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An Analysis of the Last Hour of Betting in the NFL

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Abstract

The last hour of betting for the wagering market in the National Football League (NFL) was examined. In a sample of offshore sportsbooks, nearly a quarter of all bets on NFL games occured in the last hour before kickoff. Bets were shown not to be balanced between each side of the betting proposition. When the betting percentage on the favorite increases in the last hour of betting, there is a simple strategy that has shown to earn statistically significant profits: betting against the public by wagering on the underdog. Unlike horse racing, in which informed bettors are assumed to wager late (near post time), money wagered near the kickoff of NFL action does not appear to be the actions of informed agents, but rather they are recreational bettors behaving simply as consumers.

Keywords: efficient markets, gambling, sports

The betting market for the National Football League (NFL) takes the form of a simple financial market. While betting on soccer, baseball, and hockey games is generally tied to odds, most of the betting on football in North America is based on a pointspread system. In pointspread betting, when two teams are unevenly matched, the superior team must win by more than a specified number of points (the pointspread) in order for bettors to win. For example, Minnesota played New Orleans in the first game of the 2010 NFL season. New Orleans was viewed as the better team, and most sportsbooks offered wagering on this game with a pointspread of 4.5; that is, New Orleans as the favorite (New Orleans -4.5 or Minnesota +4.5). New Orleans won that game by a score of 14 to 9 (a margin of victory of 5), just enough to cover the pointspread and leaving New Orleans bettors as winners. As the underdog, Minnesota bettors could have won with a Minnesota victory—a tie, rare in the NFL, or a loss by fewer than 4.5 points. In the totals market, sometimes called the over/under market, an overbettor will win the

wager when more points are scored by both teams than the total posted by the sportsbook. An underbetter wins when both teams score fewer points are than the posted total. In the Minnesota at New Orleans example, the posted total was 48.5 and only 23 points were scored, so underbettors won their bets. If the favorite wins by exactly the pointspread, or the combined points of both teams equals the totals, the bet is considered a push and all money is returned to the bettor.

In pointspread betting markets in the United States, most sportsbooks generate commissions by offering wagers based on what is sometimes called the 11-for-10 rule, in which bettors must risk $11 to win $10. Under these rules, bettors must win more than 52.4% of the time to overcome the commission on bets charged by the sportsbook—sometimes called the *vig* or *vigorish*—and generate positive earnings. Given the simple form of this financial market with a large number of interested participants, generally widespread availability of game results, and betting lines (pointspreads and totals), sports wagering markets became a natural place to test the efficient markets hypothesis. If all information is incorporated in the closing pointspread or total on a given football game, the pointspread and total should serve as optimal and unbiased forecasts of the score differential (favorite minus underdog score) and combined points scored in a game, respectively.

Under the traditional models of sportsbook behavior—such as Pankoff (1968), Zuber, et al. (1985), and Sauer, et al. (1988)—sportsbooks were assumed to set a market-clearing price by balancing the book. This price theoretically would attract equal amounts of money on each side of the wagering proposition. Setting prices that balance the book allows sportsbooks to earn risk-free returns when balanced wagering is achieved, with sportsbooks earning their commission on losing bets (under an 11-for-10 betting rule). A number of studies on pointspread markets concluded that the null hypothesis of market efficiency could not be rejected, despite significant public sentiment. These results served as a significant stamp of approval for this theory and supported the notion of the general *wisdom of crowds*.

Recently, detailed data on sportsbooks and sports gamblers have allowed for a more comprehensive study of the sports wagering market for the NFL and other sports. In the last few years, data on betting percentages on favorites/underdogs and overs/unders, and even forms of betting volume, have become available in addition to standard data on pointspread, totals, and odds. The availability of this data has allowed for an investigation of the traditional balanced book hypothesis when it comes to the behavior of the sportsbook. If sportsbooks do not price to balance the book—by attracting equal amounts of betting dollars on each side of the betting proposition—then natural extensions to testing the efficient markets hypothesis and other financial theories suddenly become less straightforward: Prices may not reflect the actions of bettors themselves but actually reflect sportsbook incentives.

