Does Jet Lag Create a Profitable Opportunity for NFL Bettors?

Andy Fodor
Finance Department
Ohio University

Kevin Krieger*
Department of Accounting and Finance
University of West Florida

Abstract

Traveling across multiple time zones, especially from east-to-west so that hours are "lost", has documented negative effects on athletic performance. Nichols (2012) finds mixed evidence that sports betting markets fail to account for these effects. We reconsider, for the 2005-2010 NFL regular seasons, the "jet lag" hypothesis with more direct methods. We find that closing lines of NFL contests are set irrationally such that the jet lag effect is not appreciated. More importantly, we are the first to document that betting against potential jet lag teams proves to be markedly profitable. This profitability is statistically significant, which is a standard very rarely encountered throughout the literature. Consistent with our conjectures, we find these results to be even stronger when only afternoon games are kept in the sample and when division games are omitted from the sample.

Keywords: Sports wagering, Jet-lag effect, Gambling market inefficiency

* Contact Author: Building 76, Room 226, University of West Florida, Pensacola, FL 32514.
Email: kevinkrieger@uwf.edu, Phone: 850-474-2720, Fax: 850-857-6043

Introduction

Anyone who has taken a considerable plane trip has experienced some degree of "jet lag" (formal medical term desynchronosis) which disturbs the body's rhythms. Acclimating to a new time zone creates an uncomfortable situation in which societal timing of activities like eating and sleeping does not match one's physiological state. Atkinson and Reilly (1996) describe reduced athletic performance for those crossing multiple time zones due to weaker muscular strength and reduced anaerobic output. Reilly and Edwards (2007) find that these effects are not due to mere distance, but are the result of time-zone changes. A natural question for the sports betting market is whether this condition is fully appreciated by those who handicap and wager upon contests.

Previous work by Jehue et al. (1993) describes how NFL teams that travel west to east lose a disproportionately high number of games, attributable to the lack of adjustment to jet lag. Only recently did initial analysis consider whether such effects are correctly factored into the betting market's expectations for NFL games. Nichols (2012) found mixed evidence, based on the 1981-2004 NFL regular seasons, that betting markets do not fully incorporate this physiological effect into their predictions. In an attempt to clarify these findings and provide a largely out-of-sample look at the possibility of an inefficient sports betting market, we analyze the performance of visiting teams in NFL games, from the 2002-2011 regular seasons and playoffs[1]. Nichols' (2012) primary goal, extended from Dare and Holland (2004), was the construction of a potential model which might detect specific games with a profitable betting opportunity. Our work takes a different approach, focusing on a more direct test of the jet lag effect. We explicitly consider whether betting against

teams that travel a considerable distance eastward (two or three time zones) perform as well as sports handicappers and bettors anticipate[2].

Basic market efficiency suggests that betting markets should fully incorporate the jet lag effect into the odds set for a game, but a few previous studies, e.g. Gray and Gray (1997) and Borghesi (2007), have documented inefficiencies in sports betting markets that allow for bettors to profit when wagering on the NFL, and it is possible that jet lag presents another such opportunity.

Such previously documented inefficiencies have been called into question by other scholars. Often effects do not persist out of sample, particularly when the underlying motivation for such potential effects is limited (we discuss this in further detail in the Data and Methodology section). We believe the jet lag effect to be a reasonable consideration to study, given its documentation in the medical literature, and as some evidence is provided by Nichols' (2012) study, our analysis serves as an out-of-sample study of the effect, lending further (though separately analyzed) credence to the hypothesis.

