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An Application of Prospect Theory: The Effect of Trailing at Halftime on Winning NFL Games

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Abstract: Trailing in sports is associated with losing, but can trailing operate as a powerful motivator that leads to winning? Based on research by Berger and Pope (2011), this study applies Prospect Theory and loss aversion to football to test if trailing by a small margin can motivate success. This relationship is analyzed based on teams' point differentials at halftime since halftime operates as a salient reference point and a time for teams to regroup and strategize. Analysis of over 12,000 NFL games found no significant effect of trailing at halftime on the likelihood of winning. That is, there is little evidence that Berger and Pope's (2011) finding for a motivational effect of losing in basketball exists in football. I offer several reasons why key differences between football and basketball may account for the null result in football and suggest that future research is needed in prospect theory's application to football on a play-by-play basis.

I. Introduction

Economics operates under assumptions of rationality and expected utility maximization. While Bernoulli's proposal of Expected Utility Theory in 1713 made great strides for the theory of decision making under uncertainty, it is focused on the final states of outcomes as the carriers of utility and ignores the impact of perceived gains or losses on expected utility. In 1979, Kahneman and Tversky developed "Prospect Theory," which argues that the carries of utility – and thus the driver of behavior – are gains and losses from a reference point rather than final states. For example, the utility of a 35-degree temperature is judged, not in isolation, but with reference to recent experience; a 35-degree temperature is often judged as "good" if the temperature the previous day was 5 degrees and "bad" if the temperature hit 55 degrees the day before. Another key element of Prospect Theory relevant to decision making is loss aversion; an individual's tendency to prefer avoiding losses to acquiring equivalent gains.

Prospect Theory is a powerful lens through which to understand behavior in professional sports, a setting with competitive individuals and great financial incentives. Prospect Theory has been applied to tennis, golf, and basketball to explore how gains and losses operate as motivators for players. In tennis, when players are losing, they serve harder and put in more effort on the court. In golf, when a player is putting to avoid a bad result on a hole (a bogey), they perform better than if they are putting to get a good result at a hole (a birdie). In basketball, Berger and Pope (2011) found that teams perform better when they are trailing by a few points at halftime. While Prospect Theory's perspective on decision making has been applied to numerous sports contexts, it has not yet been applied in football.

In this study, I will use Berger and Pope's method of analyzing the effect of trailing at halftime on the likelihood of winning games in football. I use data from NFL games since 1966 and employ a similar regression discontinuity method for data analysis. Berger and Pope found that the likelihood of winning was 6 percentage points greater than expected when a team was trailing by 1 point at halftime and 2 percentage points greater than expected when trailing by 2. Despite the less granular nature of scoring in football (scoring happens less frequently and in larger amounts of field goals and touchdowns), I expect to find similar results. I also intend to explore whether the effect changes across different eras and whether fan attendance affects teams' performance when trailing at halftime. Since the dataset is from 1966 to 2020, I will separate the game into different decades to compare. The 2020 season had little to no fans at games due to the COVID-19 pandemic and this will be used as a comparison for the effect of fans.

II. Theory

One of the earliest conceptions of rationality in ~~e~~economics was that people make decisions based on expected value. For example, if a project earns \$200 with a probability of 0.60 and \$100 with a probability of 0.40 the expected value is \$160 and a rational investor will undertake it when the cost is less than this amount. However, in 1713, Nicolaus Bernoulli argued against this idea and developed his conception of rational decision making under Expected Utility Theory. This was a step forward as it introduced the idea that people make decisions based on the expected (or weighted) utility of final states or outcomes rather than expected outcomes. In the example from above, it is the utility of the 4200 and \$100 that matter and not the dollar amounts. Moreover, Bernoulli introduced two key principles~~.~~: diminishing marginal utility and risk aversion. The first principle means that as people have more, they find less utility in the same gains; 5 dollars means more to a poor person than a rich person. The second principle implies that people do not like risk and prefer to avoid it. For example, while investing in a stock can bring 10% gains, it could also create 50% loss and this risk leads many people to store their money in a safe bank free of risk.

While Expected Utility Theory made improvement to how we view rationality and more descriptive of actual behavior, it was focused on the final states of outcomes while psychologists emphasize that humans perceive the world in terms of changes from reference points are more driven by the potential for gains and losses in their decision making. In their path-breaking paper in *Econometrica*, psychologists Kahneman and Tversky (1979) exploit this insight and challenge conventional thinking in economics. That is, they propose a theory that runs contrary to the rational decision-making theory in economics, which is Expected Utility Theory. What Kahneman and Tversky propose in Prospect Theory is that the utility and disutility of gains and losses guide human decision making, not the utility of final states of outcomes. A common example of this is how we perceive the weather. In Minnesota, a notoriously cold state, when it hits 32 degrees Fahrenheit in the fall, many perceive this as a loss. Accustomed to sunny walks in beautiful weather, a 32-degree day is a loss of value for many individuals. On the other hand, a 32-degree day in the spring is welcome as people drop their winter coats for cozy sweaters. The change from below freezing to freezing is a gain in our environmental circumstance. The two outcomes are the same, it is a 32-degree Fahrenheit day in both situations, but how we perceive them is completely different.