Levitt (2004) suggested that sportsbooks may not price to balance the book but may actually price to maximize profits. Under the Levitt (2004) hypothesis, this profit maximization, occurs as sportsbooks incorporate biases of sports gamblers into their prices, leading to unbalanced action and potentially biased closing prices. Levitt (2004) used data from a sports betting tournament to illustrate that road favorites are overbet by gamblers, leading to profitability when wagering on home underdogs. Levitt suggested that sportsbooks purposefully set biased prices to maximize profits; they do this by earning greater returns in cases in which sports bettors were heavily weighted on the side that lost more often than implied by efficiency.

Using data from Sportsbook.com and three sportsbooks compiled on Sportsinsights.com, Paul and Weinbach (2008a, 2011) found that sportsbooks are not balanced—that is, the percentage bet on favorites increases with the magnitude of the favorite, and the percentage bet on overs increases with the magnitude of the total. Given that the balanced book hypothesis was rejected, some evidence was found in support of the Levitt (2004) hypothesis: Underdogs who attracted very little of the betting action outperformed the overbet favorites, resulting in statistical profitability in a variety of cases.

In studies of other sports, however, Paul and Weinbach (2008b, 2009, 2010) found that the Levitt hypothesis was not supported. The balanced book hypothesis was found to be soundly rejected for the NBA, college football, and the NHL, but pointspreads did not appear to be biased. Although the same preferences exist for gamblers (for favorites and overs), simple betting strategies, which were found to be profitable for the NFL, were shown to win very close to 50% of the time as the efficient markets hypothesis could not be rejected for these sports. Paul and Weinbach (2008b, 2009, 2010) suggested that sportsbooks may actually price as a forecast, rather than to balance the books (traditional sportsbook) or to exploit known bettor biases (Levitt hypothesis) and thereby leading all simple strategies to win 50% of the time. This pricing as a forecast allows the sportsbook to earn its commission on losing bets in the long run. By viewing sports betting as a repeated game rather than a one-shot game, sportsbooks may not care about the game-to-game imbalances in betting dollars as long as the prices they set are expected to split victories and losses evenly between favorites and underdogs (and overs and unders).

We extend the analysis of more detailed betting data to the last hours of trading for the NFL. In the betting markets for horse racing, it is generally accepted that late betting action (right before the start of the race) is more likely to represent information, as informed bettors may wait until right before the close of betting to analyze the tote board prices and calculate odds which may be in their favor. Horse racing is pari-mutuel--that is, odds are not known at the time the bet is placed and betting odds are calculated based upon all bets made on the race after taking out the track take--and sports bettors in the sports wagering markets "lock-in" the wager at the price when the wager is placed. Although the horse racing market is quite different from the market for sports betting, it is still useful to examine whether the close of the betting market in the NFL wagering market is similar to that of horse racing. In other words, we attempt to answer the question, if betting action—which occurs near kickoff (the start of the game)—represents information, is it pure noise or does it represent potential biases of NFL fans who wish to wager on games as a form of consumption?

We attempt to answer this question by comparing the betting percentages on favorites and underdogs and overs and unders one hour before kickoff of an NFL game and at the close of the market. These detailed data were gathered for three NFL regular seasons: 2008–2009 through 2010–2011. We attempt to determine if following the late-betting action leads to profitable returns, if these strategies essentially break even, or if the late action is actually on the wrong side of the betting proposition. We use an overall analysis of the data coupled with simple betting simulations to address these issues.

NFL Last Hour of Trading

In betting markets such as horse racing, it is generally believed that actions at the close of the betting market (start of the race) represent information. Ottaviani and Sorensen (2008) suggest that late bets in pari-mutuel markets tend to contain superior information about the finishing order of horses. This result is driven by the point that individuals with private information can benefit by waiting until just before post time—this reduces the opportunities for others to respond by following their wagers, which would lower returns in a pari-mutuel system. This is consistent with the findings of Asch, Malkiel, and Quandt (1982) as it relates to the horse racing market.

The betting market for horse racing is quite different than that of professional sports wagering. The horse racing market is pari-mutuel, as actual betting odds are only determined after all wagers have been placed (and the take of the track removed). In professional sports betting, such as the market for the NFL, the price of the wager is known at the time of the bet. This *price* is the pointspread, and its value is locked at the time the wager is placed. Ottaviani and Sorensen (2005) note that, in fixed-odds betting, bettors with inside information have no incentive to wager late as a means of concealing their own actions. However, there still may be a benefit to betting late: The bettor may learn more information by observing the actions of others. In addition, all relevant information on the significance of injuries, game plans, weather, and other variables may not be known until shortly before kickoff. Gandar, Dare, and colleagues (1998) and Gandar, Zuber, and Dare (2000) find that closing pointspreads and totals are superior to opening pointspreads and totals. They suggest that informed traders are responsible for the line moves between the open and close of betting.