We find that, indeed, betting markets do not fully incorporate the jet lag effect into the odds given for NFL games. West-to-east traveling teams massively underperform their expectations, derived from the gambling markets. We first demonstrate this via a modeling approach which regresses the actual scoring difference in NFL regular season and playoff games on the predicted differences. More importantly, we describe how actually betting against west-to-east traveling teams crossing multiple time zones proves considerably profitable for the 2002-2011 period[3]. Both the regression and betting analyses find evidence of betting market inefficiency that is statistically significant. This is an extremely high bar for the evidence to reach, rarely seen in the literature, particularly given the

modest sample size of games available as NFL teams play but 16 regular season contests per year. We also find that the jet lag effect dissipates for those NFL games which begin in the evening. We hypothesize that the additional acclimation time, combined with the fact that an evening start time is physiologically equivalent to an afternoon game for eastward traveling teams (as opposed to a physiological "morning" start time for afternoon games in the east), mediates the impact of jet lag. As a brief final exercise, we describe how removing division games (which pit familiar teams against one another) from the sample strengthens our results even further. Like the mitigating effect of evening games, it is a conjecture that familiarity with a specific opponent or road trip may soften the documented jet lag effect.

Basics of sports betting and terminology

Bookmakers (also known as "oddsmakers" or "sportsbooks") set point spreads, or "lines", in the most common form of handicapping games. The point spread issued by the bookmaker (which is usually a casino or internet company) establishes the "favorite" and the "underdog" of a game. This point spread serves as a correction based on the perceived likelihood of each team winning a game. The favorite is considered more likely to win a game, and thus the spread is instituted in order to place the two sides of a wager on a more equivalent footing. A wager is graded by subtracting the spread from the favorite's final score and then comparing this adjusted figure to the score of the underdog. Whichever side then has the higher score is the winning team of the "against-the-spread" wager. The team that wins an against-the-spread wager is said to have "covered" the spread. Bookmakers charge bettors a 10% commission (known as "vigorish" or "juice") on winning wagers;

thus, the sportsbook can be profitable, as in many gambling ventures, via commissions as the wagers on each side of a contest are often nearly equal.[4]

For the purposes of this paper, the important empirical questions may thus be stated as: "Do visiting teams fail to cover the spread a disproportionate amount of the time when traveling across multiple time zones, from west to east? If so, does such a finding constitute a profitable trading rule that bettors may utilize against bookmakers? If detected, is said profitability statistically significant?"

Data and Methodology

Bookmaker line data are taken from Sunshine Forecasts which offers free, downloadable historical NFL wagering information[5]. Sunshine Forecasts also provides final score data for NFL contests with which to evaluate the covering of spreads. Start times of historical games are gathered from the NFL archives of espn.com. We utilize data from the 2002-2011 NFL regular seasons and playoffs as 2002 was the first season with the present divisional lineup of the NFL and the first season with start time data available from espn.com. Our sample consists of 2,670 games in order to consider the impact of "jet lag" for teams traveling west to east, thereby "losing" hours, which may place these visiting teams at a physiological disadvantage. Such an impact may not be appreciated by the public or fully incorporated by sportsbooks or bettors.

Our methodological focus varies from Nichols (2012). While Nichols (2012) models the actual point differential of NFL regular season games as a function of the closing line and numerous other factors (including weather, identity of the game's favorite, distance

travelled by the visitor, and the square of this difference) we begin by considering the more direct test of Zuber et al. (1985) which estimates the model:

$$\text{ActualPointDiff} = \alpha + \beta(\text{ClosingLine}) + \varepsilon \quad (1)$$

Where ClosingLine is the closing line of the game as taken from Sunshine Forecasts, and ActualPointDiff is the visiting team's final score in the game, minus the home team's final score. This regression is cited in the literature (by Zuber et al. (1985), Gandar et al. (1988) and others) as the basic test of betting line efficiency. Inefficiency is detected when the joint hypothesis that $\alpha = 0$ and $\beta = 1$ can be rejected by an F-test. We estimate these parameters for different subsamples, based on the time "gained" or "lost" by the visiting team due to time zone changes in order to detect whether the "jet lag" effect of west-to-east traveling teams is incorporated into closing lines. We further segment our results for those games with visitors traveling two or more time zones from west to east, based on the starting time of the game, as the negative physiological effects of eastward travel may subside after the visiting team has a chance to "wake up" throughout the day of the contest. The F-test is based on the sum of squared residuals with and without the restrictions that $\alpha = 0$ and $\beta = 1$. We employ such a test, rather than the multivariate approach of Nichols (2012) as our overall focus is somewhat different. Because the point spread of the game is designed by bookmakers to serve as a catch-all, incorporating all available information (including weather, distance, etc.), our basic test serves to evaluate this proposed design. Nichols' (2012) multivariate approach, on the other hand, is designed to build a model which predicts the probability of a wager winning and then utilize these probabilities to decide *which* wagers to conduct. We seek to analyze the potential impact of the jet lag effect in the overall sample.

