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Assessing the Feasibility of NFL Sports Betting as an Alternative Investment Strategy Through Predictive Analytics

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A thesis submitted in partial fulfillment of the requirements for a baccalaureate degree in Finance with honors in Finance

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ABSTRACT

Sports gambling is a rapidly expanding industry throughout the United States, providing many individuals with the opportunity to achieve profits through several platforms and applications – much like the financial markets. While these markets are structured differently at their core, many qualitative similarities exist that suggest that profitable investment can be accomplished through either market. Investors typically analyze a number of accounting and financial metrics to assess which financial assets should be added to their portfolios; with an abundance of information easily accessible to the public, a similar analytical approach – using performance statistics and predictive modeling – can be used in the sports betting market to determine on which outcomes to wager.

This thesis explores the feasibility of predictive modeling strategies in the sports betting market of being an alternative to traditional investment strategies. Building on techniques explored in previous literature, a probit regression model using extensive, historical NFL data is developed and refined, and its returns are compared to those observed in the financial markets during the 2022 NFL season. The results of this study suggest that exploitable arbitrage opportunities exist that allow individuals to achieve returns at a rate greater than the financial markets, providing promising evidence than sports betting can be an alternative financial asset class.

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Chapter 1

Introduction

Throughout the United States, investment is a widely used mechanism for individuals to improve their wealth outside of the income associated with their occupation. Observed in many different facets of life – including but not limited to, real estate, IRA and 401K retirement accounts, 529 college saving plans, and general investment in bonds and the stock market – investment has been the long-held approach for growing one's money without having to commit to extra hours of labor. However, there is another alternative that individuals are using to improve their wealth (albeit with greater risk): sports betting.

Over the past several years, the popularity of sports betting has been on the rise throughout the country ever since 2018 when the Supreme Court ruled that the right to legalize gambling on sport outcomes resided with each individual state. Ever since the ruling, the sports betting market has boomed in numerous states in large part due to gamification and the ability to place wagers from any location at the convenience of one's smartphone. For many people, the potential to win exorbitant sums of money off a small wager is far too appealing, especially when a gambler profiting \$75 million off the Houston Astros winning the Major League Baseball (MLB) World Series makes national headlines, as seen in the case of "Mattress Mack" in Purdum (2022). Perhaps many sports fans dream of being highlighted on the Internet for turning a few dollars into thousands of dollars when successfully predicting the final score of an NFL game or having all legs hit in a 25-leg parlay, as seems to be the case in multiple weeks of any given football season. After all, who wouldn't want to be on the winning side of these scenarios? However, the probability of these scenarios occurring is slim to none, often akin to the likelihood of winning the lottery or getting struck by lightning. Luckily, sports betting is not limited to these "flash in the pan" scenarios, instead featuring many wagers that allow an individual to profit anywhere from a fraction to a multiple of their initial investment. While not as appealing as their higher-returning alternative, the latter options provide an opportunity for bettors to recognize potential profits with a much higher likelihood of success.

In the modern age of society, many people have access to advanced technology and extensive collections of data and statistics, which can be used to further increase one's probability of earning money through sports gambling compared to using a betting strategy that solely relies on an individual's gut instinct. Using such resources, the most experienced bettors tend to utilize strategies involving machine learning and predictive modeling to construct sports betting models that produce reliable returns over the course of a calendar year or professional sports season. While unconventional, numerous experienced gamblers have opted to engage in sports betting using such strategies instead of investing in the financial markets. Most notably, this sentiment can be connected to the case of Billy Walters – perhaps the most prominent, yet controversial, name involved in the sports betting industry – in Fish (2015).

At a high-level, many similarities exist between the sports betting and financial markets, as participants seek opportunities to earn money using analytical approaches. This makes one ponder a number of questions, including if investment in either market can be used interchangeably or in combination to better diversify one's portfolio. Using predictive analytics, in this study, I set out to develop an NFL-specific sports betting model with sufficient accuracy to generate returns greater than stock market indices, enabling sports betting to be classified as an alternative financial asset class.

Chapter 2

Background

For individuals that are novices or unfamiliar with the sports betting industry, gaining an understanding of its history and common terminology is essential for possessing the foundational knowledge that frames this thesis. The ensuing chapter provides an overview of the history of the sports betting market up to the present day and is followed by explanations of the relevant terminology that recurs throughout the remainder of this paper.

History of Sports Betting

The sports betting market is an industry that is rapidly expanding and growing in popularity. However, this was not always the case as its history is mired in controversy and public debate despite its underground operations for many years. Beginning in the 19th century, betting on horse racing and professional baseball gained popularity and was soon followed by college football and basketball in the early 20th century. This activity was predominantly underground but remained prevalent throughout the country due to the lack of laws and regulation until the Interstate Wire Act of 1961 illegalized the wire transmission of gambling instructions and information across state lines. As a result, sports betting became localized and remained largely underground in most states except Nevada where legalization occurred in 1931.

In the 1970's and 1980's, Delaware, Oregon, and Montana followed suit in legalizing sports betting and its variations (e.g., fantasy sports, pools, and sports lottery). The industry was gaining momentum but was halted when legislators passed the Professional and Amateur Sports Protection Act of 1992, banning sports gambling in all states except those where operations were already established. Despite these restrictions, online platforms – such as FanDuel and DraftKings – began operating in the early 2010's by offering monetary prizes to participants in daily fantasy sports. While these providers were largely popular among sports fans, their operations were met with legal controversy and disputes in the political landscapes of many states under the argument that such action was sports betting at its core, in turn putting the futures of these companies into question.

However, in May 2018, the trajectory of this largely prohibited industry changed for the better as the Supreme Court overturned PASPA. With the 1992 act deemed a violation of the Tenth Amendment of the Constitution, the power to legalize sports betting was turned over to the states, resulting in a wave of new sportsbooks and platforms throughout the United States as legalization went underway. Currently, Forbes (2023) reports that there are now 36 states – in addition to Washington, D.C. – where sports betting is legal, including 26 where mobile sports betting is permitted. With sportsbooks' ability to provide digital services in addition to new regulations to protect both bettors and the integrity of professional sports, the sports gambling market is anticipated to continue growing for the foreseeable future.

Overview of Terminology

The background information that is arguably more relevant for the remainder of this paper lies in sports gambling's betting types and odds framework. In modern sport betting platforms, there are three prevalent bet types – moneyline, point spread, and total points – the outcomes of which are frequently predicted in sports betting models. Each bet type focuses on a different outcome for each game contested with the risk and implied probability of such outcome being reflected in its

odds framework. The following subsections provide explanations of this framework and the major bet types as it relates to the NFL sports betting market.

Explanation of Odds

Prior to the explanation of bet types, one must first understand the odds framework that all bet types employ. Odds are set by sportsbooks and can either be expressed as a positive or negative number (e.g., -110 or +110). Negative odds indicate that an outcome is more likely to occur than an outcome with positive odds or one with negative odds but a lower absolute value. For example, an outcome with odds of -500 is more likely to occur than one with +200 or -150.

	Negative Odds		Positive Odds				
Odds	Implied Probability	Risk	Odds	Implied Probability	Risk		
-500	83.33%	Low	+500	16.67%	High		
-400	80.00%	Low	+400	20.00%	High		
-300	75.00%	Low	+300	25.00%	High		
-200	66.67%	Moderate	+200	33.33%	High		
-150	60.00%	Moderate	+150	40.00%	Moderate		
-100	50.00%	Moderate	+100	50.00%	Moderate		
Implied Probability = $\frac{ Odds }{ Odds + 100} \times 100$			Implied F	$Probability = \frac{100}{0 dds +}$	100 x 100		

Table 1. Implied Probability and Level of Risk for Sample Odds

At the foundation of this principle lies the implied probability and level of risk that can be extracted from the odds. As illustrated in Table 1, a bet's level of risk has an inverse relationship with its implied probability as a function of its odds. Note that this calculation varies based on whether odds are positive or negative and that the point of inflection is at ± 100 , indicating that by design, market odds can never be less than the absolute value of 100.

Additionally, odds indicate the potential payout and profit for a specific wager. A bet's payout is simply the amount wagered multiplied by the inverse of the implied probability whereas its profit is the difference between its payout and initial wager. More simply, using a standard betting unit of \$100, a bettor would have to wager the posted negative odds to win \$100 in profit (e.g., wagering \$110 to profit \$100 when the odds are set at -110) or wager \$100 to profit an amount equal to the posted positive odds (e.g., wagering \$100 to profit \$110 when the odds are set at +110).

Odds are also an indicator of a bet's expected return. For any game, bettors can either earn the potential payout at the implied probability or earn \$0 at a percentage expressed as the difference between 1 and the implied probability; as a result, a bet's expected payout will always be equal to its initial wager, and its expected profit will always be equal to \$0. While this principle seemingly challenges the profitability of sports betting, achieving neither a gain nor loss on an individual wager is unlikely in practice and is merely a reflection of the models that sportsbooks use when publishing their lines and odds. This holds true for all bet types, which are explained below.

Moneyline Betting

Moneyline (ML) bets are perhaps the simplest of the three major bet types, with potential outcomes framed by which team wins the game in question. For any given game, both teams are assigned odds based on their implied probability to win the contest. For example, assume that the New England Patriots are hosting the New York Jets with ML odds of -300 and +250, respectively. In this game, the Patriots would be the favorite to win, while the Jets would be the underdog based on their implied probabilities. If the spread of these odds is larger (e.g., -500 and

+400), then the Patriots would be considered a heavier favorite, and the Jets would be classified as more of a longshot. When the spread is smaller (e.g., -150 and +110), sportsbooks are indicating that they expect the result of the game to be more questionable than a game with a larger ML spread.

Note that in these examples and for most published lines, the sum of both teams' implied probabilities to win does not equal one; in fact, this sum is often greater than one. Sportsbooks design odds in this way to account for the possibility of a tie or draw. In the event of this outcome, the bet is considered push or void, resulting in the return of the initial wager to the bettor.

Point Spread Betting

Point spread bets – also referred to as spread bets throughout this paper and within the industry – possess an extra layer of complication compared to the moneyline bet type. Instead of focusing solely on which team wins a game, the outcomes of spread bets revolve around the margin of such victory. For each game played, teams are assigned opposite lines – e.g., +4.5 and -4.5, where a positive line indicates that a team is an underdog, and a negative line indicates that a team is the favorite – with odds that are relatively even as sportsbooks seek equal volume on both sides of the line. The set spread line establishes the target margin of victory (MOV) that the favorite must win by for a bettor's wager to win, otherwise wagers on the underdog are successful. A team's ability to outperform their assigned line is known as "covering the spread".

For example, assume that the Baltimore Ravens are visiting the Pittsburgh Steelers with point spreads of -6.5 and +6.5, respectively. In this scenario, gamblers on the Ravens (as the favorite) are relying on the team to win by more than 6.5 points for their bet to hit, whereas

gamblers on the Pittsburgh Steelers (as the underdog) will realize a return if the Steelers lose by less than 6.5 points or win the game outright. In games where the line does not have a decimal (e.g., Team A has a spread of +4 and Team B has a spread of -4), a push or void bet can occur if the game results in a point differential that is equivalent to the set line (i.e., Team A wins by four points and Team B loses by four points), resulting in neither a gain nor loss for both bettors. Figure 1 provides a visualization of these scenarios and their potential outcomes.

Scenario	Team A Score	Team B Score	Team A Actual Spread	Team B Actual Spread	Spread Outcome	
1	36	30	-6	+6	Team A	
2	36	33	-3	+3	Team B	
3	10	27	+17	-17	Team B	
4	36	32	-4	+4	Push - Void	
Team A Spi	Scenario 4: Push (Void) Team A spread = -4 Scenario 4: Push (Void) Team A wins 36-32 Team B Spread = +4					
Tean	n A Covers	Team	B Covers	Team I	B Covers	
Scenario 1: Team A wins 36-30		-4 -3 Sce Team A	+3 +4 nario 2: wins 36-33	Te	Scenario 3: eam B wins 27-10	

Figure 1. Sample Point Spread Scenarios and Outcomes

Total Points Betting

In terms of complexity, total points bets – commonly known as over-under (O/U) bets – fall in between moneyline and spread bets, but instead of betting on a team's ability to win a game, bettors wager on the combined score of a given game. For any game, sportsbooks assign an over and under line with relatively equivalent odds like the odds framework observed in point spread bets.

For example, assume the Green Bay Packers are hosting the Chicago Bears and the overunder line is set at 52.5, in which case the two potential outcomes for bettors are "Over 52.5" and "Under 52.5". Determining the winning bet is quite simple; if more than 52.5 points are scored, then the game hit the over, but if less than 52.5 points are scored, then the game hit the under. Like point spread bets, there is a possibility of a void bet when the combined score is equivalent to the total points line set (e.g., the O/U line is set at 50 and the teams combine for 50 points). Figure 2 provides a visualization of such scenarios and their outcomes.

Scenario	Team A Score	Tea	m B Score	То	tal P	oints	O/U Outo	come
1	37	20		57		Over		
2	27		23	50			Push - Void	
3	20		27	47		Under		
<i>O/U = 50</i>			Scena Team A w	rio 2: ins 27-	23			
	Over					Und	er	
	57		50	↑	47			0
	Scenario 1: Team A wins 37	-20	Push	(Void)	Τe	Scenar eam B wi	io 3: ns 27-20	

Figure 2. Sample Total Points (O/U) Outcomes

Miscellaneous Bet Types

The sports betting model developed and analyzed in this thesis focuses only on the three major bet types (i.e., moneyline, point spread, and total points); however, there are a number of other betting types that exist but are out of scope for this research. To allow for a greater understanding of the sports betting market, a brief explanation of each miscellaneous bet type – proposition, alternate line, futures, and parlay – follows.

Proposition betting – also referred to as prop betting – involves outcomes that are associated with individual players rather than an individual team or teams in a game. For example, proposition bettors can wager on who will score a touchdown in any given game, how many yards a player will gain, and if a quarterback will throw an interception, among many other outcome options. Proposition bets can be selected based on a list of potential events (e.g., a list of all players with assigned odds of scoring a touchdown in a game) or can be presented with an over-under line (e.g., the number of receiving yards for a specified player can either be over or under 43.5).

Bet Type	Original Lines	Odds	Alternate Line A	Odds	Alternate Line B	Odds		
	Team A -4.5	-110	-9.5	+200	+10.5	-1000		
	Team B +4.5	-110	+9.5	-300	-10.5	+750		
Point Spread	Increasing a spread in the direction of the favorite results in decreased odds for the favorite and							
	increased odds for the underdog; decreasing the spread or inverting the sign of the spread results							
	in increased or	dds for the	favorite and decrea	sed odds fo	or the underdog.			
	Over 52.5	-110	Over 60.5	+120	Over 39.5	-350		
Total Bainta	Under 52.5	-110	Under 60.5	-160	Under 39.5	+230		
Total Points	An increase in points in a line results in a decrease in Over odds and an increase in Under odds; a							
	decrease in points results in an increase in Over odds and a decrease in Under odds.							
	J. Smith Over 90.5 yards	-110	Over 95.5 yards	-140	Over 60.5 Yards	-500		
Proposition	J. Smith Under 90.5 yards	-110	Under 95.5 yards	+110	Under 60.5 Yards	+400		
	Increasing a prop line results in a decrease in Over odds and an increase in Under odds; a decrease							
	in the prop line results in increased Over odds and decreased Under odds.							

Table 2. Changes in Odds for Alternate Line Betting

Alternate line betting – also known as buying and selling points betting – relates to betting types with matching odds on both sides of the line (as seen in point spread and total points betting) and involves wagering on a modified line in exchange for higher odds and a lower potential return. As a bettor moves away from the original line set by a sportsbook, the associated odds increase or decrease based on movement below and above the established line, respectively; such adjustment in odds due to alternate line adjustment results in an inverse change in a bettor's potential return. Table 2 displays the effects of line modification on associated line odds.

Unlike previous bet types that focus on player and team outcomes for a given game, futures betting involves betting on a specified outcome for a player or team over the course of an entire season. Similar to a proposition bet, futures bets enable bettors to bet on a number of outcomes such as a player winning an end-of-season award, a team winning a championship, a player scoring a certain number of touchdowns, and a team winning a certain number of games – the latter two of which are presented like a total points bet with outcomes being on both sides of a line (e.g., a specific team winning over or under 9.5 games in a season).

Parlays allow bettors to combine multiple wagers into a single ticket for any given game, combination of games, or season (for futures bets). For a parlay to be successful, all included wagers – commonly referred to as legs – must be successful, otherwise there is no return for the gambler. Since all events must occur for a parlay to hit, the implied probability of a parlay is simply the product of the implied probability of each leg or independent event; potential payouts and profits are then calculated using the same method as a singular wager. Thus, as the number of legs increases, the odds and implied probability of the parlay decrease resulting in an increased potential return.

While predictive modeling can be useful for forecasting potential outcomes in each of these miscellaneous betting types, the model developed as part of this thesis focuses on solely moneyline, point spread, and total points wagers. However, these alternate betting types should be kept in mind for future research opportunities relating to sports gambling.

Chapter 3

Literature Review

As sports gambling has become legalized and more widespread in more states across the United States, sports betting models have become a popular resource used by individuals of varying wealth levels over the past several years. In order to understand the significance and methodology behind the construction of these models, one must first understand the topics that provide the foundation for individuals to seek opportunities to outperform markets in general. This literature review will begin with an analysis of the Efficient Market Hypothesis, which will then be applied to predictive markets and extended to models and investment strategies used in the rapidly growing sports betting market. Intermediate commentary on the parallels between the sports betting and financial markets will also be provided.

Efficient Market Hypothesis

The Efficient Market Hypothesis has been one of the most prevalent theories in financial and economic literature, becoming a controversial topic in 1965 when Eugene F. Fama published his initial thesis on the random walk hypothesis in the *Financial Analysts Journal*. Fama (1965) argues that contrary to the chartist (historical) and fundamental (intrinsic value) theories that are often used by financial market professionals, stock market prices are best depicted using the theory of random walks in an efficient market. In an efficient market, investors display rational and profit-maximizing behavior and attempt to predict future market values of securities using freely available information in an environment with no transaction costs. Such investing behavior would thus result in a market where actual prices of securities move randomly and

already reflect the effects of historical and anticipatory information, providing minimal opportunities for investor to profit from differences between their intrinsic value analysis and the actual stock price.

The Forms of Market Efficiency

Fama's hypothesis on the theory of random walks was heavily contested by other researchers between 1965 and 1970. In an attempt to address these opponents, Fama (1970) built on his initial theory by incorporating additional empirical work. Recognizing that all information may not be freely available to investors, Fama (1970) studies the adjustment of stock prices to different categories of information, establishing the three forms of market efficiency:

- 1) Weak Form: Investors have access to information that is limited to just historical prices.
- Semi-Strong Form: Investors have access to all public information, encompassing public company announcements in addition to historical data.
- 3) Strong Form: Investors have complete access to all public and private information.

The empirical studies in Fama (1970) conclude that regardless of the form of efficiency that exists in the market, the Efficient Market Hypothesis still persists as all investors are using the same subset of information to develop a rational investment strategy, resulting in stock prices that accurately reflect the true intrinsic value of the security.

Modern Market Inefficiency & Anomalies

Fama's (1970) revised hypothesis provides the foundation for discussions of market efficiency in modern day literature, academia, and professional practice. Even still, researchers have been able to point out various inefficiencies and anomalies that indicate the existence of profitable arbitrage opportunities. This concept is heavily illustrated in Schwert (2003), which highlights empirically several prominent inconsistencies with market efficiency over time, outlined below:

- The size effect, where small-capitalization firms generate average returns in excess of predictions using the capital-asset pricing model, a relationship investigated by Banz (1981) and Reinganum (1981).
- The value effect, where abnormal returns are generated by firms with earnings-to-price ratios and book-to-market ratios, as analyzed by Basu (1983).
- The weekend effect, where market returns are reliably negative during weekends when compared to returns observed during weekdays, as first recorded by French (1980).
- The dividend yield effect, where dividend yields are correlated to abnormal future stock returns. Fama and French (1988) first established this correlation, although the statistical methods used have been contested by many subsequent researchers.
- The January effect, a seasonal movement where small-capitalization firms generate abnormal returns during the first weeks of January, as researched by Thaler (1987) and others.

These numerous effects suggest that various asset-pricing models are inadequate and opportunities exist to realize profits by capitalizing on apparent market inefficiencies. Following the anomalies' initial published analysis in financial academic literature, many finance professionals and portfolio managers began incorporating variables such as earnings-to price ratios and dividend yields into their investment strategies to generate abnormal returns. It is obvious that evidence of these anomalies creates arbitrage opportunities in financial markets. However, Schwert (2003) notes that the effect of each inconsistency has seemingly weakened over time, indicating that a degree of market efficiency exists due to adjustments to new information.

When applied to financial professions and broadly to other markets – such as the sports betting market and predictive markets in general – two concepts become clear. First, markets possess a degree of efficiency, but evidence of inefficiencies exists, providing profitable opportunities for market participants. Additionally, market participants – most notably, funds and institutional investors in the financial markets in addition to sportsbooks in the sports betting markets – justifiably keep their models and analyses proprietary. Firms and individuals in these markets operate to generate returns by identifying arbitrage opportunities, but the publication of such models would theoretically reduce the differences in returns among market participants, ultimately diminishing their ability to outperform the market. The preceding review of research relating to the Efficient Market Hypothesis establishes the foundation for the remaining analysis of literature, where consideration of these takeaways will persist.

Predictive Markets & Market Efficiency

Prior to its application to sports gambling, the Efficient Market Hypothesis will first be examined in prediction markets, the superclass of the sports betting market. Peters (2022) defines a prediction market as a market where participants trade the outcomes of future events – including racetrack races, political elections, and commodity prices, to name a few – whereas participants trade financial instruments in financial markets. Like financial markets, however, prediction markets face similar questions of market efficiency by researchers.

Many researchers including Williams (1999) argue that prediction markets are more effective in examining market efficiency and rationality than financial markets for several reasons. When treating a bet as an asset, each wager has a well-defined expiration at which point its value is known and finalized. This pre-established termination also allows for quick feedback which can be used to facilitate a market participant's learning and enable improvements to one's strategies. This feature provides a compelling advantage over financial markets, in which assets generally have an indefinite termination point and experience fluctuations in value that may be difficult or irrelevant for investors to interpret for strategic improvements. Other factors – such as prediction markets consisting of a vast number of participants with access to extensive data sets as also observed in financial markets – enable prediction markets to be a relevant alternative for investigating market efficiency.

To examine inefficiencies in prediction markets, Thaler and Ziemba (1988) analyzed anomalies of parimutuel betting markets, specifically involving racetracks and lotteries. In their study, the most profound anomaly found with regularity was the favorite-longshot bias in the racetrack market. Empirical evidence derived from investigation into this anomaly suggests that horses favored to win a race do so at a greater frequency than the subjective probabilities indicate, providing an opportunity for racetrack bettors to generate excess returns. Discovery of this anomaly has led to the development of a handicapping betting strategy, a system in which empirical probabilities and market odds are compared to identify wagers with a positive expected value.

When investigating for anomalies in the lottery markets, the authors find that number patterns can be exploited in lotto games, allowing for an above average positive expected return to be generated when selecting numbers that are popularly perceived by the public. It must be noted that this approach is specific to lotto games that involve a shared pool of winnings and carry over to a future drawing if a grand prize is not won. While the overall probability of winning is substantially smaller compared to the probability of generating profit in the financial markets and other prediction markets, it is encouraging to see that a positive expected return can be generated even in games perceived to be of complete luck, although an investment strategy involving the lottery market may not be optimal when attempting to optimize risk and return. However, these findings provide substantial context for generating positive expected returns in the sports betting market, where information sets are substantially more extensive and accessible.

Parallels Between Sports Betting & Financial Markets

While the sports betting market is generally classified as a predictive market like those discussed above, many parallels tie it to the financial markets. Prior to analyzing the efficiency of the sports betting market, a structural and behavioral comparison of both markets must be made to identify relevant similarities and differences and further contextualize the discussion of efficiency in the sports betting market.

High-Level Similarities

Levitt (2004) identifies multiple similarities between the markets, many of which tying to concepts highlighted throughout this literature review. Perhaps the most obvious similarity is the existence of large sums of money, especially when frequent and affluent traders are considered. Relating to the conversation of market efficiency, participants in both markets – i.e., investors and bettors – actively seek profitable opportunities using their respective intuitions and information sets in an attempt to earn a share of the stakes. When compared to the trading of financial derivatives, sports bets also involve a transaction with a trader on both sides, resulting in a zero-sum game where one trader ultimately receives a financial benefit equivalent to the loss incurred by their counterpart. Thus, on the surface, these markets appear to be no different from one another.

Behavioral Similarities

Consideration of the study of behavioral finance further accentuates these similarities. In research, behavioral finance is framed by the investigation of rationality and psychology in an attempt to understand why investors act in the way that they do. Some of the most prominent concepts found in this area are outlined below:

Conformity and herd behavior, where investors' behavior is influenced by the behavior of other investors, as empirically studied in Bikhchandani and Sharma (2000). This can be observed in individuals – and even money managers at tax-exempt equity funds – investing in certain stocks based on the investment strategies of their peers, suggesting a degree of interdependence.

- Gambler's fallacy, which describes the tendency of investors to incorrectly perceive that subsequent market events occur dependently of one another, as investigated in Rakesh (2013). Applied to the stock market, gambler's fallacy is illustrated when an investor believes that a particular week's return will be positive solely due to a positive return in the previous week.
- Illusion of control, where investors exhibit an expectation of generating returns that is higher than the true probability warrants, as covered in Fellner (2009). This suggests an inappropriate degree of overconfidence in outcomes on which the investor has no material influence.
- Anchoring, where a piece of information is too heavily factored into an investor's decision-making process, as investigated in Andersen (2010). This can be observed when an individual irrationally invests in a stock based on a favorable metric or in over-reaction to a company news release.
- Hot hand fallacy, which incorporates recency bias and the belief that a stock will
 continue to generate positive returns because it has generated positive returns over a
 specified previously occurring period. Sheffrin and Belotti (2007) investigate this fallacy
 in depth, also noting that it is more prevalent for individual investors whereas
 professional investors tend to exhibit gambler's fallacy, although both concepts are
 comparable in nature.
- Noise, perhaps one of the most prominent financial concepts in literature, refers to information that misleads investors in their decision-making when it may have no effect on a company's stock price or future performance. Black (1986) famously explores this

topic, noting that it creates a form of inefficiency to develop in financial markets yet prevents individuals from fully capitalizing on arbitrage opportunities.

Although non-exhaustive, the literature studied above provides great context for understanding the attitudes and behaviors of some investors, especially those that deviate from rationality to some degree. However, these behavioral finance concepts are equally relevant in the world of sports betting. Take, for example, Fischer Black's iconic concept of noise; bettors can easily fall victim to statistics and information – e.g., player injuries – that ultimately have no substantial impact on the outcome of games. Additionally, performance streaks for both teams and players are a popular feat to track by many pundits but are not a guarantee of future performance when an entire season is considered; thus, bettors who weigh recent performance too heavily tend to exhibit gambler's or hot hand fallacies in their decision-making. Conformity and herd behavior are also often observed among many bettors, especially those that are influenced by the predictions of their peers as well as broadcasters and talk show personalities.

Structural Differences

With so many high-level and behavioral similarities identified between the sports betting market and the financial markets, one might ponder how exactly do they differ. The most notable difference that distinctly separates the markets is in their structures. As touched on in the previous section regarding prediction markets, the sports betting market involves the trading of sporting event outcomes with bets having a pre-determined terminal date and value. This is a notable contrast compared to the financial markets, where investors trade various financial instruments with an unknown terminal date and value. Levitt (2004) adds to this discussion of structural differences, focusing on the role of the market maker. In the financial markets, market makers are primarily tasked with simply matching buyers and sellers in transactions of financial assets like stocks. However, in the sports betting market, sportsbooks – serving as market makers – are tasked with announcing various lines for each game. Sportsbooks face the risk of a substantial loss if lines are mispriced, resulting in relatively small line adjustments in order to mitigate risk, although these modifications are miniscule compared to the price fluctuations observed in the financial markets.

Further analyzing how prices are set in the financial markets, Levitt observes the tendency for bookmakers to set lines that exploit bettors' biases rather than balancing the amount of money on each side of the line, resulting in an increase in gross profit margins for sportsbooks. This seemingly indicates that market makers are an active player in the sports betting market, which is distinctly different than their role in the financial markets. This also raises multiple questions regarding the efficiency of the sports betting market, which will be analyzed in the upcoming section.

Efficiency of the Sports Betting Market

Much like the financial markets, the efficiency of the sports betting market has been a contested topic in literature. Some argue that it is improbable to generate consistent returns on sports gambling outcomes and outperform sportsbooks, yet many choose to face this challenge and submit wagers using either heuristic or analytical decision-making. According to d'Astous and Di Gaspero (2014), most betting participants exhibit a dual mediation process in their gambling decision-making, combining both heuristics and analytics. However, to examine market

efficiency and for the purposes of the remaining chapters, analytical decision-making processes will be the focal point, building on the potential indication of market inefficiency due to behavioral irrationalities identified in the previous section. Using this focus, market efficiency will be examined through two separate lenses – the prevalence of favorite-longshot bias and the effects of momentum in the sports betting market.

Favorite-Longshot Bias

The favorite-longshot bias is prominent in the analysis of racetrack markets, indicating the tendency of favorites to win at a greater probability than underdogs. Extending this to the sports betting market, Golec and Tamarkin (1991) note two specific biases that can be exploited to generate returns in the NFL betting market. Their results show that betting on home teams and underdogs generally results in a higher winning probability than betting on away teams and favorites over the time period analyzed. Although the ability to fully exploit these inefficiencies depends on the size of transaction costs, these findings contradict the favorite-longshot bias found in previous studies.

Building on this study, Woodland and Woodland (1994) extend the investigation of favorite-longshot bias into the Major League Baseball (MLB) sports betting market. Through statistical tests of weak-form efficiency, the authors observe that favorite-longshot bias does not apply, as betting on longshots resulted in expected losses less than those subjectively implied in an efficient market, confirming the findings of Golec and Tamarkin's work. Woodland and Woodland (2001) also extend this study to the National Hockey League (NHL) betting market, finding that betting on underdogs generates higher returns than betting on favorites. This confirms that the favorite-longshot bias only exists in reverse in sports betting markets, serving as a profitable opportunity to generate returns.

Gray and Gray (1997) further investigated this phenomenon through analyzing various betting strategies in the NFL betting market. The authors find that several profitable strategies exist, especially relating to betting on home teams and underdogs. These findings confirm the results of previous studies, indicating that in the sports betting market, a new theory of home team-underdog bias replaces the previously held theory of favorite-longshot bias prevalent in racetrack markets.

Recent Performance & Momentum

In analyzing trading rules in the National Football League (NFL) point spreads market, Lacey (1990) finds a small set of profitable betting strategies – namely, utilizing performance against the spread and focusing on win and loss margins – but concludes that the NFL betting market generally displays weak-form efficiency. This indicates that recent performance has some predictive power when forecasting future outcomes; however, reliance on such information should be carefully balanced by bettors to avoid the pitfalls of gambler's and hot hand fallacies in their decision-making.

Dare and Holland (2004) builds on previous literature, adding to the discussion of the effects of momentum in the sports betting market. The authors' findings provide a contradiction to those in Lacey's original study; no evidence is found that significant returns can be generated using strategies solely incorporating trends in recent performance. However, evidence is found that supports that betting on a home underdog provides profitable opportunities for bettors, further confirming the results of the literature analyzed in the previous section.

Discussion of Market Efficiency

The literature studied above heavily contributes to the discussion of efficiency in the sports betting market. Most prominently, researchers find that betting on home teams and underdogs provides bettors a strategy for generating returns, reversing and replacing the previously-held theory of favorite-longshot bias seen in alternative prediction markets. The discussion of the effects of momentum results in contradictory evidence on the predictive power of recent performance yet provides researchers and modelists an avenue for further investigation. While much of the literature surrounding sports betting market efficiency is constrained by these two concepts, it is apparent that sports betting markets possess a degree of inefficiency, and arbitrage opportunities exist that can be exploited using statistical analysis and models. However, it is important to note that commissions and transaction costs may mitigate the exploitation of such opportunities, although this frames an important consideration for developing optimal models and wagering strategies.

Analysis of Sports Betting Models & Strategies – Early Work

Based on the previous analysis, true efficiency arguably does not exist in the sports betting market, allowing some individuals to achieve profits and outperform other individuals and occasionally, the sportsbooks offering specific lines to athletic contests. Assuming some of the same principles held in the Efficient Market Hypothesis – most notably, market participants exhibiting profit-maximizing behavior – individuals can earn profits through a variety of strategies, including heuristics and analytics incorporating sports betting models. Considering that sports gambling is a relatively new subject compared to other topics in the world of finance

and economics and that models are often kept confidential, literature is comparatively scarce but does provide a strong foundation for the development of future models and betting strategies.

Probit Modeling

One of the first publicly available sports betting models in financial literature was provided by Gray and Gray (1997) in combination with their analysis of sports betting market efficiency. Acknowledging that potential econometric problems existed when using the ordinary least squares (OLS) regression technique that had become standardized in financial model development, the authors opted to use a probit model, a regression approach that uses binary dependent variables to test the predictive power of various independent variables.

Using probit methodology, their model generated returns of 6.93% and 16.67% when betting on teams with a winning probability over 50% and 57.5%, respectively. The model finds that the impact of a team's recent performance is often overstated whereas a team's overall season performance is often understated. While the value of this study is held within these takeaways, it can be argued that the information set is rather limited and simplistic. The model only incorporated both teams' winning percentage relative to the spread for the previous four games and the season overall, completely excluding fundamental variables like yards gained and external variables like weather conditions. By incorporating additional variables, the model's predictive accuracy can be increased and further applications to moneyline and total points betting can be integrated.

Multiple Least Squares Regression Analysis

Bailey (2000) built on the model construction approach used in Gray and Gray (1997), focusing on the Australian Football League (AFL) sports betting market. Finding that differences in team statistics followed a relatively normal distribution, Bailey utilizes least squares regression analysis of 1997-98 historical data to identify arbitrage opportunities in the AFL sports betting market during the 1999 season. Through a multiple regression approach of 13 initial statistical measures, Bailey finds that four variables contribute a statistically significant degree of predictive power, resulting in 96 possible arbitrage opportunities out of 162 total games. In analyzing feasible wagering strategies, Bailey also finds that fractional Kelly models are more effective than the traditional Kelly model in generating returns while managing volatility.

Bailey's findings advanced literature surrounding the construction of sports betting model construction by incorporating wagering strategies although only variations of the Kelly model were investigated and popular strategies like the Sharpe Ratio and modern portfolio theory were excluded. In terms of the model itself, using a multiple regression analysis was applicable only due to differences in statistics following a relatively normal distribution. In cases where this condition does not apply, a probit approach is ideal, especially when independent variables are correlated or are linear functions of one another. Additionally, investigating only a small set of variables usings historical data from only two seasons raises major concerns on the predictive power of the model. One of the resulting variables in Bailey's study was the market price, which is fundamentally established by bookmakers using statistical analysis of variables potentially also included in Bailey's model. This further creates questions on the predictive accuracy of the model.

Takeaways from Early Sports Betting Models

Early literature surrounding the construction of sports betting models contained many flaws yet provided a strong foundation for the future development of models. Many of these models feature data that is restricted to only a few seasons or a limited set of statistical variables for initial analysis, often including variables – like market price or odds – that could lead to overestimation and inaccuracy. Data analysis approaches varied but the use of a probit model proved to be effective for broader purposes, especially when data does not follow a relatively normal distribution. Additionally, investigation into wagering strategies was rather primitive and lacked depth of exploration. Despite these shortcomings, early research allows future strategists to produce more accurate models with these areas for improvement in mind.

Analysis of Sports Betting Models & Strategies – Recent Studies

With the expansion of information available through online means, recent studies are able to address many of the deficiencies found in earlier models, allowing for the exploration of a larger set of statistical variables. Additionally, with the expansion of technology, researchers turn to more advanced methods – like machine learning – to develop enhanced sports betting models and further investigate sports betting bankroll management and investing strategies. The following two sections provide a review of such literature.

Machine Learning & Neural Network Approach

Hubacek, Sourek, and Zelezny (2019) built on many of these previous attempted models. By leveraging machine learning, implementing vast neural networks of player statistics, and
applying the modern portfolio theory, the authors found that an optimized betting model generated positive profits using NBA (National Basketball Association) data from the 2007-2014 seasons. The authors note that the single emphasis of many previous models focused solely on predictive accuracy, arguing that accurate models can only be profitable if they are uncorrelated with the models used by bookmaker's. To counter this effect, they developed a model using aggregated player statistics, neglecting the bookmaker's odds during its formation. In any given set of games, the model incorporates the considerations of profit mean and variance from the modern portfolio theory and proposes a selection of bets based on the probabilistic nature of an outcome occurring.

This model is perhaps the most extensive of the ones available for review. As noted by the authors, many previous models that they investigated were simplistic in nature and limited to small data sets of standard box-score statistics, neglecting those that reflect the performance of various player groups on individual teams. Through an initial analysis of 85 statistical factors, the authors' models performed best using a betting approach that optimizes the betting portfolio's Sharpe ratio, generating a positive return of 63% with a steady variance over the time period analyzed.

While the model can be viewed as superior to its predecessors, it can also be viewed as incomplete. It focuses solely on money line bets, not investigating its prediction accuracy on spreads and total points bets, which could generate greater returns if accurately forecasted considering the greater odds of such bet types in addition to the relatively even distribution of bettors on either side of the line. Additionally, the model's financial strategy was limited on the assumption that gamblers have a fixed budget or unit size. Other scenarios and investment strategies – such as a reinvestment strategy – could be investigated to further develop this model.

Sports Betting Investment Strategies

Hubacek, Sourek, Zelezny, and Uhrin (2021) further built on this machine learning betting model by investigating various bankroll management and sports betting investment strategies. Expanding on their initial model which focused solely on optimizing a bet's Sharpe Ratio outlined by the modern portfolio theory, the authors investigate additional strategies, including modifications to the modern portfolio theory and the Kelly criterion. Given the nature of sports betting, the Kelly criterion approach is the most widespread approach for bettors, focusing on maximizing the long-term growth of capital compared to balancing risk and return using the modern portfolio theory. Despite the noted popularity, the authors still pondered which approach would generate the best returns while most effectively mitigating risk.

Through their analysis of ten investment strategies, the authors find that modified Kelly approaches using either fractioning or drawdown constraints generally provide the best mean and median returns with lower volatility compared to alternative strategies, supporting its widespread use in practice. Additionally, due to "unrealistic mathematical assumptions," the original Kelly and Sharpe Ratio strategies are not practical for use in betting risk mitigation, further suggesting modifications to these original approaches must be made. This advances yet confirms the findings from Michael Bailey's initial 2000 study analyzed in the previous section of this literature review.

While this study addresses some of the shortcomings apparent in the authors' previous work, additional investigation remains desired. Since the investment approaches remain focused on moneyline betting, applications to spread and total point lines could provide a more impactful approach for a larger group of bettors. Additional considerations to a bettor's financial decisions could also add another layer of dimension to the authors' work and further develop an effective sports betting strategy.

Takeaways from Recent Sports Betting Models

Overall, recent literature is effective in addressing the common deficiencies in early sports betting models. While using more advanced methods, researchers are successful in incorporating information sets that are more extensive and complete. However, more is left to be desired. Namely, investigation into all three major bet types – moneyline, spreads, and total points – would paint a clearer picture of the line options that bettors face. This literature also provided a much deeper investigation into sports betting investment strategies as it relates to measuring risk and return, but additional considerations to these strategies as it relates to unit size – i.e., fixed amount, fixed percentage, reinvestment, etc. – would further improve the significance of the models.

Takeaways for Future Model Development

The preceding review of relevant literature outlines that financial markets experience some inefficiency, presenting arbitrage opportunities for some market participants. The concept of inefficiency remains consistent when applied to prediction markets and more specifically, the sports betting market. Through an analysis of available models, a strong foundation is established for the construction of future models, and existing areas of improvement serve as opportunities to enhance predictive power and generate greater profits.

Using the concepts from this literature review, numerous takeaways can be made for the future development of sports betting models and investment strategies. More specifically, in choosing a modeling technique, a probit model is more favorable than a standard OLS regression model when machine learning and other advanced techniques are not available. Once a modeling technique is chosen, an extensive set of statistics and information encompassing a period of multiple seasons should be incorporated. A team's season to date performance should be analyzed to mitigate the impact of a team's recent performance, while performance in recent seasons also provides an avenue for further exploration especially for games played early in the season. In consideration of potentially correlated data, market prices and odds set by bookmakers should not be included as model variables, and repetitive data in model outputs should be excluded to mitigate the effects of data redundancy. Finally, once a model is established and optimal for the analysis of risk and return, multiple wagering strategies should be analyzed with considerations to reinvestment and variations in unit size made.

Chapter 4

Research Methodology

To apply the takeaways derived from the preceding literature review towards the development of a sports betting model, one must first identify relevant data and information to be incorporated within such analysis. This chapter first explores the procedure established for transforming raw data into relevant information that can utilized in model development using machine-assisted probit regression techniques. Following the explanation of relevant data and variables, an overview of the model construction methodology is provided.

Explanation of Data & Variables

Data Acquisition & Preparation

To create an extensive set of data for regression analysis, I obtained historical market odds and base performance statistics (e.g., rushing yards, points scored, interceptions, etc.) were obtained from the following three resources detailed below.

- OddsWarehouse's Historical NFL Database, which provides historical lines and consensus odds for moneyline, spread, and total points bet types for all games played in the 2009-2021 NFL seasons.
- Pro Football Reference via Sports Reference, which provides decades worth of various statistics and game logs for all teams, players, and games played. Data from the 2009-2021 NFL seasons was pulled for model construction.

 FantasyData, which provides additional statistics – most notably, data on defense and special teams performance – that are not available through the previous two resources.
 Data from the 2009-2021 seasons was pulled for model construction.

Using these sources, I developed and standardized a single cohesive data set (reference Appendix A for a complete list of base statistics and information available in this data set). To address the absence of specific information, I used OddsShark's Historical NFL Football Odds & Handicapping Database to retrieve missing lines. In addition, I performed imputation to calculate missing odds based on the average historical market price for a predetermined line (e.g., to find the game odds associated with a home team's spread line of +1.5, the average market line price for a home team with a spread of +1.5 was calculated).

