

# Early Season NFL Over/Under Bias

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## Abstract

Popular wisdom regarding athletics is that offenses are at a relative disadvantage in the early portion of seasons. The authors present evidence that this anecdotal belief holds true over the 2000-2010 National Football League (NFL) seasons. This is reflected in lower offensive yardage, fewer first downs, and fewer points scored. While total points scored are significantly lower in Week 1 of NFL seasons, bookmakers fail to reduce the total lines posted on these games. The authors find a strategy betting under total lines of all Week 1 games over the 2000-2010 NFL seasons yields a statistically significant return of 13.6% per game.

## Keywords

sports wagering, efficient markets, NFL, betting bias

... it is difficult, if not impossible, to  
find profitable rules that beat the  
vigorish of the sportsbook.

—Paul and Weinbach, 2002

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## Introduction

Sports journalists and analysts often assert that defenses have advantages over offenses in early season play. The most common cliché professing this belief is that “defenses are ahead of the offenses early.”<sup>1</sup> Underlying this theory is the belief that offenses in athletics require more practice repetition in order to hone execution to optimal levels while defenses rely more on instinct and athleticism in order to stifle offenses. We consider whether the empirical evidence supports these assertions in the National Football League (NFL).

We find evidence that offenses are, indeed, relatively slow to produce in the first week of an NFL season. Offensive yardage and number of first downs are significantly lower in the opening week of NFL seasons than at any other time. This results in fewer points scored in Week 1 of NFL seasons than in any other week.

Given that offenses perform poorly relative to defenses early in seasons, does the public fully realize the degree of this disparity? To answer this question, we consider whether poor offensive performance is fully accounted for in NFL betting markets. According to efficient market theory, gambling lines established for NFL games should incorporate all available information. This includes the tendency of Week 1 NFL games to have significantly lower total scores than games in later weeks. If total lines do not adjust to reflect differences in points scored in Week 1 relative to later weeks, an inefficiency in NFL betting markets is evident.

The rationality/efficiency of sports betting markets has been a subject of debate in the literature for many years (e.g., Gray & Gray, 1997). Several authors have documented profitable betting strategies or rules of thumb, suggesting inefficiencies in sports betting markets (e.g., Dare & Dennis, 2011). Much of this work involves the NFL, which has become the most widely viewed and highly wagered upon segment of American sports. General results of research in this area demonstrate the complexity involved in identifying stable, long-term betting strategies leading to net profitability (Gray & Gray, 1997; Summers, 2008; Tryfos, Casey, Cook, Leger, & Pylypiak, 1984). This difficulty has led researchers to examine variables ranging from team-level statistics to changes in the weather (e.g., Borghesi, 2007).

In early studies, Sturgeon (1974) and Vergin and Scriabin (1978) describe how contrarian positions (e.g., wagering against the best NFL teams) could in fact yield profits. More general betting approaches, based on a number of team statistics, are advocated by Zuber, Gandar, and Bowers (1985) and Gandar, Zuber, O'Brien, and Russo, (1988), who use regressions to determine the importance of the various measures and utilize the coefficients of these measures to forecast margins of victory. They then advocate wagering against the spread when bookmaker lines vary dramatically from these predictions. More recent research has again advocated the use of contrarian positions in order to earn profits (e.g., Paul & Weinbach, 2002). Another segment of research has focused on variables such as home teams, favored teams, and point spreads (e.g., Dare & McDonald, 1996). In another example, Golec

and Tamarkin (1991) describe how betting on underdogs can be profitable, and Sapra (2008) analyzed the efficiency of the point spread system. In the most recent lines of research in this domain, Paul and Weinbach (2011) and Wever and Aadland (2012) find that wagering specifically on large underdogs is a profitable proposition.

While many authors identify wagering strategies that appear profitable, the viability of these strategies has come under scrutiny from critics. When authors have explored numerous strategies simultaneously, with little theoretical development for their potential existence, the critiques have been particularly harsh. Burkey (2005) notes that authors who consider enough trading rules will definitely uncover signs of profitability after the fact. He suggests that a well-developed theory, *ex ante*, may serve to appreciably improve the credibility of findings. As one example, Burkey (2005) notes that Woodland and Woodland (2000) reject seven null hypotheses which individually test that the NFL betting market is efficient; however, they utilize statistical significance at the 10% level to do so and study 48 different hypotheses. Additionally, Badarinathi and Kochman (1996) reject 7 of 116 null hypotheses, each testing the betting market's efficiency.