According to Kahneman and Tversky, our perceptions of gains and losses are modeled by four key components in Prospect Theory: reference points, loss aversion, diminishing sensitivity and nonlinear weighting of probability. These are illustrated in Figure 1.

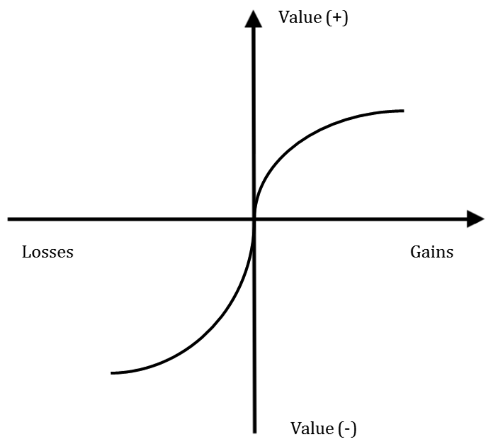

Figure 1: Prospect Theory (proposed by Kahneman & Tversky)

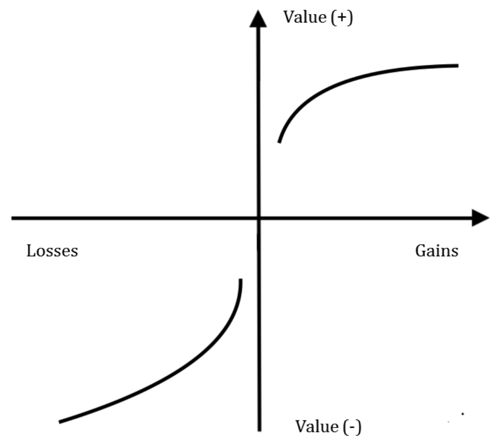

Figure 2: Prospect Theory (proposed in Football)

Reference points serve as a key driver of our perception of gains and losses. There are three key determinants of a reference point: the status quo, the expected outcome and the entitled outcome. Based on what a situation usually is, what one thinks its outcome will be and what one wants the outcome to be, people will form a reference point. If the actual outcome is greater than the reference point, people view it as a gain and it creates value. If it's less than the reference point, it's viewed as a loss and creates negative value. This can be seen in an everyday situation such as test scores. If a student consistently studies a lot and gets As, their status quo and expected outcome all indicate an A as their reference point for an exam. If this student gets a B on an exam, this is viewed as a major loss. They were not expecting this and due to their reference point dependence, they have incurred a loss in value. On the other hand, if a student doesn’t study much and consistently gets Cs, the reference is a C for their exam grade. If this student gets a B, this is viewed as a major gain in value. Value does not come from the final outcome, but how we perceive this outcome as a gain or loss relative to a reference point.

The second tenant of Prospect Theory is Loss Aversion, which states that not only do people dislike losses but that they dislike them more than they like gains of an equivalent magnitude. This is seen in Figure 1 as a steeper value function in the loss domain than in the gain domain. This feature is often argued as an evolutionary component of human behavior. Survival for early humans may have produced an evolutionary adaptation of loss aversion as those who weren't loss averse were more likely to put themselves in risky situations, which resulted in their death. Nowadays, loss aversion might be less necessary for our survival, but remains a key component of our daily decision making. The fear of loss can push many people away from investing or refusing to sell a stock that has lost value, since selling the stock would actualize the loss in one's mind. The refusal to sell has become a notorious slogan for members of the Wall Street Bets subreddit, in which they claim only beta males sell their stocks for a loss and that true alphas (or "Chads") hold their stocks until they hit the moon.

Loss Aversion does not just mean that people don't like losses, but that losses can operate as a more powerful motivator than gains. This can be seen in golf, in which it has been shown that PGA golfers perform better when they are attempting to avoid finishing a round poorly compared to when they are trying to finish a round strongly (Pope & Schweitzer, 2011). This is even seen in the highest performers who have major fiscal incentives to finish rounds strongly, but the stronger motivator is still loss aversion. Studies have shown that the psychological effect of losing is about two to four times as powerful as gaining.

Prospect Theory's third tenant is that there are diminishing returns from gains and losses, meaning that as a gain or loss increases, the change in value from each unit is less strong than the previous unit. This is seen in Figure 1 as the concavity of the value function in the gains domain and its convexity in the loss domain. Similar to gaining light in a dark room (or increasing the brightness of your computer), the initial increase— or decrease— from 0 has the biggest effect.

Everything following it has a decreasingly strong effect. This is similar to the concept of diminishing marginal returns in Expected Utility Theory.

A fourth principle of Prospect Theory is the nonlinear weighting of probability. This is seen in Figure 3. The dashed lines show the one-to-one correspondence between the weights and probabilities assumed in expected utility theory and the S-shaped function illustrates what is implied in Prospect Theory. The latter holds that people do not weigh the utility of an outcome in direct proportion to its likelihood. People overweight low probabilities and underweight high probabilities. This is due to two effects, the possibility effect and the certainty effect. The possibility that something may happen creates a value for people and this causes low probabilities to be overvalued, which is seen in common examples like buying a lottery ticket. Buying a lottery ticket creates negative value in expected utility, but the possibility of winning grand prizes is valuable to people and the nonlinear weighting of potential gain makes the transaction worthwhile for most people. On the other hand, the certainty effect says that people value knowing exactly what to expect in an outcome. This is why at the high levels of probability people do not value the probabilities as highly as they should since they are not certain the outcome will occur.

