, it was calculated that only 7 of the 84 potential teams had bye weeks following their Monday Night Football game (approximately 8.3%).

References

Ashman, T., Bowman, R. A., & Lambrinos, J. (2010). The role of fatigue in NBA wagering markets: The surprising "Home Disadvantage Situation". *Journal of Sports Economics*, *11*, 602–613.

Borghesi, R. (2007). The home team weather advantage and biases in the NFL betting market. *Journal of Economics and Business*, *59*, 340–354.

Borghesi, R. (2008). Weather biases in the NFL totals market. *Applied Financial Economics*, *18*, 947–953.

Buraimo, B., & Simmons, R. (2008). Do sports fans really value uncertainty of outcome? Evidence from the English Premier League. *International Journal of Sport Finance*, *3*, 146.

Coates, D., & Humphreys, B. R. (2010). Week to week attendance and competitive balance in the National Football League. *International Journal of Sport Finance*, *5*, 239.

Coates, D., & Humphreys, B. R. (2012). Game attendance and outcome uncertainty in the National Hockey League. *Journal of Sports Economics*, *13*, 364–377. doi:10.1177/1527002512450260

Doyle, J. M., & Leard, B. (2012). Variations in home advantage: Evidence from the National Hockey League. *Journal of Quantitative Analysis in Sports*, *8*.

Entine, O. A., & Small, D. S. (2008). The role of rest in the NBA home-court advantage. *Journal of Quantitative Analysis in Sports*, *4*, 1–9.

Flint, J. (2011, December 15). NFL signs TV right deals with Fox, NBC and CBS. *Los Angeles Times*. Retrieved from http://articles.latimes.com/2011/dec/15/business/la-fi-ct-nfl-deals-20111215

James, M. (2015, January 18). CBS, NFL extend Thursday night deal through 2015. *Los Angeles Times*. Retrieved from http://www.latimes.com/sports/nfl/la-sp-nfl-cbs-thursday-tv-20150119-story.html

Karwan, M., Kurt, M., Pandey, N. K., & Cunningham, K. (2015, February). *Alleviating competitive imbalance in NFL schedules: An integer-programming approach*. Paper presented at 9th Annual MIT Sloan Sports Analytics Conference, Boston, MA.

Leard, B., & Doyle, J. M. (2011). The effect of home advantage, momentum, and fighting on winning in the National Hockey League. *Journal of Sports Economics*, *12*, 538–560.

Lenten, L. J. (2015). Measurement of competitive balance in conference and divisional tournament design. *Journal of Sports Economics*, *16*, 3–25.

Nichols, M. W. (2012). The impact of visiting team travel on game outcome and biases in NFL betting markets. *Journal of Sports Economics*, *15*, 78–96. doi:10.1177/1527002512440580

Nutting, A. W. (2010). Travel Costs in the NBA Production Function. *Journal of Sports Economics*, *11*(5), 533–548.

Pallotta, F., & Stelter, B. (2016, February 1). NFL makes enormous 'Thursday Night Football' deal with NBC and CBS. *CNN Money International*. Retrieved from http://money.cnn.com/2016/02/01/media/thursday-night-football-nbc-cbs-deal/

Paul, R. J., Wachsman, Y., & Weinbach, A. P. (2010). The role of uncertainty of outcome and scoring in the determination of fan satisfaction in the NFL. *Journal of Sports Economics*, *12*, 213–221.

Paul, R. J., & Weinbach, A. P. (2007). The uncertainty of outcome and scoring effects on Nielsen ratings for Monday Night Football. *Journal of Economics and Business*, *59*, 199–211.

Pollock, H. (2015, January 21). *Football's still doing the touchdown dance all over baseball's home plate*. Rochester, England: Harris Interactive.

Sandomir, R. (2011, September 8). ESPN extends deal with N.F.L. for $15 billion. *New York Times*. Retrieved from http://www.nytimes.com/2011/09/09/sports/football/espn-extends-deal-with-nfl-for-15-billion.html?_r=2

Uyar, B., & Surdam, D. (2013). Searching for on-field parity: Evidence from National Football League scheduling during 1991-2006. *Journal of Sports Economics, 14*, 479–497. doi: 10.1177152700251243890 1

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