Data Aggregation

Using the takeaways from the literature review in the previous chapter, I aggregated game log base statistics to reflect a team's season-to-date and recent production as well as that team's performance in preceding seasons. In analyzing the number of games encompassed in a team's recent performance provided online by sportsbooks and other resources, the period length of such statistics varied between four and six games, providing multiple time periods to analyze for a team's recent performance.

	NFL Team Regular Season Performance, 2002-2021										
	Total Wins	Average Win %	Winning Seasons	.500 Seasons	Losing Seasons	Most Consecutive Winning Seasons	Avg. Consecutive Winning Seasons	Most Consecutive Losing Seasons	Avg. Consecutive Losing Seasons		
ARI	151	0.470	6	4	10	3	2	5	2		
ATL	164.5	0.513	9	2	9	5	2.75	4	2.25		
BAL	187	0.583	13	2	5	7	3.75	1	1		
BUF	150	0.467	6	2	12	3	1.6	9	3		
CAR	159.5	0.498	6	2	12	2	1.14	4	1.71		
CHI	153	0.477	6	4	10	4	2.5	4	2		
CIN	151	0.470	8	3	9	5	2.75	5	2.25		
CLE	108.5	0.338	3	0	17	1	1	12	5.67		
DAL	176	0.548	11	4	5	5	3	1	1		
DEN	175	0.546	10	3	7	6	4.33	5	2.33		
DET	112	0.349	4	0	16	2	1.33	9	4		
GB	203	0.632	15	1	4	8	4	2	1.33		
HOU	139	0.434	8	2	10	3	2.5	5	2		
IND	201	0.626	15	2	3	9	4.25	1	1		
JAX	118	0.368	4	2	14	4	2	6	3.5		
КС	179	0.557	13	1	6	9	3.5	3	2		
LAC	172	0.536	11	3	6	8	2.8	2	1.5		
LAR	142.5	0.443	6	2	12	5	2.67	10	4		
LV	121	0.376	3	3	14	2	1.5	7	4.67		
MIA	146	0.455	7	2	11	2	1.5	4	2.2		
MIN	165	0.514	9	3	8	5	3	2	1.6		
NYG	149	0.465	8	2	10	8	3.33	5	3.33		
NYJ	135	0.421	7	2	11	4	1.5	6	1.83		
NE	238	0.742	19	0	1	18	9.5	1	1		
NO	186	0.580	11	3	6	5	2.8	3	1.5		
PHI	182	0.567	13	2	5	6	3	2	1.25		
PIT	204.5	0.637	15	4	1	18	9.5	1	1		
SF	146.5	0.456	6	2	12	4	1.6	6	3		
SEA	186.5	0.582	14	0	6	9	7	4	2		
ТВ	143	0.444	8	0	12	2	1.5	5	2.4		
TEN	163	0.507	11	2	7	6	3.25	4	2.33		
WAS	130.5	0.407	5	1	14	2	1.5	5	2.8		
AVERAGE	160.563	0.500	9.063	2.031	8.906	5.625	3.074	4.469	2.296		

 Table 3. Analysis of Team Trends in Regular Season Performance

Additionally, an analysis of team performance between the 2002-2021 NFL seasons provides an indicator of team consistency. Looking at team trends in achieving winning seasons (see Table 3 above), I observed that on average, teams had 3.074 consecutive winning seasons and 2.296 consecutive losing seasons. Additionally, focusing on a team's ability to make the playoffs (see Table 4 below), I discovered that teams had a 1.957 season-long streak of making the playoffs and a 3.467 season-long streak of missing the playoffs on average. These averages suggest that teams are relatively consistent for up to three full seasons, providing an upper bound

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to limit the incorporation of a team's performance in previous seasons when developing a sports betting model.

		NFL Team Playoff Performance, 2002-2021										
	Wild Card Round	Divisional Round	Conference Championship	Super Bowl	Super Bowl	Playoff	Playoffs	Playoffs	Longest Playoff	Average Playoff	Longest Playoff	Average Playoff
	Losses	Losses	Losses	Losses	Wins	Appearances	Missed	Made %	Drought	Drought	Streak	Streak
ARI	2	1	1	1	0	5	15	0.25	6	5	2	1.66667
ATL	2	3	2	1	0	8	12	0.4	4	2.4	3	1.6
BAL	2	6	2	0	1	11	9	0.55	3	1.5	5	2.2
BUF	2	1	1	0	0	4	16	0.2	15	8	3	2
CAR	1	3	1	2	0	7	13	0.35	4	2.17	3	1.4
CHI	2	1	1	1	0	5	15	0.25	7	3	2	1.25
CIN	7	0	0	1	0	8	12	0.4	5	3	5	2
CLE	1	1	0	0	0	2	18	0.1	17	9	1	1
DAL	3	5	0	0	0	8	12	0.4	4	1.71	2	1.14
DEN	2	3	1	1	1	8	12	0.4	6	4	5	4
DET	3	0	0	0	0	3	17	0.15	9	4.25	1	1
GB	4	5	5	0	1	15	5	0.75	2	1.67	8	3.75
HOU	2	4	0	0	0	6	14	0.3	9	3.5	2	2
IND	5	5	2	1	1	14	6	0.7	3	1.5	9	3.5
JAX	1	1	1	0	0	3	17	0.15	9	4.25	1	1
КС	4	3	2	1	1	11	9	0.55	3	1.8	7	2.2
LAC	1	5	1	0	0	7	13	0.35	4	2.6	4	1.75
LAR	1	3	0	1	1	6	14	0.3	12	4.67	2	2
LV	2	0	0	1	0	3	17	0.15	13	8.5	1	1
MIA	2	0	0	0	0	2	18	0.1	7	6	1	1
MIN	3	2	2	0	0	7	13	0.35	3	1.86	2	1.17
NYG	4	1	0	0	2	7	13	0.35	5	3.25	4	1.75
NYJ	1	2	2	0	0	5	15	0.25	11	3.75	2	1.25
NE	3	2	4	3	5	17	3	0.85	1	1	11	5.67
NO	2	4	2	0	1	9	11	0.45	4	2.2	4	2.25
PHI	5	2	3	1	1	12	8	0.6	3	1.6	3	1.67
PIT	5	3	2	1	2	13	7	0.65	2	1.4	4	2.17
SF	0	1	3	2	0	6	14	0.3	8	4.67	3	1.5
SEA	4	7	0	2	1	14	6	0.7	2	1.2	5	3.5
ТВ	2	1	0	0	2	5	15	0.25	12	5	2	1.25
TEN	2	4	2	0	0	8	12	0.4	8	4	3	2
WAS	4	1	0	0	0	5	15	0.25	4	2.5	1	1
AVERAGE	2.625	2.500	1.250	0.625	0.625	7.625	12.375	0.381	6.406	3.467	3.469	1.957

Table 4. Analysis of Team Trends in Postseason Performance

Using these takeaways, game log base statistics were averaged over seven time periods (outlined in Table 5 below), providing numerous dimensions for downstream calculations and statistical analysis.

Performance in Current Season	Performance in Previous Seasons
Season to Date (STD)	Previous Season (P1S)
Previous Four Games (P4G)	Previous Two Seasons (P2S)
Previous Five Games (P5G)	Previous Three Seasons (P3S)
Previous Six Games (P6G)	

Table 5. Outline of Time Series Used for Statistical Averages

Data Analysis & Calculations

Based on the averages and time series outlined in the previous subsection, I calculated numerous metrics as determinants of team efficiency, allowing for more significant and accurate comparisons between NFL teams over a specified time period. A complete list of these measures and their respective calculations can be found in Appendix B.

Using these statistics, I calculated the differences between home team and away team performance in correlated statistical categories for each game occurring in the seasons observed (e.g., the difference between the home team's points for and the away team's points allowed). A larger difference would indicate that a team is stronger in a specific category which can be exploited in the teams' upcoming game, whereas a smaller or minuscule difference would indicate that the teams are evenly matched in a specific category which may not be as influential in the teams' upcoming matchup (reference Table 6 for examples of these differences and their significance). The result of this data analysis phase produced 112 differences in measures per time series – 784 total measures for all time series combined – available for regression analysis. A complete list of these differences can be found in Appendix C.

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Home Team Metric	Away Team	From the home team perspective, a large
	Correlated Metric	positive difference could indicate
Points For	Points Allowed	The home team can outscore their
		prospective opponent by a large margin.
Rushing Yards Against	Rushing Yards For	The home team can effectively defend
		against the away team's rushing attack.
Turnovers For	Turnovers Allowed	The home team can effectively force
		turnovers from the away team's offense.

Table 6. Examples & Significance of Differences in Measures

Model Construction Methodology

Due to its prevalence in relevant literature, I selected probit regression analysis through machine learning as the technique used for the development of the sports betting model. To provide a stronger foundation for the development of this model, this section first explores probit modeling in general before providing an overview of the probit technique applied towards the construction of the sports betting model.

Overview of Probit Modeling

Probit modeling is a regression methodology that is used to assess the effect of numerous predictor (independent) variables on a binary response (dependent or outcome) variable using maximum likelihood estimation techniques. Beyond the scope of this thesis, Hosmer, Lemeshow, and Sturdivant (2013) highlights that probit modeling can effectively be used in numerous research areas, such as politics and higher education where the model can help researchers identify factors that predicts who wins an election or gains admission into a graduate program, respectively. In scenarios where qualitative binary response variables exist, probit modeling is superior compared to traditional ordinary least squares (OLS) and linear probability models due to the possibility of the normality in errors and residuals assumption being violated in the latter modeling techniques.

Similar to other approaches, however, the potential effects of overfitting as well as correlation in predictor variables are prevalent. According to IBM, overfitting is observed when a model fits perfectly with its training data set but fails to accurately perform on out-of-sample data. In model development, overfitting can be compounded by the existence of correlated predictor variables, where one variable is collinear or otherwise associated with another. Both effects present a complex issue for researchers and statisticians but can be mitigated through expanding the size of the training set and applying regularization methods.

Regularization is especially effective when one does not know which noisy variables to exclude from regression analysis. Multiple regularization techniques – most prominently, ridge, lasso, and elastic net penalty – exist to reduce model noise and variance by penalizing the input variables with comparatively large and potentially correlated coefficients. In machine learning and regression programs, these regularization techniques can easily be selected through the manipulation of a model's alpha and lambda parameters, which control the distribution and strength of regularization penalties applied to model coefficients, respectively. Table 7 provides a summary of the primary regularization techniques and shows that an elastic net penalty approach is seemingly optimal for simultaneously addressing the effects of both overfitting and variable collinearity in the development of probit models.

Regularization Method	Alpha Value	Lambda Value	Effect on Model
Ridge	$\alpha = 0$	$\lambda > 0$	Proportionally penalizes correlated
$\begin{array}{c c} \text{Kluge} & u = 0 & \lambda > 0 \\ \text{coeffic} \end{array}$		coefficients to address variable collinearity	
		2 > 0	Selects variables with a statistically
Lasso	u – 1	λ > 0	significant coefficient to address overfitting
Electic Not Populty	$0 < \alpha < 1$	2 > 0	Balances traits of lasso and ridge techniques
Elastic Net Felialty	0 < u < 1	λ > 0	to address both overfitting and collinearity
No Regularization	a > 0	$\lambda = 0$	Fails to address potential overfitting and
INO REGULARIZATION	$\alpha \ge 0$	$\lambda = 0$	variable collinearity

Table 7. Summary of Regularization Techniques & Parameters

Overview of Model Construction

Using the probit methodology described above to assess the predictive power of each difference for each bet type (i.e., moneyline, spread, and total points), I conducted multiple multivariate regularized probit regressions. To ensure that the data met the pre-configuration binary conditions for Alteryx's probit regression tool, I filtered out contests that resulted in a push or void bet outcome – games that ultimately provided neither a gain nor loss for the bettor anyways – resulting in binary outcomes that were either "Home" or "Away" for spread and moneyline bets, or "Over" or "Under" for total points wagers.

In the model's configuration, I used "Home" and "Over" as the positive classes for target variables for each respective regression (i.e., home team winning the game for moneyline bets, home team covering the spread for spread bets, and points scored combining to be over the total points line, respectively). Additionally, to reduce the possibility of overfitting and minimize the effects of correlated predictor variables that share an underlying statistic (e.g., passing yards per attempt, yards per completion, and passer rating all contain the passing yards statistic), the model was constructed with an alpha of 0.05 and a lambda of 0.3 to create an elastic net penalty regularization.

These parameters were deemed the most appropriate based on the accuracy and number of variables that resulted from parameter testing when performing regressions of moneyline outcomes for all games in the training data set. The default lambda parameter in Alteryx was 0.5, so my focus of the initial phase of parameter testing was estimating alpha, which is the most influential variable in constructing regularization. At a constant lambda of 0.5, I found that the most accurate model using five measures (i.e., accuracy, precision, recall, F1 score, and true negative probability) had an alpha of 0.05. Transversely, I found that the most accurate model at an estimated alpha of 0.05 had a lambda of 0.3, establishing the parameters to be used for my sports betting model. Appendix D provides more in-depth detail on this parameter testing approach and the accuracy measures that resulted from each iteration.

For each bet type, I performed multiple regressions following the previously outlined parameters and configuration framework. Recognizing differences in the availability of data in addition to variability in team tendencies at various points of the season, I divided the original data set into seven partitions for additional analysis and streamlined model comparison, effectively creating eight total sets of data. Table 8 outlines the rationale behind each partition as well as which data is included in each partition for regression analysis.

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Subset of NFL Season	STD	P4G	P5G	P6G	P1S	P2S	P3S				
Week 1	Х	Х	Х	Х	1	✓	1				
Current season performance and stati	stics are not	applicable; s	ports bettin	g models mu	st rely on the	e teams' perf	ormance in				
previous seasons. Due	e to this, Wee	ek 1 games a	re excluded j	from all othe	r partitions o	of data.					
Regular Season & Playoffs (exc. Wk.	×	1	1	✓	1	√	✓				
A data set for all non-Week 1 games remains intact to allow for comparison with the subset models. Week 1 data is excluded											
due to the absence of current season performance explained above. Note that this was the same data set used for the initial											
	parameter testing.										
Regular Season (exc. Wk. 1)	✓	✓	✓	✓	✓	✓	✓				
The above data set is filtered to only	include regu	ılar season g	ames due to	these conte	sts' variabili	ty in team ap	proaches				
compared to playoff games. Week 1	data is exclu	ded due to th	he absence o	f current sea	ison perform	ance explain	ed above.				
Playoffs	×	✓	1	~	1	✓	×				
Playoff games are typically played tigh	hter compare	ed to regular	season gam	es with team	ns minimizing	player hold	outs due to				
injury as w	ell as the po	tential for pl	aying with a	suboptimal	strategy.						
Season Phase A (Weeks 2-5)	✓	Х	Х	Х	1	✓	✓				
Teams are still getting adjusted to new	v players and	d systems, ar	nd it is difficu	ılt to definiti	vely different	tiate betwee	n good and				
bad t	eams due to	small sample	e sizes in the	current seas	son.						
Season Phase B (Weeks 6-9)	✓	✓	✓	✓	1	✓	✓				
The majority of bye weeks sta	rt to occur; s	ample sizes j	for determini	ing a team's	true identity	become larg	er.				
Season Phase C (Weeks 10-13)	✓	✓	✓	✓	1	✓	✓				
Like Season Phase B, bye weeks contin	ue to occur,	and it becom	nes increasing	gly easier to	differentiate	between go	od and bad				
teams. Teams also see more player in	njuries comp	ared to previ	ous phases t	o due the ph	nysical dema	nds of the NI	L season.				
Season Phase D (Weeks 14-18)	✓	1	✓	✓	1	✓	✓				
By this point of the season, it is appar	ent who the	weak and st	rong teams a	are in the lea	gue. Additio	nally, team a	pproaches				
are modified as playoff-hopeful teams put more effort into winning games while weaker teams are able to settle for losses											
with the hopes of improving their draft position.											
Note: In cases where the week is greater than or equal to the number of games stipulated in the recent performance data set,											
the season-to-date statistic	s are used in	stead. For ex	ample, for ar	ny statistic in	week 6, P50	G = P6G = STE).				

Table 8. Summary of Season Subsets Used for Regression

Model Refinement & Comparison Methodology

In total, I estimated 24 regressions – for eight total subsets of data and three bet types – using the training set of historical data for 2,586 games from the 2012-2021 NFL seasons. To identify the most accurate model for any given partition, I compared the accuracy of the models produced for each bet type with the model incorporating data for all regular season and playoff games used as the benchmark for comparison. If a specific partitioned model performed more accurately than the benchmark, then it was deemed the most appropriate for that partition of the season. Alternatively, if a partitioned model was constructed with less accuracy, the benchmark model

would be used for further analysis. In cases where outperformance was not observed in all measures, overall accuracy and the F1 score were used to determine the best model due to the incorporation of precision, recall, and true negative percentage in their calculations.

Each produced model provides a formula of variables and coefficients to calculate any game's model output, which I refer to as the Power Index (PI). Using this output, the implied probability of a bet hitting for any game can be calculated as a function of its Power Index. Additionally, each model establishes an optimal probability cutoff (OPC), which is used as a threshold to distinguish between the positive and negative class in the models and provides a more accurate indicator on which gamblers can make their sports betting decisions. More specifically, if the implied probability for a specific bet is greater than the model's optimal probability cutoff, then a bettor should wager on the positive class bet (i.e., home team for moneyline and point spread bets, and over for bets on total points). Alternatively, if the implied probability is calculated to be less than the threshold, then the bettor should bet in favor of the negative class (i.e., away team for moneyline and point spread bets, and under for total points bets). The below formulas model the underlying calculations and the relationship between these outputs, where the Power Index is a function of the model's variables V scaled by coefficients c and the implied probability is a natural logarithmic function of the Power Index.

Power Index =
$$PI = f(V_1, V_2, ..., V_n) = I + c_1V_1 + c_2V_2 + ... + c_nV_n$$

Implied Probability = $IP = \frac{\ln (PI)}{1 + \ln (PI)} = \frac{1}{1 + \ln (-PI)}$
Bet on Positive Class (Home or Over): $IP \ge OPC$
Bet on Negative Class (Away or Under): $IP \le OPC$

In the absence of error terms and to find a more accurate model, I investigated the deviations between a bet's implied probability and the optimal probability cutoff established by its associated model. After segmenting the data based on the parallelism in a game's predicted and actual outcomes, I used the maximum average squared deviation to establish a conviction score for each betting type. This conviction score would be used to develop a more refined sports betting strategy where a bettor would only bet on games where the absolute value of the deviation between the implied probability and optimal probability is greater than the conviction score (play decision). Conversely, if the absolute value of the deviation is less than the conviction score, then the bettor is considered better off to not wager on that specific outcome (no play decision). The following formulas model this attempt to improve the accuracy of my sports betting models and optimize a sports gambler's wagering strategy, where X is the number of models analyzed and n is the number of games in the data set of each model.

Deviation = D = IP - OPC $Conviction \ Score = CS = MAX \left[\left(\frac{\sum_{n=1}^{n} D^{2}}{n} \right)_{1}, \left(\frac{\sum_{n=1}^{n} D^{2}}{n} \right)_{2}, ..., \left(\frac{\sum_{n=1}^{n} D^{2}}{n} \right)_{X} \right]$ $Play \ Decision: \ |D| \ge CS$ $No \ Play \ Decision: \ |D| < CS$ $Bet \ on \ Positive \ Class \ (Home \ or \ Over): \ IP \ge OPC + CS$ $Bet \ on \ Negative \ Class \ (Away \ or \ Under): \ IP \le OPC - CS$

Additionally, to account for gambler rationality, I added an extra threshold to the optimal strategy outlined above under the assumption that a rational bettor only wagers on opportunities

where the lines' implied probability using the models is greater than 50%. In the optimal strategy, there exists the potential for a gambler to wager on lines with less than a 50% probability of hitting if the absolute value of the deviation is greater than the conviction score. For example, assume the model provides an implied probability of 0.490 for a spread bet. In this scenario, the model suggests that the home team has a 49% probability of covering the spread, while the away team has a 51% probability of covering. Assuming that the threshold for betting on the home team is 0.476, then the gambler would bet on the home team spread despite the probability of the home team covering being less than 50%. To address scenarios like this, I added an additional threshold of 0.500 to develop a refined optimal strategy modeled by the following formulas below. More simply, the threshold of 0.500 replaces the original implied probability threshold in cases where the original threshold for betting on the negative class is greater than 0.500.

No Play Decision: |D| < CS AND $IP \le 0.5$

Play, Bet on Positive Class (Home or Over): $IP \ge (OPC + CS)_{Modified} \ge 0.5$ Play, Bet on Negative Class (Away or Under): $IP \le (OPC + CS)_{Modified} \le 0.5$

Using this approach, the following chapter outlines the process of identifying the optimal strategy for each bet type and applies the models to 2022 NFL season data – consisting of 273 games – to assess the out-of-sample performance of the optimal sports betting strategy.

Chapter 5

Model Results & Performance

Using the methodology outlined in the previous chapter, I performed a total of 24 regressions to account for the eight data partitions (i.e., the benchmark in addition to the seven season partitions outlined in the previous chapter) and three betting types that I examined. Through a comparison of the resulting models, this chapter identifies the most accurate sports betting model for each betting type and assesses out-of-sample performance when applied to the 2022 NFL season. Additionally, through a comparison of various wagering strategies, this chapter also identifies the optimal strategy for a gambler to maximize their returns when utilizing these models in future NFL seasons. Note that Appendix E and Appendix F can be referenced for greater information on the post-regression model variables and conviction score analysis for all bet types, respectively.

Moneyline Models

Performance on Historical Data

Through a comparison of partitioned moneyline models against the benchmark model (reference Table 9), I observed that the Week 1, Phase A, Phase D, and Playoffs models outperformed the benchmark in all accuracy measures. Additionally, due to outperformance in overall accuracy and the F1 score, I deemed that the partitioned models were most appropriate for the Phase B and Phase C subsets. Thus, for all partitions, partitioned models are most effective to be used for moneyline betting.

Model Name	Sample Size	Number of Variables	Overall Accuracy	Precision	Recall F1 Score		True Negative Percentage	Optimal Probability Cutuff
Week1-ML	150	67	0.813	0.831	0.81	0.821	0.795	0.497
RegSeason-ML	2325	133	0.672	0.724	0.662	0.691	0.619	0.558
Playoffs-ML	111	39	0.838	0.875	0.848	0.862	0.787	0.546
PhaseA-ML	601	115	0.705	0.739	0.732	0.735	0.664	0.535
PhaseB-ML	534	28	0.691	0.75	0.661	0.703	0.635	0.565
PhaseC-ML	561	37	0.677	0.7	0.725	0.712	0.647	0.515
PhaseD-ML	629	25	0.693	0.738	0.698	0.717	0.643	0.56
RegPost-ML	2436	129	0.673	0.717	0.682	0.699	0.623	0.547

Table 9. Comparison of Partitioned ML Models Against Benchmark

After analyzing the deviations between each game's implied probability and the optimal probability cutoff for each game's respective partitioned ML model, I determined the conviction score for this bet type to be 0.04. Thus, a bettor's optimal strategy can be modeled using the decision framework shown in Table 10.

Partition of	ML Model	OPC	CS	Bet on Home	Bet on Away	Do Not Bet
Season	Used			ML (Play)	ML (Play)	(No Play)
Week 1	Week1-ML	0.497	0.04	$IP \ge 0.537$	$IP \le 0.457$	0.457 < IP < 0.537
Phase A	PhaseA-ML	0.535	0.04	$IP \ge 0.575$	$IP \le 0.495$	0.495 < IP < 0.575
Phase B	PhaseB-ML	0.565	0.04	$IP \ge 0.605$	$IP \le 0.525$	0.525 < IP < 0.605
Phase C	PhaseC-ML	0.515	0.04	$IP \ge 0.555$	$IP \le 0.475$	0.475 < IP < 0.555
Phase D	PhaseD-ML	0.56	0.04	$IP \ge 0.6$	$IP \le 0.52$	0.52 < IP < 0.6
Playoffs	Playoffs-ML	0.546	0.04	$IP \ge 0.586$	$IP \le 0.506$	0.506 < IP < 0.586

 Table 10. Initial Optimal Strategy for Moneyline Betting

When comparing the accuracy of the models against the performance of the initial optimal strategy, I observed an increase between 2.5% and 3.5% in all accuracy measures for each model as shown in Table 11. This indicates that by adjusting the threshold for determining if a gambler should wager and which team to bet on through the incorporation of the conviction score, the likelihood of having an unsuccessful bet decreases.

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Partition of Season	Model Version	Sample Size	Accuracy	Precision	Recall	F1 Score	True Negative Percentage	PP-AP	PP-AN	PN-AP	PN-AN
	Original	150	0.807	0.829	0.797	0.813	0.784	63	13	16	58
Week 1	Conviction Added	134	0.851	0.836	0.884	0.859	0.869	61	12	8	53
	Difference	-16	0.044	0.007	0.087	0.046	0.085	-2	-1	-8	-5
	Original	601	0.704	0.738	0.729	0.734	0.662	245	87	91	178
Phase A	Conviction Added	520	0.729	0.755	0.758	0.756	0.696	219	71	70	160
	Difference	-81	0.025	0.017	0.029	0.022	0.034	-26	-16	-21	-18
	Original	534	0.689	0.747	0.661	0.701	0.634	195	66	100	173
Phase B	Conviction Added	436	0.722	0.785	0.683	0.731	0.665	164	45	76	151
	Difference	-98	0.033	0.038	0.022	0.03	0.031	-31	-21	-24	-22
	Original	561	0.674	0.696	0.725	0.71	0.644	224	98	85	154
Phase C	Conviction Added	463	0.715	0.722	0.774	0.747	0.705	195	75	57	136
	Difference	-98	0.041	0.026	0.049	0.037	0.061	-29	-23	-28	-18
	Original	629	0.692	0.737	0.695	0.716	0.641	244	87	107	191
Phase D	Conviction Added	495	0.707	0.764	0.701	0.731	0.646	197	61	84	153
	Difference	-134	0.015	0.027	0.006	0.015	0.005	-47	-26	-23	-38
	Original	111	0.829	0.873	0.833	0.853	0.771	55	8	11	37
Playoffs	Conviction Added	100	0.85	0.881	0.867	0.874	0.805	52	7	8	33
	Difference	-11	0.021	0.008	0.034	0.021	0.034	-3	-1	-3	-4
All Partitioned M	odels (Original)	2,586	0.703	0.741	0.714	0.727	0.659	1,026	359	410	791
All Partitioned Mode	els with Conviction	2,148	0.733	0.766	0.746	0.756	0.694	888	271	303	686
Differe	ence	-438	0.03	0.025	0.032	0.029	0.035	-138	-88	-107	-105

Table 11. Comparison in Performance of Original & Conviction ML Models

After further analyzing the initial optimal strategy, I observed that a modification needed to be made, specifically on the condition for betting on the away team's moneyline. For the Phase B, Phase D, and Playoff partitions, the framework advises that gamblers wager on the away team when the implied probability of the home team winning is 0.525, 0.52, and 0.506, respectively. In these cases, a gambler would be wagering on the visiting team when the implied probability of an away victory is less than 50%, a decision that a rational bettor likely would not make. Thus, with rationality in mind, these thresholds were adjusted to be 0.500, resulting in the updated optimal strategy and decision framework shown in Table 12.

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Partition of	ML Model	OPC	CS	Bet on Home	Bet on Away	Do Not Bet
Season	Used			ML (Play)	ML (Play)	(No Play)
Week 1	Week1-ML	0.497	0.04	$IP \ge 0.537$	$IP \le 0.457$	0.457 < IP < 0.537
Phase A	PhaseA-ML	0.535	0.04	$IP \ge 0.575$	$IP \le 0.495$	0.495 < IP < 0.575
Phase B	PhaseB-ML	0.565	0.04	$IP \ge 0.605$	$IP \le 0.5$	0.5 < IP < 0.605
Phase C	PhaseC-ML	0.515	0.04	$IP \ge 0.555$	$IP \le 0.475$	0.475 < IP < 0.555
Phase D	PhaseD-ML	0.56	0.04	$IP \ge 0.6$	$IP \le 0.5$	0.5 < IP < 0.6
Playoffs	Playoffs-ML	0.546	0.04	$IP \ge 0.586$	$IP \le 0.5$	0.5 < IP < 0.586

 Table 12. Refined Optimal Strategy for Moneyline Betting

These refined models marginally outperformed the initial optimal strategy, adding less than 1% for most cumulative performance measures as shown in Table 13. The benefit of this improvement is mostly captured in regular season games, specifically in the Phase B and Phase D partitions where gamblers are most likely to wager due to the number of games being played and the level of confidence that a bettor has on the identity of any given team. By establishing a more refined threshold for these partitions, the model's output recognizes increases of close to 1% in overall accuracy and almost 2% in the F1 score, further complementing the larger increases observed when adding conviction to the model. Thus, the refined optimal strategy outlined in this subsection is the most appropriate for moneyline betting.

Partition of Season	Model Version	Sample Size	Accuracy	Precision	Recall	F1 Score	True Negative Percentage	PP-AP	PP-AN	PN-AP	PN-AN
	Conviction Added	134	0.851	0.836	0.884	0.859	0.869	61	12	8	53
Week 1	Refined	134	0.851	0.836	0.884	0.859	0.869	61	12	8	53
	Difference	0	0	0	0	0	0	0	0	0	0
	Conviction Added	520	0.729	0.755	0.758	0.756	0.696	219	71	70	160
Phase A	Refined	520	0.729	0.755	0.758	0.756	0.696	219	71	70	160
	Difference	0	0	0	0	0	0	0	0	0	0
	Conviction Added	436	0.722	0.785	0.683	0.731	0.665	164	45	76	151
Phase B	Refined	408	0.73	0.785	0.716	0.749	0.673	164	45	65	134
	Difference	-28	0.008	0	0.033	0.018	0.008	0	0	-11	-17
	Conviction Added	463	0.715	0.722	0.774	0.747	0.705	195	75	57	136
Phase C	Refined	463	0.715	0.722	0.774	0.747	0.705	195	75	57	136
	Difference	0	0	0	0	0	0	0	0	0	0
	Conviction Added	495	0.707	0.764	0.701	0.731	0.646	197	61	84	153
Phase D	Refined	458	0.714	0.763	0.737	0.75	0.652	196	61	70	131
	Difference	-37	0.007	-0.001	0.036	0.019	0.006	-1	0	-14	-22
	Conviction Added	100	0.85	0.881	0.867	0.874	0.805	52	7	8	33
Playoffs	Refined	99	0.848	0.881	0.867	0.874	0.8	52	7	8	32
	Difference	-1	-0.002	0	0	0	-0.005	0	0	0	-1
All Partitioned Mod	els with Conviction	2,148	0.733	0.766	0.746	0.756	0.694	888	271	303	686
All Partitioned Models w	vith Conviction Refined	2,082	0.736	0.766	0.761	0.764	0.699	887	271	278	646
Differe	ence	-66	0.003	0	0.015	0.008	0.005	-1	0	-25	-40

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Table 13. Comparison in Performance of Conviction & Refined ML Models

Performance on 2022 NFL Data

As shown in Table 14, the partitioned moneyline models perform well on out-of-sample data, resulting in 60.8% accuracy with an F1 score of 0.658 for all partitions combined. At the partition-level, I observed that the models perform with accuracy above 50% for all partitions, ranging from 53.3% to 69.5% with performance in games earlier in the season (i.e., games in the Week 1 and Phase A partitions) lying on the lower end of this spectrum. When incorporating the play-no play strategy by adding the conviction score to the thresholds for decision making, the overall accuracy of the approach increases by 3.5% and is accompanied by an increase of 0.033 in the F1 score. Additionally, I also observed the same trend in the early season games as the model performs with lower accuracy than when applied to games later in the season.

Partition of Season	Model Version	Sample Size	Accuracy	Precision	Recall	F1 Score	True Negative Percentage	PP-AP	PP-AN	PN-AP	PN-AN
	Original	15	0.533	0.429	0.5	0.462	0.625	3	4	3	5
Week 1	Conviction Added	13	0.538	0.429	0.6	0.5	0.667	3	4	2	4
	Difference	-2	0.005	0	0.1	0.038	0.042	0	0	-1	-1
	Original	61	0.557	0.59	0.676	0.63	0.5	23	16	11	11
Phase A	Conviction Added	55	0.6	0.629	0.71	0.667	0.55	22	13	9	11
	Difference	-6	0.043	0.039	0.034	0.037	0.05	-1	-3	-2	0
	Original	53	0.566	0.63	0.567	0.596	0.5	17	10	13	13
Phase B	Conviction Added	41	0.61	0.667	0.609	0.636	0.55	14	7	9	11
	Difference	-12	0.044	0.037	0.042	0.04	0.05	-3	-3	-4	-2
	Original	57	0.632	0.667	0.727	0.696	0.571	24	12	9	12
Phase C	Conviction Added	50	0.7	0.719	0.793	0.754	0.667	23	9	6	12
	Difference	-7	0.068	0.052	0.066	0.058	0.096	-1	-3	-3	0
	Original	59	0.695	0.71	0.71	0.71	0.679	22	9	9	19
Phase D	Conviction Added	49	0.714	0.72	0.72	0.72	0.708	18	7	7	17
	Difference	-10	0.019	0.01	0.01	0.01	0.029	-4	-2	-2	-2
	Original	28	0.607	0.737	0.7	0.718	0.333	14	5	6	3
Playoffs	Conviction Added	27	0.593	0.737	0.7	0.718	0.25	14	5	6	2
	Difference	-1	-0.014	0	0	0	-0.083	0	0	0	-1
All Partitioned M	odels (Original)	273	0.608	0.648	0.669	0.658	0.553	103	56	51	63
All Partitioned Mode	els with Conviction	235	0.643	0.676	0.707	0.691	0.594	94	45	39	57
Differe	ence	-38	0.035	0.028	0.038	0.033	0.041	-9	-11	-12	-6

Table 14. Comparison in Out-of-Sample Performance of Original & Conviction ML Models

When refining the model in Table 15, I made the same observation as I did with the training data set as the refinement increased overall accuracy by 0.7% and increased the F1 score by 0.013. Additionally, considering the refinement did not affect the early-season partitions, I observed the same trend in the model performing with lower accuracy in all measures when comparing the early-season games to games later in the season.

Partition of Season	Model Version	Sample Size	Accuracy	Precision	Recall	F1 Score	True Negative Percentage	PP-AP	PP-AN	PN-AP	PN-AN
	Conviction Added	13	0.538	0.429	0.6	0.5	0.667	3	4	2	4
Week 1	Refined	13	0.538	0.429	0.6	0.5	0.667	3	4	2	4
	Difference	0	0	0	0	0	0	0	0	0	0
	Conviction Added	55	0.6	0.629	0.71	0.667	0.55	22	13	9	11
Phase A	Refined	55	0.6	0.629	0.71	0.667	0.55	22	13	9	11
	Difference	0	0	0	0	0	0	0	0	0	0
	Conviction Added	41	0.61	0.667	0.609	0.636	0.55	14	7	9	11
Phase B	Refined	36	0.611	0.667	0.667	0.667	0.533	14	7	7	8
	Difference	-5	0.001	0	0.058	0.031	-0.017	0	0	-2	-3
	Conviction Added	50	0.7	0.719	0.793	0.754	0.667	23	9	6	12
Phase C	Refined	50	0.7	0.719	0.793	0.754	0.667	23	9	6	12
	Difference	0	0	0	0	0	0	0	0	0	0
	Conviction Added	49	0.714	0.72	0.72	0.72	0.708	18	7	7	17
Phase D	Refined	45	0.756	0.72	0.818	0.766	0.8	18	7	4	16
	Difference	-4	0.042	0	0.098	0.046	0.092	0	0	-3	-1
	Conviction Added	27	0.593	0.737	0.7	0.718	0.25	14	5	6	2
Playoffs	Refined	27	0.593	0.737	0.7	0.718	0.25	14	5	6	2
-	Difference	0	0	0	0	0	0	0	0	0	0
All Partitioned Mode	els with Conviction	235	0.643	0.676	0.707	0.691	0.594	94	45	39	57
All Partitioned Models with Conviction Refined		226	0.65	0.676	0.734	0.704	0.609	94	45	34	53
Differe	ence	-9	0.007	0	0.027	0.013	0.015	0	0	-5	-4

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 Table 15. Comparison in Out-of-Sample Performance of Conviction & Refined ML Models

Based on the observations made about out-of-sample performance, I confirmed that the refined optimal strategy using partitioned models is most effective for moneyline betting (reference Appendix G for game-level moneyline predictions and results). Additionally, with the trends in early-season performance taken into account, it can be argued that a gambler would be better off not to bet on games falling in the Week 1 and Phase A partitions of the season. However, the model still performs with accuracy above 50% in these partitions, contradicting this argument for this betting type specifically.

Point Spread Models

Performance on Historical Data

Through a comparison of partitioned point spread models against the benchmark model (reference Table 16), I observed that the Week 1, Phase A, Phase B, and Playoffs models outperformed the benchmark in all accuracy measures. Additionally, due to outperformance in overall accuracy and the F1 score, I deemed that the partitioned model was most appropriate for the Phase C subset. Compared to the other models, the Phase D model failed to follow these trends and underperformed the benchmark model in four out of five measures. Due to this and the abnormally low number of variables in the Phase D model, I deemed the regular season model to be more appropriate for this phase of the season as it had a larger difference in measures where it outperformed the benchmark. Thus, partitioned models are most effective to be used for point spread betting for all partitions except Phase D, where the regular season model is best used.

Model Name	Sample Size	Number of Variables	Overall Accuracy	Precision	Recall	F1 Score	True Negative Percentage	Optimal Probability Cutuff
Week1-Spread	150	42	0.72	0.667	0.765	0.712	0.778	0.448
RegSeason-Spread	2325	130	0.591	0.577	0.625	0.6	0.608	0.485
Playoffs-Spread	111	39	0.856	0.843	0.843	0.843	0.867	0.463
PhaseA-Spread	601	116	0.697	0.673	0.733	0.702	0.724	0.468
PhaseB-Spread	534	52	0.65	0.637	0.62	0.628	0.661	0.482
PhaseC-Spread	561	35	0.601	0.605	0.57	0.587	0.597	0.506
PhaseD-Spread	629	3	0.552	0.548	0.586	0.566	0.556	0.498
RegPost-Spread	2436	121	0.599	0.593	0.571	0.582	0.604	0.496

Table 16. Comparison of Partitioned Spread Models Against Benchmark

After analyzing the deviations between each game's implied probability and the optimal probability cutoff for each game's respective partitioned point spread model, I determined the

conviction score for this bet type to be 0.028. Thus, a bettor's optimal strategy can be modeled using the decision framework shown in Table 17.

Partition of	Spread Model	OPC	CS	Bet on Home	Bet on Away	Do Not Bet
Season	Used			Spread (Play)	Spread (Play)	(No Play)
Week 1	Week1-Spread	0.448	0.028	$IP \ge 0.476$	$IP \le 0.42$	0.42 < IP < 0.476
Phase A	PhaseA-Spread	0.468	0.028	$IP \ge 0.496$	$IP \le 0.44$	0.44 < IP < 0.496
Phase B	PhaseB-Spread	0.482	0.028	$IP \ge 0.51$	$IP \le 0.454$	0.454 < IP < 0.51
Phase C	PhaseC-Spread	0.506	0.028	$IP \ge 0.534$	$IP \le 0.478$	0.478 < IP < 0.534
Phase D	RegSeason-Spread	0.485	0.028	$IP \ge 0.513$	$IP \le 0.457$	0.457 < IP < 0.513
Playoffs	Playoffs-Spread	0.463	0.028	$IP \ge 0.491$	$IP \le 0.435$	0.435 < IP < 0.491

Table 17. Initial Optimal Strategy for Point Spread Betting

Similar to the effect of incorporating the conviction score seen in the moneyline betting models, I also observed an increase in all accuracy measures for each spread model as shown in Table 18. This indicates that by adjusting the threshold for determining if a gambler should wager and which team's spread to bet on, the likelihood of having an unsuccessful bet decreases.

Partition of Season	Model Version	Sample Size	Accuracy	Precision	Recall	F1 Score	True Negative Percentage	РР-АР	PP-AN	PN-AP	PN-AN
	Original	150	0.713	0.662	0.75	0.703	0.767	51	26	17	56
Week 1	Conviction Added	137	0.723	0.676	0.742	0.708	0.768	46	22	16	53
	Difference	-13	0.01	0.014	-0.008	0.005	0.001	-5	-4	-1	-3
	Original	601	0.697	0.673	0.733	0.702	0.724	214	104	78	205
Phase A	Conviction Added	538	0.706	0.682	0.739	0.71	0.733	193	90	68	187
	Difference	-63	0.009	0.009	0.006	0.008	0.009	-21	-14	-10	-18
	Original	534	0.65	0.637	0.62	0.628	0.661	158	90	97	189
Phase B	Conviction Added	435	0.66	0.634	0.64	0.637	0.683	130	75	73	157
	Difference	-99	0.01	-0.003	0.02	0.009	0.022	-28	-15	-24	-32
	Original	561	0.595	0.6	0.559	0.579	0.591	156	104	123	178
Phase C	Conviction Added	451	0.621	0.624	0.594	0.609	0.618	133	80	91	147
	Difference	-110	0.026	0.024	0.035	0.03	0.027	-23	-24	-32	-31
	Original	629	0.606	0.6	0.631	0.615	0.612	198	132	116	183
Phase D	Conviction Added	474	0.633	0.636	0.657	0.646	0.629	159	91	83	141
	Difference	-155	0.027	0.036	0.026	0.031	0.017	-39	-41	-33	-42
	Original	111	0.847	0.84	0.824	0.832	0.852	42	8	9	52
Playoffs	Conviction Added	102	0.863	0.851	0.851	0.851	0.873	40	7	7	48
	Difference	-9	0.016	0.011	0.027	0.019	0.021	-2	-1	-2	-4
All Partitioned M	odels (Original)	2,586	0.65	0.638	0.651	0.644	0.662	819	464	440	863
All Partitioned Mode	els with Conviction	2,137	0.671	0.658	0.675	0.666	0.684	701	365	338	733
Differe	Difference		0.021	0.02	0.024	0.022	0.022	-118	-99	-102	-130

Table 18. Comparison in Performance of Original & Conviction Spread Models

However, after analyzing the thresholds to bet on the home team's spread, I decided that a modification needed to be made, specifically for the Week 1, Phase A, and Playoff partitions. In these partitions, the initial framework would advise a gambler to wager on the home team covering the spread in games where the implied probability is greater than the threshold but less than 0.500. Thus, to reflect rationality, the partitions' respective cutoffs were adjusted to 0.500, resulting in the updated optimal strategy shown in Table 19.