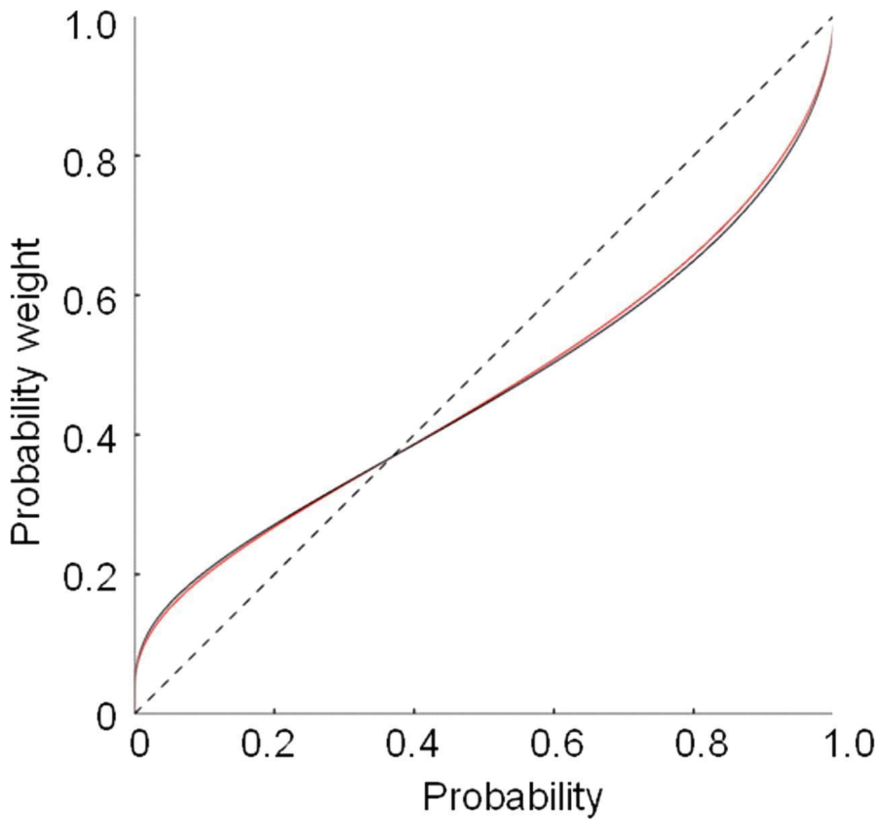

Figure 3: Nonlinear weighting of Probability

In this paper, I hypothesize that NFL players experience a unique version of the Prospect Theory value function. They experience all the previously mentioned principles of Prospect Theory, but with a discontinuous jump from a loss by 1 to 0 (tie) and from 0 to a gain of 1 (both depicted above in Figure 2). Since halftime operates as a salient reference point for teams to regroup and focus on their objectives, I argue the potential for this massive gain in value will be seen in teams performing better than expected when trailing by small margins at halftime.

III. Literature Review

"If it doesn't matter who wins or loses, why do they keep score?"

- Vince Lombardi

One would expect that leading throughout games should lead to victories. Cooper, Deneve and Mosteller (1992) found that when teams are ahead early in sports, they win about two-thirds of the time. Hal Stern (1994) developed a model for projecting victories from intermediate points of games in the National Basketball Association (NBA) and the National League of Major League Baseball (MLB). He found leading by greater amounts and leading later in games each steer teams towards victory and that this relationship was similar in both leagues. It logically follows that leading in games leads to an increased probability of winning, but are there situations where trailing in a game can lead to winning?

As discussed in the previous section, Prospect Theory's main tenets are reference dependence, loss aversion and diminishing sensitivity. Reference dependence states that people do not make decisions based on outcome, but on how the outcome relates to a reference point (Kahneman & Tversky, 1979). A reference point is formed by the status quo, the expected outcome and the outcome to which one feels entitled. If the actual outcome is greater than the reference point, individuals gain value from it. If the actual outcome is less than its reference point, individuals will lose value from it. For example, one common reference point that most people have are goals. People create goals for how they want things to pan out and judge their experiences or outcomes in reference to these goals (Heath, Larrick & Wu, 1999). For example, in football, a team's goal is victory and losing during a game creates negative value that they strive to avoid. That, a tied score is the highly salient reference point in football with winning producing positive and losing negative utility.