If late betting action in the NFL is not dominated by informed bettors and is purely the action of recreational bettors—who bet as fans of the game rather than sophisticated investors—these late bets may not reflect information at all. These consumption-based wagers could reflect bettor biases for the best and most popular teams, which could help to identify betting situations where prices—in particular favorite prices—may be slightly inflated. Under this scenario, wagering against the preferences of the public may actually be profitable. If the biased preferences of the public are incorporated into the pointspread, taking a contrarian position to the preferences of the general bettors could win more often than implied by efficiency.

Table 1 summarizes the information we were able to obtain from *Sports Insights* concerning betting action during the last hour of betting on an NFL game. *Sports Insights* uses data from three online sportsbooks: BetUS.com, CaribSports.com, and SportBet.com. Using real-time data available on their website, we were able to gather information on the percentage bet on the favorite and underdog, both at the start of the game and one hour before the start of each game. At these points in time, we were able to capture the betting volume in terms of number of bets; the percentage bet on the favorite and underdog, and over and under; and the pointspread/total at these times. In addition, the movement of the prices in these betting markets—pointspreads and totals—were captured one hour before market close. Averages and standard deviations of these price movements are also presented in Table 1. These data were calculated from that information. We split the data into home favorite games and road favorite games due to past winning strategies shown in the NFL related to home underdogs (Levitt, 2004; Golec & Tamarkin, 1991; Gray & Gray, 1997).

Table 1. NFL Last Hour of Betting

	Home favorites	Road favorites
Number of bets placed in the last hour	18,315.12	19,164.18
	(6,252.25)	(6,338.18)
Percentage of bets placed in the last hour	22.86%	22.93%
	(5.92)	(6.81)
Percentage of bets on favorite -	0.2475	-0.5078
(change in last hour)	(2.1251)	(3.0742)
Percentage of bets on over –	0.0731	0.2891
(change in last hour)	(3.5894)	(3.1614)
Percentage bet on favorite (market close)	56.63%	70.75%
	(12.71)	(9.49)
Percentage bet on over (market close)	65.88%	65.80%
	(10.65)	(9.13)
Average pointspread move in last hour	-0.0148	0.0176
	(0.4431)	(0.4437)
Average total move in last hour	-0.0484	0.0195
	(1.8343)	(0.3646)

Note. Average of each variable (Standard Deviation); data from Sportsinsights.com online sportsbooks.

The number of bets placed in the last hour was around 18,000–19,000 for NFL games. On average, games with home favorites attracted over 18,000 bets, while games with road favorites attracted over 19,000 bets. This is consistent with findings that road favorites in the NFL are generally more popular propositions with bettors (see Levitt, 2004). In the last hour before kickoff, these numbers of bets translated into nearly 23% of the total betting action for NFL games—22.86% for home favorites and 22.93% for road favorites. Therefore, nearly a quarter of the betting action occurs in the 60 min leading up to the start of an NFL game.

On average, the side that the public was backing in the last hour of betting differed based on whether there was a home favorite or road favorite. The percentage of bets on home favorites increased slightly during the last hour, but the percentage of bets on road favorites decreased by over a half of a percentage point on average in the last hour. This could represent some evidence of informed bettors wagering on home underdogs, which have been found to generate positive returns in the past in the NFL and other sports.

In relation to the totals market, the percentage bet on the over increased in the last hour for both games, with home favorites and with road favorites. Games with road favorites increased more than games with home favorites, which may imply that road favorite bettors also wagered on the over in these contests.

By the time of market close, the betting public was found to bet more heavily on the favorite and the over, as was shown previously for the NFL by Paul and Weinbach (2008a). This shows that the sportsbook is not perfectly balanced, as the predictable sides of the wager—favorites and overs—consistently attract a greater percentage of

the betting action. As also was shown in Paul and Weinbach (2008a), road favorites attract a much higher percentage of the bets (over 70% on average) compared with home favorites (nearly 57% on average). The over was shown to attract over 65% of the betting action for both home and road favorites.