Partition of	Spread Model	OPC	CS	Bet on Home	Bet on Away	Do Not Bet
Season	Used			Spread (Play)	Spread (Play)	(No Play)
Week 1	Week1-Spread	0.448	0.028	$IP \ge 0.5$	$IP \le 0.42$	0.42 < IP < 0.5
Phase A	PhaseA-Spread	0.468	0.028	$IP \ge 0.5$	$IP \le 0.44$	0.44 < IP < 0.5
Phase B	PhaseB-Spread	0.482	0.028	$IP \ge 0.51$	$IP \le 0.454$	0.454 < IP < 0.51
Phase C	PhaseC-Spread	0.506	0.028	$IP \ge 0.534$	$IP \le 0.478$	0.478 < IP < 0.534
Phase D	RegSeason-Spread	0.485	0.028	$IP \ge 0.513$	$IP \le 0.457$	0.457 < IP < 0.513
Playoffs	Playoffs-Spread	0.463	0.028	$IP \ge 0.5$	$IP \le 0.435$	0.435 < IP < 0.5

Table 19. Refined Optimal Strategy for Point Spread Betting

When comparing the conviction models with and without refinement in Table 20, I observed only a marginal change in the model's performance, adding or subtracting less than 1% for any measure and partition combination. This is justified as the modification to the threshold classified only an additional 15 contests into the group of games where a gambler makes the decision not to bet. However, despite the minuscule change in accuracy, I decided to use the refined optimal strategy for point spread betting for further testing to remain consistent with the approach taken for the moneyline bet type.

Partition of Season	Model Version	Sample Size	Accuracy	Precision	Recall	F1 Score	True Negative Percentage	PP-AP	PP-AN	PN-AP	PN-AN
	Conviction Added	137	0.723	0.676	0.742	0.708	0.768	46	22	16	53
Week 1	Refined	133	0.729	0.688	0.733	0.71	0.768	44	20	16	53
	Difference	-4	0.006	0.012	-0.009	0.002	0	-2	-2	0	0
	Conviction Added	538	0.706	0.682	0.739	0.71	0.733	193	90	68	187
Phase A	Refined	534	0.708	0.685	0.737	0.71	0.733	191	88	68	187
	Difference	-4	0.002	0.003	-0.002	0	0	-2	-2	0	0
	Conviction Added	435	0.66	0.634	0.64	0.637	0.683	130	75	73	157
Phase B	Refined	433	0.661	0.634	0.644	0.639	0.684	130	75	72	156
	Difference	-2	0.001	0	0.004	0.002	0.001	0	0	-1	-1
	Conviction Added	451	0.621	0.624	0.594	0.609	0.618	133	80	91	147
Phase C	Refined	449	0.624	0.624	0.599	0.611	0.623	133	80	89	147
	Difference	-2	0.003	0	0.005	0.002	0.005	0	0	-2	0
	Conviction Added	474	0.633	0.636	0.657	0.646	0.629	159	91	83	141
Phase D	Refined	472	0.633	0.636	0.66	0.648	0.631	159	91	82	140
	Difference	-2	0	0	0.003	0.002	0.002	0	0	-1	-1
	Conviction Added	102	0.863	0.851	0.851	0.851	0.873	40	7	7	48
Playoffs	Refined	101	0.861	0.848	0.848	0.848	0.873	39	7	7	48
	Difference	-1	-0.002	-0.003	-0.003	-0.003	0	-1	0	0	0
All Partitioned Mode	els with Conviction	2,137	0.671	0.658	0.675	0.666	0.684	701	365	338	733
All Partitioned Models w	vith Conviction Refined	2,122	0.672	0.658	0.676	0.667	0.686	696	361	334	731
Differe	Difference		0.001	0	0.001	0.001	0.002	-5	-4	-4	-2

Table 20. Comparison in Performance of Conviction & Refined Spread Models

Performance on 2022 NFL Data

When applying the original spread models to the 2022 NFL season, I observed that the overall accuracy of the models failed to exceed 50% or 0.500 in any measure as shown in Table 21. This perhaps suggests the possibility of overfitting in these models as the overall accuracy observed in the training set was 65%. Alternatively, this observation could potentially just be a reflection of the evened structure of the point spread bet type or may be attributed to larger changes in league parity during the 2022 NFL season. It is also interesting to note how the models perform the best in the Phase D partition, confirming the early-season trend observed with the moneyline models. Additionally, after incorporating the conviction score into the thresholds for decision making, the models' overall performance improved by 1.3%, but these observations remained constant as no accuracy measure managed to exceed 0.500, and only the Phase B and Phase D models experienced partition-level performance above 50% accuracy.

Partition of Season	Model Version	Sample Size	Accuracy	Precision	Recall	F1 Score	True Negative Percentage	PP-AP	PP-AN	PN-AP	PN-AN
	Original	15	0.333	0.375	0.375	0.375	0.286	3	5	5	2
Week 1	Conviction Added	15	0.333	0.375	0.375	0.375	0.286	3	5	5	2
	Difference	0	0	0	0	0	0	0	0	0	0
	Original	61	0.475	0.438	0.5	0.467	0.517	14	18	14	15
Phase A	Conviction Added	52	0.5	0.481	0.52	0.5	0.52	13	14	12	13
	Difference	-9	0.025	0.043	0.02	0.033	0.003	-1	-4	-2	-2
	Original	53	0.472	0.464	0.5	0.481	0.48	13	15	13	12
Phase B	Conviction Added	46	0.522	0.545	0.5	0.522	0.5	12	10	12	12
	Difference	-7	0.05	0.081	0	0.041	0.02	-1	-5	-1	0
	Original	57	0.439	0.5	0.344	0.407	0.4	11	11	21	14
Phase C	Conviction Added	42	0.405	0.526	0.385	0.444	0.304	10	9	16	7
-	Difference	-15	-0.034	0.026	0.041	0.037	-0.096	-1	-2	-5	-7
	Original	59	0.542	0.5	0.556	0.526	0.586	15	15	12	17
Phase D	Conviction Added	44	0.591	0.542	0.65	0.591	0.65	13	11	7	13
	Difference	-15	0.049	0.042	0.094	0.065	0.064	-2	-4	-5	-4
	Original	28	0.321	0.316	0.5	0.387	0.333	6	13	6	3
Playoffs	Conviction Added	28	0.321	0.316	0.5	0.387	0.333	6	13	6	3
	Difference	0	0	0	0	0	0	0	0	0	0
All Partitioned M	odels (Original)	273	0.458	0.446	0.466	0.456	0.47	62	77	71	63
All Partitioned Mod	els with Conviction	227	0.471	0.479	0.496	0.487	0.463	57	62	58	50
Differe	Difference		0.013	0.033	0.03	0.031	-0.007	-5	-15	-13	-13

Table 21. Comparison in Out-of-Sample Performance of Original & Conviction Spread Models

By refining the model, these observations held true as shown in Table 22. Adjusting the thresholds for decision making to reflect rationality only classified an additional three games into the "no play" category, two of which were incorrect predictions. Thus, refinement only provided a marginal benefit for the optimal strategy and the previous observations remained consistent.

Partition of Season	Model Version	Sample Size	Accuracy	Precision	Recall	F1 Score	True Negative Percentage	PP-AP	PP-AN	PN-AP	PN-AN
	Conviction Added	15	0.333	0.375	0.375	0.375	0.286	3	5	5	2
Week 1	Refined	14	0.357	0.429	0.375	0.4	0.286	3	4	5	2
	Difference	-1	0.024	0.054	0	0.025	0	0	-1	0	0
	Conviction Added	52	0.5	0.481	0.52	0.5	0.52	13	14	12	13
Phase A	Refined	51	0.49	0.462	0.5	0.48	0.52	12	14	12	13
	Difference	-1	-0.01	-0.019	-0.02	-0.02	0	-1	0	0	0
	Conviction Added	46	0.522	0.545	0.5	0.522	0.5	12	10	12	12
Phase B	Refined	46	0.522	0.545	0.5	0.522	0.5	12	10	12	12
	Difference	0	0	0	0	0	0	0	0	0	0
	Conviction Added	42	0.405	0.526	0.385	0.444	0.304	10	9	16	7
Phase C	Refined	42	0.405	0.526	0.385	0.444	0.304	10	9	16	7
	Difference	0	0	0	0	0	0	0	0	0	0
	Conviction Added	44	0.591	0.542	0.65	0.591	0.65	13	11	7	13
Phase D	Refined	44	0.591	0.542	0.65	0.591	0.65	13	11	7	13
	Difference	0	0	0	0	0	0	0	0	0	0
	Conviction Added	28	0.321	0.316	0.5	0.387	0.333	6	13	6	3
Playoffs	Refined	27	0.333	0.333	0.5	0.4	0.333	6	12	6	3
	Difference	-1	0.012	0.017	0	0.013	0	0	-1	0	0
All Partitioned Mod	els with Conviction	227	0.471	0.479	0.496	0.487	0.463	57	62	58	50
All Partitioned Models w	vith Conviction Refined	224	0.473	0.483	0.491	0.487	0.463	56	60	58	50
Differe	ence	-3	0.002	0.004	-0.005	0	0	-1	-2	0	0

Table 22. Comparison in Out-of-Sample Performance of Conviction & Refined Spread Models

Based on these observations and a comparison of each iteration of the models, it appears that the refined optimal strategy using partitioned models is the most effective for point spread betting (reference Appendix H for game-level spread predictions and results). However, this strategy should be utilized with an extra layer of caution. With model performance below 50% accuracy cumulatively and for most partitions, a gambler could be better off to avoid point spread betting and opt for moneyline wagering instead. Logically, this approach is rational as it better mirrors the primary objective of NFL teams to win games outright rather than winning or losing by a specific point margin. While the returns for a spread bet are typically greater than that of a moneyline bet by design, the out-of-sample performance indicates that such returns in spread betting would be recognized with lower frequency than that of its moneyline counterpart based on accuracy alone.

Total Points Models

Performance on Historical Data

Through a comparison of partitioned total points models against the benchmark model (reference Table 23), I observed that the Week 1, Phase A, Phase C, Phase D, and Playoffs models outperformed the benchmark in all accuracy measures. Additionally, due to outperformance in overall accuracy and the F1 score, I deemed that the partitioned model was most appropriate for the Phase B subset. Thus, for all partitions, partitioned models are most effective to be used for total points betting.

Model Name	Sample Size	Number of Variables	Overall Accuracy	Precision	Recall	F1 Score	True Negative Percentage	Optimal Probability Cutuff
Week1-OU	150	68	0.787	0.825	0.712	0.765	0.759	0.54
RegSeason-OU	2325	125	0.596	0.578	0.632	0.604	0.617	0.48
Playoffs-OU	111	35	0.847	0.851	0.8	0.825	0.844	0.492
PhaseA-OU	601	109	0.684	0.692	0.673	0.682	0.676	0.523
PhaseB-OU	534	31	0.625	0.674	0.548	0.605	0.590	0.544
PhaseC-OU	561	35	0.668	0.636	0.641	0.638	0.696	0.471
PhaseD-OU	629	36	0.65	0.622	0.635	0.628	0.676	0.471
RegPost-OU	2436	123	0.597	0.581	0.605	0.593	0.613	0.482

Table 23. Comparison of Partitioned Total Points Models Against Benchmark

After analyzing the deviations between the implied probability and the optimal probability cutoff for each game's respective partitioned total points model, I determined the conviction score for this bet type to be 0.027. Thus, a bettor's optimal strategy can be modeled using the decision framework shown in Table 24.

Partition of	OU Model	OPC	CS	Bet on Over	Bet on Under	Do Not Bet
Season	Used			(Play)	(Play)	(No Play)
Week 1	Week1-OU	0.54	0.027	$IP \ge 0.567$	$IP \le 0.513$	0.513 < IP < 0.567
Phase A	PhaseA-OU	0.523	0.027	$IP \ge 0.55$	$IP \le 0.496$	0.496 < IP < 0.55
Phase B	PhaseB-OU	0.544	0.027	$IP \ge 0.571$	$IP \le 0.517$	0.517 < IP < 0.571
Phase C	PhaseC-OU	0.471	0.027	$IP \ge 0.498$	$IP \le 0.444$	0.444 < IP < 0.498
Phase D	PhaseD-OU	0.471	0.027	$IP \ge 0.498$	$IP \le 0.444$	0.444 < IP < 0.498
Playoffs	Playoffs-OU	0.492	0.027	$IP \ge 0.519$	$IP \le 0.465$	0.465 < IP < 0.519

Table 24. Initial Optimal Strategy for Total Points Betting

Similar to the effects of incorporating the conviction score seen in moneyline and point spread betting, I also observed an improvement in all accuracy measures in the total points models as shown in Table 25. While the observed improvement was not as substantial compared to the other bet types, the conviction models still resulted in a 1.2% increase in overall accuracy and a 1.4% increase in the F1 score. For the partitions for games later in the season (i.e., Phase D and Playoffs), I observed larger increases in performance as overall accuracy improved by 2% and 3.3% and the F1 score increased by 2.4% and 4.1% respectively. Thus, for all partitions, incorporating the conviction score allows the bettor to make a decision not to gamble on lines that statistically have a higher likelihood in resulting in an unsuccessful bet.

Partition of Season	Model Version	Sample Size	Accuracy	Precision	Recall	F1 Score	True Negative Percentage	PP-AP	PP-AN	PN-AP	PN-AN
	Original	150	0.78	0.823	0.699	0.756	0.75	51	11	22	66
Week 1	Conviction Added	143	0.776	0.82	0.704	0.758	0.744	50	11	21	61
	Difference	-7	-0.004	-0.003	0.005	0.002	-0.006	-1	0	-1	-5
	Original	601	0.681	0.689	0.667	0.678	0.672	202	91	101	207
Phase A	Conviction Added	535	0.69	0.704	0.668	0.686	0.676	181	76	90	188
	Difference	-66	0.009	0.015	0.001	0.008	0.004	-21	-15	-11	-19
	Original	534	0.625	0.674	0.548	0.605	0.59	153	74	126	181
Phase B	Conviction Added	432	0.627	0.705	0.532	0.606	0.574	124	52	109	147
	Difference	-102	0.002	0.031	-0.016	0.001	-0.016	-29	-22	-17	-34
	Original	561	0.668	0.636	0.641	0.638	0.696	164	94	92	211
Phase C	Conviction Added	480	0.677	0.667	0.634	0.65	0.686	144	72	83	181
	Difference	-81	0.009	0.031	-0.007	0.012	-0.01	-20	-22	-9	-30
	Original	629	0.65	0.622	0.635	0.628	0.676	186	113	107	223
Phase D	Conviction Added	524	0.67	0.638	0.667	0.652	0.7	162	92	81	189
	Difference	-105	0.02	0.016	0.032	0.024	0.024	-24	-21	-26	-34
	Original	111	0.838	0.848	0.78	0.813	0.831	39	7	11	54
Playoffs	Conviction Added	101	0.871	0.884	0.826	0.854	0.862	38	5	8	50
	Difference	-10	0.033	0.036	0.046	0.041	0.031	-1	-2	-3	-4
All Partitioned M	odels (Original)	2,586	0.672	0.671	0.634	0.652	0.672	795	390	459	942
All Partitioned Models with Conviction		2,215	0.684	0.694	0.641	0.666	0.675	699	308	392	816
Differe	Difference		0.012	0.023	0.007	0.014	0.003	-96	-82	-67	-126

Table 25. Comparison in Performance of Original & Conviction OU Models

However, after analyzing the thresholds to place a total points bet, I decided that a modification needed to be made for most partitions. In the Phase C and Phase D partitions, the initial framework advises a gambler to wager on an over outcome when the implied probability is greater than 0.498, leaving room for irrational decision making when the implied probability is greater than the 0.498 threshold but less than 0.500. Additionally, in the Week 1 and Phase B partitions, the strategy advises a bettor to irrationally wager on an under outcome when the implied probability for such an outcome is less than 0.500 (recall that the implied probability produced by the model is for betting on the positive class). Thus, to reflect rationality, the partitions' respective cutoffs were adjusted to 0.500, resulting in the updated optimal strategy shown in Table 26.

						61
Partition of	OU Model	OPC	CS	Bet on Over	Bet on Under	Do Not Bet
Season	Used			(Play)	(Play)	(No Play)
Week 1	Week1-OU	0.54	0.027	$IP \ge 0.567$	$IP \le 0.5$	0.5 < IP < 0.567
Phase A	PhaseA-OU	0.523	0.027	$IP \ge 0.55$	$IP \le 0.496$	0.496 < IP < 0.55
Phase B	PhaseB-OU	0.544	0.027	$IP \ge 0.571$	$IP \le 0.5$	0.5 < IP < 0.571
Phase C	PhaseC-OU	0.471	0.027	$IP \ge 0.5$	$IP \le 0.444$	0.444 < IP < 0.5
Phase D	PhaseD-OU	0.471	0.027	$IP \ge 0.5$	$IP \le 0.444$	0.444 < IP < 0.5
Playoffs	Playoffs-OU	0.492	0.027	$IP \ge 0.519$	$IP \le 0.465$	0.465 < IP < 0.519

Table 26. Refined Optimal Strategy for Total Points Betting

When comparing the optimal strategies with and without refinement in Table 27, I observed an incremental change in the model's performance, adding a maximum of 1.2% in any measure for all partitions combined. When comparing the partitions individually, I observed that the majority of the benefit held in refining the optimal strategy was captured in the Phase B partition, where the overall accuracy and the F1 score increased by 2.5% and 3.6% respectively. A smaller improvement was observed in all other partitions, and even in cases where the refinement resulted in a decrease in performance, the change was much less impactful and only underperformed the initial optimal strategy by a maximum of 0.6% for any partition-measure combination. Thus, to improve accuracy and remain consistent with the strategies used for the other bet types, I used the refined optimal strategy and associated models for further testing.

Partition of Season	Model Version	Sample Size	Accuracy	Precision	Recall	F1 Score	True Negative Percentage	PP-AP	PP-AN	PN-AP	PN-AN
Week 1	Conviction Added	143	0.776	0.82	0.704	0.758	0.744	50	11	21	61
	Refined	141	0.773	0.82	0.704	0.758	0.738	50	11	21	59
	Difference	-2	-0.003	0	0	0	-0.006	0	0	0	-2
Phase A	Conviction Added	535	0.69	0.704	0.668	0.686	0.676	181	76	90	188
	Refined	535	0.69	0.704	0.668	0.686	0.676	181	76	90	188
	Difference	0	0	0	0	0	0	0	0	0	0
Phase B	Conviction Added	432	0.627	0.705	0.532	0.606	0.574	124	52	109	147
	Refined	396	0.652	0.705	0.59	0.642	0.609	124	52	86	134
	Difference	-36	0.025	0	0.058	0.036	0.035	0	0	-23	-13
Phase C	Conviction Added	480	0.677	0.667	0.634	0.65	0.686	144	72	83	181
	Refined	473	0.681	0.676	0.631	0.653	0.684	142	68	83	180
	Difference	-7	0.004	0.009	-0.003	0.003	-0.002	-2	-4	0	-1
Phase D	Conviction Added	524	0.67	0.638	0.667	0.652	0.7	162	92	81	189
	Refined	518	0.672	0.639	0.665	0.652	0.703	159	90	80	189
	Difference	-6	0.002	0.001	-0.002	0	0.003	-3	-2	-1	0
Playoffs	Conviction Added	101	0.871	0.884	0.826	0.854	0.862	38	5	8	50
	Refined	101	0.871	0.884	0.826	0.854	0.862	38	5	8	50
	Difference	0	0	0	0	0	0	0	0	0	0
All Partitioned Models with Conviction		2,215	0.684	0.694	0.641	0.666	0.675	699	308	392	816
All Partitioned Models with Conviction Refined		2,164	0.69	0.697	0.653	0.674	0.685	694	302	368	800
Difference		-51	0.006	0.003	0.012	0.008	0.01	-5	-6	-24	-16

Table 27. Comparison in Performance of Conviction & Refined OU Models

Performance on 2022 NFL Data

As shown in Table 28, applying the original partitioned models to the 2022 NFL season resulted in overall accuracy below 50% albeit only by a fraction of a percentage. At the partition-level, I observed that the Phase D partition performed the best across most measures, interestingly followed by the Week 1 subset. Additionally, the deviation in performance between the training and testing sets for the total points models resembled that of what was observed in the point spread models. When incorporating the conviction score into the threshold for decision making, the overall performance marginally worsened as more than half of the games classified as a "no play" resulted in an accurate prediction (out of the 47 games that the framework advises a gambler not to make a play on, 24 of them resulted in a true prediction while 23 resulted in a false prediction).

Partition of Season	Model Version	Sample Size	Accuracy	Precision	Recall	F1 Score	True Negative Percentage	PP-AP	PP-AN	PN-AP	PN-AN
Week 1	Original	15	0.533	0.333	0.4	0.364	0.667	2	4	3	6
	Conviction Added	14	0.5	0.2	0.25	0.222	0.667	1	4	3	6
	Difference	-1	-0.033	-0.133	-0.15	-0.142	0	-1	0	0	0
Phase A	Original	61	0.459	0.393	0.407	0.4	0.515	11	17	16	17
	Conviction Added	53	0.453	0.333	0.318	0.326	0.531	7	14	15	17
	Difference	-8	-0.006	-0.06	-0.089	-0.074	0.016	-4	-3	-1	0
Phase B	Original	53	0.472	0.333	0.273	0.3	0.543	6	12	16	19
	Conviction Added	40	0.45	0.333	0.375	0.353	0.545	6	12	10	12
	Difference	-13	-0.022	0	0.102	0.053	0.002	0	0	-6	-7
Phase C	Original	57	0.491	0.5	0.448	0.473	0.484	13	13	16	15
	Conviction Added	46	0.5	0.5	0.478	0.489	0.5	11	11	12	12
	Difference	-11	0.009	0	0.03	0.016	0.016	-2	-2	-4	-3
Phase D	Original	59	0.61	0.609	0.5	0.549	0.611	14	9	14	22
	Conviction Added	47	0.617	0.625	0.455	0.526	0.613	10	6	12	19
	Difference	-12	0.007	0.016	-0.045	-0.023	0.002	-4	-3	-2	-3
Playoffs	Original	28	0.393	0.222	0.167	0.19	0.474	2	7	10	9
	Conviction Added	26	0.423	0.25	0.182	0.211	0.5	2	6	9	9
	Difference	-2	0.03	0.028	0.015	0.021	0.026	0	-1	-1	0
All Partitioned Models (Original)		273	0.498	0.436	0.39	0.412	0.54	48	62	75	88
All Partitioned Models with Conviction		226	0.496	0.411	0.378	0.394	0.551	37	53	61	75
Difference		-47	-0.002	-0.025	-0.012	-0.018	0.011	-11	-9	-14	-13

Table 28. Comparison in Out-of-Sample Performance of Original & Conviction OU Models

After refining the models to account for gambler rationality, these observations remained consistent as shown in Table 29. The refinement process eliminated an even number of true and false predictions (i.e., two of each) that a bettor would have otherwise made a play on, resulting in overall performance worsening by a fraction of a percentage. As a result, half of the partitions had accuracy greater than or equal to 50% with two of the remaining partitions falling within 5% of reaching the 50% benchmark.
Partition of Season	Model Version	Sample Size	Accuracy	Precision	Recall	F1 Score	True Negative Percentage	PP-AP	PP-AN	PN-AP	PN-AN
	Conviction Added	14	0.5	0.2	0.25	0.222	0.667	1	4	3	6
Week 1	Refined	14	0.5	0.2	0.25	0.222	0.667	1	4	3	6
	Difference	0	0	0	0	0	0	0	0	0	0
	Conviction Added	53	0.453	0.333	0.318	0.326	0.531	7	14	15	17
Phase A	Refined	53	0.453	0.333	0.318	0.326	0.531	7	14	15	17
	Difference	0	0	0	0	0	0	0	0	0	0
	Conviction Added	40	0.45	0.333	0.375	0.353	0.545	6	12	10	12
Phase B	Refined	37	0.459	0.333	0.429	0.375	0.579	6	12	8	11
	Difference	-3	0.009	0	0.054	0.022	0.034	0	0	-2	-1
	Conviction Added	46	0.5	0.5	0.478	0.489	0.5	11	11	12	12
Phase C	Refined	46	0.5	0.5	0.478	0.489	0.5	11	11	12	12
	Difference	0	0	0	0	0	0	0	0	0	0
	Conviction Added	47	0.617	0.625	0.455	0.526	0.613	10	6	12	19
Phase D	Refined	46	0.609	0.6	0.429	0.5	0.613	9	6	12	19
	Difference	-1	-0.008	-0.025	-0.026	-0.026	0	-1	0	0	0
	Conviction Added	26	0.423	0.25	0.182	0.211	0.5	2	6	9	9
Playoffs	Refined	26	0.423	0.25	0.182	0.211	0.5	2	6	9	9
	Difference	0	0	0	0	0	0	0	0	0	0
All Partitioned Mod	els with Conviction	226	0.496	0.411	0.378	0.394	0.551	37	53	61	75
All Partitioned Models w	ith Conviction Refined	222	0.495	0.404	0.379	0.391	0.556	36	53	59	74
Differe	ence	-4	-0.001	-0.007	0.001	-0.003	0.005	-1	0	-2	-1

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Table 29. Comparison in Out-of-Sample Performance of Conviction & Refined OU Models

Based on the observations made when comparing each iteration of model analysis, it appears that the original optimal strategy using partitioned models without conviction or refinement is the most effective for total points betting. However, for consistency and with only a 0.3% difference in overall accuracy taken into account, I decided to use the refined optimal strategy for future analysis (reference Appendix I for game-level total points predictions and results). Like the point spread strategy, a level of caution should also be used for this approach as overall out-of-sample accuracy falls below 50% albeit only by 0.5%. Intuitively, this is also rational when relating back to a team's objective for any given game; a team is primarily determined to win a game rather than combine for a specific number of points with its opponent. Thus, a gambler may be better off to opt for moneyline bets instead of total points bets as the out-of-sample performance indicates that the returns in total points betting would be recognized with lower frequency than that of its moneyline counterpart despite the inverse relationship in potential winnings.

Comparison to Sportsbook and Published Models

Using the observed performance in the models for each bet type, I decided to compare it to the models analyzed in the literature review in Chapter 3. However, since these published works failed to disclose the resulting variables and coefficients included in the models, it is not possible to apply these models to the 2012-2021 NFL training data or 2022 testing set to create a perfect comparison, especially considering the variety of sports for which the authors developed models. Out of the works analyzed, Gray and Gray (1997) provided the most direct comparison, having incorporated probit methodology into the development of their NFL sports betting model. Their model performed with accuracy between 50% and 57.5%, falling short of the out-of-sample performance that was observed in my refined optimal strategy, which performed with overall accuracy of 65% and a range of partition-level accuracy between 53.8% and 75.6%.

In terms of the underlying methodology of model development, there exists a much larger opportunity for a qualitative comparison between my model and those available in literature. In Chapter 3, I deemed many published models in academic literature to be relatively primitive, having incorporated a small subset of potential variables, data from a limited number of seasons, a limited scope, or flawed methodology. Compared to these models, my approach was much more robust, having incorporated 784 total measures for regression analysis using a training set of ten seasons of data which was further divided into partitions to identify better suited models based on the availability of information and trends in team performance at any point in the season. Ultimately, my refined optimal strategy provided models for all three prominent bet types, better addressing the overall picture of sports betting compared to the published models that only managed to address a single bet type.

Perhaps a more significant comparison can be made through a contrast of the models used by sportsbooks. While these underlying models are highly confidential, the implied probability associated with the moneyline odds set by sportsbooks can provide an indicator for who the oddsmakers expect to win, using the team with a higher implied probability of winning as the sportsbooks' predicted winner (reference Appendix J for a comparison of sportsbook and model predictions on a per-game basis). After comparing both predictions in the games that a bettor would make a wager on, I observed that my model performed more accurately than that of the sportsbooks using the training set, as shown in Table 30. Specifically, my model produced a successful moneyline bet in 287 games where the sportsbooks failed to accurately predict the winner, indicating the potential for an arbitrage opportunity when observing that the sportsbooks produced a successful bet in just 148 games where my model was inaccurate.

Refined Optimal Strategy

		Successful Bet	Unsuccessful Bet
Sportshook Model	Successful Bet	1,246	148
Sportsbook Model	Unsuccessful Bet	287	401

Table 30. Comparison of In-Sample Performance to Sportsbook Models

When performing the same analysis on out-of-sample 2022 NFL data, I observed that the models had closer performance to one another as displayed in Table 31. Specifically, my model was accurate in 24 games where the sportsbooks' favorite failed to win, whereas the sportsbook was successful in 28 games where the roles were reversed. Despite the slight underperformance of my model when applied to out-of-sample data, the ability for the refined optimal strategy to outperform the sportsbooks at a nearly even rate indicates the existence of arbitrage opportunities

in the NFL sports betting market that can be exploited using predictive modeling, specifically the methodology used in the construction of my models.

		Successful Bet	Unsuccessful Bet
Sportshook Model	Successful Bet	123	28
Sportsbook Widdel	Unsuccessful Bet	24	51

Refined Optimal Strategy

Table 31. Comparison of Out-of-Sample Performance to Sportsbook Models

Summary of the Optimal Sports Betting Strategy

In this chapter, I analyzed the results and performance the sports betting models that I constructed, observing that the refined optimal strategy performs the best for all bet types when using in-sample data compared to the previous iterations included in my analysis. After applying this strategy (visualized in Figure 3) to an out-of-sample set of 2022 NFL data, I observed that the moneyline models still performed well, but the models for the point spread and total points bet types performed with overall accuracy below 50% – albeit within 3% of this – indicating that moneyline betting provides the safest opportunity for sports gamblers. Additionally, when comparing the refined optimal strategy to other models available in literature, I observed that its underlying methodology was much more robust, allowing for more accurate theoretical and actual predictions. My model also performed well against the moneyline model used by sportsbooks, effectively identifying exploitable arbitrage opportunities and providing another layer of credibility for my constructed model.

Partition of Season	Bet Type		D	ecision F	ramewor	k	
	N/I		Bet Away	DN	P	Bet Home	
	IVIL	IP=0	0.4	57	0.537		1
Week 1	Sproad		Bet Away	DNP		Bet Home	
WEEK 1	Spread	IP=0	0.4	42 (0.5		1
	Total Points		Bet Away		DNP	Bet Over	
	Total Points	IP=0		(0.5 0.5	67	1
	MI		Bet Away		DNP	Bet Home	
		IP=0		0.	495 0.5	575	1
Phase A	Spread		Bet Away	DNP		Bet Home	
Those M	opreud	IP=0	0.4	44 (0.5		1
	Total Points		Bet Under		DNP	Bet Over	
	Total Total	IP=0		0.496	0.55		1
	ML		Bet Away		DNP	Bet Home	
		IP=0			0.5 0.6	505	1
Phase B	Spread		Bet Away	DNP		Bet Home	
Those b	opreud	IP=0	0.4	154 0	.51		1
	Total Points		Bet Under		DNP	Bet Over	
	Total Total	IP=0		(0.5 0.5	571	1
	м		Bet Away	D	NP	Bet Home	
	IVIL	IP=0		0.475	0.555		1
Phase C	Spread		Bet Away	D	NP	Bet Home	
		IP=0		0.478	0.534		1
	Total Points		Bet Under	DNP		Bet Over	
		IP=0	0.4	44 (0.5		1
	ML		Bet Away		DNP	Bet Home	
		IP=0		(0.5 0.	.6	1
Phase D	Spread		Bet Away	D	NP	Bet Home	
		IP=0		0.457	0.513		1
	Total Points		Bet Under	DNP		Bet Over	
		IP=0	0.4	44 ().5	_	1
	ML		Bet Away		DNP	Bet Home	
		IP=0		(0.5 0.5	86	1
Playoffs	Spread		Bet Away	DNP		Bet Home	
		1P=0	0.4	35 (1.5		1
	Total Points		Bet Under	D	NP	Bet Over	
	Total Points	IP=0		0.465	0.519		1

Figure 3. Summary of the Optimal Sports Betting Strategy

Chapter 6

Model Returns & Financial Analysis

Using the refined optimal strategy for each bet type identified in the previous chapter, I was able to attach a return for each betting decision based on the publicly set odds and the accuracy of the predicted outcome. Using a standard betting unit of \$10, the following sections explore the returns observed for each bet type, which are ultimately compared to the returns of financial assets to best assess the feasibility of sports betting as an alternative financial instrument.

Season	Number of Games Bet	Total Return	Return Per Game	Standard Deviation	Variance
2012	216	47.939	0.222	0.852	0.726
2013	211	34.675	0.164	0.912	0.832
2014	220	48.674	0.221	0.83	0.689
2015	201	36.17	0.18	0.903	0.815
2016	189	39.81	0.211	0.862	0.743
2017	203	31.511	0.155	0.829	0.688
2018	202	53.093	0.263	0.842	0.709
2019	205	48.851	0.238	0.956	0.914
2020	215	40.712	0.189	0.802	0.643
2021	220	36.299	0.165	0.865	0.749
2022	226	6.309	0.028	0.855	0.732

Moneyline Model Returns

Table 32. Season Returns in Moneyline Betting

When calculating the returns resulting from the use of the refined optimal strategy for moneyline betting (reference Table 32), I observed promising total returns in the training set as the 2012-2021 NFL seasons produced a range of 36 to 53 units in returns per season. On a per-game basis,

this translates to a maximum unit gain of 0.263 per game. Additionally, it is important to note the relatively large variance and standard deviations associated with these returns, which given the nature of sports betting as an "all or nothing" strategy to recognize profit, are expected and will remain consistent for point spread and total points betting.

When comparing these returns to those calculated using the out-of-sample data, I observed that the 2022 NFL season only produced a gain of 0.028 units per game, resulting in a total return of 6.309 units for a profit of 5.309 units. This was comparatively lower than what was observed in-sample, which was also expected given the underperformance of the refined optimal strategy observed in the previous chapter. However, given the model's ability to generate positive returns in a single five-month NFL season, these results still provide promising evidence for using my sports betting approach to generate returns.

Point Spread Model Returns

Using the same approach for point spread betting (reference Table 33), I observed even greater in-sample returns with the highest-performing season returning 0.378 units per game and 77.065 cumulative units. However, when applied to the 2022 NFL season, I observed that the refined optimal strategy generated a loss of 0.097 units per game and 21.665 units over the course of the season. Given the structure of point spread bets and the observation that the out-of-sample testing resulted in overall accuracy below 50%, this observation was expected. Additional extrinsic factors may contribute to this effect as perhaps there was more observed parity in the 2022 NFL season compared to previous years (i.e., more teams perform at a rate closer to the average team's performance compared to preceding seasons). Nevertheless, the loss experienced

by a prospective gambler indicates that point spread betting using the refined optimal strategy is not a reliable approach for generating returns. However, there is potential to improve the reliability of using my model for betting on spreads, namely in adjusting the thresholds for decision making or opting for betting on alternate point spread lines.

Season	Number of Games Bet	Total Return	Return Per Game	Standard Deviation	Variance
2012	214	70.52	0.33	0.921	0.848
2013	218	67.204	0.308	0.923	0.851
2014	218	61.791	0.283	0.933	0.871
2015	207	52.267	0.252	0.921	0.848
2016	197	73.234	0.372	0.894	0.799
2017	214	67.198	0.314	0.92	0.846
2018	204	77.065	0.378	0.893	0.798
2019	203	61.887	0.305	0.919	0.845
2020	222	58.652	0.264	0.934	0.872
2021	225	64.941	0.289	0.905	0.819
2022	224	-21.665	-0.097	0.955	0.913

Table 33. Season Returns in Point Spread Betting

Total Points Model Returns

For the total points bet type, I made similar observations upon calculating the returns for the refined optimal strategy (reference Table 34). When applied in-sample, the model produced returns that exceeded those observed in the other two bet types, generating a maximum average return of 0.428 units per game and 90.142 units aggregated on the season. Using the in-sample performance of my model alone, it appears that betting on total points lines using the refined optimal strategy produces the most reliable returns.

Season	Number of Games Bet	Total Return	Return Per Game	Standard Deviation	Variance
2012	218	76.978	0.353	0.904	0.817
2013	214	66.588	0.311	0.917	0.841
2014	230	76.992	0.335	0.913	0.833
2015	214	44.778	0.209	0.927	0.86
2016	207	62.79	0.303	0.894	0.8
2017	205	87.83	0.428	0.868	0.754
2018	213	89.372	0.42	0.871	0.759
2019	222	66.441	0.299	0.922	0.849
2020	219	73.741	0.337	0.909	0.827
2021	222	90.142	0.406	0.848	0.719
2022	222	-12.137	-0.055	0.956	0.914

Table 34. Season Returns in Total Points Betting

However, this observation does not hold true when assessing the out-of-sample performance of the model. During the 2022 NFL season, the model generated a per-game loss of 0.055 units, which aggregates to a 12.137-unit loss on the season. While the loss observed in total points betting is not as drastic compared to what was observed in point spread betting, it still indicates that the use of the current refined optimal strategy is not a reliable strategy for generating returns in sports gambling. To mitigate this loss, a gambler can opt to bet on alternate total points lines where the probability of a successful bet is higher. Additionally, in the case that a gambler chooses to wager on the set total points line, further modification to the thresholds for decision making can be made to limit the likelihood of having an unsuccessful bet.

Model Returns & Potential Approaches

Based on the previous analyses, it appears that the refined optimal strategy for moneyline betting provides the most reliable returns for sports bettors given its ability to generate a positive return compared to the losses observed in my model's application in point spread and total points betting. This ultimately provides sports gamblers with multiple options for personalizing their own sports betting approach using the refined optimal strategy. Given the observed returns for each bet type, the most apparent strategy would be to only place moneyline wagers and avoid placing bets on point spread and total points outcomes. Alternatively, in the event that the model's resulting implied probability for either of the latter bet types deviates from its associated decision threshold by a significant difference, the bettor can opt to use the moneyline model as a hedging mechanism to improve the likelihood of generating a return and mitigate the risk associated with the more uncertain bet types. Additionally, a bettor could opt to place a bet on an alternate line for either bet type, effectively increasing the probability of having a successful bet while trading away potential returns.

Intrinsically, another approach would be to further modify the model, specifically as it relates to the underlying conviction scores and thresholds for decision making. For example, adjusting the thresholds to incorporate a multiple of the conviction score rather than just the conviction score would theoretically improve the accuracy of the models by reducing the number of plays made on lines with a more contentious implied probability (i.e., an implied probability closer to 50% or the established thresholds in each partitioned model). Further quantitative analysis would need to be conducted to test these theoretical approaches, but there are apparent opportunities to improve the likelihood of generating positive returns using my current sports betting strategic framework.

Discussion of Parlay Returns

A discussion of sports betting is seemingly incomplete without touching on parlays given the betting option's wide popularity for many sportsbook users. As described in Chapter 2, parlays allow a gambler to combine multiple bets into a single wager, effectively increasing their potential return with a tradeoff in the probability that the entire ticket is successful. To put this concept into practice, I incorporated parlays into the refined optimal strategy by establishing a decision-making framework for constructing a parlay. In essence, for any given game, a gambler would combine the wagers that they would otherwise make an individual bet on. For example, if the model for all three bet types resulted in a "play" decision, then the bettor would construct a three-leg parlay. Alternatively, if a "no play" decision was produced, then the gambler would not construct a parlay. Additionally, in cases where only two "play" decisions were reached, then a two-leg parlay would be constructed using the two betting types where an affirmative decision was reached and excluding the type where a gambler did not make an original wager.

The resulting parlay odds were then calculated as the product of the odds for each individual leg using the formulas included below. Note that in cases where a gambler bets on both the moneyline and spread of the team that is considered the favorite, the moneyline odds are not included in the calculation for the parlay odds as the spread already includes the favorite winning the game.

Decimal Odds of a Parlay Leg (if negative odds) = $OL = \frac{|Odds| + 100}{|Odds|}$ Decimal Odds of a Parlay Leg (if positive odds) = $OL = \frac{Odds + 100}{100}$

Parlay Odds for i Legs =
$$\prod_{n=1}^{l} OL = (OL_1)(OL_2) \dots (OL_i)$$

Assuming the gambler wagers the same number of units as they would when placing individual bets on each leg (i.e., a bettor would wager three units or \$30 on a three-leg parlay comprised of bets on which they would otherwise bet one unit or \$10 individually), I calculated the returns realized based on the success of the parlay. When analyzing the returns of a three-leg parlay as shown in Table 35, I observed that a bettor would recognize a loss of nearly 95 units during the 2022 NFL season. Given that each three-leg parlay incorporated two bet types that experienced negative returns, the significant loss observed – in addition to the substantial variances and standard deviations – should come as no surprise. Despite the appealing total returns recognized using in-sample data, the out-of-sample performance indicates that betting on parlays are an ineffective strategy for generating profits in sports betting.

Season	Number of Games Bet	Total Return	Return Per Game	Standard Deviation	Variance
2012	155	671.618	4.333	10.894	118.674
2013	149	550.148	3.692	8.762	76.779
2014	171	500.65	2.928	8.754	76.625
2015	137	379.741	2.772	9.056	82.005
2016	126	605.892	4.809	9.962	99.251
2017	138	483.606	3.504	10.271	105.497
2018	144	666.939	4.632	9.92	98.407
2019	146	494.949	3.39	10.036	100.721
2020	154	453.269	2.943	9.343	87.284
2021	145	612.801	4.226	9.994	99.882
2022	155	-94.646	-0.611	5.903	34.85

	-	_				
Table 35.	Season	Returns	in	Three-Leg	Parlav	' Betting
1 4010 000	Scuson	iterui iis	***	I III CC LICE	1 y	Detting

To further confirm this takeaway, I compared the returns of a three-leg parlay to the cumulative returns of wagering on each of the three bet types individually, which are shown in

Table 36. When applied out-of-sample, I observed that this betting approach generates a loss of over 27 units, which is largely attributed to the losses incurred by betting on point spread and total points outcomes. However, when compared to the returns observed when constructing a parlay of the same bets, I recognized that the individualized approach generated a much smaller loss, indicating that a gambler is better off placing three individual wagers for any given game than opting to construct a parlay.