The next key principle is loss aversion. Loss aversion says that not only do people dislike losing, but they dislike it more than they actually enjoy gaining or winning. While gains can be enticing and a good motivator, it has also been found that people's aversion to losing can operate as a more powerful motivator (Berger & Pope, 2011). Research shows that people dislike losses two to four times as much as they enjoy gains, but this can vary depending on the context (Tversky & Kahneman, 1992; Heath, Larrick & Wu, 1999). Loss aversion can also interplay with other factors to affect outcomes. A study of the effect of loss aversion and the frequent evaluation of outcomes (myopic loss aversion), showed that those who received the most frequent feedback took the least risk and gained the least amount of money (Thaleer, Tversky, Kahneman, & Schwartz, 1997). As people repeatedly check the outcome possibilities, their tendency for loss aversion will kick in and they will withdraw from risks to avoid loss.

Furthermore, people experience diminishing sensitivity to their gains and losses. In football, this suggests losing by a point is extremely distasteful and losing by two points is even more distasteful, but it is not twice as distasteful. As gains increase, the value people garner from the marginal increase in gains decreases. In football, this can be seen in victory margins. The more a team wins by, the less value they would receive from an additional point in their margin of victory— winning by 47 instead of 41 creates much less value than winning by 7 instead of 1.

Golf provides an important setting to test Prospect Theory. Pope and Schweitzer (2011) looked at professional golfers' performance during the PGA tour and analyzed over 2.5 million putts. In golf, athletes are judged and ranked by their total strokes for an 18-hole course. As golfers progress through a course, the par for each hole is a salient reference point for how a golfer is performing. Thus, golfers will consistently be in situations where they will be putting to be under-par, at par, or over-par; these can otherwise be known as a gain, met expectations or loss. Pope and Schweitzer find that, holding all else constant, PGA golfers were less likely to make a putt if they were going for under-par (a gain) than if they were trying to avoid over-par (a loss). For example, Birdie putts—a putt that puts a golfer one stroke under par— were less likely to be made than par putts by two percentage points. This indicates that golfers are more motivated by avoiding the loss domain than entering the gain domain and shows how loss aversion can operate as a strong motivator. Furthermore, this was found to be true even in the top athletes' performance, such as Tiger Woods and Phil Mickelson. These top golfers have major financial incentives to perform at their best in every moment as thousands, if not millions, of dollars are on the line for them, but even they exhibit the same loss aversion motivation that we see in all golfers.

Anbarci, Arin, Okten and Zenker (2017) looked at the application of Prospect Theory in professional tennis. They found that players put more effort into their serve when they are behind than when they are ahead. Male players increase their serve speed by 1.64 miles per hour when they are losing mid-set. They also found that as the difference in score[1] increases, players' responses in serve speed and effort levels are smaller, reflecting diminishing sensitivity to loss. Additionally, players were more risk averse in the domain of gains than in the domain of losses. These findings all support key components of Prospect Theory, loss aversion and diminishing sensitivity. Anbarci et al. also found evidence that these effects are more pronounced in men than in women, which is interesting for the NFL as it is exclusively male.

Markle, Wu, White and Sackett (2018) found evidence of loss aversion and diminishing sensitivity in marathon runners in the relationship between their satisfaction with their performance relative to their goal. Bernardi and Cozzani (2021) studied the effect of local soccer teams experiencing an unexpected loss and discovered it led to a decrease in the number of births nine months later. They argue that this is because the unexpected loss (unlike expected losses)

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[1] Score was looked at as point score, game score and set score in this study.

operates as a loss in value for individuals and this decrease in happiness leads to less reproduction.

In basketball, Berger and Pope (2011) explored the effect of trailing at halftime on winning NBA games. Based on previous research, they suggested that losing by a small amount at halftime could actually increase motivation and lead to winning. Berger and Pope focused on halftime for a couple reasons. Halftime provides feedback which helps people adjust their effort to meet their goals. Also, the break invites all players to be salient of their relative position and teams get the opportunity to regroup and work towards their goal. Using a regression discontinuity method, Pope and Berger found that when teams were trailing by one or two points, they had a higher winning percentage than expected by six and two percentage points respectively (shown in Figure 4). In fact, when home teams were trailing by one point, they were expected to win more often than home teams that were leading by one were expected to win. They claimed that teams that were losing at halftime won by about 6.5 percentage points more than expected. They concluded that their findings show how even experienced professionals will follow a nontraditional expectation of behavior.