The average pointspread and total move during the last hour is close to zero for all studied wagering propositions. For home favorites, the average pointspread move was slightly toward the underdog and slightly toward the under. On the other hand, for road favorites, the average pointspread move was slightly toward the road favorite and the over. This does not imply that pointspreads and totals do not move in the last hour of betting before an NFL kickoff; it only illustrates that the average value of news is zero within this betting market.[1]

Tables 2 and 3 present results of simple betting simulations from the NFL for the 2008–2009 through 2010–2011 seasons. Results of placing wagers on favorites and underdogs are shown for the situations in the last hour of betting, where the percentage of bets increased on the favorite and increased on the underdog. These results are shown for both home underdogs and road underdogs. In addition, results are combined to show the winning percentages of simple strategies of wagering against the percentage change toward favorites and underdogs overall (both home and road favorites) and for a strategy of wagering against all pointspread changes. These strategies are simply contrarian wagering positions, as the strategy used in these betting simulations only means wagering against the more popular side of the betting proposition in the last hour before kickoff. Log likelihood ratio tests, which do not impose an equal mean and median restriction on the forecast errors, are used to test the winning percentage of these strategies compared to the null hypothesis, winning of a fair bet (win 50% of the time). Compared to the null hypothesis of no profitability, winning 52.4% of the time is enough to overcome the implicit commission charged with the sportsbook lay 11-to-10 rule, as outlined in Evan and Noble (1992).

In observing the betting results—based upon how the betting percentages on the favorite/underdog and over/under change—a few points are readily apparent. Wagering against the betting public when they are wagering on the favorite in the last hour appears to be a winning proposition. For home favorites, betting against the preferences of the betting public when they wager on the favorite in the last hour wins over 59% of the time, and it is found to be statistically significant at the 5% level. For road favorites, betting against the public wagering on the favorite in the last hour wins two-thirds of the time in a very small sample. This result was found to be statistically significant at the 10% level.

Betting on the underdog, specifically when the percentage bet on the favorite increases in the last hour, wins over 60% of the time. This is significant at the 1% level, compared with a fair bet (winning 50% of the time). It is significant at the 5% level, compared to the null hypothesis of no profitability: winning 52.4% of the time, enough to overcome the 11-to-10 rule at the sportsbook. In addition, the strategy of wagering against all changes in betting percentages in the last hour before the start of the game wins nearly 55% of the time; it was found to be significant at the 10% level.

The totals market does not offer any findings of statistical significance in relation to betting against (or on) changes in betting percentages in the last hour before the start of an NFL game. However, wagering against changes in betting percentages was shown

Table 2: Betting Simulation Results in the NFL Pointspread Market

	Favorite	Underdog	Underdog win percentage	Log likelihood ratio: fair bet
Home Favorites				
All Games	233	263	53.0242	1.8156
Games with an increase in betting percentage on the favorite in the last hour	47	69	59.4828	4.1978**
Games with an increase in betting percentage on the underdog in the last hour	44	51	53.6842	0.5163
Road Favorites				
All Games	130	118	47.5806	0.5809
Games with an increase in betting percentage on favorite in last hour	9	18	66.6667	3.0582*
Games with an increase in betting percentage on the underdog in the last hour	37	31	45.4882	0.5301
Combined	Bet against change in betting percentage	Bet with change in betting percentage	Win percentage: betting against change in betting percentage	Log likelihood Ratio: fair bet (no profits)
Bet against percentage increase on favorites in the last hour	87	56	60.8392	6.7738*** (4.1449**)
Bet against percentage increase on underdogs in the last hour	80	83	49.0798	0.0552
Bet against all percentage increases in the last hour	167	138	54.7541	2.7615*

Note. Betting percentage change in the last hour. The log likelihood test statistics have a chi-square distribution with one degree of freedom. Critical Values are 2.706 (for an $\alpha = 0.10$), 3.841 (for an $\alpha = 0.05$), and 6.635 (for an $\alpha = 0.01$). *is significant at 10%; ** is significance at 5%.