Season	Number of Games Bet	Total Return	Return Per Game	Standard Deviation	Variance
2012	259	195.437	0.755	1.601	2.564
2013	255	168.467	0.661	1.673	2.799
2014	257	187.457	0.729	1.557	2.423
2015	258	133.215	0.516	1.534	2.355
2016	249	175.834	0.706	1.569	2.463
2017	259	186.539	0.72	1.488	2.215
2018	253	219.53	0.868	1.528	2.336
2019	257	177.179	0.689	1.572	2.47
2020	263	173.105	0.658	1.43	2.045
2021	276	191.382	0.693	1.513	2.29
2022	273	-27.493	-0.101	1.537	2.361

Table 36. Cumulative Season Returns on Individual Bets

To further provide evidence to this point, I analyzed the returns of constructing a two-leg parlay that is comprised of one leg being a moneyline bet, given its ability to generate a positive return on its own. Using Table 37, I observed that both potential parlay constructions meeting these criteria were able to generate positive returns. Specifically, when combining a moneyline bet with a point spread bet, a gamble would have gained 4.638 units during the 2022 NFL season, while they would have gained 2.652 units if they opted to parlay a total points bet with a

moneyline bet. This observation provides further evidence for two of the main takeaways included in my previous analysis. First, given that an individual moneyline bet resulted in a gain of 6.309 units, the smaller returns of both two-leg parlay combinations indicate that would be better off wagering on solely moneyline bets instead of partaking in parlay betting. On the contrary, however, given the losses observed on individual point spread and total points bets, the positive returns of moneyline-included parlays indicates the potential for moneyline betting to be a hedging mechanism for gamblers who choose to bet on outcomes associated with the lower-performing betting types.

	Moneyline & Point Spread					Moneyline & Total Points					
Season	Number of Games Bet	Total Return	Return Per Game	Standard Deviation	Variance	Number of Games Bet	Total Return	Return Per Game	Standard Deviation	Variance	
2012	26	13.042	0.502	2.705	7.319	29	29.548	1.019	3.29	10.826	
2013	29	36.016	1.242	4.268	18.214	28	5.324	0.19	3.09	9.549	
2014	20	39.842	1.992	3.421	11.701	25	2.627	0.105	2.695	7.264	
2015	27	21.752	0.806	3.463	11.994	33	6.278	0.19	3.876	15.021	
2016	24	5.579	0.232	2.767	7.654	33	39.68	1.202	3.306	10.927	
2017	34	19.151	0.563	2.436	5.935	24	31.715	1.321	3.096	9.583	
2018	19	28.861	1.519	2.746	7.538	30	22.403	0.747	2.864	8.203	
2019	22	43.812	1.991	4.05	16.405	31	17.446	0.563	2.742	7.517	
2020	32	24.498	0.766	2.939	8.637	24	-4.92	-0.205	2.957	8.746	
2021	37	-3.697	-0.1	3.136	9.832	31	34.13	1.101	3.216	10.344	
2022	30	4.638	0.155	2.79	7,783	37	2.652	0.072	2.987	8.925	

Table 37. Season Returns on ML-Included Two-Leg Parlays

Comparison to Financial Assets

To finally assess the potential for sports betting to be an alternative financial asset class, I compared the model returns to those observed in the financial markets. To create a more effective comparison, I assumed that a sports gambler began the 2022 NFL season with a bankroll of \$1,000 – or 100 betting units – to match an investor's initial investment of \$1,000 made at the start of the regular season. Additionally, I restricted the time period of analysis to reflect the span of the 2022 NFL season – beginning on September 8, 2022 and ending on February 12, 2023 – with the date in which cumulative weekly returns are recognized shifted towards the following Friday to match the weekly close of the financial markets, such that the returns of the first week of the regular season are realized on September 16 despite games concluding on September 12. Finally, for further standardization, I converted each weekly return for both the model and the financial assets to an index – scaled to 100 at the time of the initial investment made on September 9. Once standardized, I compared the model returns to the following financial indices gathered from Federal Reserve Economic Data (FRED) to gain an understanding of overall performance against different subsections of the stock market, disregarding taxes, commissions, and transaction costs.

- 1. The Standard and Poors (S&P) 500
- 2. The Dow Jones Industrial Average
- 3. The Nasdaq-100
- 4. The Nasdaq Composite
- 5. The Wilshire 5000 Total Market Full Cap Index



Figure 4. High-Level Comparison of Model & Financial Returns

Figure 4 provides a high-level comparison of standardized model and financial returns during the 2022 NFL season, incorporating all eight potential betting options and all five financial indices within focus (reference Appendix K for a tabular view of weekly returns). At first glance, I observed that every charted return – except for the three-leg parlay – is relatively clustered, further indicating that parlays are not a reliable approach for sports gambling. Additionally, I observed that the spread, total points, cumulative, and two-leg parlays of spread and total points wagers were the next four lowest performing charted returns, further indicating that betting on these potential outcomes is not reliable using the refined optimal strategy in its current state, despite competitive early to mid-season performance against the other indices tracked. To conduct a more in-depth analysis, I removed the five underperforming betting options, allowing me to compare the returns of individual and two-leg parlays incorporating the moneyline with the returns of the five in-focus financial indices. Figure 5 provides a visualization of such returns charted against one another.



Figure 5. Focused Comparison of Model & Financial Returns

After focusing my comparison of model returns, I observe that the Dow Jones Industrial Average outperforms all other charted returns based on an analysis of the index at the end of the observation period. However, perhaps most interesting, the next two highest performing returns were the approaches using individualized moneyline bets and constructing parlays consisting of moneyline and spread bets, with the latter strategy outperforming all other returns for a majority of the 2022 NFL regular season (note that the playoffs start in mid-January). Additionally, I observed that these models had strong performance throughout the season, often outperforming all financial indices at points of a down market.

This observation can be further illustrated in Figure 6 after eliminating from analysis the Dow Jones Industrial Average and two-leg parlays of moneyline and total points bets. In this more focused analysis, I observed that parlays of moneyline and spread bets outperformed the four remaining indices during every week in the observation period. Despite underperformance during a few week period between November and December, this observation also holds true for a strategy involving straight moneyline wagers.



Figure 6. Comparison of ML Model & Non-DJIA Financial Returns

The preceding analysis of observed returns during the 2022 NFL season provides evidence that suggests that model-aided sports betting can be a reliable alternative investment strategy, specifically during periods of a down market or when various financial assets are declining in value. During the five-month period of observation, the financial markets have struggled due to a variety of economic reasons, including fears of a looming recession, rising inflation, and changing interest rates, resulting in a decline in stock market prices as indicated by the decrease in value of various financial indices, including the S&P 500 and the Nasdaq Composite. Thus, the 2022 NFL season would have been an ideal time to utilize sports betting to generate returns, mitigate losses incurred in the financial markets, and further diversify one's portfolio with sports betting serving as a financial asset class. While this indication provides promising evidence of the possibility of sports betting being a viable asset class, such a conclusion is accompanied by a caveat associated with the short period of observation, and more extensive analysis must be undertaken to reach a more compelling conclusion.

Chapter 7

Conclusions & Areas for Future Research

After reviewing the relevant literature and identifying an opening for additional work, I built upon existing studies by developing a robust sports betting model to assess the feasibility of sports betting as an alternative investment strategy using predictive analytics. Using a probit model with regularization and a sample of NFL betting data, I examined 784 potential variables across seven partitions of the season to develop a partitioned sports betting model for each of the three major bet types. After adjusting the model to incorporate gambler rationality and identify games on which a bet should not be made, I identified a refined optimal strategy and decision framework that incorporated the partitioned models.

When applied to out-of-sample 2022 NFL season data, I observed mixed results across the three bet types though the moneyline models exhibited the greatest accuracy and was the only bet type to produce a positive return during the same season. After further comparing the accuracy of the moneyline models to theoretical models used by sportsbooks, I also observed that the refined optimal strategy performed with greater accuracy than oddsmaker models, indicating the existence of potential arbitrage opportunities and challenging the efficiency of the sports betting market. Ultimately, when these returns were compared to those of financial assets, I observed that my model outperformed notable stock market indices during the 2022 NFL season, providing initial evidence that sports betting can be a viable investment strategy although a concrete conclusion cannot be made due to the short period of observation and the abnormal nature of equity markets in 2022. While the results of this study are promising, there are additional opportunities for future research, relating to the development of my model and sports betting model construction in general. As it relates to my model construction methodology, considerations for adjusting the decision-making framework – designed utilizing a conviction score for each bet type – can be made to further limit the number of outcomes on which a bet is made, which could prove beneficial in increasing the out-of-sample accuracy of the point spread and total points models. To further improve these models, alternate line betting can also be investigated, effectively increasing the likelihood of having successful bets.

In terms of the data used in the development of my model, there are also opportunities for improvement, specifically as it relates to extrinsic factors like weather and the time of game. Additionally, my model failed to account for the effects that injuries have on any given game, as even the best team statistically can lose a game to a weaker opponent in the absence of a star player or several key starters. To incorporate injuries into future model development, each team can be assigned an overall rating that is a function of individual player ratings, such that when an injury occurs, the overall rating changes based on the severity of the injury and the importance of the impaired player.

Outside of my model specifically, there is an opportunity to replicate the same methodology to proposition betting and to gambling in other major sports leagues, namely Major League Baseball (MLB), the National Hockey League (NHL), and the National Basketball Association (NBA). Given the ability for the partitioned moneyline models to generate returns of 6% over a span of five months, accurate models for each sport could theoretically establish sports betting as a reliable and appealing investment strategy year-round, especially considering that the seasons in these leagues are longer in duration than the NFL season.

Appendix A

Summary of Base Statistics

The following tables provide a defined list of base statistics obtained for data analysis, categorized by area of performance. Note that each team has a corresponding base statistic, such that for any given game, the home team's points for is equivalent to the away team's points allowed, for example.

Category	Base Statistic			
	Passing Yards			
Dessing	Passing Touchdowns			
Fassing	Completions			
	Passing Attempts			
	Rushing Yards			
Rushing	Rushing Touchdowns			
	Rushing Attempts			
	Field Goals Made			
Kicking	Field Goals Attempted			
	Punts			
	Punting Yards			
	Extra Points Made			
	Extra Points Attempted			
	First Downs			
	Third Downs			
Downs	Third Down Conversions			
	Fourth Downs			
	Fourth Down Conversions			
	Turnovers			
	Tackles For Loss			
	Sacks			
Defense & Turnovers	Sack Yards			
Defense & Tumovers	Quarterback Hits			
	Interceptions			
	Safeties			
	Defensive & Return Touchdowns			
Team & Aggregate	Points			
realli & Aggregate	Time of Possession			

Appendix B

Summary of Calculated Metrics & Formulas

Following the aggregation of base statistics for each time series analyzed, a number of metrics were calculated to assess team performance and efficiency. The following tables provide a summary of such calculations, categorized by area of team performance. Similar to the base statistics, the metrics are calculated for performance in favor of and against each team.

Category: Passing

Metric	Calculation	
Completion Persontage	Completions	
Completion Percentage	Passing Attempts	
Dessing Vards Dar Attempt	Passing Yards	
Passing Tards Per Attempt	Passing Attempts	
Passing Yards Per Completion	Passing Yards	
	Completions	
Passing Touchdown Frequency	Passing Touchdowns	
	Passing Attempts	

Category: Rushing

Metric	Calculation	
Bushing Vonda Don Attornat	Rushing Yards	
Rusning Yards Per Attempt	Rushing Attempts	
Rushing Touchdown Frequency	Rushing Touchdowns	
	Rushing Attempts	

Category: Kicking

Metric	Calculation		
Field Coal Demonstrate	Field Goals Made		
Field Goal Fercentage	Field Goals Attempted		
Vonde Den Dunt	Punting Yards		
f alds Per Pullt	Punts Attempted		
Extra Daint Dargantaga	Extra Points Made		
Extra Form Percentage	Extra Points Attempted		

Category: Downs

Metric	Calculation	
Third Dours Conversion Boto	3rd Down Conversions	
I hird Down Conversion Rate	3rd Down Attempts	
Fourth Down Conversion Data	4th Down Conversions	
Fourth Down Conversion Rate	4th Down Attempts	
Third & Fourth Down Conversions	3rd Down Conversions + 4th Down Conversions	
Third & Fourth Down Attempts	3rd Down Attempts + 4th Down Attempts	
Third & Fourth Down Conversion Rate	3rd & 4th Down Conversions	
	3rd & 4th Down Attempts	

Category: Defense & Turnovers

Metric	Calculation	
L	Interceptions	
Interception Frequency	Passing Attempts	
Τ Γ	Turnovers	
Turnover Frequency	Offensive Plays	
Vania Dan Casia	Sack Yards	
i arus Per Sack	Sacks	

Category: Team & Aggregate

Metric	Calculation	
Total Yards	Passing Yards + Rushing Yards	
Total Touchdowns	Passing Touchdowns + Rushing Touchdowns	
Pagaggion Bata	Time of Possession	
Possession Rate	<i>Time of Possession + Opp.Time of Possession</i>	
	Points Scored	
Points Per Minute	Possession Rate * 60	
	Passing Attempts Allowed	
Defensive Plays	+ Rushing Attempts Allowed	
	+ Sacks For	
Defensive Plays Including Special Terms	Defensive Plays + Field Goal Attempts Allowed	
Defensive Plays including Special Teams	+ Punt Attempts Allowed	
	Passing Attempts + Rushing Attempts	
Offensive Plays	+ Sacks Allowed	
	Offensive Plays + Field Goal Attempts	
Offensive Plays Including Special Teams	+ Punt Attempts	

Category: Ratings

Metric	Calculation	
Completion Rating	a = (Completion Rating - 0.3) * 5	
Passing Efficiency Rating	b = (Passing Yards Per Attempt - 3) * 0.25	
Passing Touchdown Efficiency Rating	c = Passing TD Frequency * 20	
Interception Rating	d = 2.375 - (Interception Frequency * 25)	
Cumulative Passer Rating	$\left(\frac{a+b+c+d}{6}\right)*100$	
Note: The above metrics were calculated using two variations: True & Adjusted. The True rating follows the calculations provided in the second column. The Adjusted rating follows the NFL's rating adjustments, where a single rating cannot be negative or exceed 2.375. In such cases, the invalid rating is set to zero or 2.375, respectively. This results in twenty metrics per team and time series (i.e., ten ratings for, ten ratings against).		

Category: Performance Against Lines (Betting Data)

Metric	Calculation	
II	Home Wins	
Home winning Percentage	Home Games Played	
Away Winning Dansonto as	Away Wins	
Away winning Percentage	Away Games Played	
Winning Percentage	Total Wins	
	Total Games Played	
Over Percentage	Games Hitting Over	
	Total Games Played	
Under Percentage	1 – Over Percentage	
Total Points Outperformance (OU +/-)	Total Points Scored – Total Points Line	
Cover Percentage	Games Covered Spread	
	Total Games Played	
Margin of Victory (MOV +/-)	Points For – Points Allowed	
Spread Outperformance (ATS +/-)	-(MOV + Spread)	

Appendix C

Differences in Measures Analyzed in Regressions

The following tables depict the differences in measures – categorized by area of team performance – incorporated into regression analysis. Note that the measures shown are for the P1S time series only; the other time series' feature the same model variables based on data from their respective series'. All differences are calculated as the Home Team Metric minus the Away Team Metric. Additionally, correlated variables are addressed through the model construction and variable selection outlined in Chapter 4.

Model Variable	Home Team Metric	Away Team Metric
Diff P1S Rush Attempts	Rushing Attempts Allowed	Rushing Attempts For
H.Allowed-A.For		
Diff P1S Rush Attempts H.For-	Rushing Attempts For	Rushing Attempts Allowed
A.Allowed		
Diff P1S Rush TD Frequency	Rushing Touchdown	Rushing Touchdown
H.Allowed-A.For	Frequency Allowed	Frequency For
Diff P1S Rush TD Frequency	Rushing Touchdown	Rushing Touchdown
H.For-A.Allowed	Frequency For	Frequency Allowed
Diff P1S Rush TD H.Allowed-	Rushing Touchdowns	Rushing Touchdowns For
A.For	Allowed	
Diff P1S Rush TD H.For-	Rushing Touchdowns For	Rushing Touchdowns
A.Allowed		Allowed
Diff P1S Rush Yards H.Allowed-	Rushing Yards Allowed	Rushing Yards For
A.For		_
Diff P1S Rush Yards H.For-	Rushing Yards For	Rushing Yards Allowed
A.Allowed		
Diff P1S Rush Yards Per Attempt	Rushing Yards Per Attempt	Rushing Yards Per Attempt
H.Allowed-A.For	Allowed	For
Diff P1S Rush Yards Per Attempt	Rushing Yards Per Attempt	Rushing Yards Per Attempt
H.For-A.Allowed	For	Allowed

Category: Passing

Model Variable	Home Team Metric	Away Team Metric
Diff P1S Completion % H.Allowed-	Completion Percentage	Completion Percentage For
A.For	Allowed	
Diff P1S Completion % H.For-	Completion Percentage For	Completion Percentage
A.Allowed		Allowed
Diff P1S Completions H.Allowed-	Completions Allowed	Completions For
A.For		
Diff P1S Completions H.For-	Completions For	Completions Allowed
A.Allowed		
Diff P1S Pass Attempts H.Allowed-	Passing Attempts Allowed	Passing Attempts For
A.For		
Diff P1S Pass Attempts H.For-	Passing Attempts For	Passing Attempts Allowed
A.Allowed		
Diff P1S Pass TD Frequency	Passing TD Frequency	Passing TD Frequency For
H.Allowed-A.For	Allowed	
Diff P1S Pass TD Frequency H.For-	Passing TD Frequency For	Passing TD Frequency
A.Allowed		Allowed
Diff P1S Pass TD H.Allowed-A.For	Passing Touchdowns	Passing Touchdowns For
	Allowed	
Diff P1S Pass TD H.For-A.Allowed	Passing Touchdowns For	Passing Touchdowns
		Allowed
Diff P1S Pass Yards H.Allowed-	Passing Yards Allowed	Passing Yards For
A.For		
Diff P1S Pass Yards H.For-	Passing Yards For	Passing Yards Allowed
A.Allowed		
Diff P1S Pass Yards Per Attempt	Passing Yards Per Attempt	Passing Yards Per Attempt
H.Allowed-A.For	Allowed	For
Diff P1S Pass Yards Per Attempt	Passing Yards Per Attempt	Passing Yards Per Attempt
H.For-A.Allowed	For	Allowed
Diff P1S Pass Yards Per	Passing Yards Per	Passing Yards Per
Completion H.Allowed-A.For	Completion Allowed	Completion For
Diff P1S Pass Yards Per	Passing Yards Per	Passing Yards Per
Completion H.For-A.Allowed	Completion For	Completion Allowed

Category: Kicking

Model Variable	Home Team Metric	Away Team Metric
Diff P1S Extra Point % H.Allowed-	Extra Point Percentage	Extra Point Percentage For
A.For	Allowed	
Diff P1S Extra Point % H.For-	Extra Point Percentage For	Extra Point Percentage
A.Allowed		Allowed
Diff P1S Field Goal % H.Allowed-	Field Goal Percentage	Field Goal Percentage For
A.For	Allowed	
Diff P1S Field Goal % H.For-	Field Goal Percentage For	Field Goal Percentage
A.Allowed		Allowed
Diff P1S Yards Per Punt	Yards Per Punt Allowed	Yards Per Punt For
H.Allowed-A.For		
Diff P1S Yards Per Punt H.For-	Yards Per Punt For	Yards Per Punt Allowed
A.Allowed		
Diff P1S Punting Yards H.Allowed-	Punting Yards Allowed	Punting Yards For
A.For		
Diff P1S Punting Yards H.For-	Punting Yards For	Punting Yards Allowed
A.Allowed	-	-
Diff P1S Punts H.Allowed-A.For	Punts Allowed	Punts For
Diff P1S Punts H.For-A.Allowed	Punts For	Punts Allowed

Category: Downs

Model Variable	Home Team Metric	Away Team Metric	
Diff P1S 1st Downs H.Allowed-	First Downs Allowed	First Downs For	
A.For			
Diff P1S 1st Downs H.For-	First Downs For	First Downs Allowed	
A.Allowed			
Diff P1S 3rd Down Conversion %	Third Down Conversion	Third Down Conversion	
H.Allowed-A.For	Rate Allowed	Rate For	
Diff P1S 3rd Down Conversion %	Third Down Conversion	Third Down Conversion	
H.For-A.Allowed	Rate For	Rate Allowed	
Diff P1S 3rd 4th Down Conversion	Third & Fourth Down	Third & Fourth Down	
% H.Allowed-A.For	Conversion Rate Allowed	Conversion Rate For	
Diff P1S 3rd 4th Down Conversion	Third & Fourth Down	Third & Fourth Down	
% H.For-A.Allowed	Conversion Rate For	Conversion Rate Allowed	
Diff P1S 4th Down Conversion %	Fourth Down Conversion	Fourth Down Conversion	
H.Allowed-A.For	Rate Allowed	Rate For	
Diff P1S 4th Down Conversion %	Fourth Down Conversion	Fourth Down Conversion	
H.For-A.Allowed	Rate For	Rate Allowed	

Model Variable	Home Team Metric	Away Team Metric			
Diff P1S Def TD H.Allowed-A.For	Defensive & Return	Defensive & Return			
	Touchdowns Allowed	Touchdowns For			
Diff P1S Def TD H.For-A.Allowed	Defensive & Return	Defensive & Return			
	Touchdowns For	Touchdowns Allowed			
Diff P1S Defensive Plays	Defensive Plays Allowed	Defensive Plays For			
H.Allowed-A.For					
Diff P1S Defensive Plays Inc	Defensive Plays For	Defensive Plays Allowed			
Special Teams H.Allowed-A.For					
Diff P1S Sack Yards H.Allowed-	Sack Yards Allowed	Sack Yards For			
A.For					
Diff P1S Sack Yards H.For-	Sack Yards For	Sack Yards Allowed			
A.Allowed					
Diff P1S Sacks H.Allowed-A.For	Sacks Allowed	Sacks For			
Diff P1S Sacks H.For-A.Allowed	Sacks For	Sacks Allowed			
Diff P1S Yards Per Sack	Yards Per Sack Allowed	Yards Per Sack For			
H.Allowed-A.For					
Diff P1S Yards Per Sack H.For-	Yards Per Sack For	Yards Per Sack Allowed			
A.Allowed					
Diff P1S Safeties H.Allowed-A.For	Safeties Allowed	Safeties For			
Diff P1S Safeties H.For-A.Allowed	Safeties For	Safeties Allowed			
Diff P1S Tackles For Loss	Tackles For Loss AllowedTackles For Loss For				
H.Allowed-A.For					
Diff P1S Tackles For Loss H.For-	Tackles For Loss For	Tackles For Loss Allowed			
A.Allowed					
Diff P1S Int Frequency H.Allowed-	Interception Frequency	Interception Frequency For			
A.For	Allowed				
Diff P1S Int Frequency H.For-	Interception Frequency For	Interception Frequency			
A.Allowed		Allowed			
Diff P1S Interceptions H.Allowed-	Interceptions Allowed	Interceptions For			
A.For					
Diff P1S Interceptions H.For-	Interceptions For	Interceptions Allowed			
A.Allowed					
Diff P1S Turnovers Frequency	Turnover Frequency	Turnover Frequency For			
H.Allowed-A.For	Allowed				
Diff P1S Turnovers Frequency	Turnover Frequency For	Turnover Frequency			
H.For-A.Allowed		Allowed			
Diff P1S Turnovers H.Allowed-	Turnovers Allowed	Turnovers For			
A.For					
Diff P1S Turnovers H.For-	Turnovers For	Turnovers Allowed			
A.Allowed					
Diff P1S QB Hits H.Allowed-A.For	Quarterback Hits Allowed	Quarterback Hits For			
Diff P1S QB Hits H.For-A.Allowed	Quarterback Hits For Quarterback Hits Allowed				

Category: Team & Aggregate

Model Variable	Home Team Metric	Away Team Metric		
Diff P1S Offensive Plays H.For-	Offensive Plays For	Offensive Plays Allowed		
A.Allowed				
Diff P1S Offensive Plays Inc Spec	Offensive Plays Allowed	Offensive Plays For		
Teams H.For-A.Allowed				
Diff P1S Point Differential	Point Differential	Point Differential		
Diff P1S Points H.Allowed-A.For	Points Allowed	Points For		
Diff P1S Points H.For-A.Allowed	Points For	Points Allowed		
Diff P1S Points Per Min	Points Allowed Per Minute	Points For Per Minute		
H.Allowed-A.For				
Diff P1S Points Per Min H.For-	Points For Per Minute	Points Allowed Per Minute		
A.Allowed				
Diff P1S Time of Possession %	Time of Possession	Time of Possession		
H.Allowed-A.For	Percentage Allowed	Percentage For		
Diff P1S Time of Possession %	Time of Possession	Time of Possession		
H.For-A.Allowed	Percentage For	Percentage Allowed		
Diff P1S Offensive TD H.Allowed-	Offensive Touchdowns Offensive Touchdowns			
A.For	Allowed			
Diff P1S Offensive TD H.For-	Offensive Touchdowns For	Offensive Touchdowns		
A.Allowed		Allowed		
Diff P1S Total TD H.Allowed-	Total Touchdowns Allowed	Total Touchdowns For		
A.For				
Diff P1S Total TD H.For-	Total Touchdowns For	Total Touchdowns Allowed		
A.Allowed				
Diff P1S Total Yards H.Allowed-	Total Yards Allowed	Total Yards For		
A.For				
Diff P1S Total Yards H.For-	Total Yards For	Total Yards Allowed		
A.Allowed				

Category: Performance Against Lines (Betting Data)

Model Variable	Home Team Metric	Away Team Metric			
Diff P1S ATS +/-	Spread Outperformance	Spread Outperformance			
Diff P1S Cover %	Cover Percentage	Cover Percentage			
Diff P1S Total +/-	Total Points Total Poi				
	Outperformance Outperformance				
Diff P1S MOV +/-	Margin of Victory	Margin of Victory			
Diff P1S Over %	Over Percentage	Over Percentage			
Diff P1S Under %	nder % Under Percentage				
Diff P1S Win %	Winning Percentage	Winning Percentage			
Diff P1S Situational Win %	Home Winning Percentage	Away Winning Percentage			
Diff P1S Total Points	Total Points Scored	Total Points Scored			

Category: Ratings

Model Variable	Home Team Metric	Away Team Metric
Diff P1S Adj Completion Rating	Adjusted Completion Rating	Adjusted Completion Rating
H.Allowed-A.For	Allowed	For
Diff P1S Adj Completion Rating	Adjusted Completion Rating	Adjusted Completion Rating
H.For-A.Allowed	For	Allowed
Diff P1S Adj Interception Rating	Adjusted Interception	Adjusted Interception
H.Allowed-A.For	Rating Allowed	Rating For
Diff P1S Adj Interception Rating	Adjusted Interception	Adjusted Interception
H.For-A.Allowed	Rating For	Rating Allowed
Diff P1S Adj Pass Efficiency Rating	Adjusted Passing Efficiency	Adjusted Passing Efficiency
H.Allowed-A.For	Rating Allowed	Rating For
Diff P1S Adj Pass Efficiency Rating	Adjusted Passing Efficiency	Adjusted Passing Efficiency
H.For-A.Allowed	Rating For	Rating Allowed
Diff P1S Adj Pass TD Efficiency	Adjusted Passing Touchdown	Adjusted Passing Touchdown
Rating H.Allowed-A.For	Efficiency Rating Allowed	Efficiency Rating For
Diff P1S Adj Pass TD Efficiency	Adjusted Passing	Adjusted Passing
Rating H.For-A.Allowed	Touchdown Efficiency	Touchdown Efficiency
	Rating For	Rating Allowed
Diff P1S Adj Passer Rating	Adjusted Passer Rating	Adjusted Passer Rating For
H.Allowed-A.For	Allowed	
Diff P1S Adj Passer Rating H.For-	Adjusted Passer Rating For	Adjusted Passer Rating
A.Allowed		Allowed
Diff P1S True Completion Rating	True Completion Rating	True Completion Rating For
H.Allowed-A.For	Allowed	
Diff P1S True Completion Rating	True Completion Rating For	True Completion Rating
H.For-A.Allowed		Allowed
Diff P1S True Interception Rating	True Interception Rating	True Interception Rating For
H.Allowed-A.For	Allowed	
Diff P1S True Interception Rating	True Interception Rating For	True Interception Rating
H.For-A.Allowed		Allowed
Diff P1S True Pass Efficiency	True Passing Efficiency	True Passing Efficiency
Rating H.Allowed-A.For	Rating Allowed	Rating For
Diff PIS True Pass Efficiency	True Passing Efficiency	True Passing Efficiency
Rating H.For-A.Allowed	Rating For	Rating Allowed
Diff PIS True Pass TD Efficiency	True Passing Touchdown	True Passing Touchdown
Rating H.Allowed-A.For	Efficiency Rating Allowed	Efficiency Rating For
Diff PIS True Pass TD Efficiency	True Passing Touchdown	True Passing Touchdown
Rating H.For-A.Allowed	Efficiency Rating For	Efficiency Rating Allowed
Diff PIS True Passer Rating	Irue Passer Rating Allowed	Irue Passer Rating For
H.Allowed-A.For		
Diff PIS True Passer Rating H.For-	True Passer Rating For	True Passer Rating Allowed
A.Allowed		

Appendix D

Results of Parameter Testing

The following tables outline the iterations completed for estimating alpha and lambda. Note that alpha is bounded by 0 and 1 and must be a multiple of 0.001, whereas lambda is bounded by 0 and 10 and must be a multiple of 0.01.

Regularization Method	Alpha	Lambda	Num Variables	Accuracy	Precision	Recall	F1	True Neg %
Ridge	0	0.5	784	0.672	0.722	0.669	0.694	0.619
ENP - Ridge	0.025	0.5	153	0.672	0.718	0.677	0.697	0.621
ENP - Ridge	0.05	0.5	105	0.67	0.71	0.69	0.7	0.624
ENP - Ridge	0.075	0.5	81	0.663	0.71	0.669	0.689	0.612
ENP - Ridge	0.1	0.5	70	0.659	0.716	0.643	0.678	0.602
ENP - Ridge	0.15	0.5	51	0.657	0.713	0.643	0.676	0.600
ENP - Ridge	0.2	0.5	45	0.563	0.71	0.638	0.672	0.596
ENP - Ridge	0.3	0.5	35	0.642	0.706	0.612	0.655	0.582
ENP - Ridge	0.4	0.5	30	0.644	0.68	0.683	0.682	0.599
ENP - Balanced	0.5	0.5	28	0.653	0.68	0.713	0.696	0.615
ENP - Lasso	0.6	0.5	22	0.644	0.683	0.676	0.679	0.597
ENP - Lasso	0.7	0.5	20	0.632	0.689	0.618	0.652	0.575
ENP - Lasso	0.8	0.5	20	0.63	0.683	0.642	0.662	0.581
ENP - Lasso	0.9	0.5	19	0.639	0.68	0.666	0.673	0.590
Lasso	1	0.5	18	0.639	0.68	0.665	0.672	0.590
AVERAGES			0.645	0.699	0.660	0.678	0.600	

Estimating Alpha using Constant Initial Lambda

Estimating Lambda using Established Alpha

Regularization Method	Alpha	Lambda	Num Variables	Accuracy	Precision	Recall	F1	True Neg %
ENP - Ridge	0.05	0.25	145	0.672	0.722	0.671	0.695	0.620
ENP - Ridge	0.05	0.3	129	0.673	0.717	0.682	0.699	0.623
ENP - Ridge	0.05	0.35	120	0.672	0.721	0.67	0.694	0.619
ENP - Ridge	0.05	0.4	117	0.671	0.718	0.674	0.696	0.620
ENP - Ridge	0.05	0.45	110	0.668	0.718	0.665	0.69	0.614
ENP - Ridge	0.05	0.5	105	0.67	0.71	0.69	0.7	0.624
ENP - Ridge	0.05	0.75	82	0.663	0.712	0.662	0.686	0.610
ENP - Ridge	0.05	1	71	0.659	0.712	0.651	0.68	0.604
ENP - Ridge	0.05	2	48	0.652	0.715	0.624	0.666	0.592
ENP - Ridge	0.05	3	37	0.64	0.704	0.612	0.655	0.584
ENP - Ridge	0.05	4	29	0.64	0.686	0.652	0.669	0.588
ENP - Ridge	0.05	5	28	0.646	0.679	0.693	0.686	0.603
AVERAGES		0.661	0.710	0.662	0.685	0.608		

Appendix E

Post-Regression Model Variables

The following visualizations depict the top 40 variables (as applicable) included in the formulas for each of the 24 partitioned regression models. Note that the model variables included are the differences in correlated team measures. Reference Appendix C for the underlying calculations of these differences; additional information on the variables involved in the calculations can be found in Appendix A and Appendix B.





Model: PhaseC-ML Intercept = 0.278431 (37 out of 37 Variables Shown)




Model: Playoffs-ML Intercept = 1.024507 (39 out of 39 Variables Shown)



Model : (40 or	RegPost-ML (Benchmark) Intercept = 0.315366 at of 129 Variables Shown)		
	Co	pefficient	
Diff P6G ATS Plus Minus -0 0	32244		
Diff.P5G.MOV		0.0298	806
Diff.P6G.MOV		0.027442	2
Diff.P4G.MOV		0.027098	
Diff.P2S.Points.H.For.A.Allowed		0.021719	
Diff.P4G.Rush.Attempts.H.For.A.Allowed	-0.021325		
Diff.P4G.OB.Hits.H.Allowed.A.For	-0.020114		
Diff.P4G.ATS.Plus.Minus	-0.016394		
Diff.P5G.Pass.Attempts.H.Allowed.A.For		0.016279	
Diff.P4G.Defensive.Plays.Inc.Special.Teams.H.Allowed.A.For	-0.015771		
Diff.P1S.MOV		0.015067	
Diff.STD.Def.TD.H.Allowed.A.For	-0.014734		
Diff.STD.Interceptions.H.Allowed.A.For	-0.013672		
Diff.P5G.ATS.Plus.Minus	-0.013658		
Diff.P6G.True.Passer.Rating.H.For.A.Allowed		0.013656	
Diff.STD.ATS.Plus.Minus	-0.013588		
Diff.P3S.Defensive.Plays.Inc.Special.Teams.H.Allowed.A.For		0.011149	
Diff.STD.Yards.Per.Punt.H.Allowed.A.For	-0.011057		
Diff.STD.Pass.TD.H.Allowed.A.For		0.010921	
Diff.STD.Total.Plus.Minus	-0.01069		
Diff.STD.Adj.Passer.Rating.H.For.A.Allowed	-0.010252		
> Diff.P2S.MOV		0.009943	
Diff.P1S.Offensive.Plays.H.For.A.Allowed		0.00926	
Diff.P5G.Yards.Per.Punt.H.For.A.Allowed		0.008421	
Diff.P3S.Punting.Yards.H.Allowed.A.For	-0.007973		
Diff.P4G.1st.Downs.H.For.A.Allowed		0.007894	
Diff.P2S.Pass.Yards.H.Allowed.A.For		0.007706	
Diff.STD.Sacks.H.Allowed.A.For	-0.007688		
Diff.P4G.Pass.Attempts.H.For.A.Allowed		0.007422	
Diff.P6G.Total.Plus.Minus	-0.007173		
Diff.STD.Rush.Attempts.H.Allowed.A.For		0.007128	
Diff.P3S.Pass.Yards.H.Allowed.A.For	-0.006977		
Diff.STD.QB.Hits.H.For.A.Allowed		0.006952	
Diff.P6G.Rush.Yards.H.For.A.Allowed		0.006734	
Diff.P1S.Yards.Per.Punt.H.Allowed.A.For		0.006371	
Diff.STD.MOV		0.006063	
Diff.P5G.Yards.Per.Punt.H.Allowed.A.For	-0.005507		
Diff.P3S.Punting.Yards.H.For.A.Allowed		0.005466	
Diff.STD.Total.Points		0.005315	
Diff.P3S.True.Passer.Rating.H.Allowed.A.For		0.005311	

(4	Model: RegSeason-ML Intercept = 0.319681 40 out of 133 Variables Shown)		
	Coef	ficient	
Diff.P6G.ATS.Plus.Minus -0.033859			
Diff.P5G.MOV			0.032197
Diff.P4G.MOV			0.02923
Diff.P6G.MOV			0.029212
Diff.P2S.Points.H.For.A.Allowed		0.0215	539
Diff.P5G.ATS.Plus.Minus	-0.019815		
Diff.P4G.Rush.Attempts.H.For.A.Allowed	-0.019505		
Diff.STD.Pass.TD.H.Allowed.A.For		0.015504	
Diff.STD.Def.TD.H.Allowed.A.For	-0.014722		
Diff.STD.Interceptions.H.Allowed.A.For	-0.014498		
Diff.P6G.True.Passer.Rating.H.For.A.Allowed		0.014345	
Diff.P4G.QB.Hits.H.Allowed.A.For	-0.014012		
Diff.P4G.ATS.Plus.Minus	-0.013765		
Diff.P5G.Pass.Attempts.H.Allowed.A.For		0.013179	
Diff.P6G.Point.Differential		0.012894	
Diff.P2S.MOV		0.012662	
Diff.STD.Adj.Passer.Rating.H.For.A.Allowed	-0.012312		
Diff.P4G.Defensive.Plays.Inc.Special.Teams.H.Allowed.A.For	-0.012118		
Diff.P4G.Total.Points		0.011887	
Diff.P5G.Yards.Per.Punt.H.Allowed.A.For	-0.011881		
Diff.P3S.Defensive.Plays.Inc.Special.Teams.H.Allowed.A.For		0.011044	
Diff.P5G.Total.Plus.Minus	-0.010912		
Diff.P1S.MOV		0.010693	
Diff.STD.ATS.Plus.Minus	-0.009562		
Diff.P1S.Offensive.Plays.H.For.A.Allowed		0.009384	
Diff.STD.Total.Plus.Minus	-0.009344		
Diff.P5G.Yards.Per.Punt.H.For.A.Allowed		0.008972	
Diff.P4G.Rush.Attempts.H.Allowed.A.For	-0.00882		
Diff.P2S.Pass.Yards.H.Allowed.A.For		0.008157	
Diff.P3S.Adj.Passer.Rating.H.Allowed.A.For		0.00776	
Diff.P6G.Rush.Yards.H.For.A.Allowed		0.007611	
Diff.STD.Point.Differential	-0.007469		
Diff.P3S.Punting.Yards.H.Allowed.A.For	-0.007372		
Diff.STD.OB.Hits.H.Allowed.A.For	-0.007351		
Diff.P3S.True.Passer.Rating.H.Allowed.A.For		0.007324	
Diff.P6G.Rush.Attempts.H.Allowed.A.For	-0.007068		
Diff.STD.Rush.Attempts.H.Allowed.A.For		0.00685	
Diff.STD.QB.Hits.H.For.A.Allowed		0.006743	
Diff.P3S.Pass,Yards.H.Allowed.A.For	-0.006488		
Diff.P1S.Rush.Attempts.H.Allowed.A.For		0.005671	
-0.04	-0.03 -0.02 -0.01	0 0.01 0.02	0.03 0

		Mo Inte (40 out c	odel: Week1-N ercept = 0.1580 of 67 Variables	IL)28 Shown)					
					Coefficient				
Diff.P3S.MOV									0.109426
Diff.P3S.Adj.Passer.Rating.H.For.A.Allowed							0.069832		
Diff.P3S.True.Passer.Rating.H.For.A.Allowed						1	0.069498		
DIII.PIS.MOV Diff D2S Doint Differential	0.064216						0.065582		
Diff D2S Page Vande II For A Allowed	-0.064316	0.04508							
Diff P3S Offensive Plays Inc Spec Teams H For A Allowed		-0.04398				0.042042			
Diff P3S Push Attempts H Allowed A For		0.043444				0.043943			
Diff P1S Adi Passer Pating H Allowed A For		-0.043444				0.040104			
Diff P1S True Passer Rating H Allowed A For					1	0.040104			
Diff P1S Defensive Plays Inc Special Teams H Allowed A For						0.039032			
Diff P3S Defensive Plays H Allowed A For		0.022	508			0.03741			
Diff. P1S ATS Plus Minus		-0.033	308						
Diff D3S Push Varde H Allowed A For		-0.033	185			22454			
Diff P1S Sack Vards H Allowed A For					0.0	2152			
Diff P1S Total Vards H Allowed A For		0.0	20012		0.0.	51.52			
Diff P1S Points H For A Allowed		-0.0	29912		0.028	002			
Diff P2S Rush Attempts H Allowed A For		0.1	028600		0.028	1003			
Diff P3S Punting Vards H Allowed A For		-0.5	028099		0.028	112			
Diff P2S Point Differential		(0.02841		0.028	442			
Diff P1S Adi Passar Pating H For A Allowed		-(027740						
Diff P1S True Passer Rating H For A Allowed		-0	027348						
Diff P1S Tackles For Loss H For A Allowed		-0	.027348		0.0265	86			
Diff P2S Pass Vards H Allowed A For					0.0203	5			
Diff D1S Daga Attempts H For A Allowed					0.02333	7			
Diff P2S Offensive Plays H For A Allowed					0.024201				
Diff P2S Sack Vards H Allowed A For			0.02252		0.023712				
Diff D2S Dass Attempts H For A Allowed			-0.02333		0.022208				
Diff P1S Total Points					0.023398				
Diff P3S Pass Vards H Allowed A For			0.020054		0.022207				
Diff P1S Punting Vards H Allowed A For			-0.020934						
Diff P2S Tasklas For Loss H For A Allowed			-0.020787		0.019676				
Diff P3S Vards Par Punt H For A Allowed			0.016058		0.018070				
Diff P2S Adi Passer Pating H Allowed A For			-0.010938						
Diff P2S True Passer Pating H Allowed A For			-0.010419						
Diff P1S Punting Vards H For A Allowed			-0.013734		0.015475				
Diff P3S Rush Vards H For A Allowed			-0.014483		0.015475				
Diff D1S Doint Difformatial			-0.014465						
Diff P2S Sack Vards H For A Allowed			-0.015554		0.012671				
Diff D1C Dass Vards II For A Allowed					0.0120/1				
Diff.r 15.r ass. 1 arus.if.r 01.A.Allowed					0.012516				
-(- 80.0	0.06 -0	-0.02	0	0.02 0	0.04 0.06	0.08	0.1	0.12