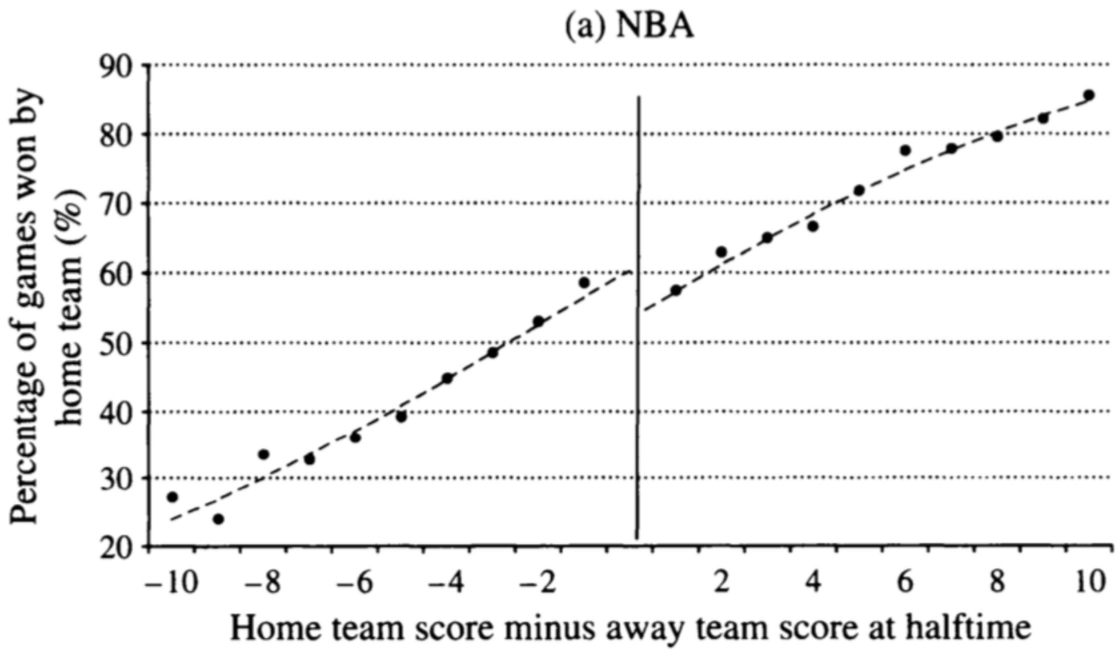

Figure 4: Berger and Pope's (2011) finding about the effect of trailing at halftime on winning NBA games

Teeselink et al. (2020) followed Berger and Pope (2011) by using a regression discontinuity analysis to look at four sports and see how trailing at halftime affected game outcomes. Among Australian football, American football, basketball and rugby, they found little to no effect of trailing at halftime on the outcome of games. However, they included insufficient control variables relative to Berger and Pope's study. The most notable one being the season winning percentage to account for team quality and also the effect of coaching ability via coach winning percentage.

Furthermore, the differences in play throughout history can be analyzed further. Most sports in the modern era are increasingly high scoring because it is believed that this will help draw viewer attention to games. This higher scoring could change how teams would view a halftime deficit.

In this study, I aim to utilize Berger and Pope's (2011) method to test "Can Losing lead to Winning?" in NFL games. I will use their regression discontinuity approach and analyze game level outcomes for 12,455 games between 1966 and 2020. 1966 is considered the beginning of the modern football era since the sport's premier teams were all operating under a unified league. Additionally, I will investigate whether the effect of halftime can be seen differently in different decades or eras of football. Unlike the game today that is much more pass happy and scoring centric, football of the 1970s and 80s was notoriously brutal and defense heavy, which makes coming back from a deficit much harder. I also plan to look at how the lack of fan attendance affected home team performance in the 2020 season, which was played under COVID-19 restrictions. This data provides a very interesting natural experiment with the removal of fans while holding most of the football game process as it was previously.

Data Description

This study is based on NFL game data that was collected from *Stathead*, a site that specializes in game statistics for major American sports leagues. *Stathead* has game data going back until the 1940s, but this study will restrict the dataset from 1966 to 2020. Most NFL statistics and records are tracked from 1966 since it was the first time the sport's best teams all operated under a unified league. 2020 was the last completed season of football at the time of this writing and will thus be the last season used in the analysis.

Table 1 describes the key variable for this dataset: the halftime margin. My data set covers 24,910 games and, on average, the home (away) team was leading (losing) by 1.77 points at halftime. The largest number of points the home (away) team was behind at halftime was 38 (45) points. It follows then that the largest number of points the home (away) team was ahead at halftime was 45 (38) points.

Table 1
Descriptive Statistics: Halftime Margins

VARIABLES	(1) N	(2) Mean	(3) Std. err.	(4) Min	(5) Max
Halftime Margin (All)	24,910	0	11.24	-45	45
Halftime Margin (Home)	12,455	1.77	11.10	-38	45
Halftime Margin (Away)	12,455	-1.77	11.10	-45	38

Table 1: Depicts descriptive measures for the key variable of halftime margin. Row 1 (All) shows all observations (every NFL game from 1966 to 2020 from both the home and away perspective) and its mean of 0 indicates that the data has been collected correctly. This is further confirmed by Row 2 (Home) and Row 3 (Away) having perfectly inverse results between each other.

Table 2 shows summary statistics for historical win-frequency for home teams that are tied at halftime (*M*=0.56, *SD*=0.02), winning by 1 at halftime (*M*=0.58, *SD*=0.03) and losing by 1 at halftime (*M*=0.48, *SD*=0.03). The home team was tied at halftime in 1,078 games and won 55.66 percent of these. The fact that this win percentage is greater than 50 percent reflects the advantage to playing at home. The home team was ahead (behind) by one point at halftime in 240 (231) games and won 58.13 (48.48) percent of these. Relative to the case of being tied, losing by one at halftime has a much larger negative marginal impact on the winning percentage (from 55.66 to 48.48 percent) than does winning by one at halftime (from 55.66 to 58.13 percent).