In this article, we consider one new potential inefficiency of the NFL betting market. Based on popular belief and further advanced by our analysis, we provide specific reasoning for this identified market inefficiency. Specifically, in the early weeks of an NFL season, we hypothesize that total lines of games will systematically be set too high and betting under total lines in Week 1 will result in a profitable betting strategy.<sup>2</sup> We find that betting under total lines of Week 1 games results in returns of 13.6% per game on average over the 2000-2010 NFL seasons. As well as being economically profitable, these returns are statistically significant, a threshold reached by very few studies which consider the efficiency of gambling markets.<sup>3</sup>

## Data, Methodology, and Results

The sample for our study consists of all NFL regular season games from the 2000-2010 seasons. Offensive first down, yardage, and points scored data are from The Sunshine Forecast. Total line data are also from The Sunshine Forecast.<sup>4</sup> The total line is a betting line set by bookmakers allowing bettors to wager that the total score for the game will be above or below this total line. The bettor pays the amount of the wager upfront plus vigorish, a commission charged by the bookmaker for providing services that is typically 10% of the bet. If the bettor is correct, the vigorish is returned along with 2 times the wager amount. There is no repayment if the bettor is incorrect. If total points scored equals the total line, termed a "push," the amount of the bet and vigorish is returned to the bettor. For example, if a bettor wishes to wager \$100 that the total points scored in a game will exceed 45, he would pay \$100 plus \$10 vigorish to make the bet. If the points scored exceeded 45, the bettor would be paid \$210. If the points scored were less than 45, the bettor would receive nothing. If

total points scored equaled the total line of 45, termed a “push,” the \$100 along with the \$10 vigorish would be returned to the bettor.

We first calculate means and medians for offensive points, offensive yardage, and offensive first downs. Each team in the game is considered separately. Means and medians are calculated for each week in the seasons.<sup>5</sup> Means and medians are also calculated for all games and for all games excluding games played in Week 1 of the seasons. We then present analyses comparing total lines and total points scored after dividing the sample according to week as described above. Finally, we examine the success and profitability of a strategy that bets under the total line on all Week 1 games. This is examined for all seasons as well as for each individual season from 2000 to 2010.

In Table 1, Panel A (B), mean (median) offensive points, yardage, and first downs are presented for the sample of all NFL regular season games over the 2000-2010 seasons, each individual week, and Weeks 2–17. The results show that NFL offenses perform relatively poorly compared to defenses early in seasons. Specifically, points, yardage, and first downs are lower in the first week of seasons than in later weeks. The average number of points scored per team is 19.63 in Week 1 games relative to 21.33 points per team on average for games later in the season. This difference is significant at the 1% level. Differences between average Week 1 points and average points in all other individual weeks are also calculated. Average points are lower in Week 1 than for each other individual week. Thirteen of the 16 differences between the average Week 1 score and later week scores are significant at the 10% level or better.

Lower points scored in Week 1 can be explained by relatively low offensive yardage and fewer first downs on average in Week 1. Average offensive yardage per team in Week 1 is 323.4 yards compared to an average of 337.2 yards in other weeks. This difference is significant at the 1% level. Average yardage in Week 1 is lower than the average yardage for any of the other 16 weeks. Thirteen of the 16 differences between the Week 1 average yardage and yardage averages for other weeks are significant at the 10% level or better. For first downs, the average for Week 1 is 17.63 per team compared to 18.60 in other weeks. The difference is again significant at the 1% level. First downs are also lower in Week 1 than in each other individual week with 14 of 16 differences significant at the 5% level or better. For points, yardage and first downs, median results are nearly identical to mean results, showing the findings presented in Panel A are not driven by a small number of games where teams exhibit especially poor offensive performance. These findings provide evidence that defenses are ahead in their preparation for the beginning of seasons compared to offenses. We next test for inefficiency in total line setting across weeks.

In Table 2, Panel A (B) mean (median) total lines and total points are presented for all games in the 2000-2010 NFL regular seasons. Results are presented for the sample of all NFL regular season games, each individual week, and Weeks 2–17. In Week 1, the mean total score is less than the mean total line by 1.99 points. The