Point Spread Models



Model: PhaseB-Spread Intercept = -0.067146 (40 out of 52 Variables Shown)

Diff.STD.Turnovers.H.For.A.Allowed.Percentage	-0.011254			
Diff.P3S.Punting.Yards.H.Allowed.A.For				0.008
Diff.P5G.Punting.Yards.H.Allowed.A.For				0.00779
Diff.P6G.Total.Yards.H.Allowed.A.For				0.007264
Diff.STD.Completions.H.For.A.Allowed				0.006088
Diff.P2S.Pass.Yards.H.Allowed.A.For				0.006021
Diff.STD.1st.Downs.H.For.A.Allowed				0.005072
Diff.P1S.Pass.Yards.H.Allowed.A.For		-0.004959		
Diff.P1S.Adj.Passer.Rating.H.For.A.Allowed				0.004835
Diff.P1S.True.Passer.Rating.H.For.A.Allowed				0.00482
Diff.STD.Pass.Attempts.H.Allowed.A.For				0.004796
Diff.STD.QB.Hits.H.Allowed.A.For		-0.004683		
Diff.P6G.Rush.Yards.H.For.A.Allowed				0.004507
Diff.STD.Points.H.Allowed.A.For		-0.004198		
Diff.P1S.Total.Yards.H.For.A.Allowed		-0.00412		
Diff.P1S.Punting.Yards.H.For.A.Allowed		-0.004077		
Diff.P2S.Total.Yards.H.Allowed.A.For			0.00	03574
Diff.STD.QB.Hits.H.For.A.Allowed			0.003	3335
Diff.P6G.MOV		-0.003332		
Diff.P2S.Punting.Yards.H.For.A.Allowed		-0.003061		
Diff.P5G.Pass.Yards.H.For.A.Allowed		-0,002853		
Diff.P4G.Rush.Yards.H.For.A.Allowed		-0.002826		
Diff.P1S.Total.Points			0.00273	35
Diff.STD.Tackles.For.Loss.H.Allowed.A.For		-0.002679		
Diff.P3S.Total.Yards.H.For.A.Allowed			0.002396	5
Diff.P2S.True.Passer.Rating.H.Allowed.A.For			0.002151	
Diff.P2S.Adj.Passer.Rating.H.Allowed.A.For			0.002135	
Diff.P5G.Total.Yards.H.Allowed.A.For		-0.002071		
Diff.P4G.True.Passer.Rating.H.For.A.Allowed		-0.001972		
Diff.P4G.Rush.Yards.H.Allowed.A.For		-0.001914		
Diff.P4G.Punting.Yards.H.Allowed.A.For		-0.001875		
Diff.P4G.Adj.Passer.Rating.H.Allowed.A.For			0.001866	
Diff.P4G.Total.Yards.H.Allowed.A.For		-0.001677		
Diff.P6G.Pass.Yards.H.For.A.Allowed		-0.001583		
Diff.STD.ATS.Plus.Minus		-0.001581		
Diff.STD.Punting.Yards.H.Allowed.A.For		-0.001287		
Diff.STD.MOV		-0.001248		
Diff.P4G.True.Passer.Rating.H.Allowed.A.For			0.001135	
Diff.STD.Offensive.Plays.H.For.A.Allowed		-0.000951		
Diff.P2S.Punting.Yards.H.Allowed A.For			0.000767	

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Model: Playoffs-Spread Intercept = 0.84659(39 out of 39 Variables Shown)

Diff.P5G.Punting.Yards.H.For.A.Allowed Diff.P4G.Punting.Yards.H.For.A.Allowed Diff.STD.Sack.Yards.H.Allowed.A.For Diff.P1S.Punting.Yards.H.For.A.Allowed Diff.P6G.Rush.Yards.H.Allowed.A.For Diff.P4G.Total.Yards.H.Allowed.A.For Diff.P5G.Total.Yards.H.For.A.Allowed Diff.P5G.Punting.Yards.H.Allowed.A.For Diff.STD.Completions.H.Allowed.A.For Diff.STD.Rush.Attempts.H.For.A.Allowed Diff.P2S.Total.Yards.H.Allowed.A.For Diff.STD.Completions.H.For.A.Allowed Diff.P2S.Punting.Yards.H.Allowed.A.For Diff.P1S.Punting.Yards.H.Allowed.A.For Diff.STD.QB.Hits.H.For.A.Allowed Diff.P2S.Total.Yards.H.For.A.Allowed Diff.P2S.Pass.Yards.H.Allowed.A.For Diff.P4G.Total.Yards.H.For.A.Allowed Variable Diff.P3S.Punting.Yards.H.Allowed.A.For Diff.STD.Pass.Attempts.H.Allowed.A.For Diff.P6G.Pass.Yards.H.For.A.Allowed Diff.P3S.Punting.Yards.H.For.A.Allowed Diff.STD.Sack.Yards.H.For.A.Allowed Diff.STD.Rush.Attempts.H.Allowed.A.For Diff.STD.Points.H.For.A.Allowed Diff.P4G.Rush.Yards.H.For.A.Allowed Diff.P4G.Rush.Yards.H.Allowed.A.For Diff.STD.Pass.Yards.H.For.A.Allowed Diff.STD.Punting.Yards.H.For.A.Allowed Diff.STD.Pass.Yards.H.Allowed.A.For Diff.P2S.Pass.Yards.H.For.A.Allowed Diff.STD.Punting.Yards.H.Allowed.A.For Diff.P6G.Pass.Yards.H.Allowed.A.For Diff.STD.Total.Yards.H.For.A.Allowed Diff.STD.Rush.Yards.H.Allowed.A.For Diff.P6G.Punting.Yards.H.Allowed.A.For Diff.STD.Pass.Attempts.H.For.A.Allowed Diff.P5G.Pass.Yards.H.For.A.Allowed

							1		0.02454
19573									
				1				0.014899	
	-0.014488			-					
	-0.0	11257 💻							
							0.0109	012	
	_	0.009474							
							0.008998		
		-0.0080	11						
		-0.0080	05						
		0.0000	0.0			0.0	07732		
		-0.00	7129			0.0			
		-0.00	1147			0.00	7117		
						0.00	6080		
		_0.00	6868			0.00	0707		
		-0.00	0808			0.00521	2		
						0.00331	. 4 1		
			0.002025			0.004037			
			-0.003925			002251			
			0.000		0.	003351			
			-0.00254	9		0.5.41			
					0.00	02541			
					0.00	02494			
					0.00	02407	_		
					0.001	663			
			-0.0	016 💻					
			-0.001	597 💻					
					0.0013	335			
					0.0012	.09			
			-0.00	0833 💻					
			-0.00	00727 🗖					
				1	0.00050	8			
			-0.0	00453 🗖					
					0.00030	9			
					0.00029				
					0.00021	1			
					0.000179)			
					0.000073	;			
			-0.0	000024					

		Model: Re Int (40 out	gPost-Spread (Bench <i>ercept</i> = -0.031381 of 121 Variables Show	mark) vn)			
				Coefficient			
	Diff.P4G.QB.Hits.H.Allowed.A.For -0.035	855					
I	Diff.P3S.Defensive.Plays.Inc.Special.Teams.H.Allowed.A.For					0.0	22019
	Diff.STD.ATS.Plus.Minus	-0.0215	5				
	Diff.STD.Interceptions.H.Allowed.A.For	-0.0	19961				
	Diff.STD.Turnovers.H.Allowed.A.For.Percentage				0.013	597	
	Diff.P6G.Offensive.Plays.Inc.Spec.Teams.H.For.A.Allowed				0.0133	-21	
	Diff.STD.Def.TD.H.For.A.Allowed		-0.013015				
	Diff.P5G.Yards.Per.Punt.H.Allowed.A.For		-0.012083				
	Diff.P1S.Yards.Per.Punt.H.Allowed.A.For				0.010776		
	Diff.P5G.MOV				0.010398		
	Diff.P2S.Sack.Yards.H.Allowed.A.For		-0.010327				
	Diff.STD.Offensive.Plays.Inc.Spec.Teams.H.For.A.Allowed				0.010322		
	Diff.STD.Offensive.Plays.H.For.A.Allowed		-0.010033				
	Diff.P3S.Pass.Yards.H.Allowed.A.For		-0.009243	R.			
	Diff.P1S.Total.Plus.Minus				0.008718		
	Diff.P2S.Pass.Yards.H.Allowed.A.For				0.008643		
	Diff.STD.Punts.H.For.A.Allowed		-0.00854	19			
	Diff.P5G.Sack.Yards.H.For.A.Allowed		-0.0080	085			
le	Diff.P5G.Pass.Attempts.H.Allowed.A.For				0.007983		
iab	Diff.P4G.Yards.Per.Punt.H.Allowed.A.For		-0.007	888			
/ar	Diff.P1S.Points.H.For.A.Allowed				0.007827		
-	Diff.P4G.Total.Points		-0.007	618			
	Diff.P3S.Adj.Passer.Rating.H.Allowed.A.For				0.007589		
	Diff.P3S.True.Passer.Rating.H.Allowed.A.For				0.00746		
	Diff.STD.Yards.Per.Sack.H.Allowed.A.For		-0.00	0746			
	Diff.P3S.Defensive.Plays.H.Allowed.A.For				0.007278		
	Diff.P5G.Tackles.For.Loss.H.Allowed.A.For		-0.00	06975			
	Diff.P2S.Tackles.For.Loss.H.For.A.Allowed		-0.0	06954			
	Diff.P4G.ATS.Plus.Minus		-0.0	06894			
	Diff.P6G.True.Passer.Rating.H.For.A.Allowed				0.006559		
	Diff.P1S.Sack.Yards.H.For.A.Allowed				0.005365		
	Diff.P4G.Defensive.Plays.H.Allowed.A.For			-0.00523			
	Diff.P4G.Pass.Attempts.H.For.A.Allowed				0.005145		
	Diff.P1S.Total.Points				0.004933		
	Diff.P5G.True.Passer.Rating.H.For.A.Allowed				0.004555		
	Diff.P3S.Punting.Yards.H.Allowed.A.For			-0.004395			
	Diff.P4G.Adj.Passer.Rating.H.For.A.Allowed			-0.004332			
	Diff.P5G.Total.Yards.H.For.A.Allowed			-0.004218			
	Diff.P4G.Sack.Yards.H.For.A.Allowed				0.004165		
	Diff.STD.Tackles.For.Loss.H.Allowed.A.For				0.004161		
	-0.04	-0.03	-0.02 -0.0	01	0 0.01	0.02	0.03

		[40]	Model: RegSea Intercept = -) out of 130 Var	son-Spread 0.030753 iables Shown	n)		
					Coefficient		
	Diff.P4G.QB.Hits.H.Allowed.A.For -0.	34578					
	Diff.STD.Interceptions.H.Allowed.A.For		-0.022381				
	Diff.P3S.Defensive.Plays.Inc.Special.Teams.H.Allowed.A.For						0.020844
	Diff.STD.ATS.Plus.Minus		-0.018979				
	Diff.P5G.Yards.Per.Punt.H.Allowed.A.For		-	0.01528			
	Diff.P2S.Tackles.For.Loss.H.For.A.Allowed			-0.012621			
	Diff.STD.Turnovers.H.Allowed.A.For.Percentage					0.011938	
	Diff.P2S.Sack.Yards.H.Allowed.A.For			-0.010512			
	Diff.P3S.Pass.Yards.H.Allowed.A.For			-0.010147			
	Diff.P6G.Offensive.Plays.Inc.Spec.Teams.H.For.A.Allowed					0.010125	
	Diff.P3S.Adj.Passer.Rating.H.Allowed.A.For					0.00943	
	Diff.P3S.True.Passer.Rating.H.Allowed.A.For					0.009223	
	Diff.P5G.MOV					0.008932	
	Diff.PIS.Points.H.For.A.Allowed					0.008675	
	Diff.P6G.ATS.Plus.Minus			-0.0082	.03		
	Diff.P2S.Pass.Yards.H.Allowed.A.For					0.008009	
	Diff.STD.Yards.Per.Sack.H.Allowed.A.For			-0.0079	959		
	Diff.PIS.Total.Points					0.007519	
ole	Diff.PIS.Sack.Yards.H.For.A.Allowed					0.007397	
riat	Diff.SID.Offensive.Plays.Inc.Spec.Teams.H.For.A.Allowed					0.007221	
Vai	Diff.PIS.Yards.Per.Punt.H.Allowed.A.For					0.007219	
	Diff.P6G.True.Passer.Rating.H.For.A.Allowed					0.007063	
	Diff.P5G.Sack.Yards.H.For.A.Allowed			-0.00	06623		
	Diff.SID.Offensive.Plays.H.For.A.Allowed			-0.00	06623		
	Diff.P3S.Detensive.Plays.H.Allowed.A.For					0.006197	
	Diff.PIS.QB.Hits.H.For.A.Allowed			-0	.005498		
	Diff.P5G.Pass.Attempts.H.Allowed.A.For					0.005318	
	Diff.P4G.Adj.Passer.Rating.H.For.A.Allowed			-	0.004922		
	Diff.SID.Def.ID.H.For.A.Allowed			-	-0.004766		
	DIII.S I D.Pass.Attempts.H.Allowed.A.For				-0.004696	0.001/072	
	Diff.PIS.Iotal.Plus.Minus					0.004653	
	Diff.SID.Tackles.For.Loss.H.Allowed.A.For				0.004126	0.004418	
	Diff.P6G.Punting. Yards.H.For.A.Allowed				-0.004136		
	Diff.P4G.Detensive.Plays.H.Allowed.A.For				-0.004041	0.000000	
	DIFF. P3S. Completions. H. Allowed. A. For				0.002040	0.003998	
	DIII.P2S.Kusn. y ards.H.Allowed.A.For				-0.003948		
	DIII.POG. Yards.Per.Sack.H.Allowed.A.For				-0.003725		
	Diff. P3S. Punting. Yards. H. Allowed. A. For				-0.003/14	0.00265	
	DIII.SID.Completions.H.Allowed.A.For				0.000(1)(=	0.00365	
	DITLP3G. Total.Points				-0.003616		
	-0.04		-0.03 -0.	-0	0.01	0 0.01	0.02 0.03



Total Points Models



Model: PhaseB-OU Intercept = 0.091546(31 out of 31 Variables Shown) Coefficient Diff.P5G.MOV -0.005782 Diff.P5G.Punting.Yards.H.Allowed.A.For -0.003515 Diff.STD.Sack.Yards.H.Allowed.A.For -0.003234 Diff.P5G.Punting.Yards.H.For.A.Allowed 0.003081 Diff.P2S.Total.Yards.H.For.A.Allowed -0.002853 Diff.P1S.Punting.Yards.H.For.A.Allowed -0.002208 Diff.STD.3D.4D.Conversions 0.002157 Diff.P5G.Pass.Yards.H.Allowed.A.For -0.002009 Diff.STD.Defensive.Plays.Inc.Special.Teams.H.Allowed.A.For 0.001992 Diff.P5G.ATS.Plus.Minus -0.001732 Diff.P6G.Total.Yards.H.For.A.Allowed 0.001666 Diff.P1S.Punting.Yards.H.Allowed.A.For -0.001523 Diff.P2S.Rush.Yards.H.Allowed.A.For -0.001384 Diff.P6G.Punting.Yards.H.For.A.Allowed -0.001177 Variable Diff.STD.Sack.Yards.H.For.A.Allowed -0.00091 Diff.STD.Rush.Yards.H.For.A.Allowed 0.000892 Diff.P2S.Total.Yards.H.Allowed.A.For -0.000869 Diff.STD.Rush.Yards.H.Allowed.A.For -0.000779 Diff.STD.Pass.Yards.H.For.A.Allowed -0.000596 Diff.STD.Points.H.Allowed.A.For -0.000578 Diff.STD.Punting.Yards.H.For.A.Allowed 0.000544 Diff.STD.Total.Yards.H.Allowed.A.For -0.000417 Diff.STD.1st.Downs.H.For.A.Allowed -0.000372 Diff.P3S.Pass.Yards.H.For.A.Allowed -0.000308 Diff.STD.Punting.Yards.H.Allowed.A.For -0.00023 Diff.P4G.Adj.Passer.Rating.H.For.A.Allowed 0.000218 Diff.P1S.Total.Yards.H.For.A.Allowed -0.000116 Diff.STD.Adj.Passer.Rating.H.Allowed.A.For -0.000061 Diff.STD.True.Passer.Rating.H.Allowed.A.For -0.000054 Diff.P2S.Pass.Yards.H.For.A.Allowed -0.00002 -0.007 -0.006 -0.005 -0.004 -0.003 -0.002 -0.001 0.001 0.002 0.003 0.004 0







Model (40 o	: RegPost-OU (Benchmark) Intercept = -0.07272 ut of 123 Variables Shown)	
	Coef	fficient
Diff.P4G.Yards.Per.Sack.H.Allowed.A.For		0.018759
Diff.STD.MOV	-0.0183	
Diff.P4G.Points.H.Allowed.A.For		0.014967
Diff.P4G.Total.Plus.Minus		0.013904
Diff.P4G.QB.Hits.H.For.A.Allowed		0.013473
Diff.P5G.Points.H.Allowed.A.For		0.012799
Diff.STD.3D.4D.Conversions	-0.010638	
Diff.P3S.Sack.Yards.H.For.A.Allowed	-0.009939	
Diff.P4G.Sack.Yards.H.Allowed.A.For	-0.009765	
Diff.P6G.ATS.Plus.Minus		0.009088
Diff.STD.3D.4D		0.008384
Diff.P1S.Yards.Per.Punt.H.For.A.Allowed	-0.008369	
Diff.P5G.Offensive.Plays.H.For.A.Allowed	-0.008021	
Diff.P6G.Rush.Yards.H.Allowed.A.For	-0.008	
Diff.P2S.Sack.Yards.H.Allowed.A.For		0.007966
Diff.P6G.Yards.Per.Punt.H.For.A.Allowed		0.007926
Diff.P3S.Completions.H.Allowed.A.For		0.007733
Diff.STD.Point.Differential	-0.007475	
Diff.P6G.Yards.Per.Sack.H.For.A.Allowed		0.007406
Diff.P6G.True.Passer.Rating.H.Allowed.A.For	-0.007202	
Diff.P5G.MOV		0.006918
Diff.P2S.Punting.Yards.H.Allowed.A.For	-0.006593	
Diff.STD.Interceptions.H.For.A.Allowed	-0.006251	
Diff.P4G.Point.Differential	-0.006198	
Diff.P6G.Offensive.Plays.Inc.Spec.Teams.H.For.A.Allowed	-0.006143	
Diff.P6G.Adj.Passer.Rating.H.Allowed.A.For	-0.00613	
Diff.P1S.ATS.Plus.Minus		0.005998
Diff.P6G.Sack.Yards.H.Allowed.A.For		0.005977
Diff.P3S.Rush.Yards.H.Allowed.A.For	-0.005904	
Diff.P2S.Punting.Yards.H.For.A.Allowed		0.005703
Diff.P4G.Rush.Attempts.H.For.A.Allowed		0.005656
Diff.STD.Tackles.For.Loss.H.Allowed.A.For		0.005312
Diff.STD.Yards.Per.Sack.H.For.A.Allowed		0.005179
Diff.STD.Points.H.Allowed.A.For	-0.004972	
Diff.P4G.Completions.H.For.A.Allowed	-0.004944	
Diff.P5G.True.Passer.Rating.H.For.A.Allowed		0.004897
Diff.P3S.Adj.Passer.Rating.H.Allowed.A.For		0.004727
Diff.STD.Rush.TD.H.Allowed.A.For		0.004604
Diff.P1S.Rush.Yards.H.Allowed.A.For		0.004588
Diff.P3S.True.Passer.Rating.H.Allowed.A.For		0.004547

(40	Model: RegSeason-OU Intercept = -0.059674 out of 125 Variables Shown)	
	Coefficie	nt
Diff.STD.MOV	-0.018881	
Diff.P5G.Points.H.Allowed.A.For		0.017193
Diff.P4G.Points.H.Allowed.A.For		0.015684
Diff.P4G.Total.Plus.Minus		0.01201
Diff.P3S.Sack.Yards.H.For.A.Allowed	-0.011559	
Diff.P6G.Sack.Yards.H.Allowed.A.For		0.011287
Diff.P2S.Sack.Yards.H.Allowed.A.For		0.011045
Diff.STD.3D.4D.Conversions	-0.010827	
Diff.P6G.Offensive.Plays.Inc.Spec.Teams.H.For.A.Allowed	-0.009785	
Diff.P4G.Sack.Yards.H.Allowed.A.For	-0.009613	
Diff.P6G.Yards.Per.Punt.H.For.A.Allowed		0.009093
Diff.P1S.Yards.Per.Punt.H.For.A.Allowed	-0.008966	
Diff.P6G.Rush.Yards.H.Allowed.A.For	-0.008798	
Diff.STD.3D.4D		0.008158
Diff.P5G.Offensive.Plays.H.For.A.Allowed	-0.008107	
Diff.STD.Interceptions.H.For.A.Allowed	-0.008058	
Diff.P6G.True.Passer.Rating.H.Allowed.A.For	-0.007425	
Diff.P6G.Yards.Per.Sack.H.For.A.Allowed		0.007406
Diff.P4G.Yards.Per.Sack.H.Allowed.A.For		0.007385
Diff.P4G.Point.Differential	-0.007156	
Diff.STD.Yards.Per.Sack.H.For.A.Allowed		0.006994
Diff.P5G.MOV		0.006582
Diff.P6G.ATS.Plus.Minus		0.006561
Diff.STD.Point.Differential	-0.006494	
Diff.P3S.Yards.Per.Punt.H.Allowed.A.For	-0.005986	0.005757
Diff.P3S.True.Passer.Rating.H.Allowed.A.For		0.005757
Diff.P5G.Sack.Yards.H.Allowed.A.For	-0.005586	
Diff.SID.Points.H.Allowed.A.For	-0.005559	
Diff.P3S.Adj.Passer.Rating.H.Allowed.A.For	0.005150	0.005432
DIII.P3S.Rush. Yards.H.Allowed.A.For	-0.005159	0.00506
Diff. D(C, Adi Descen Deties II Allowed A Fee	0.005051	0.00506
DIII.PoG.AdJ.Passer.Kating.H.Allowed.A.For	-0.005051	0.004067
Diff STD Buch Attempts H For A Allowed	0.00487	0.004967
Diff D2S Durting Varda H Allowed A For	-0.00487	
Diff P2S Dupting Vards U For A Allowed	-0.004848	0.00467
Diff.P5C Push Varda II Allowed A For		0.00467
Diff D4G Duch Attempts U For A Allowed		0.004545
DHI.F4G.KUSH.AUCHIPUS.H.F0F.A.AHOWCO		0.004343
Diff D5G Total Vards H Allowed A For		0.004374
Diff.i 50. Fotal. Fatus.ff.Allowed.A.For		0.004293

		Model: Intercept (40 out of 68	Week1-OU t = -0.109945 Variables Shown)				
			Coefficient				
	Diff.P1S.Sack.Yards.H.Allowed.A.For					0.098274	4
	Diff.P2S.Sack.Yards.H.Allowed.A.For-0.0511	04					
	Diff.P3S.ATS.Plus.Minus			0.049247			
	Diff.P3S.Total.Points			0.043926			
	Diff.P3S.Sack.Yards.H.Allowed.A.For			0.037727			
	Diff.P2S.Completions.H.Allowed.A.For			0.037034			
	Diff.P3S.Offensive.Plays.H.For.A.Allowed		0.	035986			
	Diff.P2S.Yards.Per.Punt.H.Allowed.A.For		0.0	3487			
	Diff.P1S.Pass.Attempts.H.For.A.Allowed	-0.034533					
Diff	P2S.Defensive.Plays.Inc.Special.Teams.H.Allowed.A.For	-0.032613					
	Diff.P2S.Rush.Yards.H.For.A.Allowed	-0.028654					
Γ	Diff.P3S.Offensive.Plays.Inc.Spec.Teams.H.For.A.Allowed		0.028588				
	Diff.P2S.Total.Plus.Minus	-0.028136					
	Diff.P2S.Pass.Attempts.H.For.A.Allowed	-0.027578					
Γ	Diff.P1S.Offensive.Plays.Inc.Spec.Teams.H.For.A.Allowed	-0.026984					
	Diff.P1S.Yards.Per.Sack.H.For.A.Allowed		0.026142				
	Diff.P3S.Rush.Attempts.H.Allowed.A.For	-0.025471					
	Diff.P3S.Rush.Yards.H.Allowed.A.For		0.024689				
0	Diff.P2S.Total.Yards.H.Allowed.A.For	-0.024382					
abl	Diff.P3S.Punting, Yards.H.For.A.Allowed		0.023511				
aria	Diff.P1S.1st.Downs.H.For.A.Allowed	-0.023128					
\geq	Diff.P1S.True.Passer.Rating.H.For.A.Allowed		0.023042				
	Diff.P1S.Adj.Passer.Rating.H.For.A.Allowed		0.022536				
	Diff.P2S.MOV	-0.020784					
	Diff.P2S.Rush.Attempts.H.For.A.Allowed		0.019205				
	Diff.P3S.Total.Yards.H.For.A.Allowed		0.018642				
	Diff.P2S.Adj.Passer.Rating.H.For.A.Allowed		0.018418				
	Diff.P3S.Yards.Per.Punt.H.For.A.Allowed		0.018326				
	Diff.P2S.True.Passer.Rating.H.For.A.Allowed		0.01815				
	Diff.P3S.Completions.H.Allowed.A.For		0.018009				
	Diff.P2S.Punting.Yards.H.For.A.Allowed	-0.016643	-				
	Diff.P1S.QB.Hits.H.For.A.Allowed	-0.016011					
	Diff.P3S.Points.H.Allowed.A.For		0.015457				
	Diff.P1S.Points.H.Allowed.A.For		0.015239				
	Diff.P2S.Total.Yards.H.For.A.Allowed	-0.013725					
	Diff.P3S.Defensive.Plays.H.Allowed.A.For	-0.013501					
	Diff.P2S.Defensive.Plays.H.Allowed.A.For	-0.013491					
	Diff.P2S.Rush.Attempts.H.Allowed.A.For	-0.012841					
Diff	P3S.Defensive.Plays.Inc.Special.Teams.H.Allowed.A.For	-0.012167					
	Diff.P1S.Tackles.For.Loss.H.Allowed.A.For		0.011241				
	-0.06	-0.04 -0.02	0 0.02 0	0.04 0.06	0.08	0.1	0.12

Appendix F

Conviction Score Results

The following tables display the average squared deviation for each betting type's partitioned sports betting model based on result classification. The maximum of the average squared deviation was determined to be the conviction score for the respective betting type.

Moneyline Models					
Result Classification	Average Squared Deviation				
Correct Prediction	0.04				
Incorrect Prediction	0.029				
Predicted Away, Actual Home	0.019				
Predicted Away, Actual Away	0.038				
Predicted Home, Actual Home	0.04				
Predicted Home, Actual Away	0.018				
Conviction Score = MAX(Avg. Sq. Dev.)	0.04				

Point Spread Models					
Result Classification	Average Squared Deviation				
Correct Prediction	0.028				
Incorrect Prediction	0.016				
Predicted Away, Actual Home	0.01				
Predicted Away, Actual Away	0.022				
Predicted Home, Actual Home	0.028				
Predicted Home, Actual Away	0.012				
Conviction Score = MAX(Avg. Sq. Dev.)	0.028				

Total Points Models									
Result Classification	Average Squared Deviation								
Correct Prediction	0.021								
Incorrect Prediction	0.021								
Predicted Under, Actual Over	0.016								
Predicted Under, Actual Under	0.027								
Predicted Over, Actual Over	0.021								
Predicted Over, Actual Under	0.011								
Conviction Score = MAX(Avg. Sq. Dev.)	0.027								

Appendix G

2022 NFL Moneyline Predictions & Results

The following table displays the partitioned model's output for moneyline bets during the 2022 NFL season. For greater clarity, reference the following notes regarding the information captured in the table:

- Game ID is a logistic construct for uniquely identifying games within the statistical database.
- A moneyline without a sign indicates positive odds (e.g., "109" = "+109").
- IP is abbreviation for implied probability.
- "Wk" is abbreviation for week of the NFL season.
- Outcome refers to the true result or winning bet for any given game.

					Betting Lines			Model Out	puts	
Game ID	Wk	Date	Home Team	Away Team	Home ML	Away ML	Model IP	Play Decision	Prediction	Outcome
223549R	1	9/8/2022	Los Angeles Rams	Buffalo Bills	109	-130	0.471	No Play	Away	Away
223550R	1	9/11/2022	Atlanta Falcons	New Orleans Saints	199	-240	0.201	Play	Away	Away
223551R	1	9/11/2022	Chicago Bears	San Francisco 49ers	229	-281	0.395	Play	Away	Home
223552R	1	9/11/2022	Cincinnati Bengals	Pittsburgh Steelers	-321	255	0.178	Play	Away	Away
223553R	1	9/11/2022	Detroit Lions	Philadelphia Eagles	200	-242	0.074	Play	Away	Away
223554R	1	9/11/2022	Miami Dolphins	New England Patriots	-168	141	0.497	No Play	Away	Home
223555R	1	9/11/2022	New York Jets	Baltimore Ravens	243	-300	0.175	Play	Away	Away
223556R	1	9/11/2022	Washington Commanders	Jacksonville Jaguars	-155	130	0.664	Play	Home	Home
223557R	1	9/11/2022	Carolina Panthers	Cleveland Browns	-124	105	0.578	Play	Home	Away
223559R	1	9/11/2022	Tennessee Titans	New York Giants	-240	199	0.917	Play	Home	Away
223560R	1	9/11/2022	Minnesota Vikings	Green Bay Packers	-127	106	0.38	Play	Away	Home
223561R	1	9/11/2022	Arizona Cardinals	Kansas City Chiefs	212	-258	0.67	Play	Home	Away

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					Betting	Lines		Model Out	puts	
Game ID	Wk	Date	Home Team	Away Team	Home ML	Away ML	Model IP	Play Decision	Prediction	Outcome
223562R	1	9/11/2022	Los Angeles Chargers	Las Vegas Raiders	-186	155	0.735	Play	Home	Home
223563R	1	9/11/2022	Dallas Cowboys	Tampa Bay Buccaneers	114	-136	0.608	Play	Home	Away
223564R	1	9/12/2022	Seattle Seahawks	Denver Broncos	227	-277	0.818	Play	Home	Home
223565R	2	9/15/2022	Kansas City Chiefs	Los Angeles Chargers	-202	168	0.657	Play	Home	Home
223566R	2	9/18/2022	Cleveland Browns	New York Jets	-265	218	0.717	Play	Home	Away
223567R	2	9/18/2022	New Orleans Saints	Tampa Bay Buccaneers	122	-145	0.86	Play	Home	Away
223568R	2	9/18/2022	New York Giants	Carolina Panthers	103	-116	0.482	Play	Away	Home
223570R	2	9/18/2022	Jacksonville Jaguars	Indianapolis Colts	137	-163	0.093	Play	Away	Home
223571R	2	9/18/2022	Baltimore Ravens	Miami Dolphins	-178	149	0.573	No Play	Home	Away
223572R	2	9/18/2022	Detroit Lions	Washington Commanders	106	-113	0.522	No Play	Away	Home
223573R	2	9/18/2022	San Francisco 49ers	Seattle Seahawks	-392	307	0.866	Play	Home	Home
223574R	2	9/18/2022	Los Angeles Rams	Atlanta Falcons	-501	378	0.94	Play	Home	Home
223575R	2	9/18/2022	Denver Broncos	Houston Texans	-498	383	0.733	Play	Home	Home
223577R	2	9/18/2022	Dallas Cowboys	Cincinnati Bengals	270	-341	0.669	Play	Home	Home
223578R	2	9/18/2022	Green Bay Packers	Chicago Bears	-489	369	0.792	Play	Home	Home
223579R	2	9/19/2022	Buffalo Bills	Tennessee Titans	-452	353	0.735	Play	Home	Home
223580R	2	9/19/2022	Philadelphia Eagles	Minnesota Vikings	-149	125	0.581	Play	Home	Home
223581R	3	9/22/2022	Cleveland Browns	Pittsburgh Steelers	-210	176	0.701	Play	Home	Home
223582R	3	9/25/2022	Indianapolis Colts	Kansas City Chiefs	186	-224	0.728	Play	Home	Home
223583R	3	9/25/2022	New England Patriots	Baltimore Ravens	120	-143	0.293	Play	Away	Away
223585R	3	9/25/2022	Tennessee Titans	Las Vegas Raiders	109	-130	0.515	No Play	Away	Home
223586R	3	9/25/2022	Miami Dolphins	Buffalo Bills	173	-208	0.363	Play	Away	Home
223587R	3	9/25/2022	Minnesota Vikings	Detroit Lions	-277	226	0.818	Play	Home	Home
223588R	3	9/25/2022	New York Jets	Cincinnati Bengals	226	-277	0.421	Play	Away	Away
223589R	3	9/25/2022	Washington Commanders	Philadelphia Eagles	206	-252	0.267	Play	Away	Away
223590R	3	9/25/2022	Carolina Panthers	New Orleans Saints	110	-131	0.146	Play	Away	Home
223591R	3	9/25/2022	Los Angeles Chargers	Jacksonville Jaguars	-267	219	0.859	Play	Home	Away

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-					Betting	Lines		Model Out	puts	
Game ID	Wk	Date	Home Team	Away Team	Home ML	Away ML	Model IP	Play Decision	Prediction	Outcome
223592R	3	9/25/2022	Tampa Bay Buccaneers	Green Bay Packers	-123	103	0.754	Play	Home	Away
223593R	3	9/25/2022	Arizona Cardinals	Los Angeles Rams	155	-184	0.612	Play	Home	Away
223594R	3	9/25/2022	Seattle Seahawks	Atlanta Falcons	-115	104	0.725	Play	Home	Away
223595R	3	9/25/2022	Denver Broncos	San Francisco 49ers	102	-122	0.422	Play	Away	Home
223596R	3	9/26/2022	New York Giants	Dallas Cowboys	-121	102	0.301	Play	Away	Away
223597R	4	9/29/2022	Cincinnati Bengals	Miami Dolphins	-199	167	0.209	Play	Away	Home
223598R	4	10/2/2022	New Orleans Saints	Minnesota Vikings	172	-204	0.61	Play	Home	Away
223599R	4	10/2/2022	Atlanta Falcons	Cleveland Browns	101	-120	0.275	Play	Away	Home
223600R	4	10/2/2022	Dallas Cowboys	Washington Commanders	-164	138	0.684	Play	Home	Home
223601R	4	10/2/2022	Detroit Lions	Seattle Seahawks	-180	150	0.707	Play	Home	Away
223602R	4	10/2/2022	Indianapolis Colts	Tennessee Titans	-202	169	0.695	Play	Home	Away
223603R	4	10/2/2022	New York Giants	Chicago Bears	-152	128	0.556	No Play	Home	Home
223604R	4	10/2/2022	Philadelphia Eagles	Jacksonville Jaguars	-284	232	0.851	Play	Home	Home
223605R	4	10/2/2022	Pittsburgh Steelers	New York Jets	-169	142	0.793	Play	Home	Away
223606R	4	10/2/2022	Baltimore Ravens	Buffalo Bills	145	-173	0.428	Play	Away	Away
223607R	4	10/2/2022	Houston Texans	Los Angeles Chargers	200	-240	0.19	Play	Away	Away
223608R	4	10/2/2022	Carolina Panthers	Arizona Cardinals	-114	105	0.32	Play	Away	Away
223609R	4	10/2/2022	Green Bay Packers	New England Patriots	-470	357	0.585	Play	Home	Home
223610R	4	10/2/2022	Las Vegas Raiders	Denver Broncos	-146	123	0.601	Play	Home	Home
223611R	4	10/2/2022	Tampa Bay Buccaneers	Kansas City Chiefs	-127	107	0.544	No Play	Home	Away
223612R	4	10/3/2022	San Francisco 49ers	Los Angeles Rams	-124	105	0.622	Play	Home	Home
223613R	5	10/6/2022	Denver Broncos	Indianapolis Colts	-180	151	0.257	Play	Away	Away
223614R	5	10/9/2022	Green Bay Packers	New York Giants	-435	336	0.882	Play	Home	Away
223615R	5	10/9/2022	Buffalo Bills	Pittsburgh Steelers	-898	611	0.858	Play	Home	Home
223616R	5	10/9/2022	Cleveland Browns	Los Angeles Chargers	102	-122	0.608	Play	Home	Away
223617R	5	10/9/2022	Minnesota Vikings	Chicago Bears	-384	302	0.825	Play	Home	Home
223618R	5	10/9/2022	New England Patriots	Detroit Lions	-155	131	0.448	Play	Away	Home

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					Betting	Lines		Model Out	puts	
Game ID	Wk	Date	Home Team	Away Team	Home ML	Away ML	Model IP	Play Decision	Prediction	Outcome
223619R	5	10/9/2022	New Orleans Saints	Seattle Seahawks	-229	189	0.821	Play	Home	Home
223620R	5	10/9/2022	New York Jets	Miami Dolphins	144	-174	0.193	Play	Away	Home
223621R	5	10/9/2022	Tampa Bay Buccaneers	Atlanta Falcons	-506	383	0.687	Play	Home	Home
223622R	5	10/9/2022	Washington Commanders	Tennessee Titans	108	-111	0.48	Play	Away	Away
223623R	5	10/9/2022	Jacksonville Jaguars	Houston Texans	-320	258	0.44	Play	Away	Away
223624R	5	10/9/2022	Carolina Panthers	San Francisco 49ers	210	-255	0.146	Play	Away	Away
223625R	5	10/9/2022	Los Angeles Rams	Dallas Cowboys	-232	192	0.572	No Play	Home	Away
223626R	5	10/9/2022	Arizona Cardinals	Philadelphia Eagles	192	-234	0.577	Play	Home	Away
223627R	5	10/9/2022	Baltimore Ravens	Cincinnati Bengals	-166	140	0.862	Play	Home	Home
223628R	5	10/10/2022	Kansas City Chiefs	Las Vegas Raiders	-351	278	0.819	Play	Home	Home
223629R	6	10/13/2022	Chicago Bears	Washington Commanders	101	-121	0.645	Play	Home	Away
223630R	6	10/16/2022	Atlanta Falcons	San Francisco 49ers	161	-194	0.538	No Play	Away	Home
223631R	6	10/16/2022	Cleveland Browns	New England Patriots	-150	124	0.513	No Play	Away	Away
223632R	6	10/16/2022	Green Bay Packers	New York Jets	-362	285	0.597	No Play	Home	Away
223633R	6	10/16/2022	Indianapolis Colts	Jacksonville Jaguars	-124	105	0.497	Play	Away	Home
223634R	6	10/16/2022	Miami Dolphins	Minnesota Vikings	147	-177	0.516	No Play	Away	Away
223635R	6	10/16/2022	New Orleans Saints	Cincinnati Bengals	140	-166	0.389	Play	Away	Away
223636R	6	10/16/2022	New York Giants	Baltimore Ravens	200	-244	0.522	No Play	Away	Home
223637R	6	10/16/2022	Pittsburgh Steelers	Tampa Bay Buccaneers	356	-462	0.363	Play	Away	Home
223638R	6	10/16/2022	Los Angeles Rams	Carolina Panthers	-459	354	0.742	Play	Home	Home
223639R	6	10/16/2022	Seattle Seahawks	Arizona Cardinals	116	-138	0.517	No Play	Away	Home
223640R	6	10/16/2022	Kansas City Chiefs	Buffalo Bills	124	-148	0.398	Play	Away	Away
223641R	6	10/16/2022	Philadelphia Eagles	Dallas Cowboys	-294	241	0.593	No Play	Home	Home
223642R	6	10/17/2022	Los Angeles Chargers	Denver Broncos	-200	165	0.612	Play	Home	Home
223643R	7	10/20/2022	Arizona Cardinals	New Orleans Saints	-143	121	0.529	No Play	Away	Home
223644R	7	10/23/2022	Cincinnati Bengals	Atlanta Falcons	-288	235	0.633	Play	Home	Home
223645R	7	10/23/2022	Dallas Cowboys	Detroit Lions	-305	248	0.603	No Play	Home	Home
223646R	7	10/23/2022	Tennessee Titans	Indianapolis Colts	-142	120	0.543	No Play	Away	Home

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					Betting	Lines		Model Out	puts	
Game ID	Wk	Date	Home Team	Away Team	Home ML	Away ML	Model IP	Play Decision	Prediction	Outcome
223647R	7	10/23/2022	Washington Commanders	Green Bay Packers	173	-209	0.346	Play	Away	Home
223648R	7	10/23/2022	Carolina Panthers	Tampa Bay Buccaneers	512	-719	0.413	Play	Away	Home
223649R	7	10/23/2022	Jacksonville Jaguars	New York Giants	-169	142	0.643	Play	Home	Away
223650R	7	10/23/2022	Baltimore Ravens	Cleveland Browns	-283	233	0.665	Play	Home	Home
223651R	7	10/23/2022	Denver Broncos	New York Jets	108	-130	0.443	Play	Away	Away
223652R	7	10/23/2022	Las Vegas Raiders	Houston Texans	-313	255	0.69	Play	Home	Home
223653R	7	10/23/2022	Los Angeles Chargers	Seattle Seahawks	-225	186	0.548	No Play	Away	Away
223654R	7	10/23/2022	San Francisco 49ers	Kansas City Chiefs	102	-118	0.495	Play	Away	Away
223655R	7	10/23/2022	Miami Dolphins	Pittsburgh Steelers	-323	260	0.687	Play	Home	Home
223656R	7	10/24/2022	New England Patriots	Chicago Bears	-406	320	0.804	Play	Home	Away
223657R	8	10/27/2022	Tampa Bay Buccaneers	Baltimore Ravens	-130	110	0.627	Play	Home	Away
223658R	8	10/30/2022	Jacksonville Jaguars	Denver Broncos	-120	101	0.642	Play	Home	Away
223659R	8	10/30/2022	Atlanta Falcons	Carolina Panthers	-206	171	0.791	Play	Home	Home
223660R	8	10/30/2022	Dallas Cowboys	Chicago Bears	-439	345	0.693	Play	Home	Home
223661R	8	10/30/2022	Detroit Lions	Miami Dolphins	161	-192	0.552	No Play	Away	Away
223662R	8	10/30/2022	Minnesota Vikings	Arizona Cardinals	-199	165	0.59	No Play	Home	Home
223663R	8	10/30/2022	New Orleans Saints	Las Vegas Raiders	102	-122	0.336	Play	Away	Home
223664R	8	10/30/2022	New York Jets	New England Patriots	136	-163	0.427	Play	Away	Away
223665R	8	10/30/2022	Philadelphia Eagles	Pittsburgh Steelers	-558	415	0.821	Play	Home	Home
223666R	8	10/30/2022	Houston Texans	Tennessee Titans	101	-118	0.459	Play	Away	Away
223667R	8	10/30/2022	Indianapolis Colts	Washington Commanders	-153	127	0.675	Play	Home	Away
223668R	8	10/30/2022	Los Angeles Rams	San Francisco 49ers	-115	104	0.63	Play	Home	Away
223669R	8	10/30/2022	Seattle Seahawks	New York Giants	-176	146	0.686	Play	Home	Home
223670R	8	10/30/2022	Buffalo Bills	Green Bay Packers	-498	380	0.846	Play	Home	Home
223672R	9	11/3/2022	Houston Texans	Philadelphia Eagles	559	-801	0.305	Play	Away	Away
223673R	9	11/6/2022	Atlanta Falcons	Los Angeles Chargers	120	-142	0.583	No Play	Home	Away
223674R	9	11/6/2022	Chicago Bears	Miami Dolphins	166	-198	0.579	No Play	Home	Away