Table 2
Descriptive Statistics: Home Team Win Percentages

VARIABLES	(1) N	(2) Mean	(3) Std. err.	(4) [95% conf.	(5) interval]
Outcome (+0)	1,078	.5566	.0150	.5271	.5861
Outcome (+1)	240	.5813	.0132	.5185	.6440
Outcome (-1)	231	.4848	.0330	.4199	.5498

Table 2: These results show the likelihood of winning at different halftime margins (around 0) for home teams. The likelihood of the home team winning when the game is tied at halftime is 55%. When home teams are losing by 1 point, it is 48% and 56% when they are winning by 1 point at halftime. (Evidence from Pope and Berger suggests that the -likelihood of winning at -1 should be greater than the 1 likelihood of winning at +1)

Figure 5 shows the relationship between winning percentage and the point margin at halftime. For example, the home teams won 38 percent of their games when down by 5 points at halftime and 62 percent of their games when up by 5 points at halftime. While this graph is just a visualization of the data and doesn't incorporate data analysis, one can still see that it presents a distribution indicating a positive linear relationship between likelihood of winning and halftime margin, between halftime margin values of -10 and 10. In Figure 4, from Berger and Pope (2011), we can see that teams' likelihood of winning increases in the loss domain until 0, and then there is a significant drop off after the 0 point, suggesting that trailing was operating as a powerful motivator for teams to win.

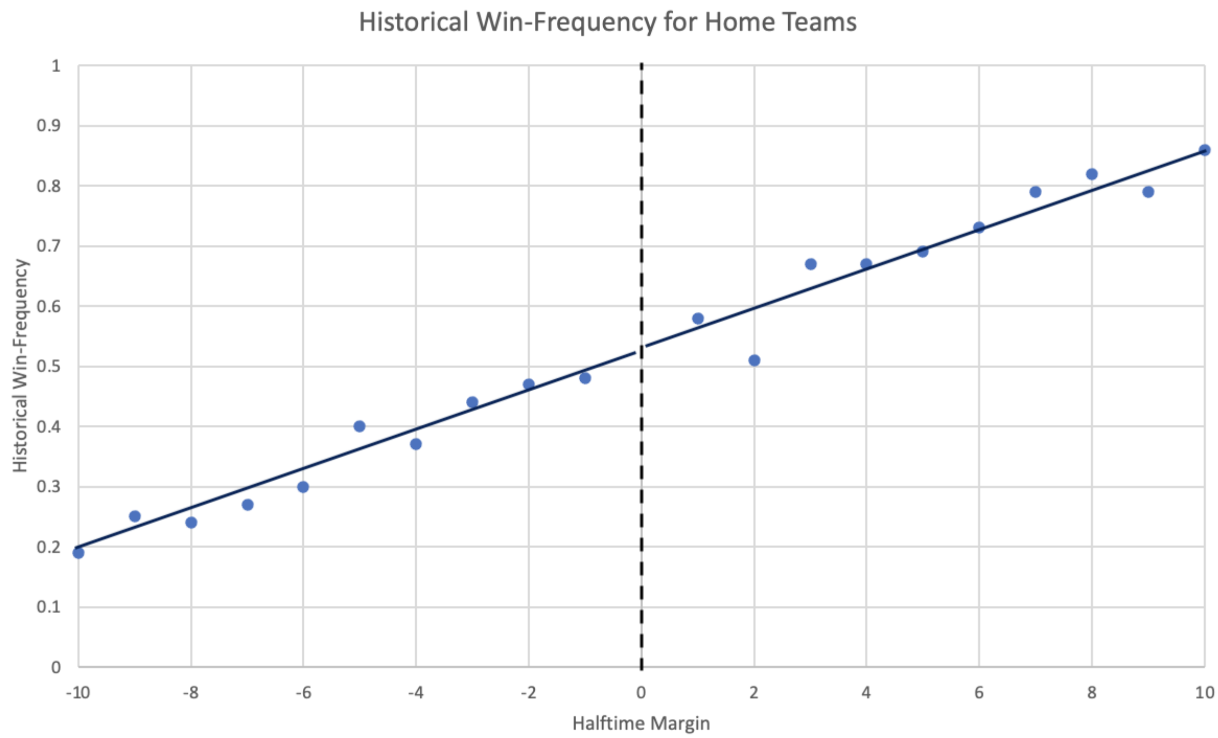

Figure 5: The probability of the home team winning the game at halftime margins between -10 and +10; +2 seems to stand out as an outlier, but this is likely due to its small sample size

Empirical Strategy

Since this dataset includes both home and away team perspectives in every game score, the analysis will look at home teams exclusively for consistency. These findings will be compared to the results of the same method but using away teams and these two analyses should have exactly opposite results.

I use the Regression Discontinuity (RD) method to test for causality running from the halftime margin to the likelihood of winning the game. RD designs are typically used when an independent variable's treatment status is determined by its relation to a threshold. In this study, the independent variable is halftime margin and its threshold is having a negative margin at halftime. This can also be thought of as being interested in how teams react when they are being "treated" with losing at halftime. In the context of Figure 5, we expect a positive relationship between the horizontal and vertical axis variables, and test whether this relationship differs when the team is behind at halftime compared to when they are ahead. For example, Berger and Pope (2011) found that there is an upward shift in win probability for home teams that are behind at halftime and use this to conclude that loss aversion causes losing teams to try harder.