Evaluating efficiency of betting lines based on a regression approach is an interesting test, but ignores the most practical and interesting question to bettors. Namely, do the betting lines create a scenario in which bettors cannot overcome the vigorish price of wagering by employing a strategy? Does the NFL gambling market set an efficient price for wagers, or is it possible that the marketplace neglects the impact of the west-to-east jet lag effect on visiting teams? If, for example, visiting teams were as likely to cover the spread as home teams, but were disproportionately outscored, relative to spreads, in those games in which they failed to cover, then the rationality/efficiency test of Zuber et al. (1985) may detect a systematic error in the line. However, that line might actually be completely efficient for purposes of wagering.

We consider whether systematically betting against visiting teams which are traveling west to east will yield profitable returns due to an under-appreciation by the betting markets of the difficulties of such travel. Due to the typical 10% vigorish charge, a bettor must actually win over 52.38% of wagers in order to make a profit.[6] Nichols' (2012) model utilization approach where certain visiting NFL teams are wagered against, based on probit coefficient estimates and specific independent variable inputs, shows some in-sample success, but is not profitable out of sample. Our approach considers only the time change of the visiting team and simply wagers upon the opponents of those NFL teams which must travel two or more time zones from west to east and wagers in all such games. This direct test evaluates whether the closing line is truly an efficient catch-all metric which may stop the savvy bettor from profiting.

Some studies of potential betting strategies report successful in-sample performance above the 52.38% level; however, very few studies report betting rules that

lead to a success rate *statistically significantly greater* than 52.38%. Even widely recognized studies, such as Zuber et al. (1985) and Gandar et al. (1988), do not exhibit statistical significance for those results claimed to demonstrate profitability[7]. We provide test statistics for one-sample difference of proportion tests relative to the 52.38% success rate for wagering against visiting teams in NFL regular season and playoff games, segmenting the sample based on the time gained or lost via time zone changes for visiting teams.[8] Again, we further segment the results, for games with visitors traveling two or more time zones from west to east, based on the starting time of the game because the negative physiological effects of eastward travel may subside throughout the day of the contest. Burkey (2005) describes how ex-post searches for profitability will definitely succeed if enough potential hypotheses are considered, particularly when the theoretical rationale for such strategies is undeveloped. Our focus is entirely on the impact of travel on NFL teams, and the research on the physiological impacts of west-to-east travel provides a strong footing from which to approach such a study.

As a final exercise, we consider whether our findings might be stronger when we omit intra-division games from our analysis. The motivation for this exercise is that the familiarity between division opponents, which play one another twice every NFL season, may offset some of the disadvantage that a weary or jet lagged visiting team encounters in an NFL game with considerable travel eastward. Against a division opponent, a west-to-east traveling team will be more familiar with the particulars of a certain road contest because it makes the identical trip every season, thus mitigating some of the typical disadvantage of travel that comes with unfamiliarity. We therefore repeat our earlier analyses after removing intra-division games from the sample.

Results

Our initial results provide the parameters resulting from the estimation of equation (1). A significant F-statistic serves as evidence of irrationality or inefficiency of closing lines. After segmenting the sample based on the time change experienced by the visiting team, we detect interesting results.