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					Betting	Lines		Model Out	puts	
Game ID	Wk	Date	Home Team	Away Team	Home ML	Away ML	Model IP	Play Decision	Prediction	Outcome
223675R	9	11/6/2022	Cincinnati Bengals	Carolina Panthers	-328	261	0.818	Play	Home	Home
223676R	9	11/6/2022	Detroit Lions	Green Bay Packers	169	-203	0.549	No Play	Away	Home
223677R	9	11/6/2022	New England Patriots	Indianapolis Colts	-223	185	0.755	Play	Home	Home
223678R	9	11/6/2022	New York Jets	Buffalo Bills	408	-544	0.223	Play	Away	Home
223680R	9	11/6/2022	Jacksonville Jaguars	Las Vegas Raiders	116	-139	0.434	Play	Away	Home
223681R	9	11/6/2022	Arizona Cardinals	Seattle Seahawks	-132	111	0.452	Play	Away	Away
223683R	9	11/6/2022	Kansas City Chiefs	Tennessee Titans	-835	573	0.741	Play	Home	Home
223684R	9	11/7/2022	New Orleans Saints	Baltimore Ravens	109	-129	0.511	No Play	Away	Away
223685R	10	11/10/2022	Carolina Panthers	Atlanta Falcons	123	-147	0.477	No Play	Away	Home
223686R	10	11/13/2022	Tampa Bay Buccaneers	Seattle Seahawks	-149	125	0.477	No Play	Away	Home
223687R	10	11/13/2022	Buffalo Bills	Minnesota Vikings	-273	225	0.792	Play	Home	Away
223688R	10	11/13/2022	Chicago Bears	Detroit Lions	-157	132	0.681	Play	Home	Away
223689R	10	11/13/2022	Tennessee Titans	Denver Broncos	-137	116	0.706	Play	Home	Home
223690R	10	11/13/2022	Kansas City Chiefs	Jacksonville Jaguars	-461	356	0.698	Play	Home	Home
223691R	10	11/13/2022	Miami Dolphins	Cleveland Browns	-182	152	0.453	Play	Away	Home
223692R	10	11/13/2022	New York Giants	Houston Texans	-227	188	0.692	Play	Home	Home
223693R	10	11/13/2022	Pittsburgh Steelers	New Orleans Saints	-117	102	0.335	Play	Away	Home
223694R	10	11/13/2022	Las Vegas Raiders	Indianapolis Colts	-211	174	0.665	Play	Home	Away
223695R	10	11/13/2022	Green Bay Packers	Dallas Cowboys	168	-200	0.379	Play	Away	Home
223696R	10	11/13/2022	Los Angeles Rams	Arizona Cardinals	-178	148	0.454	Play	Away	Away
223697R	10	11/13/2022	San Francisco 49ers	Los Angeles Chargers	-362	288	0.731	Play	Home	Home
223698R	10	11/14/2022	Philadelphia Eagles	Washington Commanders	-524	398	0.817	Play	Home	Away
223699R	11	11/17/2022	Green Bay Packers	Tennessee Titans	-179	149	0.602	Play	Home	Away
223700R	11	11/20/2022	Atlanta Falcons	Chicago Bears	-137	115	0.472	Play	Away	Home
223702R	11	11/20/2022	Indianapolis Colts	Philadelphia Eagles	235	-287	0.336	Play	Away	Away
223703R	11	11/20/2022	New England Patriots	New York Jets	-180	150	0.741	Play	Home	Home

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					Betting	Lines		Model Out	puts	
Game ID	Wk	Date	Home Team	Away Team	Home ML	Away ML	Model IP	Play Decision	Prediction	Outcome
223704R	11	11/20/2022	New Orleans Saints	Los Angeles Rams	-137	116	0.58	Play	Home	Home
223705R	11	11/20/2022	New York Giants	Detroit Lions	-166	139	0.662	Play	Home	Away
223706R	11	11/20/2022	Baltimore Ravens	Carolina Panthers	-700	505	0.714	Play	Home	Home
223707R	11	11/20/2022	Houston Texans	Washington Commanders	137	-164	0.456	Play	Away	Away
223708R	11	11/20/2022	Denver Broncos	Las Vegas Raiders	-151	126	0.344	Play	Away	Away
223709R	11	11/20/2022	Minnesota Vikings	Dallas Cowboys	108	-129	0.525	No Play	Home	Away
223710R	11	11/20/2022	Pittsburgh Steelers	Cincinnati Bengals	157	-187	0.302	Play	Away	Away
223711R	11	11/20/2022	Los Angeles Chargers	Kansas City Chiefs	194	-235	0.39	Play	Away	Away
223712R	11	11/21/2022	Arizona Cardinals	San Francisco 49ers	346	-446	0.314	Play	Away	Away
223713R	12	11/24/2022	Detroit Lions	Buffalo Bills	343	-438	0.421	Play	Away	Away
223714R	12	11/24/2022	Dallas Cowboys	New York Giants	-483	364	0.747	Play	Home	Home
223715R	12	11/24/2022	Minnesota Vikings	New England Patriots	-145	122	0.347	Play	Away	Home
223716R	12	11/27/2022	Cleveland Browns	Tampa Bay Buccaneers	145	-174	0.65	Play	Home	Home
223717R	12	11/27/2022	Tennessee Titans	Cincinnati Bengals	-110	108	0.433	Play	Away	Away
223718R	12	11/27/2022	Miami Dolphins	Houston Texans	-879	594	0.759	Play	Home	Home
223719R	12	11/27/2022	New York Jets	Chicago Bears	-383	303	0.517	No Play	Home	Home
223720R	12	11/27/2022	Washington Commanders	Atlanta Falcons	-193	161	0.66	Play	Home	Home
223721R	12	11/27/2022	Carolina Panthers	Denver Broncos	103	-117	0.607	Play	Home	Home
223722R	12	11/27/2022	Jacksonville Jaguars	Baltimore Ravens	139	-167	0.672	Play	Home	Home
223723R	12	11/27/2022	Arizona Cardinals	Los Angeles Chargers	123	-146	0.442	Play	Away	Away
223724R	12	11/27/2022	Seattle Seahawks	Las Vegas Raiders	-208	173	0.694	Play	Home	Away
223725R	12	11/27/2022	Kansas City Chiefs	Los Angeles Rams	-1299	785	0.646	Play	Home	Home
223726R	12	11/27/2022	San Francisco 49ers	New Orleans Saints	-409	320	0.762	Play	Home	Home
223727R	12	11/27/2022	Philadelphia Eagles	Green Bay Packers	-288	233	0.699	Play	Home	Home
223728R	12	11/28/2022	Indianapolis Colts	Pittsburgh Steelers	-139	117	0.611	Play	Home	Away
223729R	13	12/1/2022	New England Patriots	Buffalo Bills	167	-200	0.543	No Play	Home	Away
223730R	13	12/4/2022	Atlanta Falcons	Pittsburgh Steelers	101	-118	0.58	Play	Home	Away

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					Betting	Lines		Model Out	<mark>puts</mark>	
Game ID	Wk	Date	Home Team	Away Team	Home ML	Away ML	Model IP	Play Decision	Prediction	Outcome
223731R	13	12/4/2022	Chicago Bears	Green Bay Packers	160	-192	0.546	No Play	Home	Away
223732R	13	12/4/2022	Detroit Lions	Jacksonville Jaguars	-118	101	0.699	Play	Home	Home
223733R	13	12/4/2022	Minnesota Vikings	New York Jets	-155	131	0.587	Play	Home	Home
223735R	13	12/4/2022	Philadelphia Eagles	Tennessee Titans	-221	183	0.699	Play	Home	Home
223736R	13	12/4/2022	Baltimore Ravens	Denver Broncos	-399	314	0.768	Play	Home	Home
223737R	13	12/4/2022	Houston Texans	Cleveland Browns	263	-333	0.31	Play	Away	Away
223738R	13	12/4/2022	Los Angeles Rams	Seattle Seahawks	251	-308	0.387	Play	Away	Away
223739R	13	12/4/2022	San Francisco 49ers	Miami Dolphins	-233	194	0.706	Play	Home	Home
223740R	13	12/4/2022	Cincinnati Bengals	Kansas City Chiefs	120	-142	0.51	No Play	Away	Home
223741R	13	12/4/2022	Las Vegas Raiders	Los Angeles Chargers	-137	115	0.596	Play	Home	Home
223742R	13	12/4/2022	Dallas Cowboys	Indianapolis Colts	-542	410	0.835	Play	Home	Home
223743R	13	12/5/2022	Tampa Bay Buccaneers	New Orleans Saints	-188	157	0.397	Play	Away	Home
223744R	14	12/8/2022	Los Angeles Rams	Las Vegas Raiders	236	-273	0.391	Play	Away	Home
223745R	14	12/11/2022	Buffalo Bills	New York Jets	-476	368	0.697	Play	Home	Home
223746R	14	12/11/2022	Cincinnati Bengals	Cleveland Browns	-206	171	0.663	Play	Home	Home
223747R	14	12/11/2022	Dallas Cowboys	Houston Texans	-1973	959	0.87	Play	Home	Home
223748R	14	12/11/2022	Detroit Lions	Minnesota Vikings	-139	118	0.665	Play	Home	Home
223749R	14	12/11/2022	Tennessee Titans	Jacksonville Jaguars	-182	151	0.382	Play	Away	Away
223750R	14	12/11/2022	New York Giants	Philadelphia Eagles	268	-337	0.354	Play	Away	Away
223751R	14	12/11/2022	Pittsburgh Steelers	Baltimore Ravens	-130	110	0.498	Play	Away	Away
223752R	14	12/11/2022	Denver Broncos	Kansas City Chiefs	345	-443	0.216	Play	Away	Away
223753R	14	12/11/2022	San Francisco 49ers	Tampa Bay Buccaneers	-186	154	0.726	Play	Home	Home
223754R	14	12/11/2022	Seattle Seahawks	Carolina Panthers	-188	152	0.692	Play	Home	Away
223755R	14	12/11/2022	Los Angeles Chargers	Miami Dolphins	145	-174	0.564	No Play	Home	Home
223756R	14	12/12/2022	Arizona Cardinals	New England Patriots	112	-133	0.612	Play	Home	Away
223757R	15	12/15/2022	Seattle Seahawks	San Francisco 49ers	150	-182	0.4	Play	Away	Away
223758R	15	12/17/2022	Minnesota Vikings	Indianapolis Colts	-196	163	0.637	Play	Home	Home

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					Betting	Lines		Model Out	puts	
Game ID	Wk	Date	Home Team	Away Team	Home ML	Away ML	Model IP	Play Decision	Prediction	Outcome
223759R	15	12/17/2022	Cleveland Browns	Baltimore Ravens	-158	134	0.47	Play	Away	Home
223760R	15	12/17/2022	Buffalo Bills	Miami Dolphins	-348	275	0.566	No Play	Home	Home
223761R	15	12/18/2022	New Orleans Saints	Atlanta Falcons	-230	189	0.512	No Play	Away	Home
223762R	15	12/18/2022	Chicago Bears	Philadelphia Eagles	313	-396	0.323	Play	Away	Away
223763R	15	12/18/2022	New York Jets	Detroit Lions	-131	110	0.478	Play	Away	Away
223764R	15	12/18/2022	Carolina Panthers	Pittsburgh Steelers	-147	124	0.568	No Play	Home	Away
223765R	15	12/18/2022	Jacksonville Jaguars	Dallas Cowboys	172	-205	0.422	Play	Away	Home
223766R	15	12/18/2022	Houston Texans	Kansas City Chiefs	627	-962	0.275	Play	Away	Away
223767R	15	12/18/2022	Denver Broncos	Arizona Cardinals	-127	106	0.423	Play	Away	Home
223768R	15	12/18/2022	Las Vegas Raiders	New England Patriots	-137	114	0.607	Play	Home	Home
223770R	15	12/18/2022	Tampa Bay Buccaneers	Cincinnati Bengals	153	-183	0.46	Play	Away	Away
223771R	15	12/18/2022	Washington Commanders	New York Giants	-206	172	0.64	Play	Home	Away
223772R	15	12/19/2022	Green Bay Packers	Los Angeles Rams	-367	292	0.648	Play	Home	Home
223773R	16	12/22/2022	New York Jets	Jacksonville Jaguars	-142	119	0.451	Play	Away	Away
223774R	16	12/24/2022	Chicago Bears	Buffalo Bills	310	-390	0.289	Play	Away	Away
223775R	16	12/24/2022	Cleveland Browns	New Orleans Saints	-182	151	0.58	No Play	Home	Away
223776R	16	12/24/2022	Kansas City Chiefs	Seattle Seahawks	-500	385	0.727	Play	Home	Home
223777R	16	12/24/2022	Minnesota Vikings	New York Giants	-220	182	0.653	Play	Home	Home
223778R	16	12/24/2022	New England Patriots	Cincinnati Bengals	135	-161	0.412	Play	Away	Away
223779R	16	12/24/2022	Carolina Panthers	Detroit Lions	112	-134	0.508	No Play	Away	Home
223780R	16	12/24/2022	Baltimore Ravens	Atlanta Falcons	-285	232	0.586	No Play	Home	Home
223781R	16	12/24/2022	Tennessee Titans	Houston Texans	-176	147	0.627	Play	Home	Away
223782R	16	12/24/2022	San Francisco 49ers	Washington Commanders	-288	236	0.727	Play	Home	Home
223783R	16	12/24/2022	Dallas Cowboys	Philadelphia Eagles	-201	169	0.532	No Play	Away	Home
223784R	16	12/24/2022	Pittsburgh Steelers	Las Vegas Raiders	-138	116	0.54	No Play	Away	Home
223785R	16	12/25/2022	Miami Dolphins	Green Bay Packers	-190	157	0.532	No Play	Away	Away
223786R	16	12/25/2022	Los Angeles Rams	Denver Broncos	148	-179	0.64	Play	Home	Home

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					Betting	Lines		<mark>Model Out</mark>	puts	
Game ID	Wk	Date	Home Team	Away Team	Home ML	Away ML	Model IP	Play Decision	Prediction	Outcome
223787R	16	12/25/2022	Arizona Cardinals	Tampa Bay Buccaneers	285	-363	0.646	Play	Home	Away
223788R	16	12/26/2022	Indianapolis Colts	Los Angeles Chargers	166	-200	0.518	No Play	Away	Away
223789R	17	12/29/2022	Tennessee Titans	Dallas Cowboys	570	-805	0.239	Play	Away	Away
223790R	17	1/1/2023	Atlanta Falcons	Arizona Cardinals	-291	237	0.606	Play	Home	Home
223791R	17	1/1/2023	Detroit Lions	Chicago Bears	-218	180	0.777	Play	Home	Home
223792R	17	1/1/2023	Kansas City Chiefs	Denver Broncos	-763	542	0.761	Play	Home	Home
223793R	17	1/1/2023	New England Patriots	Miami Dolphins	-158	134	0.504	No Play	Away	Home
223794R	17	1/1/2023	New York Giants	Indianapolis Colts	-245	202	0.566	No Play	Home	Home
223795R	17	1/1/2023	Philadelphia Eagles	New Orleans Saints	-229	190	0.69	Play	Home	Away
223796R	17	1/1/2023	Tampa Bay Buccaneers	Carolina Panthers	-199	165	0.644	Play	Home	Home
223797R	17	1/1/2023	Washington Commanders	Cleveland Browns	-122	103	0.544	No Play	Away	Away
223798R	17	1/1/2023	Houston Texans	Jacksonville Jaguars	159	-190	0.386	Play	Away	Away
223799R	17	1/1/2023	Las Vegas Raiders	San Francisco 49ers	356	-459	0.432	Play	Away	Away
223800R	17	1/1/2023	Seattle Seahawks	New York Jets	104	-124	0.613	Play	Home	Home
223801R	17	1/1/2023	Green Bay Packers	Minnesota Vikings	-176	146	0.646	Play	Home	Home
223803R	17	1/1/2023	Baltimore Ravens	Pittsburgh Steelers	-118	102	0.605	Play	Home	Away
223804R	18	1/7/2023	Las Vegas Raiders	Kansas City Chiefs	325	-411	0.682	Play	Home	Away
223805R	18	1/7/2023	Jacksonville Jaguars	Tennessee Titans	-276	226	0.024	Play	Away	Home
223806R	18	1/8/2023	Atlanta Falcons	Tampa Bay Buccaneers	-251	207	0.655	Play	Home	Home
223807R	18	1/8/2023	Buffalo Bills	New England Patriots	-384	305	0.878	Play	Home	Home
223808R	18	1/8/2023	Chicago Bears	Minnesota Vikings	234	-285	0.88	Play	Home	Away
223809R	18	1/8/2023	Cincinnati Bengals	Baltimore Ravens	-641	471	0.976	Play	Home	Home
223810R	18	1/8/2023	Indianapolis Colts	Houston Texans	-151	127	0.951	Play	Home	Away
223811R	18	1/8/2023	Miami Dolphins	New York Jets	-215	179	0.965	Play	Home	Home
223812R	18	1/8/2023	New Orleans Saints	Carolina Panthers	-186	155	0.903	Play	Home	Away
223813R	18	1/8/2023	Pittsburgh Steelers	Cleveland Browns	-152	128	0.136	Play	Away	Home
223814R	18	1/8/2023	Denver Broncos	Los Angeles Chargers	-275	222	0.836	Play	Home	Home

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					Betting	Lines		Model Out	puts	
Game ID	Wk	Date	Home Team	Away Team	Home ML	Away ML	Model IP	Play Decision	Prediction	Outcome
223815R	18	1/8/2023	Philadelphia Eagles	New York Giants	-1536	860	0.66	Play	Home	Home
223816R	18	1/8/2023	San Francisco 49ers	Arizona Cardinals	-1072	706	0.851	Play	Home	Home
223817R	18	1/8/2023	Seattle Seahawks	Los Angeles Rams	-242	199	0.974	Play	Home	Home
223818R	18	1/8/2023	Washington Commanders	Dallas Cowboys	270	-343	0.378	Play	Away	Home
223819R	18	1/8/2023	Green Bay Packers	Detroit Lions	-244	201	0.328	Play	Away	Away
223820P	19	1/14/2023	San Francisco 49ers	Seattle Seahawks	-493	373	0.282	Play	Away	Home
223821P	19	1/14/2023	Jacksonville Jaguars	Los Angeles Chargers	114	-135	0.342	Play	Away	Home
223822P	19	1/15/2023	Buffalo Bills	Miami Dolphins	-993	670	0.828	Play	Home	Home
223823P	19	1/15/2023	Minnesota Vikings	New York Giants	-150	126	0.162	Play	Away	Away
223824P	19	1/15/2023	Cincinnati Bengals	Baltimore Ravens	-428	327	0.967	Play	Home	Home
223825P	19	1/16/2023	Tampa Bay Buccaneers	Dallas Cowboys	123	-147	0.538	No Play	Away	Away
223826P	20	1/21/2023	Kansas City Chiefs	Jacksonville Jaguars	-506	389	0.954	Play	Home	Home
223827P	20	1/21/2023	Philadelphia Eagles	New York Giants	-378	302	0.877	Play	Home	Home
223828P	20	1/22/2023	Buffalo Bills	Cincinnati Bengals	-257	211	0.917	Play	Home	Away
223829P	20	1/22/2023	San Francisco 49ers	Dallas Cowboys	-193	160	0.183	Play	Away	Home
223830P	21	1/29/2023	Philadelphia Eagles	San Francisco 49ers	-154	130	0.908	Play	Home	Home
223831P	21	1/29/2023	Kansas City Chiefs	Cincinnati Bengals	-133	112	0.946	Play	Home	Home
223832S	22	2/12/2023	Philadelphia Eagles	Kansas City Chiefs	-120	101	0.396	Play	Away	Away

Appendix H

2022 Predictions & Results for NFL Point Spread Bets

The following table displays the partitioned model's output for point spread bets during the 2022 NFL season. For greater clarity, reference the following notes regarding the information captured in the table:

- Game ID is a logistic construct for uniquely identifying games within the statistical database.
- Point spread odds without a sign are positive odds (e.g., "109" = "+109").
- While not included in the table, the Away Spread is simply the opposite of the home spread (i.e., multiply the Home Spread by -1).
- IP is abbreviation for implied probability.
- "Wk" is abbreviation for week of the NFL season.
- Outcome refers to the true result or winning bet for any given game.

			Betting Lines			Model Outputs					
Game ID	Wk	Date	Home Team	Away Team	Home Spread	Home Spread Odds	Away Spread Odds	Model IP	Play Decision	Prediction	Outcome
223549R	1	9/8/2022	Los Angeles Rams	Buffalo Bills	1.5	-104	-118	0.366	Play	Away	Away
223550R	1	9/11/2022	Atlanta Falcons	New Orleans Saints	5.5	-111	-110	0.593	Play	Home	Home
223551R	1	9/11/2022	Chicago Bears	San Francisco 49ers	6.5	-110	-110	0.693	Play	Home	Home
223552R	1	9/11/2022	Cincinnati Bengals	Pittsburgh Steelers	-7	-110	-111	0.042	Play	Away	Away
223553R	1	9/11/2022	Detroit Lions	Philadelphia Eagles	5.5	-110	-110	0.257	Play	Away	Home
223554R	1	9/11/2022	Miami Dolphins	New England Patriots	-3	-117	-105	0.4	Play	Away	Home
223555R	1	9/11/2022	New York Jets	Baltimore Ravens	6.5	-110	-110	0.668	Play	Home	Away
223556R	1	9/11/2022	Washington Commanders	Jacksonville Jaguars	-3	-112	-110	0.122	Play	Away	Home

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					Betting Lines			Model Outputs			
Game ID	Wk	Date	Home Team	Away Team	Home Spread	Home Spread Odds	Away Spread Odds	Model IP	Play Decision	Prediction	Outcome
223557R	1	9/11/2022	Carolina Panthers	Cleveland Browns	-1.5	-111	-110	0.577	Play	Home	Away
223559R	1	9/11/2022	Tennessee Titans	New York Giants	-5.5	-110	-110	0.499	No Play	Home	Away
223560R	1	9/11/2022	Minnesota Vikings	Green Bay Packers	-1.5	-112	-109	0.401	Play	Away	Home
223561R	1	9/11/2022	Arizona Cardinals	Kansas City Chiefs	6	-109	-112	0.56	Play	Home	Away
223562R	1	9/11/2022	Los Angeles Chargers	Las Vegas Raiders	-3.5	-110	-110	0.575	Play	Home	Home
223563R	1	9/11/2022	Dallas Cowboys	Tampa Bay Buccaneers	2.5	-110	-110	0.716	Play	Home	Away
223564R	1	9/12/2022	Seattle Seahawks	Denver Broncos	6	-110	-111	0.368	Play	Away	Home
223565R	2	9/15/2022	Kansas City Chiefs	Los Angeles Chargers	-4	-110	-110	0.301	Play	Away	Away
223566R	2	9/18/2022	Cleveland Browns	New York Jets	-6.5	-110	-110	0.453	No Play	Away	Away
223567R	2	9/18/2022	New Orleans Saints	Tampa Bay Buccaneers	2.5	-106	-115	0.871	Play	Home	Away
223568R	2	9/18/2022	New York Giants	Carolina Panthers	1	-111	-110	0.408	Play	Away	Home
223570R	2	9/18/2022	Jacksonville Jaguars	Indianapolis Colts	3	-110	-110	0.072	Play	Away	Home
223571R	2	9/18/2022	Baltimore Ravens	Miami Dolphins	-3.5	-106	-115	0.459	No Play	Away	Away
223572R	2	9/18/2022	Detroit Lions	Washington Commanders	0.5	-109	-112	0.488	No Play	Home	Home
223573R	2	9/18/2022	San Francisco 49ers	Seattle Seahawks	-8.5	-109	-112	0.849	Play	Home	Home
223574R	2	9/18/2022	Los Angeles Rams	Atlanta Falcons	-10.5	-108	-114	0.931	Play	Home	Away
223575R	2	9/18/2022	Denver Broncos	Houston Texans	-10	-112	-109	0.55	Play	Home	Away
223577R	2	9/18/2022	Dallas Cowboys	Cincinnati Bengals	7	-108	-114	0.498	No Play	Home	Home
223578R	2	9/18/2022	Green Bay Packers	Chicago Bears	-10.5	-107	-114	0.551	Play	Home	Home
223579R	2	9/19/2022	Buffalo Bills	Tennessee Titans	-10	-111	-110	0.542	Play	Home	Home
223580R	2	9/19/2022	Philadelphia Eagles	Minnesota Vikings	-3	-103	-119	0.611	Play	Home	Home
223581R	3	9/22/2022	Cleveland Browns	Pittsburgh Steelers	-4.5	-109	-112	0.408	Play	Away	Home
223582R	3	9/25/2022	Indianapolis Colts	Kansas City Chiefs	4.5	-109	-113	0.859	Play	Home	Home
223583R	3	9/25/2022	New England Patriots	Baltimore Ravens	2.5	-108	-114	0.324	Play	Away	Away
223585R	3	9/25/2022	Tennessee Titans	Las Vegas Raiders	2	-111	-110	0.384	Play	Away	Home
223586R	3	9/25/2022	Miami Dolphins	Buffalo Bills	4.5	-110	-110	0.518	Play	Home	Home
223587R	3	9/25/2022	Minnesota Vikings	Detroit Lions	-6.5	-110	-110	0.805	Play	Home	Away

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					Betting Lines		Model Outputs				
Game ID	Wk	Date	Home Team	Away Team	Home Spread	Home Spread Odds	Away Spread Odds	Model IP	Play Decision	Prediction	Outcome
223588R	3	9/25/2022	New York Jets	Cincinnati Bengals	6.5	-111	-110	0.397	Play	Away	Away
223589R	3	9/25/2022	Washington Commanders	Philadelphia Eagles	6	-112	-110	0.298	Play	Away	Away
223590R	3	9/25/2022	Carolina Panthers	New Orleans Saints	2	-110	-110	0.076	Play	Away	Home
223591R	3	9/25/2022	Los Angeles Chargers	Jacksonville Jaguars	-6.5	-110	-111	0.771	Play	Home	Away
223592R	3	9/25/2022	Tampa Bay Buccaneers	Green Bay Packers	-1.5	-110	-111	0.655	Play	Home	Away
223593R	3	9/25/2022	Arizona Cardinals	Los Angeles Rams	3.5	-113	-109	0.481	No Play	Home	Away
223594R	3	9/25/2022	Seattle Seahawks	Atlanta Falcons	-1	-109	-112	0.686	Play	Home	Away
223595R	3	9/25/2022	Denver Broncos	San Francisco 49ers	1.5	-112	-109	0.337	Play	Away	Home
223596R	3	9/26/2022	New York Giants	Dallas Cowboys	-1.5	-110	-110	0.229	Play	Away	Away
223597R	4	9/29/2022	Cincinnati Bengals	Miami Dolphins	-4	-110	-110	0.401	Play	Away	Home
223598R	4	10/2/2022	New Orleans Saints	Minnesota Vikings	4	-110	-110	0.464	No Play	Away	Home
223599R	4	10/2/2022	Atlanta Falcons	Cleveland Browns	1	-109	-112	0.435	Play	Away	Home
223600R	4	10/2/2022	Dallas Cowboys	Washington Commanders	-3	-112	-109	0.665	Play	Home	Home
223601R	4	10/2/2022	Detroit Lions	Seattle Seahawks	-3	-118	-105	0.42	Play	Away	Away
223602R	4	10/2/2022	Indianapolis Colts	Tennessee Titans	-4	-109	-112	0.811	Play	Home	Away
223603R	4	10/2/2022	New York Giants	Chicago Bears	-3	-104	-116	0.287	Play	Away	Home
223604R	4	10/2/2022	Philadelphia Eagles	Jacksonville Jaguars	-6.5	-110	-111	0.674	Play	Home	Home
223605R	4	10/2/2022	Pittsburgh Steelers	New York Jets	-3	-110	-111	0.759	Play	Home	Away
223606R	4	10/2/2022	Baltimore Ravens	Buffalo Bills	3.5	-118	-104	0.316	Play	Away	Home
223607R	4	10/2/2022	Houston Texans	Los Angeles Chargers	5.5	-110	-110	0.359	Play	Away	Away
223608R	4	10/2/2022	Carolina Panthers	Arizona Cardinals	-1	-111	-110	0.193	Play	Away	Away
223609R	4	10/2/2022	Green Bay Packers	New England Patriots	-9.5	-112	-110	0.558	Play	Home	Away
223610R	4	10/2/2022	Las Vegas Raiders	Denver Broncos	-2.5	-116	-105	0.439	Play	Away	Home
223611R	4	10/2/2022	Tampa Bay Buccaneers	Kansas City Chiefs	-2	-109	-112	0.528	Play	Home	Away
223612R	4	10/3/2022	San Francisco 49ers	Los Angeles Rams	-1.5	-113	-109	0.71	Play	Home	Home
223613R	5	10/6/2022	Denver Broncos	Indianapolis Colts	-3	-119	-104	0.217	Play	Away	Away
223614R	5	10/9/2022	Green Bay Packers	New York Giants	-9.5	-110	-110	0.756	Play	Home	Away
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					B	etting Lin	es		Model Out	puts	
Game ID	Wk	Date	Home Team	Away Team	Home Spread	Home Spread Odds	Away Spread Odds	Model IP	Play Decision	Prediction	Outcome
223615R	5	10/9/2022	Buffalo Bills	Pittsburgh Steelers	-14	-110	-110	0.304	Play	Away	Home
223616R	5	10/9/2022	Cleveland Browns	Los Angeles Chargers	1.5	-111	-110	0.709	Play	Home	Away
223617R	5	10/9/2022	Minnesota Vikings	Chicago Bears	-8.5	-110	-111	0.478	No Play	Home	Away
223618R	5	10/9/2022	New England Patriots	Detroit Lions	-3	-107	-114	0.546	Play	Home	Home
223619R	5	10/9/2022	New Orleans Saints	Seattle Seahawks	-5.5	-110	-111	0.6	Play	Home	Home
223620R	5	10/9/2022	New York Jets	Miami Dolphins	3	-106	-115	0.46	No Play	Away	Home
223621R	5	10/9/2022	Tampa Bay Buccaneers	Atlanta Falcons	-10	-113	-109	0.363	Play	Away	Away
223622R	5	10/9/2022	Washington Commanders	Tennessee Titans	0.5	-109	-112	0.476	No Play	Home	Away
223623R	5	10/9/2022	Jacksonville Jaguars	Houston Texans	-7	-107	-114	0.221	Play	Away	Away
223624R	5	10/9/2022	Carolina Panthers	San Francisco 49ers	6	-111	-110	0.084	Play	Away	Away
223625R	5	10/9/2022	Los Angeles Rams	Dallas Cowboys	-5	-112	-110	0.493	No Play	Home	Away
223626R	5	10/9/2022	Arizona Cardinals	Philadelphia Eagles	5.5	-110	-110	0.588	Play	Home	Home
223627R	5	10/9/2022	Baltimore Ravens	Cincinnati Bengals	-3	-115	-105	0.543	Play	Home	Away
223628R	5	10/10/2022	Kansas City Chiefs	Las Vegas Raiders	-7	-114	-107	0.402	Play	Away	Away
223629R	6	10/13/2022	Chicago Bears	Washington Commanders	1	-109	-113	0.486	No Play	Home	Away
223630R	6	10/16/2022	Atlanta Falcons	San Francisco 49ers	3.5	-111	-110	0.669	Play	Home	Home
223631R	6	10/16/2022	Cleveland Browns	New England Patriots	-3	-105	-115	0.586	Play	Home	Away
223632R	6	10/16/2022	Green Bay Packers	New York Jets	-7.5	-110	-110	0.433	Play	Away	Away
223633R	6	10/16/2022	Indianapolis Colts	Jacksonville Jaguars	-1.5	-110	-110	0.431	Play	Away	Home
223634R	6	10/16/2022	Miami Dolphins	Minnesota Vikings	3.5	-115	-106	0.354	Play	Away	Away
223635R	6	10/16/2022	New Orleans Saints	Cincinnati Bengals	3	-108	-114	0.408	Play	Away	Away
223636R	6	10/16/2022	New York Giants	Baltimore Ravens	5.5	-109	-112	0.709	Play	Home	Home
223637R	6	10/16/2022	Pittsburgh Steelers	Tampa Bay Buccaneers	9.5	-109	-113	0.582	Play	Home	Home
223638R	6	10/16/2022	Los Angeles Rams	Carolina Panthers	-10	-108	-113	0.561	Play	Home	Home
223639R	6	10/16/2022	Seattle Seahawks	Arizona Cardinals	2.5	-109	-110	0.33	Play	Away	Home
223640R	6	10/16/2022	Kansas City Chiefs	Buffalo Bills	2.5	-103	-117	0.519	Play	Home	Away
223641R	6	10/16/2022	Philadelphia Eagles	Dallas Cowboys	-7	-107	-114	0.561	Play	Home	Home

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					B	etting Lin	es		Model Out	puts	
Game ID	Wk	Date	Home Team	Away Team	Home Spread	Home Spread Odds	Away Spread Odds	Model IP	Play Decision	Prediction	Outcome
223642R	6	10/17/2022	Los Angeles Chargers	Denver Broncos	-3.5	-110	-110	0.41	Play	Away	Away
223643R	7	10/20/2022	Arizona Cardinals	New Orleans Saints	-2.5	-112	-109	0.63	Play	Home	Home
223644R	7	10/23/2022	Cincinnati Bengals	Atlanta Falcons	-6.5	-111	-109	0.499	No Play	Home	Home
223645R	7	10/23/2022	Dallas Cowboys	Detroit Lions	-7	-108	-113	0.304	Play	Away	Home
223646R	7	10/23/2022	Tennessee Titans	Indianapolis Colts	-2.5	-112	-109	0.511	Play	Home	Home
223647R	7	10/23/2022	Washington Commanders	Green Bay Packers	4	-110	-110	0.339	Play	Away	Home
223648R	7	10/23/2022	Carolina Panthers	Tampa Bay Buccaneers	13	-110	-110	0.538	Play	Home	Home
223649R	7	10/23/2022	Jacksonville Jaguars	New York Giants	-3	-115	-106	0.561	Play	Home	Away
223650R	7	10/23/2022	Baltimore Ravens	Cleveland Browns	-6.5	-111	-110	0.431	Play	Away	Away
223651R	7	10/23/2022	Denver Broncos	New York Jets	2	-110	-112	0.453	Play	Away	Away
223652R	7	10/23/2022	Las Vegas Raiders	Houston Texans	-7	-110	-110	0.412	Play	Away	Home
223653R	7	10/23/2022	Los Angeles Chargers	Seattle Seahawks	-5	-110	-110	0.507	No Play	Home	Away
223654R	7	10/23/2022	San Francisco 49ers	Kansas City Chiefs	1	-110	-110	0.365	Play	Away	Away
223655R	7	10/23/2022	Miami Dolphins	Pittsburgh Steelers	-7.5	-105	-115	0.539	Play	Home	Away
223656R	7	10/24/2022	New England Patriots	Chicago Bears	-8.5	-110	-110	0.485	No Play	Home	Away
223657R	8	10/27/2022	Tampa Bay Buccaneers	Baltimore Ravens	-2	-110	-110	0.626	Play	Home	Away
223658R	8	10/30/2022	Jacksonville Jaguars	Denver Broncos	-1	-112	-110	0.337	Play	Away	Away
223659R	8	10/30/2022	Atlanta Falcons	Carolina Panthers	-4	-110	-110	0.713	Play	Home	Away
223660R	8	10/30/2022	Dallas Cowboys	Chicago Bears	-9.5	-110	-110	0.479	No Play	Away	Home
223661R	8	10/30/2022	Detroit Lions	Miami Dolphins	3.5	-110	-110	0.504	No Play	Home	Away
223662R	8	10/30/2022	Minnesota Vikings	Arizona Cardinals	-4	-112	-110	0.369	Play	Away	Home
223663R	8	10/30/2022	New Orleans Saints	Las Vegas Raiders	1	-110	-112	0.279	Play	Away	Home
223664R	8	10/30/2022	New York Jets	New England Patriots	3	-110	-110	0.499	No Play	Home	Away
223665R	8	10/30/2022	Philadelphia Eagles	Pittsburgh Steelers	-11.5	-111	-109	0.669	Play	Home	Home
223666R	8	10/30/2022	Houston Texans	Tennessee Titans	1	-112	-109	0.626	Play	Home	Away
223667R	8	10/30/2022	Indianapolis Colts	Washington Commanders	-2.5	-120	-104	0.389	Play	Away	Away
223668R	8	10/30/2022	Los Angeles Rams	San Francisco 49ers	-1	-110	-112	0.6	Play	Home	Away

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					B	etting Lin	es		Model Out	puts	
Game ID	Wk	Date	Home Team	Away Team	Home Spread	Home Spread Odds	Away Spread Odds	Model IP	Play Decision	Prediction	Outcome
223669R	8	10/30/2022	Seattle Seahawks	New York Giants	-3.5	-103	-118	0.589	Play	Home	Home
223670R	8	10/30/2022	Buffalo Bills	Green Bay Packers	-10.5	-110	-110	0.379	Play	Away	Away
223672R	9	11/3/2022	Houston Texans	Philadelphia Eagles	14	-110	-110	0.422	Play	Away	Home
223673R	9	11/6/2022	Atlanta Falcons	Los Angeles Chargers	2.5	-110	-110	0.565	Play	Home	Away
223674R	9	11/6/2022	Chicago Bears	Miami Dolphins	4	-112	-110	0.401	Play	Away	Home
223675R	9	11/6/2022	Cincinnati Bengals	Carolina Panthers	-7	-111	-109	0.609	Play	Home	Home
223676R	9	11/6/2022	Detroit Lions	Green Bay Packers	4	-110	-110	0.424	Play	Away	Home
223677R	9	11/6/2022	New England Patriots	Indianapolis Colts	-5	-110	-110	0.552	Play	Home	Home
223678R	9	11/6/2022	New York Jets	Buffalo Bills	10.5	-110	-110	0.385	Play	Away	Home
223680R	9	11/6/2022	Jacksonville Jaguars	Las Vegas Raiders	2.5	-110	-111	0.425	Play	Away	Home
223681R	9	11/6/2022	Arizona Cardinals	Seattle Seahawks	-2.5	-110	-112	0.452	Play	Away	Away
223683R	9	11/6/2022	Kansas City Chiefs	Tennessee Titans	-14	-109	-113	0.677	Play	Home	Away
223684R	9	11/7/2022	New Orleans Saints	Baltimore Ravens	2	-112	-110	0.408	Play	Away	Away
223685R	10	11/10/2022	Carolina Panthers	Atlanta Falcons	2.5	-107	-114	0.616	Play	Home	Home
223686R	10	11/13/2022	Tampa Bay Buccaneers	Seattle Seahawks	-2.5	-117	-104	0.422	Play	Away	Home
223687R	10	11/13/2022	Buffalo Bills	Minnesota Vikings	-6.5	-110	-110	0.604	Play	Home	Away
223688R	10	11/13/2022	Chicago Bears	Detroit Lions	-3	-109	-112	0.65	Play	Home	Away
223689R	10	11/13/2022	Tennessee Titans	Denver Broncos	-2.5	-112	-110	0.547	Play	Home	Home
223690R	10	11/13/2022	Kansas City Chiefs	Jacksonville Jaguars	-9.5	-110	-110	0.433	Play	Away	Home
223691R	10	11/13/2022	Miami Dolphins	Cleveland Browns	-3.5	-105	-117	0.409	Play	Away	Home
223692R	10	11/13/2022	New York Giants	Houston Texans	-5	-109	-112	0.473	Play	Away	Home
223693R	10	11/13/2022	Pittsburgh Steelers	New Orleans Saints	-1	-110	-112	0.412	Play	Away	Home
223694R	10	11/13/2022	Las Vegas Raiders	Indianapolis Colts	-4.5	-110	-110	0.457	Play	Away	Away
223695R	10	11/13/2022	Green Bay Packers	Dallas Cowboys	3.5	-108	-113	0.497	No Play	Away	Home
223696R	10	11/13/2022	Los Angeles Rams	Arizona Cardinals	-3.5	-106	-115	0.486	No Play	Away	Away
223697R	10	11/13/2022	San Francisco 49ers	Los Angeles Chargers	-8	-110	-110	0.585	Play	Home	Away
223698R	10	11/14/2022	Philadelphia Eagles	Washington Commanders	-11	-110	-110	0.485	No Play	Away	Away