The regression discontinuity model for this study is a modified logistic model. It is specified as

$$win_i = \beta_0 + \beta_1([losing\ at\ halftime]) + \beta_2(margin\ at\ halftime) + \beta_3 X_i + \varepsilon_i$$

in which win_i is an indicator equal to 1 if the home team won the game *i*, 0 if the home team lost game *i*. The second key variable is $losing\ at\ halftime_i$, an indicator equal to 1 if the home team was trailing at halftime in game *i* and 0 if the home team was winning at halftime in game *i.* The third key variable is $margin\ at\ halftime_i$ is the independent (or "forcing") variable of the regression discontinuity model. This is the variable shown on the horizontal axis of Figure 5. X_i represents the control variables for each game. Control variables I consider include the season winning percentage for home and away teams. This is done to ensure that the quality of teams is accounted for in the analysis. The error term represents the difference between the predicted outcomes of the model and the actual observed outcomes of the data.

This RD model aims to see if, when inducing a possible discontinuity at 0, teams perform significantly differently when they are losing than when they are winning. By comparing these two states, we can see the treatment effect of losing. The key coefficient in this model is β_1 as it indicates the effect of trailing on winning. The hypothesis of this study is that if trailing at halftime does not affect performance, we will see a smooth, continuous regression line throughout the data, but if trailing positively affects the likelihood of winning, this will be shown through the $\beta_1 > 0$ and we will see an upward shift in the regression line prior to the discontinuity at 0.

Results

The data was analyzed using the aforementioned strategy and employed four main regressions and the results are shown in Table 3. Columns (1) and (3) look at halftime margin linearly and columns (2) and (4) include a cubic function of halftime margin. Columns (1) and (2) introduce no controls while columns (3) and (4) control for the home team's win percentage and the away team's win percentage.

As indicated by the Pseudo R-squareds, the models explain between 31 and 35 percent of the variation in the dependent variable: the win-lose binary variable. As columns 3 and 4 show, about four more percentage points of variation is explained when the home and away team winning percentages are included. The Pseudo R-squareds indicate that allowing for a cubic relationship between the halftime margin and the likelihood of winning does not improve the fit of the model.

Most importantly, across all four specifications, we find no statistically significant relationship between trailing at halftime and the likelihood of winning. This is seen in the top row off Table 3 where all the coefficients are not significantly different from zero. Only one of the four coefficients is positive as predicted based on Berger and Pope's findings and the t-statistic indicates we cannot infer that it is different from zero at the 5 percent level. Additionally, the standard error is also at its lowest in column (SE=0.01), and varies between values of 0.07 (for column 3) and 0.11 (for columns 2 and 4).

Table 3 The Impact of Trailing at Halftime on Winning				
	(1)	(2)	(3)	(4)
Trailing at Halftime	0.02 (0.01)	-0.03 (0.11)	0.00 (0.07)	-0.04 (0.11)
Home Team Win Percentage			-0.95 (0.10)	2.25 (0.13)
Away Team Win Percentage			1.27 (0.10)	-2.30 (0.13)
Halftime Margin (Linear)	X	X	X	X
Halftime Margin (Cubic)		X		X
Pseudo R2	0.31	0.31	0.35	0.35
Observations	11,377	11,377	11,377	11,377

Table 3: Logistic regression results from linear logit without controls (1), a cubic logit without controls (2), a linear logit with controls (3) and cubic logit with controls (4).

The results in Table 4 provide further description of the results of column 3, which includes a linear fit of the halftime margin and control variables for home and away team win percentages. The results show that there are statistically significant relationships between the halftime margin (p<0.01), home team win percentage (p<0.01), and away team win percentage (p<0.01). However, as discussed above, trailing at halftime (p=0.97) has a very high p-value.

Table 4
The Impact of Trailing at Halftime on Winning

	(1) Coefficient	(2) Std. Error	(3) *p*-value	(4) [95% conf.	(5) interval]
Constant	0.28	0.10	.01***	0.08	0 .48
Trailing at Halftime	0.00	0.09	.97	-0.18	0.17
Halftime Margin	0.15	0.01	<.01***	0.14	0.16
Away Team Win Percentage	-2.31	0.13	<.01***	-2.56	-2.05
Home Team Win Percentage	2.25	0.13	<.01***	1.99	2.5

Table 4: Full results and values from Column 3— linear logistic regression with controls to predict the likelihood of winning a game.

To explore whether there are possible threshold effects during the game, I also investigated the end of the third quarter. The rationale for this is that prospect theory proposes that teams will work harder to enter the gains domain when they are in the loss domain. The third quarter is a more specific context of after halftime than the entire second half and looking at this shorter after halftime period allows us to find any insights that are lost in teams' adjustments to the fourth quarter, which some argue can be considered its own game in a vacuum since it is the last and most critical part of a game. analysis was also executed on teams' likelihoods to win the third quarter to isolate an effect closer to halftime.

The results are shown in Table 5. Trailing at halftime still had statistically insignificant results (p=0.48), while away team (p<0.01) and home team win percentages (p<0.01) still had statistically significant effects. However, halftime margin (p=0.54) no longer had a statistically significant effect.