**Table 1.** Offensive Statistics

Week	Offensive Points	Difference From Week 1	Offensive Yards	Difference From Week 1	Offensive First Downs	Difference From Week 1
Panel A: Means						
1	19.63	NA	323.4	NA	17.63	NA
2	20.75	1.12	337.7	14.2 ***	18.44	0.80 **
3	21.08	1.45 *	338.2	14.8 ***	18.77	1.14 ***
4	21.35	1.72 **	334.8	11.4 *	18.53	0.89 ***
5	22.09	2.47 ***	338.2	14.8 ***	18.86	1.23 ***
6	20.92	1.30 *	341.2	17.7 ***	18.57	0.94 ***
7	22.37	2.75 ***	340.4	17.0 ***	18.85	1.22 ***
8	21.48	1.85 ***	337.1	13.6 *	18.63	0.99 ***
9	21.22	1.60 **	333.5	10.1	18.86	1.23 ***
10	22.00	2.37 ***	342.7	19.3 ***	18.75	1.12 ***
11	20.39	0.77	338.1	14.7 ***	18.53	0.90 ***
12	21.88	2.25 ***	342.8	19.4 ***	19.02	1.39 ***
13	21.42	1.79 **	337.0	13.6 **	18.53	0.90 ***
14	20.74	1.11	333.2	9.7	18.21	0.58
15	21.46	1.84 ***	335.5	12.1 **	18.50	0.87 ***
16	21.04	1.41 *	335.6	12.1 *	18.58	0.94 ***
17	21.27	1.65 **	330.1	6.6	18.08	0.45
2–17	21.33	1.70 ***	337.2	13.8 ***	18.60	0.97 ***
All	21.22	NA	336.3	NA	18.54	NA
Panel B: Medians						
1	19.5	NA	316.5	NA	18.00	NA
2	20	0.50	336.0	19.5 **	18.00	0.00
3	21	1.50 *	336.0	19.5 **	19.00	1.00 ***
4	20	0.50 *	340.0	23.5 **	19.00	1.00 **
5	21	1.50 ***	339.5	23.0 **	19.00	1.00 ***
6	21	1.50 *	337.0	20.5 ***	19.00	1.00 **
7	21	1.50 ***	341.0	24.5 ***	19.00	1.00 ***
8	21	1.50 **	347.5	31.0 **	19.00	1.00 **
9	21	1.50 **	333.0	16.5	19.00	1.00 ***
10	21.5	2.00 ***	342.0	25.5 ***	19.00	1.00 ***
11	20	0.50	341.5	25.0 **	19.00	1.00 **
12	21	1.50 ***	341.0	24.5 ***	19.00	1.00 ***
13	21	1.50 **	338.0	21.5 **	18.50	0.50 ***
14	20	0.50	331.5	15.0 *	18.00	0.00
15	21	1.50 **	336.0	19.5 **	19.00	1.00 **
16	21	1.50 **	338.5	22.0 **	19.00	1.00 **
17	21	1.50 **	330.0	13.5	18.00	0.00
2–17	21	1.50 ***	338.0	21.5 ***	19.00	1.00 ***
All	21	NA	337.0	NA	19.00	NA

Note. Table 1 presents mean and median offensive points, offensive yardage, and number of first downs, by week, for Weeks 2–17, and for all games in Panels A and B, respectively. Means and medians are calculated using statistics for each team in a game individually. Results are presented over the 2000–2010 NFL seasons. Mean and median differences between Week 1 and each individual week as well as Week 1 and Weeks 2–17 are also presented. Significance levels from two-sided *t* tests for mean differences and two-sided Wilcoxon rank-sum tests for median differences are indicated.

\*\*\*, \*\*, and \* indicate significance at the 1, 5, and 10% levels, respectively.

**Table 2.** Total Line Errors

Week	N	Total Line	Total Score	Difference
Panel A: Means				
1	174	41.2	39.3	1.99 *
2	172	41.0	41.5	-0.51
3	162	41.3	42.2	-0.82
4	154	41.2	42.7	-1.52
5	154	41.2	44.2	-3.03 ***
6	151	41.8	41.8	-0.05
7	152	41.7	44.7	-3.03 ***
8	151	41.7	43.0	-1.21
9	153	41.8	42.4	-0.61
10	159	41.8	44.0	-2.21 *
11	174	42.1	40.8	1.33
12	174	42.0	43.8	-1.80
13	174	41.9	42.8	-0.98
14	174	41.7	41.5	0.19
15	175	41.4	42.9	-1.55
16	173	41.7	42.1	-0.38
17	174	40.9	42.5	-1.58
2-17	2,626	41.6	42.7	-1.08 ***
All	2,800	41.5	42.4	-0.89 ***
Panel B: Medians				
1	174	41.0	37.5	3.50 **
2	172	41.0	40.0	1.00
3	162	41.5	41.0	0.50
4	154	41.5	42.0	-0.50
5	154	41.3	45.0	-3.75 ***
6	151	42.5	41.0	1.50
7	152	41.8	44.0	-2.25
8	151	41.5	42.0	-0.50
9	153	41.0	43.0	-2.00
10	159	41.5	44.0	-2.50
11	174	41.8	41.0	0.75
12	174	42.0	42.5	-0.50
13	174	42.0	43.0	-1.00
14	174	41.3	41.0	0.25
15	175	41.0	42.0	-1.00
16	173	41.0	42.0	-1.00
17	174	40.8	41.0	-0.25
2-17	2,626	41.5	42.0	-0.50 *
All	2,800	41.5	41.5	0.00