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					B	Betting Lin	es		Model Out	puts	
Game ID	Wk	Date	Home Team	Away Team	Home Spread	Home Spread Odds	Away Spread Odds	Model IP	Play Decision	Prediction	Outcome
223699R	11	11/17/2022	Green Bay Packers	Tennessee Titans	-3.5	-103	-118	0.612	Play	Home	Away
223700R	11	11/20/2022	Atlanta Falcons	Chicago Bears	-2.5	-112	-110	0.547	Play	Home	Home
223702R	11	11/20/2022	Indianapolis Colts	Philadelphia Eagles	6.5	-109	-112	0.426	Play	Away	Home
223703R	11	11/20/2022	New England Patriots	New York Jets	-3.5	-106	-115	0.529	No Play	Home	Home
223704R	11	11/20/2022	New Orleans Saints	Los Angeles Rams	-2	-110	-110	0.472	Play	Away	Home
223705R	11	11/20/2022	New York Giants	Detroit Lions	-3	-112	-108	0.577	Play	Home	Away
223706R	11	11/20/2022	Baltimore Ravens	Carolina Panthers	-12.5	-112	-110	0.647	Play	Home	Away
223707R	11	11/20/2022	Houston Texans	Washington Commanders	3	-109	-112	0.484	No Play	Away	Away
223708R	11	11/20/2022	Denver Broncos	Las Vegas Raiders	-3	-103	-118	0.361	Play	Away	Away
223709R	11	11/20/2022	Minnesota Vikings	Dallas Cowboys	2	-110	-110	0.469	Play	Away	Away
223710R	11	11/20/2022	Pittsburgh Steelers	Cincinnati Bengals	3.5	-112	-109	0.508	No Play	Home	Away
223711R	11	11/20/2022	Los Angeles Chargers	Kansas City Chiefs	5.5	-110	-111	0.46	Play	Away	Home
223712R	11	11/21/2022	Arizona Cardinals	San Francisco 49ers	10	-113	-108	0.377	Play	Away	Away
223713R	12	11/24/2022	Detroit Lions	Buffalo Bills	9.5	-111	-110	0.418	Play	Away	Home
223714R	12	11/24/2022	Dallas Cowboys	New York Giants	-10	-111	-110	0.504	No Play	Away	Away
223715R	12	11/24/2022	Minnesota Vikings	New England Patriots	-2.5	-116	-105	0.41	Play	Away	Home
223716R	12	11/27/2022	Cleveland Browns	Tampa Bay Buccaneers	3.5	-115	-107	0.613	Play	Home	Home
223717R	12	11/27/2022	Tennessee Titans	Cincinnati Bengals	-0.5	-112	-109	0.507	No Play	Home	Away
223718R	12	11/27/2022	Miami Dolphins	Houston Texans	-14	-110	-112	0.424	Play	Away	Home
223719R	12	11/27/2022	New York Jets	Chicago Bears	-8.5	-110	-110	0.477	Play	Away	Home
223720R	12	11/27/2022	Washington Commanders	Atlanta Falcons	-3.5	-113	-108	0.649	Play	Home	Home
223721R	12	11/27/2022	Carolina Panthers	Denver Broncos	1	-110	-110	0.489	No Play	Away	Home
223722R	12	11/27/2022	Jacksonville Jaguars	Baltimore Ravens	3.5	-115	-106	0.604	Play	Home	Home
223723R	12	11/27/2022	Arizona Cardinals	Los Angeles Chargers	2.5	-104	-118	0.474	Play	Away	Home
223724R	12	11/27/2022	Seattle Seahawks	Las Vegas Raiders	-4	-110	-112	0.48	No Play	Away	Away
223725R	12	11/27/2022	Kansas City Chiefs	Los Angeles Rams	-16.5	-108	-113	0.355	Play	Away	Away
223726R	12	11/27/2022	San Francisco 49ers	New Orleans Saints	-8.5	-111	-109	0.472	Play	Away	Home
223727R	12	11/27/2022	Philadelphia Eagles	Green Bay Packers	-6.5	-110	-111	0.468	Play	Away	Home

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					В	etting Lin	es		Model Out	puts	
Game ID	Wk	Date	Home Team	Away Team	Home Spread	Home Spread Odds	Away Spread Odds	Model IP	Play Decision	Prediction	Outcome
223728R	12	11/28/2022	Indianapolis Colts	Pittsburgh Steelers	-2.5	-111	-110	0.566	Play	Home	Away
223729R	13	12/1/2022	New England Patriots	Buffalo Bills	4	-112	-109	0.458	Play	Away	Away
223730R	13	12/4/2022	Atlanta Falcons	Pittsburgh Steelers	1	-110	-110	0.61	Play	Home	Away
223731R	13	12/4/2022	Chicago Bears	Green Bay Packers	3.5	-110	-110	0.493	No Play	Away	Away
223732R	13	12/4/2022	Detroit Lions	Jacksonville Jaguars	-1	-110	-110	0.606	Play	Home	Home
223733R	13	12/4/2022	Minnesota Vikings	New York Jets	-3	-105	-116	0.465	Play	Away	Home
223735R	13	12/4/2022	Philadelphia Eagles	Tennessee Titans	-4.5	-111	-110	0.584	Play	Home	Home
223736R	13	12/4/2022	Baltimore Ravens	Denver Broncos	-9	-110	-110	0.596	Play	Home	Away
223737R	13	12/4/2022	Houston Texans	Cleveland Browns	7.5	-110	-110	0.481	No Play	Away	Away
223738R	13	12/4/2022	Los Angeles Rams	Seattle Seahawks	6.5	-108	-113	0.497	No Play	Away	Home
223739R	13	12/4/2022	San Francisco 49ers	Miami Dolphins	-5.5	-108	-113	0.543	Play	Home	Home
223740R	13	12/4/2022	Cincinnati Bengals	Kansas City Chiefs	2.5	-109	-112	0.5	No Play	Away	Home
223741R	13	12/4/2022	Las Vegas Raiders	Los Angeles Chargers	-2.5	-111	-110	0.542	Play	Home	Home
223742R	13	12/4/2022	Dallas Cowboys	Indianapolis Colts	-11	-109	-112	0.485	No Play	Away	Home
223743R	13	12/5/2022	Tampa Bay Buccaneers	New Orleans Saints	-3.5	-106	-116	0.237	Play	Away	Away
223744R	14	12/8/2022	Los Angeles Rams	Las Vegas Raiders	6	-110	-110	0.469	No Play	Away	Home
223745R	14	12/11/2022	Buffalo Bills	New York Jets	-10	-110	-110	0.589	Play	Home	Away
223746R	14	12/11/2022	Cincinnati Bengals	Cleveland Browns	-4	-112	-109	0.366	Play	Away	Home
223747R	14	12/11/2022	Dallas Cowboys	Houston Texans	-17	-110	-110	0.476	No Play	Away	Away
223748R	14	12/11/2022	Detroit Lions	Minnesota Vikings	-2.5	-112	-110	0.489	No Play	Home	Home
223749R	14	12/11/2022	Tennessee Titans	Jacksonville Jaguars	-3.5	-104	-117	0.474	No Play	Away	Away
223750R	14	12/11/2022	New York Giants	Philadelphia Eagles	7	-108	-114	0.392	Play	Away	Away
223751R	14	12/11/2022	Pittsburgh Steelers	Baltimore Ravens	-1.5	-110	-110	0.548	Play	Home	Away
223752R	14	12/11/2022	Denver Broncos	Kansas City Chiefs	9	-110	-110	0.268	Play	Away	Home
223753R	14	12/11/2022	San Francisco 49ers	Tampa Bay Buccaneers	-3.5	-106	-115	0.692	Play	Home	Home
223754R	14	12/11/2022	Seattle Seahawks	Carolina Panthers	-3.5	-110	-110	0.565	Play	Home	Away
223755R	14	12/11/2022	Los Angeles Chargers	Miami Dolphins	3	-106	-116	0.594	Play	Home	Home

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					B	etting Line	es		Model Out	puts	
Game ID	Wk	Date	Home Team	Away Team	Home Spread	Home Spread Odds	Away Spread Odds	Model IP	Play Decision	Prediction	Outcome
223756R	14	12/12/2022	Arizona Cardinals	New England Patriots	2	-112	-109	0.576	Play	Home	Away
223757R	15	12/15/2022	Seattle Seahawks	San Francisco 49ers	3	-104	-118	0.459	No Play	Away	Away
223758R	15	12/17/2022	Minnesota Vikings	Indianapolis Colts	-3.5	-110	-110	0.438	Play	Away	Away
223759R	15	12/17/2022	Cleveland Browns	Baltimore Ravens	-3	-106	-117	0.476	No Play	Away	Home
223760R	15	12/17/2022	Buffalo Bills	Miami Dolphins	-7	-114	-107	0.533	Play	Home	Away
223761R	15	12/18/2022	New Orleans Saints	Atlanta Falcons	-5	-112	-110	0.41	Play	Away	Away
223762R	15	12/18/2022	Chicago Bears	Philadelphia Eagles	8.5	-110	-110	0.459	No Play	Away	Home
223763R	15	12/18/2022	New York Jets	Detroit Lions	-2	-112	-110	0.45	Play	Away	Away
223764R	15	12/18/2022	Carolina Panthers	Pittsburgh Steelers	-3	-105	-118	0.524	Play	Home	Away
223765R	15	12/18/2022	Jacksonville Jaguars	Dallas Cowboys	4	-110	-110	0.443	Play	Away	Home
223766R	15	12/18/2022	Houston Texans	Kansas City Chiefs	14	-109	-113	0.411	Play	Away	Home
223767R	15	12/18/2022	Denver Broncos	Arizona Cardinals	-2	-109	-113	0.35	Play	Away	Home
223768R	15	12/18/2022	Las Vegas Raiders	New England Patriots	-2.5	-110	-110	0.615	Play	Home	Home
223770R	15	12/18/2022	Tampa Bay Buccaneers	Cincinnati Bengals	3	-102	-119	0.494	No Play	Home	Away
223771R	15	12/18/2022	Washington Commanders	New York Giants	-4	-113	-109	0.491	No Play	Home	Away
223772R	15	12/19/2022	Green Bay Packers	Los Angeles Rams	-7.5	-110	-110	0.661	Play	Home	Home
223773R	16	12/22/2022	New York Jets	Jacksonville Jaguars	-2.5	-115	-107	0.465	No Play	Away	Away
223774R	16	12/24/2022	Chicago Bears	Buffalo Bills	8.5	-110	-110	0.388	Play	Away	Away
223775R	16	12/24/2022	Cleveland Browns	New Orleans Saints	-3.5	100	-121	0.411	Play	Away	Away
223776R	16	12/24/2022	Kansas City Chiefs	Seattle Seahawks	-10	-110	-110	0.534	Play	Home	Home
223777R	16	12/24/2022	Minnesota Vikings	New York Giants	-4.5	-110	-110	0.609	Play	Home	Away
223778R	16	12/24/2022	New England Patriots	Cincinnati Bengals	3	-109	-112	0.431	Play	Away	Away
223779R	16	12/24/2022	Carolina Panthers	Detroit Lions	2	-110	-112	0.561	Play	Home	Home
223780R	16	12/24/2022	Baltimore Ravens	Atlanta Falcons	-6.5	-109	-112	0.526	Play	Home	Home
223781R	16	12/24/2022	Tennessee Titans	Houston Texans	-3	-117	-104	0.498	No Play	Home	Away
223782R	16	12/24/2022	San Francisco 49ers	Washington Commanders	-6.5	-112	-110	0.463	No Play	Away	Home
223783R	16	12/24/2022	Dallas Cowboys	Philadelphia Eagles	-4	-112	-110	0.427	Play	Away	Home

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					B	etting Lin	es		Model Out	puts	
Game ID	Wk	Date	Home Team	Away Team	Home Spread	Home Spread Odds	Away Spread Odds	Model IP	Play Decision	Prediction	Outcome
223784R	16	12/24/2022	Pittsburgh Steelers	Las Vegas Raiders	-2.5	-110	-112	0.503	No Play	Home	Home
223785R	16	12/25/2022	Miami Dolphins	Green Bay Packers	-3.5	-106	-115	0.444	Play	Away	Away
223786R	16	12/25/2022	Los Angeles Rams	Denver Broncos	3	-102	-119	0.597	Play	Home	Home
223787R	16	12/25/2022	Arizona Cardinals	Tampa Bay Buccaneers	7.5	-110	-110	0.645	Play	Home	Home
223788R	16	12/26/2022	Indianapolis Colts	Los Angeles Chargers	3.5	-110	-112	0.521	Play	Home	Away
223789R	17	12/29/2022	Tennessee Titans	Dallas Cowboys	13.5	-108	-114	0.545	Play	Home	Away
223790R	17	1/1/2023	Atlanta Falcons	Arizona Cardinals	-6.5	-114	-106	0.636	Play	Home	Away
223791R	17	1/1/2023	Detroit Lions	Chicago Bears	-4.5	-110	-112	0.465	No Play	Away	Home
223792R	17	1/1/2023	Kansas City Chiefs	Denver Broncos	-12.5	-111	-110	0.503	No Play	Home	Away
223793R	17	1/1/2023	New England Patriots	Miami Dolphins	-3	-110	-111	0.391	Play	Away	Away
223794R	17	1/1/2023	New York Giants	Indianapolis Colts	-5.5	-110	-110	0.332	Play	Away	Home
223795R	17	1/1/2023	Philadelphia Eagles	New Orleans Saints	-4.5	-110	-110	0.267	Play	Away	Away
223796R	17	1/1/2023	Tampa Bay Buccaneers	Carolina Panthers	-3.5	-109	-113	0.665	Play	Home	Home
223797R	17	1/1/2023	Washington Commanders	Cleveland Browns	-1	-109	-112	0.341	Play	Away	Away
223798R	17	1/1/2023	Houston Texans	Jacksonville Jaguars	3.5	-110	-112	0.455	Play	Away	Away
223799R	17	1/1/2023	Las Vegas Raiders	San Francisco 49ers	9.5	-110	-112	0.555	Play	Home	Home
223800R	17	1/1/2023	Seattle Seahawks	New York Jets	2	-112	-109	0.577	Play	Home	Home
223801R	17	1/1/2023	Green Bay Packers	Minnesota Vikings	-3	-123	100	0.597	Play	Home	Home
223803R	17	1/1/2023	Baltimore Ravens	Pittsburgh Steelers	-0.5	-114	-106	0.553	Play	Home	Away
223804R	18	1/7/2023	Las Vegas Raiders	Kansas City Chiefs	8.5	-110	-110	0.589	Play	Home	Away
223805R	18	1/7/2023	Jacksonville Jaguars	Tennessee Titans	-5.5	-112	-109	0.017	Play	Away	Away
223806R	18	1/8/2023	Atlanta Falcons	Tampa Bay Buccaneers	-6	-110	-112	0.358	Play	Away	Home
223807R	18	1/8/2023	Buffalo Bills	New England Patriots	-8	-110	-110	0.525	Play	Home	Home
223808R	18	1/8/2023	Chicago Bears	Minnesota Vikings	6.5	-109	-111	0.936	Play	Home	Away
223809R	18	1/8/2023	Cincinnati Bengals	Baltimore Ravens	-11.5	-112	-109	0.494	No Play	Home	Away
223810R	18	1/8/2023	Indianapolis Colts	Houston Texans	-3	-104	-118	0.986	Play	Home	Away
223811R	18	1/8/2023	Miami Dolphins	New York Jets	-4	-112	-110	0.887	Play	Home	Home

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					B	etting Line	es		Model Out	puts	
Game ID	Wk	Date	Home Team	Away Team	Home Spread	Home Spread Odds	Away Spread Odds	Model IP	Play Decision	Prediction	Outcome
223812R	18	1/8/2023	New Orleans Saints	Carolina Panthers	-3.5	-109	-113	0.67	Play	Home	Away
223813R	18	1/8/2023	Pittsburgh Steelers	Cleveland Browns	-2.5	-115	-107	0.235	Play	Away	Home
223814R	18	1/8/2023	Denver Broncos	Los Angeles Chargers	-6.5	-112	-110	0.92	Play	Home	Away
223815R	18	1/8/2023	Philadelphia Eagles	New York Giants	-16.5	-112	-110	0.831	Play	Home	Away
223816R	18	1/8/2023	San Francisco 49ers	Arizona Cardinals	-14.5	-109	-112	0.603	Play	Home	Home
223817R	18	1/8/2023	Seattle Seahawks	Los Angeles Rams	-5	-110	-112	0.961	Play	Home	Away
223818R	18	1/8/2023	Washington Commanders	Dallas Cowboys	7.5	-115	-106	0.378	Play	Away	Home
223819R	18	1/8/2023	Green Bay Packers	Detroit Lions	-4.5	-110	-112	0.25	Play	Away	Away
223820P	19	1/14/2023	San Francisco 49ers	Seattle Seahawks	-9.5	-110	-110	0.173	Play	Away	Home
223821P	19	1/14/2023	Jacksonville Jaguars	Los Angeles Chargers	2	-112	-110	0.106	Play	Away	Home
223822P	19	1/15/2023	Buffalo Bills	Miami Dolphins	-14	-107	-114	0.839	Play	Home	Away
223823P	19	1/15/2023	Minnesota Vikings	New York Giants	-2.5	-116	-106	0.592	Play	Home	Away
223824P	19	1/15/2023	Cincinnati Bengals	Baltimore Ravens	-8	-112	-109	0.903	Play	Home	Away
223825P	19	1/16/2023	Tampa Bay Buccaneers	Dallas Cowboys	3	-126	103	0.259	Play	Away	Away
223826P	20	1/21/2023	Kansas City Chiefs	Jacksonville Jaguars	-9.5	-112	-110	0.925	Play	Home	Away
223827P	20	1/21/2023	Philadelphia Eagles	New York Giants	-8.5	-108	-113	0.844	Play	Home	Home
223828P	20	1/22/2023	Buffalo Bills	Cincinnati Bengals	-5.5	-112	-109	0.963	Play	Home	Away
223829P	20	1/22/2023	San Francisco 49ers	Dallas Cowboys	-3.5	-110	-111	0.228	Play	Away	Home
223830P	21	1/29/2023	Philadelphia Eagles	San Francisco 49ers	-3	100	-121	0.568	Play	Home	Home
223831P	21	1/29/2023	Kansas City Chiefs	Cincinnati Bengals	-2	-110	-110	0.978	Play	Home	Home
2238328	22	2/12/2023	Philadelphia Eagles	Kansas City Chiefs	-1.5	-110	-111	0.355	Play	Away	Away

Appendix I

2022 Predictions & Results for NFL Total Points Bets

The following table displays the partitioned model's output for total points bets during the 2022 NFL season. For greater clarity, reference the following notes regarding the information captured in the table:

- Game ID is a logistic construct for uniquely identifying games within the statistical database.
- Any odds without a sign are positive odds (e.g., "109" = "+109").
- IP is abbreviation for implied probability.
- "Wk" is abbreviation for week of the NFL season.
- Outcome refers to the true result or winning bet for any given game.

				B	etting Lin	es		puts			
Game ID	Wk	Date	Home Team	Away Team	Over Under Line	Over Odds	Under Odds	Model IP	Play Decision	Prediction	Outcome
223549R	1	9/8/2022	Los Angeles Rams	Buffalo Bills	52	-110	-112	0.867	Play	Over	Under
223550R	1	9/11/2022	Atlanta Falcons	New Orleans Saints	44	-107	-115	0.542	No Play	Over	Over
223551R	1	9/11/2022	Chicago Bears	San Francisco 49ers	37.5	-112	-109	0.148	Play	Under	Under
223552R	1	9/11/2022	Cincinnati Bengals	Pittsburgh Steelers	44.5	-109	-112	0.956	Play	Over	Under
223553R	1	9/11/2022	Detroit Lions	Philadelphia Eagles	48.5	-110	-110	0.499	Play	Under	Over
223554R	1	9/11/2022	Miami Dolphins	New England Patriots	46	-113	-107	0.691	Play	Over	Under
223555R	1	9/11/2022	New York Jets	Baltimore Ravens	44	-112	-109	0.119	Play	Under	Under
223556R	1	9/11/2022	Washington Commanders	Jacksonville Jaguars	44	-110	-110	0.386	Play	Under	Over
223557R	1	9/11/2022	Carolina Panthers	Cleveland Browns	41.5	-113	-108	0.443	Play	Under	Over
223559R	1	9/11/2022	Tennessee Titans	New York Giants	44	-110	-110	0.481	Play	Under	Under
223560R	1	9/11/2022	Minnesota Vikings	Green Bay Packers	46.5	-112	-110	0.411	Play	Under	Under

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-					B	Betting Lin	es		Model Out	puts	
Game ID	Wk	Date	Home Team	Away Team	Over Under Line	Over Odds	Under Odds	Model IP	Play Decision	Prediction	Outcome
223561R	1	9/11/2022	Arizona Cardinals	Kansas City Chiefs	53.5	-114	-107	0.783	Play	Over	Over
223562R	1	9/11/2022	Los Angeles Chargers	Las Vegas Raiders	52.5	-110	-111	0.417	Play	Under	Under
223563R	1	9/11/2022	Dallas Cowboys	Tampa Bay Buccaneers	50	-110	-110	0.377	Play	Under	Under
223564R	1	9/12/2022	Seattle Seahawks	Denver Broncos	44	-108	-113	0.907	Play	Over	Under
223565R	2	9/15/2022	Kansas City Chiefs	Los Angeles Chargers	52.5	-110	-111	0.677	Play	Over	Under
223566R	2	9/18/2022	Cleveland Browns	New York Jets	38.5	-110	-110	0.492	Play	Under	Over
223567R	2	9/18/2022	New Orleans Saints	Tampa Bay Buccaneers	43.5	-110	-110	0.534	No Play	Over	Under
223568R	2	9/18/2022	New York Giants	Carolina Panthers	43.5	-112	-109	0.591	Play	Over	Under
223570R	2	9/18/2022	Jacksonville Jaguars	Indianapolis Colts	43.5	-110	-111	0.383	Play	Under	Under
223571R	2	9/18/2022	Baltimore Ravens	Miami Dolphins	43.5	-110	-110	0.389	Play	Under	Over
223572R	2	9/18/2022	Detroit Lions	Washington Commanders	48.5	-107	-114	0.714	Play	Over	Over
223573R	2	9/18/2022	San Francisco 49ers	Seattle Seahawks	39.5	-111	-110	0.268	Play	Under	Under
223574R	2	9/18/2022	Los Angeles Rams	Atlanta Falcons	46	-111	-110	0.349	Play	Under	Over
223575R	2	9/18/2022	Denver Broncos	Houston Texans	45.5	-111	-110	0.207	Play	Under	Under
223577R	2	9/18/2022	Dallas Cowboys	Cincinnati Bengals	42	-111	-110	0.683	Play	Over	Under
223578R	2	9/18/2022	Green Bay Packers	Chicago Bears	42	-109	-112	0.524	No Play	Over	Under
223579R	2	9/19/2022	Buffalo Bills	Tennessee Titans	47	-112	-109	0.373	Play	Under	Over
223580R	2	9/19/2022	Philadelphia Eagles	Minnesota Vikings	49.5	-111	-110	0.541	No Play	Over	Under
223581R	3	9/22/2022	Cleveland Browns	Pittsburgh Steelers	38	-110	-112	0.471	Play	Under	Over
223582R	3	9/25/2022	Indianapolis Colts	Kansas City Chiefs	51	-111	-110	0.309	Play	Under	Under
223583R	3	9/25/2022	New England Patriots	Baltimore Ravens	45	-110	-112	0.488	Play	Under	Over
223585R	3	9/25/2022	Tennessee Titans	Las Vegas Raiders	45.5	-110	-112	0.578	Play	Over	Over
223586R	3	9/25/2022	Miami Dolphins	Buffalo Bills	54	-110	-110	0.605	Play	Over	Under
223587R	3	9/25/2022	Minnesota Vikings	Detroit Lions	51.5	-112	-109	0.47	Play	Under	Over
223588R	3	9/25/2022	New York Jets	Cincinnati Bengals	46	-109	-112	0.638	Play	Over	Under
223589R	3	9/25/2022	Washington Commanders	Philadelphia Eagles	47.5	-111	-110	0.333	Play	Under	Under
223590R	3	9/25/2022	Carolina Panthers	New Orleans Saints	41	-112	-109	0.367	Play	Under	Under

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					B	etting Lin	es		Model Out	puts	
Game ID	Wk	Date	Home Team	Away Team	Over Under Line	Over Odds	Under Odds	Model IP	Play Decision	Prediction	Outcome
223591R	3	9/25/2022	Los Angeles Chargers	Jacksonville Jaguars	46	-110	-110	0.71	Play	Over	Over
223592R	3	9/25/2022	Tampa Bay Buccaneers	Green Bay Packers	42	-110	-110	0.551	Play	Over	Under
223593R	3	9/25/2022	Arizona Cardinals	Los Angeles Rams	48.5	-110	-110	0.662	Play	Over	Under
223594R	3	9/25/2022	Seattle Seahawks	Atlanta Falcons	43.5	-110	-110	0.425	Play	Under	Over
223595R	3	9/25/2022	Denver Broncos	San Francisco 49ers	45	-110	-110	0.285	Play	Under	Under
223596R	3	9/26/2022	New York Giants	Dallas Cowboys	38.5	-110	-110	0.375	Play	Under	Over
223597R	4	9/29/2022	Cincinnati Bengals	Miami Dolphins	48.5	-110	-110	0.592	Play	Over	Under
223598R	4	10/2/2022	New Orleans Saints	Minnesota Vikings	41.5	-113	-108	0.388	Play	Under	Over
223599R	4	10/2/2022	Atlanta Falcons	Cleveland Browns	48.5	-112	-110	0.459	Play	Under	Under
223600R	4	10/2/2022	Dallas Cowboys	Washington Commanders	41	-110	-112	0.756	Play	Over	Under
223601R	4	10/2/2022	Detroit Lions	Seattle Seahawks	48.5	-109	-112	0.371	Play	Under	Over
223602R	4	10/2/2022	Indianapolis Colts	Tennessee Titans	43	-108	-113	0.315	Play	Under	Under
223603R	4	10/2/2022	New York Giants	Chicago Bears	39	-112	-110	0.42	Play	Under	Under
223604R	4	10/2/2022	Philadelphia Eagles	Jacksonville Jaguars	44	-110	-110	0.529	No Play	Over	Over
223605R	4	10/2/2022	Pittsburgh Steelers	New York Jets	41.5	-109	-113	0.623	Play	Over	Over
223606R	4	10/2/2022	Baltimore Ravens	Buffalo Bills	50	-113	-108	0.465	Play	Under	Under
223607R	4	10/2/2022	Houston Texans	Los Angeles Chargers	45	-110	-110	0.361	Play	Under	Over
223608R	4	10/2/2022	Carolina Panthers	Arizona Cardinals	43.5	-111	-111	0.217	Play	Under	Under
223609R	4	10/2/2022	Green Bay Packers	New England Patriots	40.5	-107	-114	0.584	Play	Over	Over
223610R	4	10/2/2022	Las Vegas Raiders	Denver Broncos	45.5	-111	-110	0.536	No Play	Over	Over
223611R	4	10/2/2022	Tampa Bay Buccaneers	Kansas City Chiefs	47	-110	-110	0.539	No Play	Over	Over
223612R	4	10/3/2022	San Francisco 49ers	Los Angeles Rams	42	-111	-110	0.637	Play	Over	Under
223613R	5	10/6/2022	Denver Broncos	Indianapolis Colts	42	-110	-110	0.241	Play	Under	Under
223614R	5	10/9/2022	Green Bay Packers	New York Giants	42	-112	-109	0.673	Play	Over	Over
223615R	5	10/9/2022	Buffalo Bills	Pittsburgh Steelers	44.5	-110	-110	0.453	Play	Under	Under
223616R	5	10/9/2022	Cleveland Browns	Los Angeles Chargers	47	-110	-112	0.216	Play	Under	Over
223617R	5	10/9/2022	Minnesota Vikings	Chicago Bears	44	-111	-110	0.687	Play	Over	Over

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					B	Betting Lin	es		Model Out	puts	
Game ID	Wk	Date	Home Team	Away Team	Over Under Line	Over Odds	Under Odds	Model IP	Play Decision	Prediction	Outcome
223618R	5	10/9/2022	New England Patriots	Detroit Lions	46	-114	-107	0.432	Play	Under	Under
223619R	5	10/9/2022	New Orleans Saints	Seattle Seahawks	45	-110	-110	0.462	Play	Under	Over
223620R	5	10/9/2022	New York Jets	Miami Dolphins	46	-110	-112	0.321	Play	Under	Over
223621R	5	10/9/2022	Tampa Bay Buccaneers	Atlanta Falcons	46.5	-110	-110	0.789	Play	Over	Under
223622R	5	10/9/2022	Washington Commanders	Tennessee Titans	43	-112	-109	0.19	Play	Under	Under
223623R	5	10/9/2022	Jacksonville Jaguars	Houston Texans	43.5	-111	-110	0.55	Play	Over	Under
223624R	5	10/9/2022	Carolina Panthers	San Francisco 49ers	40	-110	-112	0.499	No Play	Under	Over
223625R	5	10/9/2022	Los Angeles Rams	Dallas Cowboys	42	-110	-110	0.584	Play	Over	Under
223626R	5	10/9/2022	Arizona Cardinals	Philadelphia Eagles	48.5	-112	-110	0.452	Play	Under	Under
223627R	5	10/9/2022	Baltimore Ravens	Cincinnati Bengals	47.5	-110	-110	0.729	Play	Over	Under
223628R	5	10/10/2022	Kansas City Chiefs	Las Vegas Raiders	51.5	-109	-113	0.531	No Play	Over	Over
223629R	6	10/13/2022	Chicago Bears	Washington Commanders	38.5	-110	-111	0.638	Play	Over	Under
223630R	6	10/16/2022	Atlanta Falcons	San Francisco 49ers	45.5	-112	-109	0.582	Play	Over	Under
223631R	6	10/16/2022	Cleveland Browns	New England Patriots	43	-110	-111	0.581	Play	Over	Over
223632R	6	10/16/2022	Green Bay Packers	New York Jets	45	-110	-110	0.537	No Play	Under	Under
223633R	6	10/16/2022	Indianapolis Colts	Jacksonville Jaguars	40.5	-114	-107	0.426	Play	Under	Over
223634R	6	10/16/2022	Miami Dolphins	Minnesota Vikings	45	-110	-110	0.52	No Play	Under	Under
223635R	6	10/16/2022	New Orleans Saints	Cincinnati Bengals	43	-109	-113	0.516	No Play	Under	Over
223636R	6	10/16/2022	New York Giants	Baltimore Ravens	46	-112	-109	0.756	Play	Over	Under
223637R	6	10/16/2022	Pittsburgh Steelers	Tampa Bay Buccaneers	46.5	-111	-110	0.453	Play	Under	Under
223638R	6	10/16/2022	Los Angeles Rams	Carolina Panthers	41	-111	-109	0.346	Play	Under	Under
223639R	6	10/16/2022	Seattle Seahawks	Arizona Cardinals	50.5	-110	-112	0.45	Play	Under	Under
223640R	6	10/16/2022	Kansas City Chiefs	Buffalo Bills	54.5	-110	-110	0.516	No Play	Under	Under
223641R	6	10/16/2022	Philadelphia Eagles	Dallas Cowboys	42.5	-110	-110	0.633	Play	Over	Over
223642R	6	10/17/2022	Los Angeles Chargers	Denver Broncos	45.5	-112	-110	0.525	No Play	Under	Under
223643R	7	10/20/2022	Arizona Cardinals	New Orleans Saints	44	-110	-110	0.577	Play	Over	Over
223644R	7	10/23/2022	Cincinnati Bengals	Atlanta Falcons	47.5	-112	-109	0.507	No Play	Under	Over

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					B	Betting Lin	es		Model Out	puts	
Game ID	Wk	Date	Home Team	Away Team	Over Under Line	Over Odds	Under Odds	Model IP	Play Decision	Prediction	Outcome
223645R	7	10/23/2022	Dallas Cowboys	Detroit Lions	49	-112	-109	0.541	No Play	Under	Under
223646R	7	10/23/2022	Tennessee Titans	Indianapolis Colts	43	-111	-111	0.532	No Play	Under	Under
223647R	7	10/23/2022	Washington Commanders	Green Bay Packers	41.5	-110	-110	0.383	Play	Under	Over
223648R	7	10/23/2022	Carolina Panthers	Tampa Bay Buccaneers	39	-113	-108	0.498	Play	Under	Under
223649R	7	10/23/2022	Jacksonville Jaguars	New York Giants	43.5	-112	-110	0.494	Play	Under	Under
223650R	7	10/23/2022	Baltimore Ravens	Cleveland Browns	46	-112	-109	0.598	Play	Over	Under
223651R	7	10/23/2022	Denver Broncos	New York Jets	37	-109	-112	0.648	Play	Over	Under
223652R	7	10/23/2022	Las Vegas Raiders	Houston Texans	46	-109	-112	0.414	Play	Under	Over
223653R	7	10/23/2022	Los Angeles Chargers	Seattle Seahawks	51	-112	-110	0.543	No Play	Under	Over
223654R	7	10/23/2022	San Francisco 49ers	Kansas City Chiefs	49	-110	-110	0.675	Play	Over	Over
223655R	7	10/23/2022	Miami Dolphins	Pittsburgh Steelers	44.5	-110	-110	0.331	Play	Under	Under
223656R	7	10/24/2022	New England Patriots	Chicago Bears	40	-110	-110	0.451	Play	Under	Over
223657R	8	10/27/2022	Tampa Bay Buccaneers	Baltimore Ravens	46.5	-110	-110	0.541	No Play	Under	Over
223658R	8	10/30/2022	Jacksonville Jaguars	Denver Broncos	40.5	-111	-110	0.521	No Play	Under	Under
223659R	8	10/30/2022	Atlanta Falcons	Carolina Panthers	41	-110	-112	0.595	Play	Over	Over
223660R	8	10/30/2022	Dallas Cowboys	Chicago Bears	42.5	-110	-110	0.476	Play	Under	Over
223661R	8	10/30/2022	Detroit Lions	Miami Dolphins	52	-110	-112	0.534	No Play	Under	Over
223662R	8	10/30/2022	Minnesota Vikings	Arizona Cardinals	48.5	-110	-112	0.462	Play	Under	Over
223663R	8	10/30/2022	New Orleans Saints	Las Vegas Raiders	48.5	-109	-112	0.573	Play	Over	Under
223664R	8	10/30/2022	New York Jets	New England Patriots	40	-110	-112	0.659	Play	Over	Under
223665R	8	10/30/2022	Philadelphia Eagles	Pittsburgh Steelers	43	-112	-110	0.54	No Play	Under	Over
223666R	8	10/30/2022	Houston Texans	Tennessee Titans	39.5	-111	-110	0.596	Play	Over	Under
223667R	8	10/30/2022	Indianapolis Colts	Washington Commanders	40	-110	-110	0.333	Play	Under	Under
223668R	8	10/30/2022	Los Angeles Rams	San Francisco 49ers	42	-109	-112	0.437	Play	Under	Over
223669R	8	10/30/2022	Seattle Seahawks	New York Giants	44.5	-109	-112	0.344	Play	Under	Under
223670R	8	10/30/2022	Buffalo Bills	Green Bay Packers	47	-108	-112	0.317	Play	Under	Under
223672R	9	11/3/2022	Houston Texans	Philadelphia Eagles	45.5	-108	-113	0.522	No Play	Under	Over

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					B	Betting Lin	es		Model Out	puts	
Game ID	Wk	Date	Home Team	Away Team	Over Under Line	Over Odds	Under Odds	Model IP	Play Decision	Prediction	Outcome
223673R	9	11/6/2022	Atlanta Falcons	Los Angeles Chargers	49.5	-111	-110	0.54	No Play	Under	Under
223674R	9	11/6/2022	Chicago Bears	Miami Dolphins	46	-110	-112	0.747	Play	Over	Over
223675R	9	11/6/2022	Cincinnati Bengals	Carolina Panthers	42.5	-110	-110	0.28	Play	Under	Over
223676R	9	11/6/2022	Detroit Lions	Green Bay Packers	49.5	-110	-110	0.326	Play	Under	Under
223677R	9	11/6/2022	New England Patriots	Indianapolis Colts	40	-110	-110	0.453	Play	Under	Under
223678R	9	11/6/2022	New York Jets	Buffalo Bills	46	-111	-110	0.682	Play	Over	Under
223680R	9	11/6/2022	Jacksonville Jaguars	Las Vegas Raiders	48	-109	-112	0.632	Play	Over	Under
223681R	9	11/6/2022	Arizona Cardinals	Seattle Seahawks	49.5	-109	-112	0.534	No Play	Under	Over
223683R	9	11/6/2022	Kansas City Chiefs	Tennessee Titans	44.5	-110	-110	0.58	Play	Over	Under
223684R	9	11/7/2022	New Orleans Saints	Baltimore Ravens	46	-112	-110	0.71	Play	Over	Under
223685R	10	11/10/2022	Carolina Panthers	Atlanta Falcons	41.5	-110	-110	0.449	No Play	Under	Under
223686R	10	11/13/2022	Tampa Bay Buccaneers	Seattle Seahawks	45	-110	-112	0.54	Play	Over	Under
223687R	10	11/13/2022	Buffalo Bills	Minnesota Vikings	46.5	-110	-110	0.503	Play	Over	Over
223688R	10	11/13/2022	Chicago Bears	Detroit Lions	48.5	-109	-112	0.689	Play	Over	Over
223689R	10	11/13/2022	Tennessee Titans	Denver Broncos	39.5	-110	-110	0.388	Play	Under	Under
223690R	10	11/13/2022	Kansas City Chiefs	Jacksonville Jaguars	51.5	-109	-112	0.537	Play	Over	Under
223691R	10	11/13/2022	Miami Dolphins	Cleveland Browns	49.5	-110	-110	0.384	Play	Under	Over
223692R	10	11/13/2022	New York Giants	Houston Texans	41.5	-111	-110	0.564	Play	Over	Under
223693R	10	11/13/2022	Pittsburgh Steelers	New Orleans Saints	39.5	-112	-109	0.372	Play	Under	Under
223694R	10	11/13/2022	Las Vegas Raiders	Indianapolis Colts	41	-109	-113	0.451	No Play	Under	Over
223695R	10	11/13/2022	Green Bay Packers	Dallas Cowboys	44.5	-110	-110	0.335	Play	Under	Over
223696R	10	11/13/2022	Los Angeles Rams	Arizona Cardinals	38	-109	-112	0.313	Play	Under	Over
223697R	10	11/13/2022	San Francisco 49ers	Los Angeles Chargers	45.5	-110	-111	0.466	No Play	Under	Under
223698R	10	11/14/2022	Philadelphia Eagles	Washington Commanders	43	-110	-110	0.488	No Play	Over	Over
223699R	11	11/17/2022	Green Bay Packers	Tennessee Titans	40.5	-113	-108	0.371	Play	Under	Over
223700R	11	11/20/2022	Atlanta Falcons	Chicago Bears	48.5	-111	-111	0.316	Play	Under	Over
223702R	11	11/20/2022	Indianapolis Colts	Philadelphia Eagles	45.5	-112	-110	0.416	Play	Under	Under

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					Over				Widder Out	puts	
Game ID	Wk	Date	Home Team	Away Team	Under Line	Over Odds	Under Odds	Model IP	Play Decision	Prediction	Outcome
223703R	11	11/20/2022	New England Patriots	New York Jets	38	-110	-110	0.456	No Play	Under	Under
223704R	11	11/20/2022	New Orleans Saints	Los Angeles Rams	39	-110	-112	0.446	No Play	Under	Over
223705R	11	11/20/2022	New York Giants	Detroit Lions	44.5	-109	-112	0.659	Play	Over	Over
223706R	11	11/20/2022	Baltimore Ravens	Carolina Panthers	41	-110	-110	0.202	Play	Under	Under
223707R	11	11/20/2022	Houston Texans	Washington Commanders	41	-112	-109	0.353	Play	Under	Under
223708R	11	11/20/2022	Denver Broncos	Las Vegas Raiders	41.5	-110	-110	0.703	Play	Over	Under
223709R	11	11/20/2022	Minnesota Vikings	Dallas Cowboys	48.5	-112	-109	0.404	Play	Under	Under
223710R	11	11/20/2022	Pittsburgh Steelers	Cincinnati Bengals	39.5	-110	-110	0.385	Play	Under	Over
223711R	11	11/20/2022	Los Angeles Chargers	Kansas City Chiefs	52.5	-112	-109	0.34	Play	Under	Over
223712R	11	11/21/2022	Arizona Cardinals	San Francisco 49ers	43	-112	-109	0.461	No Play	Under	Over
223713R	12	11/24/2022	Detroit Lions	Buffalo Bills	55	-112	-109	0.555	Play	Over	Under
223714R	12	11/24/2022	Dallas Cowboys	New York Giants	45.5	-110	-110	0.542	Play	Over	Over
223715R	12	11/24/2022	Minnesota Vikings	New England Patriots	41.5	-110	-110	0.563	Play	Over	Over
223716R	12	11/27/2022	Cleveland Browns	Tampa Bay Buccaneers	42	-111	-110	0.278	Play	Under	Under
223717R	12	11/27/2022	Tennessee Titans	Cincinnati Bengals	42.5	-110	-110	0.397	Play	Under	Under
223718R	12	11/27/2022	Miami Dolphins	Houston Texans	47	-110	-110	0.485	No Play	Over	Under
223719R	12	11/27/2022	New York Jets	Chicago Bears	36.5	-112	-109	0.443	Play	Under	Over
223720R	12	11/27/2022	Washington Commanders	Atlanta Falcons	40.5	-109	-112	0.514	Play	Over	Under
223721R	12	11/27/2022	Carolina Panthers	Denver Broncos	36	-112	-109	0.411	Play	Under	Under
223722R	12	11/27/2022	Jacksonville Jaguars	Baltimore Ravens	43	-113	-108	0.438	Play	Under	Over
223723R	12	11/27/2022	Arizona Cardinals	Los Angeles Chargers	48.5	-112	-110	0.478	No Play	Over	Over
223724R	12	11/27/2022	Seattle Seahawks	Las Vegas Raiders	47.5	-110	-111	0.616	Play	Over	Over
223725R	12	11/27/2022	Kansas City Chiefs	Los Angeles Rams	41.5	-110	-112	0.504	Play	Over	Under
223726R	12	11/27/2022	San Francisco 49ers	New Orleans Saints	43.5	-111	-110	0.606	Play	Over	Under
223727R	12	11/27/2022	Philadelphia Eagles	Green Bay Packers	46	-109	-112	0.555	Play	Over	Over
223728R	12	11/28/2022	Indianapolis Colts	Pittsburgh Steelers	39.5	-110	-110	0.401	Play	Under	Over
223729R	13	12/1/2022	New England Patriots	Buffalo Bills	44	-110	-112	0.474	No Play	Over	Under
223730R	13	12/4/2022	Atlanta Falcons	Pittsburgh Steelers	43	-107	-114	0.253	Play	Under	Under