Table 5
The Impact of Losing at Halftime on Winning the Third Quarter

	(1) Coefficient	(2) Std. Error	(3) *p*-value	(4) [95% conf.	(5) interval]
Constant	-0.68	0.00	<.01***	-0.84	-0.53
Trailing at Halftime	-.05	0.07	.48	-0.19	0.09
Halftime Margin	0.00	0.00	.54	-0.01	0.00
Away Team Win Percentage	1.27	0.10	<.01***	1.07	1.47
Home Team Win Percentage	-0.95	0.10	<.01***	-1.15	-0.75

Table 5: Same logistic regression method as Table 4 (includes controls and has a linear relationship), but instead predicting the likelihood of the home team outscoring their opponent in the third quarter.

The analysis methods used to look at the outcomes and who wins the third quarter of NFL games was also applied exclusively to the 2020 NFL season, which was affected by the COVID-19 pandemic and had minimal fans at home games. Trailing at halftime (p=0.24) did not affect teams' likelihood of winning games during the pandemic, nor did it affect their likelihood of winning the third quarter (p=0.24)

While there still are statistically significant effects for home(p<0.01) and away team win percentages (p<0.01) in winning games, there is no significant effect on winning the third quarter during the pandemic for home teams (p=0.62) or away teams (p=0.24).

Table 6
The Impact of Losing at Halftime on Winning in the COVID-19 affected season

	(1) Coefficient	(2) Std. Error	(3) *p*-value	(4) [95% conf.	(5) interval]
Constant	0.70	0.70	0.31	-.66	2.07
Trailing at Halftime	-0.73	0.62	0.24	-1.96	0.49
Halftime Margin	0.12	0.04	<0.01***	0.05	0.19
Away Team Win Percentage	-3.02	0.86	<0.01***	-4.718	-1.33
Home Team Win Percentage	2.37	0.86	0.01***	0.69	4.05

Table 6: Logistic regression results from a linear logit with controls that predicts the likelihood of the home team winning a game, exclusively in the 2020 season affected by the COVID-19 pandemic

Table 7
The Impact of Losing at Halftime on Winning the Third Quarter in the COVID-19 affected season

	(1) Coefficient	(2) Std. Error	(3) *p*-value	(4) [95% conf.	(5) interval]
Constant	-0.30	0.54	0.57	-1.36	0.75
Trailing at Halftime	-0.34	0.48	0.48	-1.28	0.60
Halftime Margin	-0.01	0.02	0.78	-0.05	0.04
Away Team Win Percentage	0.73	0.62	0.24	-0.49	1.95
Home Team Win Percentage	-0.32	0.63	0.62	-1.56	0.93

Table 7: Logistic regression results from a linear logit with controls that predicts the likelihood of the home team outscoring their opponent in the third quarter, exclusively in the 2020 season affected by the COVID-19 pandemic

Discussion

Does trailing at halftime lead to winning? The evidence presented above for the National Football League suggests that it does not. Being a better team or playing inferior opponents leads to winning and how much one is losing at halftime predicts the likelihood of a victory, but these are both intuitively expected results. Contrary to the predictions of prospect theory, NFL teams are no more likely to win when they are losing at halftime.

There is evidence of prospect theory's validity in applications to sports; basketball, tennis and golf have all had significant findings under analysis guided by prospect theory. Why do we not see this in the NFL? One main reason could be the lumpier nature of NFL scoring. Basketball, golf and tennis all reward success with points frequently and on a small scale. Basketball uses ones, twos and threes. Golf uses ones and tennis, although they label them as 10 or 15 points, uses one real point. In football, however, teams are generally rewarded for success over the course of many plays in point groupings of threes and sevens. This means that, even if a team is increasingly motivated by trailing at halftime, they will have a difficult time representing this on the scoreboard. It takes longer to score in the NFL and, if a team does score, their progress is immediately reflected on the scoreboard and it is unlikely that they will score again quickly. This can also give the other team time to reassess their situation and become more motivated because now they are under greater threat to lose.

Football also has the increased importance of possession, in which the ball is given to the other side far less commonly than in basketball, tennis or golf. In golf, players actually never give up possession and are in control of their game the entire time. In football, when a team has possession, they are at a strong advantage because the opponent usually won't get an opportunity to score for a few minutes, and in the other aforementioned sports it could take a few seconds. Thus, data about whether the home team receives the ball after halftime would be greatly beneficial to future research.

Future research would greatly benefit from looking at play-by-play data to assess applications of prospect theory to football. How do defenses perform after an interception? How do offenses perform after falling behind in the 4th quarter? Or how does a quarterback perform after getting sacked? After entering the loss domain in these settings, are players or teams any more likely to enter the gains domain?

Overall, this study shows that prospect theory does not have significant effects when applied to halftime of NFL games. However, this does not mean that prospect theory does not have applications to football. Research in other sports has shown that it can consistently be applied in settings where players are consistently able to impact their outcomes in small point groupings. Future research in prospect theory's application to football would greatly benefit from delving into smaller scale analysis of NFL games.

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