[Insert Table 1]

Panel A shows the initial results. The F-test for those games with a team traveling two or more time zones eastward is statistically significant at the 1% level, with a negative intercept of -3.28. Because ActualPointDiff is measured as the visiting team's final score minus the home team's final score, the bottom-line implication is that lines are systematically set to give the visiting team too much credit. In other words, betting on home teams when their opponents travel across multiple time zones, from west to east, would seem to be a potentially good strategy. Because the possibility exists, however, that home teams may cover spreads by larger amounts than visiting teams in their respective against-the-spread victories, we specifically consider the performance of such a strategy in Tables 2 and 3.

Before doing so, however, we note that our findings regarding inefficient lines are driven by those NFL games which are played earlier in the afternoon (as opposed to evening). In Panel B of Table 1, we see that the small sample of evening games with visiting teams which travel two or more time zones eastward has an insignificant F-statistic. Afternoon games (which start at either 1 pm or 4-4:25 pm eastern time), meanwhile, have a significant F-statistic at the 1% level of 8.22. It appears that the impact to eastward-

traveling NFL teams from time loss subsides if the team has a longer recovery period before the contest.

In Table 2, we present results which demonstrate how bettors would have fared, from the 2002-2011 NFL regular seasons and playoffs, by wagering on visiting teams, segmented by the time changes experienced by these teams. Wagering systematically on all visiting teams that gained time via travel would prove to be a losing strategy. The 51.01% covering rate for teams gaining two or more hours, and the 50.52% covering rate of teams gaining one hour, are less than the 52.38% covering mark that must be exceeded to demonstrate a profit, post commission. Betting on visiting teams with no time change results in a 53.57% rate of covering the spread. While this rate is slightly profitable, it is not significantly so.[9] Betting on visiting teams losing one hour results in a 51.57% rate of covering the spread.

[Insert Table 2]

Most strikingly, we find that betting against visiting teams traveling two or more time zones eastward results in winning 57.34% of wagers over the 2002-2011 NFL regular seasons and playoffs. With a test statistic of 1.70, this result is significantly greater than winning 52.38% at the 10% (5%) significance level for the two-sided (one-sided) test. Such a finding is rare in analyzing potential betting strategies. This would result in a net return of 9.5% if one wagered equally against every NFL team traveling two or more time zones eastward.[10] In fact, from 2002-2011, visiting teams cover the spread in 52.2% of games where they do *not* travel eastward two or more time zones. The severe underperformance of NFL teams traveling substantially eastward is the only factor that makes blindly wagering on all visiting teams less than a near-breakeven exercise.

Table 3 considers only those 293 instances where a visiting team loses two or more hours by traveling across time zones, as first segmented in Table 2, and further separates these observations by the start time of the game. Wagering results improve by omitting evening games from the bettor's selections. 57.79% of against-the-spread wagers on home teams win after discarding the evening games, increasing the test statistic to 1.76 (despite the loss of power), which is again significant at the 10% (5%) level for the two-sided (one-sided) test. The statistical significance is a rare finding and striking, particularly given the modest sample size.

[Insert Table 3]

Finally, we reconsider all analyses after removing intra-division games from the sample. Our aim, because games against division opponents are a common occurrence, is to analyze whether the west-to-east travel effect might be even larger if visiting teams are not aided with the potentially mitigating familiarity of a given road trip. As the Oakland Raiders, for example, travel two time zones eastward every regular season in order to play the Kansas City Chiefs, the routine the Raiders have established for such a contest may soften some of the physiological impact of eastward travel. Alternatively, familiarity with the Chiefs as an opponent, or a relatively higher motivation level, given the relatively high stakes of intra-division games, may offset some of the typical disadvantage that might go unaccounted for in west-to-east games.

[Insert Table 4]

In Panel A1 of Table 4, we find an F-stat of 8.43, greater than the 6.60 statistic noted in Table 1, despite the smaller sample. When only afternoon games are considered, in Panel A2, the F-statistic increases further still, to 11.33, despite a sample size of only 234 games.