Table 3: Betting Simulation Results in NFL Totals Market

	Overs	Unders	Under win percentage	Log likelihood ratio: fair bet
Home favorites				
All games	251	245	49.3952	0.0726
Games with an increase in betting percentage on the over in last hour	83	75	47.4684	0.4052
Games with an increase in betting percentage on the under in last hour	68	69	50.3650	0.0073
Road favorites				
All	129	120	48.1928	0.3254
Games with an increase in betting percentage on the over in last hour	39	49	44.6818	1.1388
Games with an increase in betting percentage on the under in last hour	35	24	40.6780	2.0629
Combined	Bet against move	Bet with move	Bet against move win percentage	Log likelihood ratio – fair bet
Bet against percentage increase on overs in last hour	124	122	50.4065	0.0163
Bet against percentage increase on unders in last hour	103	93	52.5510	0.5104
Bet against all percentage increases in last hour	227	215	51.3575	0.3258

Note. Betting percentage change in the last hour. The log likelihood test statistics have a chi-square distribution with one degree of freedom. Critical Values are 2.706 (for an $\alpha = 0.10$), 3.841 (for an $\alpha = 0.05$), and 6.635 (for an $\alpha = 0.01$). *is significant at 10%; ** is significant at 5%.

to win more than 50% of the time (51.36%). As mentioned, the threshold to earn profits was not met for this sample, nor was the null hypothesis of a fair bet (winning 50% of the time) rejected.

These results clearly show that there is not information embedded in wagers that occur in the hour leading up to kickoff in NFL games. Late information—in relation to injuries, game plans, weather, and other factors—does not appear to be used by bet-

tors to exploit informational advantages and earn profits. In fact, wagering against the actions of the betting public was shown to earn statistically significant profits. This supports previous findings that show NFL betting as a consumption activity for fans in which wagers are placed on games to increase the enjoyment of watching NFL football. Access to information—specifically regarding which propositions the public is placing wagers in the last hour—provides insight into where contrarian bettors can win often enough to reject market efficiency and earn statistically significant profits.

Conclusions

Through the examination of actual betting percentages from three online sportsbooks—gathered through data available on http://www.sportsinsights.com—the last hour of betting before the start of NFL games was analyzed. In the gambling market for horse racing, there is general sentiment and some evidence to support that informed bettors tend to wager near the start of the race. There is little evidence to support late betting as informed betting in the wagering market for professional football in the United States. In fact, there is evidence that wagering against the preferences of the public, which are evident in the last hour before kickoff, actually leads to profitability as market efficiency can be rejected.

More than 22% of all wagering occurred in the last hour before kickoff in the NFL. For the online sportsbooks from which the data were gathered, this accounted for nearly 20,000 wagers on each game in the 60 min leading up to kickoff. On average, more of the bets accrued to home teams in the sides markets, as both home favorites and home underdogs attracted more wagers in the last hour. In the totals market, more wagers were found to be on the over during this same time span. Favorites and overs attracted the most wagers, well above 50%; this clearly rejects the notion of the sportsbook attempting to balance the book. The average pointspread move was close to zero, even though the public clearly favored the home team and the over in the last hour.

Simple betting simulations were performed using the changes in betting percentages. When the betting percentages changed in the last hour toward the home favorite, betting on the underdog (the opposite of the move in the percentages) was found to win 59% of the time and the null hypothesis of a fair bet was rejected. A general strategy of betting against any percentage moving toward the favorite (home or road) in the last hour won more than 60% of the time. It was found to be statistically profitable compared to the null of no profitability—a 52.4% win percentage, enough to overcome the commission charged by the sportsbook in wagering. In the totals market, statistical significance was not found.

Overall, the actions of the betting public in the last hour before kickoff in the NFL do not appear to represent information. It appears that bettors who wager on NFL games in the hour leading up to kickoff are much more likely to be recreational bettors, placing bets on their favorite teams or on the over in totals wagers. These activities are consistent with the notion of sports betting as consumption, as opposed to investment, and leads to profits in following a simple contrarian strategy of betting against the wagering action of the public in the last hour of betting before kickoff. This strategy may persist as the information on betting percentages is not yet widespread. To actually use this information, bettors would either need to pay for an account on http://www.sportsinsights.com or actively track and monitor the percentages on

Sunday morning on http://www.sportsbook.com. This information does appear valuable since a statistically significant wagering strategy is generated from real–time numbers presented on these websites.

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Endnote

[1]28.87% of all games had a pointspread move in the last hour before kickoff. 51.36% of these games had the pointspread move toward the favorite. Of the moves, 73.64% were half-point moves.