Note. Table 2 presents mean and median total scores and total lines by week, for Weeks 2-17, and for all games. Results are presented over the 2000-2010 NFL seasons. Mean and median differences between total scores and total lines are presented in Panels A and B, respectively, with significance levels from two-sided t tests for mean differences and Wilcoxon rank-sum tests for median differences indicated. \*\*\*, \*\*, and \* indicate significance at the 1, 5, and 10% levels, respectively.

**Table 3.** Over/Under Results

Week	N	Under	Over	% Under
1	171	102	69	59.6 <sup>b</sup>
2	167	88	79	52.7
3	160	76	84	47.5
4	149	73	76	49.0
5	152	61	91	40.1 <sup>b</sup>
6	150	77	73	51.3
7	148	66	82	44.6
8	148	71	77	48.0
9	148	75	73	50.7
10	156	71	85	45.5
11	169	97	72	57.4
12	171	93	78	54.4
13	174	86	88	49.4
14	169	94	75	55.6
15	169	79	90	46.7
16	170	86	84	50.6
17	174	86	88	49.4
2–17	2,574	1,279	1,295	49.7
All	2,745	1,381	1,364	50.3

Note. Table 3 presents the number of games with total scores over and under the total line, by week, for Weeks 2–17, and for all games. Results are presented over the 2000–2010 NFL seasons. The percentage of games where the total score was below the total line is also presented. Significance levels from one-sided z tests that proportions exceed 52.38% are indicated. Games that result in a “push” are excluded from this analysis.

<sup>b</sup>Indicates significance at the 5% level.

median total score is less than the median total line by 3.5 points. These differences are significant at the 10% and 5% levels, respectively. Further, mean and median differences between Week 1 total lines and totals lines in Weeks 2–17 are insignificant while total score differences between Week 1 and Weeks 2–17 are significant at the 1% level for both means and medians. These results suggest that a significant level of inefficiency exists in Week 1 total line setting.

Given the findings presented in Tables 1 and 2, we examine if a strategy of betting on all games to go under total lines in Week 1 is profitable. If total lines do not take into account the tendency of offenses to perform relatively poorly compared to defenses in Week 1, profit should be possible from such a strategy. Table 3 presents the number of games where total points are over and under the total lines for all games in the 2000–2010 NFL regular seasons excluding those games where the result was a push. Results are presented for the sample of all NFL regular season games, each individual week, and Weeks 2–17. In Week 1, total points are lower than total lines in 102 of 171 games in the sample. This is much higher than the 52.38% of successful bets required for a profitable betting strategy. Further, this

**Table 4.** Profitability of Betting Under the Total Line

Season	N	Under	Push	Over	% Return
2000	15	10	0	5	27.3
2001	15	10	0	5	27.3
2002	16	4	0	12	-52.3
2003	16	9	0	7	7.4
2004	16	9	0	7	7.4
2005	16	9	2	5	19.9
2006	16	12	0	4	43.2
2007	16	11	0	5	31.3
2008	16	9	0	7	7.4
2009	16	8	0	8	-4.5
2010	16	11	1	4	37.5
Total	174	102	3	69	13.6

Note. Table 4 presents the results of over/under bets in Week 1. Results are presented for each NFL season from 2000 through 2010 as well as for all Week 1 games over our sample period. % Return is calculated as total return based on equal bets under the total line of each game relative to the total amount bet. On a bet of \$110 (including vigorish), a win pays \$210, a push pays \$110 and a loss pays nothing.

percentage is significantly different from 52.38% at the 5% level. Not surprisingly, the percentage of games where the total score is less than the total line in Weeks 2–17 is almost precisely 50% (49.7%). The finding of significant profitability for a strategy that bets total scores will be less than total lines suggests bookmakers do not adjust total lines in Week 1 to account for relatively poor offensive performance.