In Panel B1 of Table 4, we demonstrate improved wagering performance from omitting intra-division games. 59.84% of such bets on home teams were successful against the spread when visiting teams travelled two or more time zones eastward. The test statistic of 2.38 indicates significance of the two-sided test of profitability (covering more than 52.38% of games) at the stronger 5% level. Finally, in Panel B2, we see that wagering on only the home teams of inter-division afternoon games, with opponents traveling two or more time zones eastward, results in a winning rate of 60.96% against the spread. The t-stat of this finding is 2.59, statistically significant at the still-stronger 1% level. The return rate of 16.4% for wagering on home teams in afternoon, interdivision games where the visiting team is traveling two or more time zones eastward is perhaps the most extreme profitability level ever noted in any study of sports betting strategies. Given the theoretical underpinnings of our wagering findings and their status as partial, out-of-sample verification of earlier findings (as seen in Nichols (2012)), the likelihood that the results are purely anomalous is small. Whether such results will continue to persist, given exposure by academics, will be an exercise in market efficiency analysis going forward.

Conclusion

The jet lag effect is the physiological reaction that travelers experience from a considerable plane ride as their bodies attempt to acclimate to the new time zone they reach. We consider whether sports betting markets fully appreciate the jet lag effect based on the lines set for NFL regular season and playoff games.

Earlier work by Nichols (2012) finds mixed evidence of a jet lag effect; thus, our 2002-2011 analysis provides partial out-of-sample analysis, a rare development in studies

of betting strategies. However, we utilize more direct methods of testing the jet lag effect than seen previously and consider the most important question to the participants of betting markets: potential profitability. We find a jet lag effect to be present. Besides out-of-sample evidence, it is also quite rare to detect statistical significance of a finding of betting market inefficiency, yet our results, even with a relatively modest sample size, are statistically strong. This strength improves even further when we remove games with an evening start time (where the jet lag effect would have naturally dissipated) and when we remove games with division opponents (where the visiting team has greater experience with the particular trip and opponent in question). Whether such an effect continues to persist as scholarly articles highlight the finding is a further test of market efficiency that will require study at a subsequent point.

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Table 1: Regression Tests of Line Efficiency Based on Visiting Team Travel

Table 1, below, presents estimates of intercepts and slopes for the regression model of actual point differential realized in NFL games on the closing spread of these games (equation 1). The dependent variable of the simple OLS regression, ActualPointDiff, is the visiting team's final score in the game, minus the home team's final score in the game. The independent variable of the regression is ClosingLine, the closing bookmaker line of the game as reported by Sunshine Forecasts. The closing line is reported relative to the home team (e.g., if Team X is the home team and favored by three points, ClosingLine is -3). The sample is from the 2002-2011 NFL regular seasons and playoffs. Panel A presents results based on the time change experienced by the visiting team. Teams traveling from more western (eastern) to more eastern (western) time zones are said to "lose" ("gain") hours, based on the number of time zones changed. Panel B further segments games in which visiting teams lose two or more hours based on the starting time of the contest. F-statistics are presented which test the joint hypothesis that $\alpha = 0$ and $\beta = 1$, a test for efficiency of the betting line notetd by Zuber et al. (1985) and other authors . *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Tests of Line Efficiency for Visiting Teams by Time Zone Change

Visitor Time Change	n	α	β	F-stat
Gain 2+ Hours	310	-0.42	0.97	0.15
Gain 1 Hour	489	0.19	0.99	0.06
No Change	1080	0.88	1.13	2.87*
Lose 1 Hour	491	0.25	1.01	0.06
Lose 2+ Hours	300	-3.28***	0.87	6.60***

Panel B: Tests of Line Efficiency for Teams Traveling East 2+ Time Zones by Start Time

Visitor Time Change	n	α	β	F-stat
1:00pm ET	232	-3.34***	0.93	6.33***
4:00-4:25pm ET	38	-5.23**	0.65*	2.31*
All afternoon (1:00-4:25pm ET)	270	-3.61***	0.89	8.22***
7:00pm ET or later	30	-0.44	0.59	0.25