In Table 4, we directly test for the presence and consistency of this inefficiency by presenting profitability results for betting total scores in each Week 1 game will fall below the total line. Results are presented for all Week 1 games in the 2000–2010 NFL regular seasons and for Week 1 games in each individual season from 2000 to 2010. Over the full sample, the strategy yields an average return of 13.6% per game and is profitable in 9 of 11 seasons.<sup>6</sup>

In practice, the strategy of betting under total lines on all games in Week 1 has two unique characteristics relative to most other strategies. First, betting this strategy would require a large cash outlay, and thus a larger bankroll, relative to other strategies. While most strategies would dictate betting far fewer than half of games in any given week, a bettor following our strategy wagers on all 16 games in the first week of the NFL season. If a bettor wished to wager \$100 per game, \$1,600 would be required for wagers and an additional \$160 for vigorish.<sup>7</sup> However, a very positive aspect of the strategy relative to sports futures wagers or conventional financial investments is that money is tied up for less than 48 hours. The first game of Week 1 typically begins at 1:00 p.m. Eastern Time (ET) on Sunday and the last Monday Night game of Week 1 concludes early Tuesday morning.

Overall, the results suggest that NFL offenses perform poorly relative to defenses in Week 1 of NFL seasons. However, bookmakers do not adjust total lines to reflect



this deficiency. As a result, total lines for Week 1 games tend to be too high, allowing bettors an opportunity to profit by betting under total lines.

## Conclusion

We document a rare, statistically significant, inefficiency in NFL betting markets. Following the notion that offenses are behind defenses in preparation early in NFL seasons, we examine Week 1 offensive performance relative to performance in other weeks. Our results confirm the inferior performance of offenses early in the season, particularly in Week 1, relative to future weeks. This is reflected in lower offensive yardage, fewer first downs, and fewer points scored.

While these anomalies exist over the length of our sample period (2000-2010 NFL regular seasons), bookmakers have failed to adjust total lines. Points scored are significantly lower (by 3.4 points) in Week 1 than in later weeks while total lines show small (.4 points), insignificant differences. Given this, it is not surprising that we find 59.6% of games in Week 1 have total scores less than total lines. This percentage is significantly higher than the 52.38% win percentage needed for a profitable betting strategy. In later weeks, 49.7% of games have total scores less than total lines.

The strategy of betting under total lines in Week 1 yields an average return of 13.6% per game over the 2000-2010 NFL seasons. Further, this strategy is profitable in 9 of the 11 seasons examined. If bookmakers fail to adjust Week 1 lines to reflect the relatively poor performance of NFL offenses relative to defenses in Week 1, a continued opportunity may exist to profit from this inefficiency in NFL betting markets.

## Declaration of Conflicting Interests

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

## Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

## Notes

1. For example: [http://www.howardbison.com/sports/fball/200910/releases/Defense\\_Stand\\_Out\\_In\\_First\\_Scimmage](http://www.howardbison.com/sports/fball/200910/releases/Defense_Stand_Out_In_First_Scimmage)  
<http://www.thepilot.com/news/2010/aug/14/defense-ahead-offense-scimmages/>  
[http://www.mysoutex.com/view/full\\_story\\_landing/282084/article-Trojan-defense-ahead-of-O-in-early-practices-Scimmages-set-for-Saturday-morning-for-all-Bee-County-teams](http://www.mysoutex.com/view/full_story_landing/282084/article-Trojan-defense-ahead-of-O-in-early-practices-Scimmages-set-for-Saturday-morning-for-all-Bee-County-teams)  
<http://www.jimfeist.com/editorials-by-sport.html?leagueid=NCAAF&editorialid=1173>

2. “Total lines” reflect the total number of points that oddsmakers project to be scored in a contest. Bettors may wager that the number of points scored between the two teams will go over (under) this number, oftentimes because bettors expect a game to have more (less) successful offensive play than the total would suggest. For this reason, a total line is often referred to colloquially as an “over/under”.
3. For example, the high-profile study of Gandar et al. (1988) notes: “None of the mechanical rules can be considered profitable based on these (statistical) criteria . . . while several achieve higher winning-bet percentages than needed to break even, none of these have *Z* values sufficiently large to reject the null hypothesis of randomness and unprofitability at conventional levels of significance.”
4. The source of total lines provided by The Sunshine Forecast is <http://www.scoresandodds.com>. Lines are collected at approximately noon (Eastern Time) on game days such that they approximate closing lines. We thank Warren Repole at The Sunshine Report for providing extensive and detailed data and for his assistance.
5. For example, Week 4 means are means for all games occurring in the fourth week of the seasons across the 11 seasons in our sample.
6. Average annual return is calculated as the average of the total percentage returns for the 11 seasons in our sample.
7. The amount required would be slightly lower assuming winning tickets (and the presence of winning tickets) could be cashed before Sunday Night and Monday Night games.

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