Table 2: Visiting Team Performance vs. Spread, Based on Time Change

Table 2, below, demonstrates the performance of visiting teams in NFL games relative to closing spreads (ClosingLine) recorded by Sunshine Forecasts. The sample period covers games from the 2002-2011 NFL regular seasons and playoffs. Results are segmented based on the travel of the visiting team. Teams traveling from more western (eastern) to more eastern (western) time zones are said to "lose" ("gain") hours, based on the number of time zones changed. The |t-stat| figure is the test statistic based on the two-sided approach that demonstrates the bettor's search for profitability. i.e., given the need for a strategy to prevail 52.38% of the time in order to be profitable, %'s of covering the spread greater than (less than) 50% are evaluated relative to the 52.38% (47.62%) level in order to calculate a conservative test statistic which demonstrates how a bettor performs who always wagers on (against) the visiting team. "Push" results, where a bettor would tie on a wager, are omitted from the sample. * denotes two-sided statistical significance at the 10% level (or one-sided significance at the 5% level).

	Time Change for Visiting Team				
Visiting Team	Gain 2+ Hours	Gain 1 Hour	No Change	Lose 1 Hour	Lose 2+ Hours
Cover	152	242	562	247	125
Fail to cover	146	237	487	232	168
Covered %	51.01	50.52	53.57	51.57	42.66
|t-stat|	0.47	0.82	0.77	0.35	1.70*

Table 3: Performance vs. Spread of Teams Traveling 2+ Time Zones East, Based on Start Time

Table 3, below, segments the against-the-spread (based on ClosingLine) results of teams traveling two or more time zones eastward (thereby "losing time") based on the start time of the game. Spread data is taken from Sunshine Forecast. The sample period covers games from the 2002-2011 NFL regular seasons and playoffs. The |t-stat| figure is the test statistic based on the two-sided approach that demonstrates the bettor's search for profitability. i.e., given the need for a strategy to prevail 52.38% of the time in order to be profitable, percentages of covering the spread less than 50% are evaluated relative to the 47.62% level in order to calculate a conservative test statistic which demonstrates how a bettor performs who always wagers on (against) the visiting team. "Push" results, where a bettor would tie on a wager, are omitted from the sample. * denotes two-sided statistical significance at the 10% level (or one-sided significance at the 5% level).

	Game Starting Time			
	1:00pm ET	4:00-4:25pm ET	All afternoon (1:00-4:25pm ET)	7:00pm ET or later
Covered	96	15	111	14
Failed to cover	130	22	152	16
Covered %	42.28	40.54	42.21	46.67
|t-stat|	1.61	0.86	1.76*	0.10

Table 4: Results Omitting Intra-Division Games

Table 4, below, demonstrates the traveling effects of Tables 1, 2, and 3 for NFL teams after omitting intra-division contests from the 2002-2011 sample of NFL regular season and playoff games. Panel A1 presents estimates of intercepts (α) and slopes (β) for the regression model of actual point differential realized in NFL games on the closing spread of these games. F-statistics are presented which test the joint hypothesis that $\alpha = 0$ and $\beta = 1$, a test for efficiency of the betting line noted by Zuber et al. (1985) and other authors. The dependent variable of the simple OLS regression, ActualPointDiff, is the visiting team's final score in the game, minus the home team's final score in the game. The independent variable of the regression is ClosingLine, the closing bookmaker line as reported by Sunshine Forecasts. The closing line is reported relative to the home team (e.g., if Team X is the home team and favored by three points, ClosingLine is -3). The results of Panel A1 are based on the time change experienced by the visiting team. Teams traveling from more western (eastern) to more eastern (western) time zones are said to "lose" ("gain") hours, based on the number of time zones changed. Panel A2 further segments games in which visiting teams lose two or more hours based on the starting time of the contest. Panel B1 demonstrates the performance of visiting teams in NFL regular season and playoff games relative to the closing spreads recorded by SportsInsights.com. The |t-stat| figure is the test statistic based on the two-sided approach that demonstrates the bettor's search for profitability. i.e., given the need for a strategy to prevail 52.38% of the time in order to be profitable, percentages of covering the spread greater than (less than) 50% are evaluated relative to the 52.38% (47.62%) level in order to calculate a test statistic which demonstrates how a bettor performs who always wagers on (against) the visiting team. "Push" results, where a bettor would tie on a wager, are omitted from the sample of Panel B1. Panel B2 further segments the against-the-spread results from Panel B1 of teams traveling two or more time zones east (thereby "losing time") based on the start time of the game. ** and *** denote statistical significance at the 5% and 1% levels, respectively.

Panel A1: Tests of Line Efficiency for Visiting Teams by Time Zone Change

Visitor Time Change	n	α	β	F-stat
Gain 2+ Hours	269	-0.04	0.93	0.12
Gain 1 Hour	297	0.81	0.99	0.52
No Change	570	0.44	1.10	0.74
Lose 1 Hour	301	-0.69	1.02	0.43
Lose 2+ Hours	260	-4.14***	0.84	8.43***

Panel A2: Tests of Line Efficiency for Teams Traveling East 2+ Time Zones by Start Time

Visitor Time Change	n	α	β	F-stat
1:00pm ET	198	-4.48***	0.86	8.44***
4:00-4:25pm ET	36	-6.03**	0.68	3.32**
All afternoon (1:00-4:25pm ET)	234	-4.77***	0.83	11.33***
7:00pm ET or later	26	0.69	0.74	0.14

Table 4, Continued

Panel B1 Spread Covering Frequency of Visiting Teams Based on Time Change

Visiting Team	Gain 2+ Hours	Gain 1 Hour	No Change	Lose 1 Hour	Lose 2+ Hours
Cover	133	150	286	145	102
Fail to cover	124	142	265	149	152
Covered %	51.75	51.37	51.91	49.32	40.16
|t-stat|	0.20	0.35	0.22	0.58	2.38**

Panel B2: Spread Covering Frequency of Visiting Teams Traveling 2+ Time Zones East, Based on Start Time

	1:00pm ET	4:00-4:25pm ET	All afternoon (1:00-4:25pm ET)	7:00pm ET or later
Cover	76	13	89	13
Fail to cover	117	22	139	13
Covered %	39.37	37.14	39.04	50.00
|t-stat|	2.29**	1.24	2.59***	0.24

Notes

[1] We include playoff games in our analysis as well (they make up less than 5% of our overall sample) as we see no reason to distinguish such games from any potential jet lag effect.

[2] We focus on the 2002-2011 period as 2002 marks the earliest year with readily available historical game starting time data from espn.com and the beginning of the current eight-division format of the NFL. Both of these data questions play a part in our analysis.

[3] We combine results for those teams traveling both two and three time zones eastward, in our analysis, to provide for a larger sample size, more consistent with the other subsamples of our study.

[4] In reality, bookmakers do not necessarily seek to balance the number or dollars of wagers on the two sides of a contest. Levitt (2004) and others demonstrate that bookmakers instead seek to maximize profitability by sometimes taking a non-neutral position on a contest to take advantage of bettor biases. This does not impact our analysis regarding the potential for profitability from utilizing the jet lag effect.

[5] http://www.repole.com/sun4cast/pred.html

[6] Details of this calculation may be found in Levitt (2004).

[7] Rare cases demonstrating significant profitability include Paul and Weinbach (2011) and Wever and Aadland (2012).

[8] Basic market efficiency would suggest that news of the potential profitability of wagering against west-to-east visiting teams would dampen the jet lag effect. However, since this paper considers seasons prior to the documentation, the viability of such a strategy will remain an open question, going forward.

[9] Additionally, as Burkey (2005) notes, because there is no theoretical foundation for such a betting strategy, the likelihood of future reversion to unprofitability is considerably high.

[10] i.e., if one wagered $110 on the 293 NFL games where visiting teams lost 2+ hours, this would cost $32,230. As seen in Table 2, 168 of these wagers would have won, returning $210 each, while 125 would have lost, returning $0 each. Thus, the revenue of the strategy is $35,280, providing a 9.5% return.