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					B	Betting Lin	es		Model Out	puts	
Game ID	Wk	Date	Home Team	Away Team	Over Under Line	Over Odds	Under Odds	Model IP	Play Decision	Prediction	Outcome
223731R	13	12/4/2022	Chicago Bears	Green Bay Packers	45	-110	-112	0.538	Play	Over	Over
223732R	13	12/4/2022	Detroit Lions	Jacksonville Jaguars	51	-112	-109	0.5	Play	Over	Over
223733R	13	12/4/2022	Minnesota Vikings	New York Jets	44	-110	-110	0.42	Play	Under	Over
223735R	13	12/4/2022	Philadelphia Eagles	Tennessee Titans	44.5	-110	-112	0.384	Play	Under	Over
223736R	13	12/4/2022	Baltimore Ravens	Denver Broncos	40	-112	-109	0.228	Play	Under	Under
223737R	13	12/4/2022	Houston Texans	Cleveland Browns	46.5	-109	-112	0.502	Play	Over	Under
223738R	13	12/4/2022	Los Angeles Rams	Seattle Seahawks	41	-110	-112	0.466	No Play	Under	Over
223739R	13	12/4/2022	San Francisco 49ers	Miami Dolphins	46	-110	-110	0.603	Play	Over	Over
223740R	13	12/4/2022	Cincinnati Bengals	Kansas City Chiefs	53.5	-110	-112	0.58	Play	Over	Under
223741R	13	12/4/2022	Las Vegas Raiders	Los Angeles Chargers	49.5	-110	-111	0.432	Play	Under	Under
223742R	13	12/4/2022	Dallas Cowboys	Indianapolis Colts	44.5	-111	-110	0.724	Play	Over	Over
223743R	13	12/5/2022	Tampa Bay Buccaneers	New Orleans Saints	40.5	-113	-109	0.69	Play	Over	Under
223744R	14	12/8/2022	Los Angeles Rams	Las Vegas Raiders	41.5	-110	-110	0.24	Play	Under	Under
223745R	14	12/11/2022	Buffalo Bills	New York Jets	43.5	-110	-112	0.474	No Play	Over	Under
223746R	14	12/11/2022	Cincinnati Bengals	Cleveland Browns	47	-112	-109	0.424	Play	Under	Under
223747R	14	12/11/2022	Dallas Cowboys	Houston Texans	44.5	-110	-110	0.683	Play	Over	Over
223748R	14	12/11/2022	Detroit Lions	Minnesota Vikings	51.5	-110	-112	0.543	Play	Over	Over
223749R	14	12/11/2022	Tennessee Titans	Jacksonville Jaguars	41.5	-112	-110	0.265	Play	Under	Over
223750R	14	12/11/2022	New York Giants	Philadelphia Eagles	44.5	-111	-110	0.334	Play	Under	Over
223751R	14	12/11/2022	Pittsburgh Steelers	Baltimore Ravens	36.5	-110	-111	0.345	Play	Under	Under
223752R	14	12/11/2022	Denver Broncos	Kansas City Chiefs	44	-110	-112	0.347	Play	Under	Over
223753R	14	12/11/2022	San Francisco 49ers	Tampa Bay Buccaneers	38.5	-112	-110	0.472	No Play	Over	Over
223754R	14	12/11/2022	Seattle Seahawks	Carolina Panthers	44.5	-110	-110	0.701	Play	Over	Over
223755R	14	12/11/2022	Los Angeles Chargers	Miami Dolphins	54.5	-111	-109	0.45	No Play	Under	Under
223756R	14	12/12/2022	Arizona Cardinals	New England Patriots	44	-110	-111	0.421	Play	Under	Under
223757R	15	12/15/2022	Seattle Seahawks	San Francisco 49ers	43	-109	-112	0.761	Play	Over	Under
223758R	15	12/17/2022	Minnesota Vikings	Indianapolis Colts	47	-112	-110	0.615	Play	Over	Over

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					B	Betting Line	es		Model Out	puts		
Game ID	Wk	Date	Home Team	Away Team	Over Under Line	Over Odds	Under Odds	Model IP	Play Decision	Prediction	Outcome	
223759R	15	12/17/2022	Cleveland Browns	Baltimore Ravens	39.5	-107	-113	0.361	Play	Under	Under	
223760R	15	12/17/2022	Buffalo Bills	Miami Dolphins	44	-109	-112	0.457	No Play	Under	Over	
223761R	15	12/18/2022	New Orleans Saints	Atlanta Falcons	43.5	-110	-111	0.416	Play	Under	Under	
223762R	15	12/18/2022	Chicago Bears	Philadelphia Eagles	47.5	-112	-110	0.377	Play	Under	Under	
223763R	15	12/18/2022	New York Jets	Detroit Lions	44	-110	-112	0.403	Play	Under	Under	
223764R	15	12/18/2022	Carolina Panthers	Pittsburgh Steelers	37	-109	-112	0.277	Play	Under	Over	
223765R	15	12/18/2022	Jacksonville Jaguars	Dallas Cowboys	48	-112	-110	0.483	No Play	Over	Over	
223766R	15	12/18/2022	Houston Texans	Kansas City Chiefs	48.5	-110	-110	0.548	Play	Over	Over	
223767R	15	12/18/2022	Denver Broncos	Arizona Cardinals	37.5	-109	-112	0.256	Play	Under	Over	
223768R	15	12/18/2022	Las Vegas Raiders	New England Patriots	45	-112	-110	0.619	Play	Over	Over	
223770R	15	12/18/2022	Tampa Bay Buccaneers	Cincinnati Bengals	47.5	-108	-113	0.417	Play	Under	Over	
223771R	15	12/18/2022	Washington Commanders	New York Giants	40.5	-112	-109	0.371	Play	Under	Under	
223772R	15	12/19/2022	Green Bay Packers	Los Angeles Rams	39.5	-110	-110	0.417	Play	Under	Under	
223773R	16	12/22/2022	New York Jets	Jacksonville Jaguars	36.5	-110	-112	0.438	Play	Under	Under	
223774R	16	12/24/2022	Chicago Bears	Buffalo Bills	40.5	-110	-112	0.321	Play	Under	Over	
223775R	16	12/24/2022	Cleveland Browns	New Orleans Saints	32	-112	-110	0.486	No Play	Over	Under	
223776R	16	12/24/2022	Kansas City Chiefs	Seattle Seahawks	50.5	-109	-112	0.696	Play	Over	Under	
223777R	16	12/24/2022	Minnesota Vikings	New York Giants	48	-112	-109	0.49	No Play	Over	Over	
223778R	16	12/24/2022	New England Patriots	Cincinnati Bengals	41.5	-112	-110	0.412	Play	Under	Under	
223779R	16	12/24/2022	Carolina Panthers	Detroit Lions	43.5	-110	-111	0.361	Play	Under	Over	
223780R	16	12/24/2022	Baltimore Ravens	Atlanta Falcons	35	-112	-110	0.331	Play	Under	Under	
223781R	16	12/24/2022	Tennessee Titans	Houston Texans	34	-112	-110	0.33	Play	Under	Under	
223782R	16	12/24/2022	San Francisco 49ers	Washington Commanders	37.5	-112	-110	0.418	Play	Under	Over	
223783R	16	12/24/2022	Dallas Cowboys	Philadelphia Eagles	48	-109	-113	0.499	No Play	Over	Over	
223784R	16	12/24/2022	Pittsburgh Steelers	Las Vegas Raiders	38	-109	-112	0.482	No Play	Over	Under	
223785R	16	12/25/2022	Miami Dolphins	Green Bay Packers	49.5	-110	-112	0.449	No Play	Under	Under	
223786R	16	12/25/2022	Los Angeles Rams	Denver Broncos	36	-110	-110	0.483	No Play	Over	Over	

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	_				B	Betting Lin	es		Model Out	puts	
Game ID	Wk	Date	Home Team	Away Team	Over Under Line	Over Odds	Under Odds	Model IP	Play Decision	Prediction	Outcome
223787R	16	12/25/2022	Arizona Cardinals	Tampa Bay Buccaneers	42	-112	-109	0.432	Play	Under	Under
223788R	16	12/26/2022	Indianapolis Colts	Los Angeles Chargers	44.5	-110	-110	0.613	Play	Over	Under
223789R	17	12/29/2022	Tennessee Titans	Dallas Cowboys	40.5	-110	-110	0.237	Play	Under	Under
223790R	17	1/1/2023	Atlanta Falcons	Arizona Cardinals	40.5	-111	-110	0.422	Play	Under	Under
223791R	17	1/1/2023	Detroit Lions	Chicago Bears	52.5	-112	-109	0.4	Play	Under	Under
223792R	17	1/1/2023	Kansas City Chiefs	Denver Broncos	46	-110	-112	0.653	Play	Over	Over
223793R	17	1/1/2023	New England Patriots	Miami Dolphins	41.5	-112	-110	0.392	Play	Under	Over
223794R	17	1/1/2023	New York Giants	Indianapolis Colts	38.5	-112	-110	0.446	No Play	Under	Over
223795R	17	1/1/2023	Philadelphia Eagles	New Orleans Saints	42	-112	-110	0.518	Play	Over	Under
223796R	17	1/1/2023	Tampa Bay Buccaneers	Carolina Panthers	40.5	-110	-112	0.441	Play	Under	Over
223797R	17	1/1/2023	Washington Commanders	Cleveland Browns	41.5	-110	-112	0.257	Play	Under	Under
223798R	17	1/1/2023	Houston Texans	Jacksonville Jaguars	43.5	-113	-109	0.506	Play	Over	Under
223799R	17	1/1/2023	Las Vegas Raiders	San Francisco 49ers	41.5	-110	-110	0.508	Play	Over	Over
223800R	17	1/1/2023	Seattle Seahawks	New York Jets	43.5	-110	-112	0.836	Play	Over	Under
223801R	17	1/1/2023	Green Bay Packers	Minnesota Vikings	47.5	-112	-109	0.548	Play	Over	Over
223803R	17	1/1/2023	Baltimore Ravens	Pittsburgh Steelers	35.5	-110	-111	0.445	No Play	Under	Under
223804R	18	1/7/2023	Las Vegas Raiders	Kansas City Chiefs	52	-110	-110	0.21	Play	Under	Under
223805R	18	1/7/2023	Jacksonville Jaguars	Tennessee Titans	39.5	-110	-111	0.22	Play	Under	Under
223806R	18	1/8/2023	Atlanta Falcons	Tampa Bay Buccaneers	40.5	-112	-110	0.102	Play	Under	Over
223807R	18	1/8/2023	Buffalo Bills	New England Patriots	44	-109	-112	0.377	Play	Under	Over
223808R	18	1/8/2023	Chicago Bears	Minnesota Vikings	42.5	-112	-110	0.506	No Play	Over	Under
223809R	18	1/8/2023	Cincinnati Bengals	Baltimore Ravens	39	-112	-109	0.219	Play	Under	Over
223810R	18	1/8/2023	Indianapolis Colts	Houston Texans	37.5	-110	-110	0.481	No Play	Under	Over
223811R	18	1/8/2023	Miami Dolphins	New York Jets	37	-112	-110	0.163	Play	Under	Under
223812R	18	1/8/2023	New Orleans Saints	Carolina Panthers	41.5	-110	-112	0.068	Play	Under	Under
223813R	18	1/8/2023	Pittsburgh Steelers	Cleveland Browns	40	-112	-110	0.332	Play	Under	Over
223814R	18	1/8/2023	Denver Broncos	Los Angeles Chargers	39.5	-108	-114	0.604	Play	Over	Over

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					B	etting Lin	es		Model Out	puts	
Game ID	Wk	Date	Home Team	Away Team	Over Under Line	Over Odds	Under Odds	Model IP	Play Decision	Prediction	Outcome
223815R	18	1/8/2023	Philadelphia Eagles	New York Giants	42.5	-112	-110	0.205	Play	Under	Under
223816R	18	1/8/2023	San Francisco 49ers	Arizona Cardinals	40	-109	-113	0.045	Play	Under	Over
223817R	18	1/8/2023	Seattle Seahawks	Los Angeles Rams	42.5	-113	-108	0.578	Play	Over	Under
223818R	18	1/8/2023	Washington Commanders	Dallas Cowboys	40.5	-110	-110	0.339	Play	Under	Under
223819R	18	1/8/2023	Green Bay Packers	Detroit Lions	48.5	-110	-110	0.761	Play	Over	Under
223820P	19	1/14/2023	San Francisco 49ers	Seattle Seahawks	42	-110	-112	0.143	Play	Under	Over
223821P	19	1/14/2023	Jacksonville Jaguars	Los Angeles Chargers	46.5	-112	-109	0.775	Play	Over	Over
223822P	19	1/15/2023	Buffalo Bills	Miami Dolphins	44	-113	-108	0.291	Play	Under	Over
223823P	19	1/15/2023	Minnesota Vikings	New York Giants	48	-110	-111	0.362	Play	Under	Over
223824P	19	1/15/2023	Cincinnati Bengals	Baltimore Ravens	40	-110	-110	0.33	Play	Under	Over
223825P	19	1/16/2023	Tampa Bay Buccaneers	Dallas Cowboys	45.5	-110	-111	0.625	Play	Over	Under
223826P	20	1/21/2023	Kansas City Chiefs	Jacksonville Jaguars	52	-110	-110	0.647	Play	Over	Under
223827P	20	1/21/2023	Philadelphia Eagles	New York Giants	48	-110	-110	0.228	Play	Under	Under
223828P	20	1/22/2023	Buffalo Bills	Cincinnati Bengals	48.5	-110	-110	0.782	Play	Over	Under
223829P	20	1/22/2023	San Francisco 49ers	Dallas Cowboys	46.5	-110	-110	0.364	Play	Under	Under
223830P	21	1/29/2023	Philadelphia Eagles	San Francisco 49ers	44.5	-112	-110	0.448	Play	Under	Under
223831P	21	1/29/2023	Kansas City Chiefs	Cincinnati Bengals	48.5	-110	-111	0.937	Play	Over	Under
2238328	22	2/12/2023	Philadelphia Eagles	Kansas City Chiefs	51.5	-108	-114	0.42	Play	Under	Over

Appendix J

Comparison of 2022 Sportsbook & Model ML Predictions

The following table compares the partitioned model's predictions to the underlying predictions in sportsbook odds models. Note that only games where the refined optimal strategy outputs a play decision are included for comparison. For greater clarity, reference the following notes regarding the information captured in the table:

- Game ID is a logistic construct for uniquely identifying games within the statistical database.
- A moneyline without a sign indicates positive odds (e.g., "109" = "+109").
- IP is abbreviation for implied probability.
- "Wk" is abbreviation for week of the NFL season; "Pred." is abbreviation for prediction.
- Outcome refers to the true result or winning bet for any given game.

					Bettin	g Lines	Spor	<mark>tsbook N</mark>	lodel	Dev	<mark>eloped M</mark>	odel	
Game ID	Wk	Date	Home Team	Away Team	Home ML	Away ML	Home IP	Away IP	Pred.	Home IP	Away IP	Pred.	Outcome
223550R	1	9/11/2022	Atlanta Falcons	New Orleans Saints	199	-240	0.334	0.706	Away	0.201	0.799	Away	Away
223551R	1	9/11/2022	Chicago Bears	San Francisco 49ers	229	-281	0.304	0.738	Away	0.395	0.605	Away	Home
223552R	1	9/11/2022	Cincinnati Bengals	Pittsburgh Steelers	-321	255	0.762	0.282	Home	0.178	0.822	Away	Away
223553R	1	9/11/2022	Detroit Lions	Philadelphia Eagles	200	-242	0.333	0.708	Away	0.074	0.926	Away	Away
223555R	1	9/11/2022	New York Jets	Baltimore Ravens	243	-300	0.292	0.75	Away	0.175	0.825	Away	Away
223556R	1	9/11/2022	Washington Commanders	Jacksonville Jaguars	-155	130	0.608	0.435	Home	0.664	0.336	Home	Home
223557R	1	9/11/2022	Carolina Panthers	Cleveland Browns	-124	105	0.554	0.488	Home	0.578	0.422	Home	Away
223559R	1	9/11/2022	Tennessee Titans	New York Giants	-240	199	0.706	0.334	Home	0.917	0.083	Home	Away
223560R	1	9/11/2022	Minnesota Vikings	Green Bay Packers	-127	106	0.559	0.485	Home	0.38	0.62	Away	Home
223561R	1	9/11/2022	Arizona Cardinals	Kansas City Chiefs	212	-258	0.321	0.721	Away	0.67	0.33	Home	Away

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C					Bettin	g Lines	Spor	<mark>tsbook N</mark>	Iodel	Dev	<mark>eloped M</mark>	odel	
Game ID	Wk	Date	Home Team	Away Team	Home ML	Away ML	Home IP	Away IP	Pred.	Home IP	Away IP	Pred.	Outcome
223562R	1	9/11/2022	Los Angeles Chargers	Las Vegas Raiders	-186	155	0.65	0.392	Home	0.735	0.265	Home	Home
223563R	1	9/11/2022	Dallas Cowboys	Tampa Bay Buccaneers	114	-136	0.467	0.576	Away	0.608	0.392	Home	Away
223564R	1	9/12/2022	Seattle Seahawks	Denver Broncos	227	-277	0.306	0.735	Away	0.818	0.182	Home	Home
223565R	2	9/15/2022	Kansas City Chiefs	Los Angeles Chargers	-202	168	0.669	0.373	Home	0.657	0.343	Home	Home
223566R	2	9/18/2022	Cleveland Browns	New York Jets	-265	218	0.726	0.314	Home	0.717	0.283	Home	Away
223567R	2	9/18/2022	New Orleans Saints	Tampa Bay Buccaneers	122	-145	0.45	0.592	Away	0.86	0.14	Home	Away
223568R	2	9/18/2022	New York Giants	Carolina Panthers	103	-116	0.493	0.537	Away	0.482	0.518	Away	Home
223570R	2	9/18/2022	Jacksonville Jaguars	Indianapolis Colts	137	-163	0.422	0.62	Away	0.093	0.907	Away	Home
223573R	2	9/18/2022	San Francisco 49ers	Seattle Seahawks	-392	307	0.797	0.246	Home	0.866	0.134	Home	Home
223574R	2	9/18/2022	Los Angeles Rams	Atlanta Falcons	-501	378	0.834	0.209	Home	0.94	0.06	Home	Home
223575R	2	9/18/2022	Denver Broncos	Houston Texans	-498	383	0.833	0.207	Home	0.733	0.267	Home	Home
223577R	2	9/18/2022	Dallas Cowboys	Cincinnati Bengals	270	-341	0.27	0.773	Away	0.669	0.331	Home	Home
223578R	2	9/18/2022	Green Bay Packers	Chicago Bears	-489	369	0.83	0.213	Home	0.792	0.208	Home	Home
223579R	2	9/19/2022	Buffalo Bills	Tennessee Titans	-452	353	0.819	0.221	Home	0.735	0.265	Home	Home
223580R	2	9/19/2022	Philadelphia Eagles	Minnesota Vikings	-149	125	0.598	0.444	Home	0.581	0.419	Home	Home
223581R	3	9/22/2022	Cleveland Browns	Pittsburgh Steelers	-210	176	0.677	0.362	Home	0.701	0.299	Home	Home
223582R	3	9/25/2022	Indianapolis Colts	Kansas City Chiefs	186	-224	0.35	0.691	Away	0.728	0.272	Home	Home
223583R	3	9/25/2022	New England Patriots	Baltimore Ravens	120	-143	0.455	0.588	Away	0.293	0.707	Away	Away
223586R	3	9/25/2022	Miami Dolphins	Buffalo Bills	173	-208	0.366	0.675	Away	0.363	0.637	Away	Home
223587R	3	9/25/2022	Minnesota Vikings	Detroit Lions	-277	226	0.735	0.307	Home	0.818	0.182	Home	Home
223588R	3	9/25/2022	New York Jets	Cincinnati Bengals	226	-277	0.307	0.735	Away	0.421	0.579	Away	Away
223589R	3	9/25/2022	Washington Commanders	Philadelphia Eagles	206	-252	0.327	0.716	Away	0.267	0.733	Away	Away
223590R	3	9/25/2022	Carolina Panthers	New Orleans Saints	110	-131	0.476	0.567	Away	0.146	0.854	Away	Home
223591R	3	9/25/2022	Los Angeles Chargers	Jacksonville Jaguars	-267	219	0.728	0.313	Home	0.859	0.141	Home	Away
223592R	3	9/25/2022	Tampa Bay Buccaneers	Green Bay Packers	-123	103	0.552	0.493	Home	0.754	0.246	Home	Away
223593R	3	9/25/2022	Arizona Cardinals	Los Angeles Rams	155	-184	0.392	0.648	Away	0.612	0.388	Home	Away
223594R	3	9/25/2022	Seattle Seahawks	Atlanta Falcons	-115	104	0.535	0.49	Home	0.725	0.275	Home	Away

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Game ID	Wk	Date	Home Team	Away Team	Home ML	Away ML	Home IP	Away IP	Pred.	Home IP	Away IP	Pred.	Outcome
223595R	3	9/25/2022	Denver Broncos	San Francisco 49ers	102	-122	0.495	0.55	Away	0.422	0.578	Away	Home
223596R	3	9/26/2022	New York Giants	Dallas Cowboys	-121	102	0.548	0.495	Home	0.301	0.699	Away	Away
223597R	4	9/29/2022	Cincinnati Bengals	Miami Dolphins	-199	167	0.666	0.375	Home	0.209	0.791	Away	Home
223598R	4	10/2/2022	New Orleans Saints	Minnesota Vikings	172	-204	0.368	0.671	Away	0.61	0.39	Home	Away
223599R	4	10/2/2022	Atlanta Falcons	Cleveland Browns	101	-120	0.498	0.545	Away	0.275	0.725	Away	Home
223600R	4	10/2/2022	Dallas Cowboys	Washington Commanders	-164	138	0.621	0.42	Home	0.684	0.316	Home	Home
223601R	4	10/2/2022	Detroit Lions	Seattle Seahawks	-180	150	0.643	0.4	Home	0.707	0.293	Home	Away
223602R	4	10/2/2022	Indianapolis Colts	Tennessee Titans	-202	169	0.669	0.372	Home	0.695	0.305	Home	Away
223604R	4	10/2/2022	Philadelphia Eagles	Jacksonville Jaguars	-284	232	0.74	0.301	Home	0.851	0.149	Home	Home
223605R	4	10/2/2022	Pittsburgh Steelers	New York Jets	-169	142	0.628	0.413	Home	0.793	0.207	Home	Away
223606R	4	10/2/2022	Baltimore Ravens	Buffalo Bills	145	-173	0.408	0.634	Away	0.428	0.572	Away	Away
223607R	4	10/2/2022	Houston Texans	Los Angeles Chargers	200	-240	0.333	0.706	Away	0.19	0.81	Away	Away
223608R	4	10/2/2022	Carolina Panthers	Arizona Cardinals	-114	105	0.533	0.488	Home	0.32	0.68	Away	Away
223609R	4	10/2/2022	Green Bay Packers	New England Patriots	-470	357	0.825	0.219	Home	0.585	0.415	Home	Home
223610R	4	10/2/2022	Las Vegas Raiders	Denver Broncos	-146	123	0.593	0.448	Home	0.601	0.399	Home	Home
223612R	4	10/3/2022	San Francisco 49ers	Los Angeles Rams	-124	105	0.554	0.488	Home	0.622	0.378	Home	Home
223613R	5	10/6/2022	Denver Broncos	Indianapolis Colts	-180	151	0.643	0.398	Home	0.257	0.743	Away	Away
223614R	5	10/9/2022	Green Bay Packers	New York Giants	-435	336	0.813	0.229	Home	0.882	0.118	Home	Away
223615R	5	10/9/2022	Buffalo Bills	Pittsburgh Steelers	-898	611	0.9	0.141	Home	0.858	0.142	Home	Home
223616R	5	10/9/2022	Cleveland Browns	Los Angeles Chargers	102	-122	0.495	0.55	Away	0.608	0.392	Home	Away
223617R	5	10/9/2022	Minnesota Vikings	Chicago Bears	-384	302	0.793	0.249	Home	0.825	0.175	Home	Home
223618R	5	10/9/2022	New England Patriots	Detroit Lions	-155	131	0.608	0.433	Home	0.448	0.552	Away	Home
223619R	5	10/9/2022	New Orleans Saints	Seattle Seahawks	-229	189	0.696	0.346	Home	0.821	0.179	Home	Home
223620R	5	10/9/2022	New York Jets	Miami Dolphins	144	-174	0.41	0.635	Away	0.193	0.807	Away	Home
223621R	5	10/9/2022	Tampa Bay Buccaneers	Atlanta Falcons	-506	383	0.835	0.207	Home	0.687	0.313	Home	Home
223622R	5	10/9/2022	Washington Commanders	Tennessee Titans	108	-111	0.481	0.526	Away	0.48	0.52	Away	Away

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Game ID	Wk	Date	Home Team	Away Team	Home ML	Away ML	Home IP	Away IP	Pred.	Home IP	Away IP	Pred.	Outcome
223623R	5	10/9/2022	Jacksonville Jaguars	Houston Texans	-320	258	0.762	0.279	Home	0.44	0.56	Away	Away
223624R	5	10/9/2022	Carolina Panthers	San Francisco 49ers	210	-255	0.323	0.718	Away	0.146	0.854	Away	Away
223626R	5	10/9/2022	Arizona Cardinals	Philadelphia Eagles	192	-234	0.342	0.701	Away	0.577	0.423	Home	Away
223627R	5	10/9/2022	Baltimore Ravens	Cincinnati Bengals	-166	140	0.624	0.417	Home	0.862	0.138	Home	Home
223628R	5	10/10/2022	Kansas City Chiefs	Las Vegas Raiders	-351	278	0.778	0.265	Home	0.819	0.181	Home	Home
223629R	6	10/13/2022	Chicago Bears	Washington Commanders	101	-121	0.498	0.548	Away	0.645	0.355	Home	Away
223633R	6	10/16/2022	Indianapolis Colts	Jacksonville Jaguars	-124	105	0.554	0.488	Home	0.497	0.503	Away	Home
223635R	6	10/16/2022	New Orleans Saints	Cincinnati Bengals	140	-166	0.417	0.624	Away	0.389	0.611	Away	Away
223637R	6	10/16/2022	Pittsburgh Steelers	Tampa Bay Buccaneers	356	-462	0.219	0.822	Away	0.363	0.637	Away	Home
223638R	6	10/16/2022	Los Angeles Rams	Carolina Panthers	-459	354	0.821	0.22	Home	0.742	0.258	Home	Home
223640R	6	10/16/2022	Kansas City Chiefs	Buffalo Bills	124	-148	0.446	0.597	Away	0.398	0.602	Away	Away
223642R	6	10/17/2022	Los Angeles Chargers	Denver Broncos	-200	165	0.667	0.377	Home	0.612	0.388	Home	Home
223644R	7	10/23/2022	Cincinnati Bengals	Atlanta Falcons	-288	235	0.742	0.299	Home	0.633	0.367	Home	Home
223647R	7	10/23/2022	Washington Commanders	Green Bay Packers	173	-209	0.366	0.676	Away	0.346	0.654	Away	Home
223648R	7	10/23/2022	Carolina Panthers	Tampa Bay Buccaneers	512	-719	0.163	0.878	Away	0.413	0.587	Away	Home
223649R	7	10/23/2022	Jacksonville Jaguars	New York Giants	-169	142	0.628	0.413	Home	0.643	0.357	Home	Away
223650R	7	10/23/2022	Baltimore Ravens	Cleveland Browns	-283	233	0.739	0.3	Home	0.665	0.335	Home	Home
223651R	7	10/23/2022	Denver Broncos	New York Jets	108	-130	0.481	0.565	Away	0.443	0.557	Away	Away
223652R	7	10/23/2022	Las Vegas Raiders	Houston Texans	-313	255	0.758	0.282	Home	0.69	0.31	Home	Home
223654R	7	10/23/2022	San Francisco 49ers	Kansas City Chiefs	102	-118	0.495	0.541	Away	0.495	0.505	Away	Away
223655R	7	10/23/2022	Miami Dolphins	Pittsburgh Steelers	-323	260	0.764	0.278	Home	0.687	0.313	Home	Home
223656R	7	10/24/2022	New England Patriots	Chicago Bears	-406	320	0.802	0.238	Home	0.804	0.196	Home	Away
223657R	8	10/27/2022	Tampa Bay Buccaneers	Baltimore Ravens	-130	110	0.565	0.476	Home	0.627	0.373	Home	Away
223658R	8	10/30/2022	Jacksonville Jaguars	Denver Broncos	-120	101	0.545	0.498	Home	0.642	0.358	Home	Away
223659R	8	10/30/2022	Atlanta Falcons	Carolina Panthers	-206	171	0.673	0.369	Home	0.791	0.209	Home	Home
223660R	8	10/30/2022	Dallas Cowboys	Chicago Bears	-439	345	0.814	0.225	Home	0.693	0.307	Home	Home

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Game					Home	g Lines	Spor Home	tsdook iv Awav		Home	eloped M		
ID	Wk	Date	Home Team	Away Team	ML	ML	IP	IP	Pred.	IP	IP	Pred.	Outcome
223663R	8	10/30/2022	New Orleans Saints	Las Vegas Raiders	102	-122	0.495	0.55	Away	0.336	0.664	Away	Home
223664R	8	10/30/2022	New York Jets	New England Patriots	136	-163	0.424	0.62	Away	0.427	0.573	Away	Away
223665R	8	10/30/2022	Philadelphia Eagles	Pittsburgh Steelers	-558	415	0.848	0.194	Home	0.821	0.179	Home	Home
223666R	8	10/30/2022	Houston Texans	Tennessee Titans	101	-118	0.498	0.541	Away	0.459	0.541	Away	Away
223667R	8	10/30/2022	Indianapolis Colts	Washington Commanders	-153	127	0.605	0.441	Home	0.675	0.325	Home	Away
223668R	8	10/30/2022	Los Angeles Rams	San Francisco 49ers	-115	104	0.535	0.49	Home	0.63	0.37	Home	Away
223669R	8	10/30/2022	Seattle Seahawks	New York Giants	-176	146	0.638	0.407	Home	0.686	0.314	Home	Home
223670R	8	10/30/2022	Buffalo Bills	Green Bay Packers	-498	380	0.833	0.208	Home	0.846	0.154	Home	Home
223672R	9	11/3/2022	Houston Texans	Philadelphia Eagles	559	-801	0.152	0.889	Away	0.305	0.695	Away	Away
223675R	9	11/6/2022	Cincinnati Bengals	Carolina Panthers	-328	261	0.766	0.277	Home	0.818	0.182	Home	Home
223677R	9	11/6/2022	New England Patriots	Indianapolis Colts	-223	185	0.69	0.351	Home	0.755	0.245	Home	Home
223678R	9	11/6/2022	New York Jets	Buffalo Bills	408	-544	0.197	0.845	Away	0.223	0.777	Away	Home
223680R	9	11/6/2022	Jacksonville Jaguars	Las Vegas Raiders	116	-139	0.463	0.582	Away	0.434	0.566	Away	Home
223681R	9	11/6/2022	Arizona Cardinals	Seattle Seahawks	-132	111	0.569	0.474	Home	0.452	0.548	Away	Away
223683R	9	11/6/2022	Kansas City Chiefs	Tennessee Titans	-835	573	0.893	0.149	Home	0.741	0.259	Home	Home
223687R	10	11/13/2022	Buffalo Bills	Minnesota Vikings	-273	225	0.732	0.308	Home	0.792	0.208	Home	Away
223688R	10	11/13/2022	Chicago Bears	Detroit Lions	-157	132	0.611	0.431	Home	0.681	0.319	Home	Away
223689R	10	11/13/2022	Tennessee Titans	Denver Broncos	-137	116	0.578	0.463	Home	0.706	0.294	Home	Home
223690R	10	11/13/2022	Kansas City Chiefs	Jacksonville Jaguars	-461	356	0.822	0.219	Home	0.698	0.302	Home	Home
223691R	10	11/13/2022	Miami Dolphins	Cleveland Browns	-182	152	0.645	0.397	Home	0.453	0.547	Away	Home
223692R	10	11/13/2022	New York Giants	Houston Texans	-227	188	0.694	0.347	Home	0.692	0.308	Home	Home
223693R	10	11/13/2022	Pittsburgh Steelers	New Orleans Saints	-117	102	0.539	0.495	Home	0.335	0.665	Away	Home
223694R	10	11/13/2022	Las Vegas Raiders	Indianapolis Colts	-211	174	0.678	0.365	Home	0.665	0.335	Home	Away
223695R	10	11/13/2022	Green Bay Packers	Dallas Cowboys	168	-200	0.373	0.667	Away	0.379	0.621	Away	Home
223696R	10	11/13/2022	Los Angeles Rams	Arizona Cardinals	-178	148	0.64	0.403	Home	0.454	0.546	Away	Away
223697R	10	11/13/2022	San Francisco 49ers	Los Angeles Chargers	-362	288	0.784	0.258	Home	0.731	0.269	Home	Home

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C					Betting	g Lines	Spor	tsbook N	lodel	Dev	eloped M	odel		
Game ID	Wk	Date	Home Team	Away Team	Home ML	Away ML	Home IP	Away IP	Pred.	Home IP	Away IP	Pred.	Outcome	
223698R	10	11/14/2022	Philadelphia Eagles	Washington Commanders	-524	398	0.84	0.201	Home	0.817	0.183	Home	Away	
223699R	11	11/17/2022	Green Bay Packers	Tennessee Titans	-179	149	0.642	0.402	Home	0.602	0.398	Home	Away	
223700R	11	11/20/2022	Atlanta Falcons	Chicago Bears	-137	115	0.578	0.465	Home	0.472	0.528	Away	Home	
223702R	11	11/20/2022	Indianapolis Colts	Philadelphia Eagles	235	-287	0.299	0.742	Away	0.336	0.664	Away	Away	
223703R	11	11/20/2022	New England Patriots	New York Jets	-180	150	0.643	0.4	Home	0.741	0.259	Home	Home	
223704R	11	11/20/2022	New Orleans Saints	Los Angeles Rams	-137	116	0.578	0.463	Home	0.58	0.42	Home	Home	
223705R	11	11/20/2022	New York Giants	Detroit Lions	-166	139	0.624	0.418	Home	0.662	0.338	Home	Away	
223706R	11	11/20/2022	Baltimore Ravens	Carolina Panthers	-700	505	0.875	0.165	Home	0.714	0.286	Home	Home	
223707R	11	11/20/2022	Houston Texans	Washington Commanders	137	-164	0.422	0.621	Away	0.456	0.544	Away	Away	
223708R	11	11/20/2022	Denver Broncos	Las Vegas Raiders	-151	126	0.602	0.442	Home	0.344	0.656	Away	Away	
223710R	11	11/20/2022	Pittsburgh Steelers	Cincinnati Bengals	157	-187	0.389	0.652	Away	0.302	0.698	Away	Away	
223711R	11	11/20/2022	Los Angeles Chargers	Kansas City Chiefs	194	-235	0.34	0.701	Away	0.39	0.61	Away	Away	
223712R	11	11/21/2022	Arizona Cardinals	San Francisco 49ers	346	-446	0.224	0.817	Away	0.314	0.686	Away	Away	
223713R	12	11/24/2022	Detroit Lions	Buffalo Bills	343	-438	0.226	0.814	Away	0.421	0.579	Away	Away	
223714R	12	11/24/2022	Dallas Cowboys	New York Giants	-483	364	0.828	0.216	Home	0.747	0.253	Home	Home	
223715R	12	11/24/2022	Minnesota Vikings	New England Patriots	-145	122	0.592	0.45	Home	0.347	0.653	Away	Home	
223716R	12	11/27/2022	Cleveland Browns	Tampa Bay Buccaneers	145	-174	0.408	0.635	Away	0.65	0.35	Home	Home	
223717R	12	11/27/2022	Tennessee Titans	Cincinnati Bengals	-110	108	0.524	0.481	Home	0.433	0.567	Away	Away	
223718R	12	11/27/2022	Miami Dolphins	Houston Texans	-879	594	0.898	0.144	Home	0.759	0.241	Home	Home	
223720R	12	11/27/2022	Washington Commanders	Atlanta Falcons	-193	161	0.659	0.383	Home	0.66	0.34	Home	Home	
223721R	12	11/27/2022	Carolina Panthers	Denver Broncos	103	-117	0.493	0.539	Away	0.607	0.393	Home	Home	
223722R	12	11/27/2022	Jacksonville Jaguars	Baltimore Ravens	139	-167	0.418	0.625	Away	0.672	0.328	Home	Home	
223723R	12	11/27/2022	Arizona Cardinals	Los Angeles Chargers	123	-146	0.448	0.593	Away	0.442	0.558	Away	Away	
223724R	12	11/27/2022	Seattle Seahawks	Las Vegas Raiders	-208	173	0.675	0.366	Home	0.694	0.306	Home	Away	
223725R	12	11/27/2022	Kansas City Chiefs	Los Angeles Rams	-1299	785	0.929	0.113	Home	0.646	0.354	Home	Home	
223726R	12	11/27/2022	San Francisco 49ers	New Orleans Saints	-409	320	0.804	0.238	Home	0.762	0.238	Home	Home	

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Game ID	Wk	Date	Home Team	Away Team	Home ML	Away ML	Home IP	Away IP	Pred.	Home IP	Away IP	Pred.	Outcome
223727R	12	11/27/2022	Philadelphia Eagles	Green Bay Packers	-288	233	0.742	0.3	Home	0.699	0.301	Home	Home
223728R	12	11/28/2022	Indianapolis Colts	Pittsburgh Steelers	-139	117	0.582	0.461	Home	0.611	0.389	Home	Away
223730R	13	12/4/2022	Atlanta Falcons	Pittsburgh Steelers	101	-118	0.498	0.541	Away	0.58	0.42	Home	Away
223732R	13	12/4/2022	Detroit Lions	Jacksonville Jaguars	-118	101	0.541	0.498	Home	0.699	0.301	Home	Home
223733R	13	12/4/2022	Minnesota Vikings	New York Jets	-155	131	0.608	0.433	Home	0.587	0.413	Home	Home
223735R	13	12/4/2022	Philadelphia Eagles	Tennessee Titans	-221	183	0.688	0.353	Home	0.699	0.301	Home	Home
223736R	13	12/4/2022	Baltimore Ravens	Denver Broncos	-399	314	0.8	0.242	Home	0.768	0.232	Home	Home
223737R	13	12/4/2022	Houston Texans	Cleveland Browns	263	-333	0.275	0.769	Away	0.31	0.69	Away	Away
223738R	13	12/4/2022	Los Angeles Rams	Seattle Seahawks	251	-308	0.285	0.755	Away	0.387	0.613	Away	Away
223739R	13	12/4/2022	San Francisco 49ers	Miami Dolphins	-233	194	0.7	0.34	Home	0.706	0.294	Home	Home
223741R	13	12/4/2022	Las Vegas Raiders	Los Angeles Chargers	-137	115	0.578	0.465	Home	0.596	0.404	Home	Home
223742R	13	12/4/2022	Dallas Cowboys	Indianapolis Colts	-542	410	0.844	0.196	Home	0.835	0.165	Home	Home
223743R	13	12/5/2022	Tampa Bay Buccaneers	New Orleans Saints	-188	157	0.653	0.389	Home	0.397	0.603	Away	Home
223744R	14	12/8/2022	Los Angeles Rams	Las Vegas Raiders	236	-273	0.298	0.732	Away	0.391	0.609	Away	Home
223745R	14	12/11/2022	Buffalo Bills	New York Jets	-476	368	0.826	0.214	Home	0.697	0.303	Home	Home
223746R	14	12/11/2022	Cincinnati Bengals	Cleveland Browns	-206	171	0.673	0.369	Home	0.663	0.337	Home	Home
223747R	14	12/11/2022	Dallas Cowboys	Houston Texans	-1973	959	0.952	0.094	Home	0.87	0.13	Home	Home
223748R	14	12/11/2022	Detroit Lions	Minnesota Vikings	-139	118	0.582	0.459	Home	0.665	0.335	Home	Home
223749R	14	12/11/2022	Tennessee Titans	Jacksonville Jaguars	-182	151	0.645	0.398	Home	0.382	0.618	Away	Away
223750R	14	12/11/2022	New York Giants	Philadelphia Eagles	268	-337	0.272	0.771	Away	0.354	0.646	Away	Away
223751R	14	12/11/2022	Pittsburgh Steelers	Baltimore Ravens	-130	110	0.565	0.476	Home	0.498	0.502	Away	Away
223752R	14	12/11/2022	Denver Broncos	Kansas City Chiefs	345	-443	0.225	0.816	Away	0.216	0.784	Away	Away
223753R	14	12/11/2022	San Francisco 49ers	Tampa Bay Buccaneers	-186	154	0.65	0.394	Home	0.726	0.274	Home	Home
223754R	14	12/11/2022	Seattle Seahawks	Carolina Panthers	-188	152	0.653	0.397	Home	0.692	0.308	Home	Away
223756R	14	12/12/2022	Arizona Cardinals	New England Patriots	112	-133	0.472	0.571	Away	0.612	0.388	Home	Away
223757R	15	12/15/2022	Seattle Seahawks	San Francisco 49ers	150	-182	0.4	0.645	Away	0.4	0.6	Away	Away

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Game ID	Wk	Date	Home Team	Away Team	Home ML	Away ML	Home IP	Away IP	Pred.	Home IP	Away IP	Pred.	Outcome
223758R	15	12/17/2022	Minnesota Vikings	Indianapolis Colts	-196	163	0.662	0.38	Home	0.637	0.363	Home	Home
223759R	15	12/17/2022	Cleveland Browns	Baltimore Ravens	-158	134	0.612	0.427	Home	0.47	0.53	Away	Home
223762R	15	12/18/2022	Chicago Bears	Philadelphia Eagles	313	-396	0.242	0.798	Away	0.323	0.677	Away	Away
223763R	15	12/18/2022	New York Jets	Detroit Lions	-131	110	0.567	0.476	Home	0.478	0.522	Away	Away
223765R	15	12/18/2022	Jacksonville Jaguars	Dallas Cowboys	172	-205	0.368	0.672	Away	0.422	0.578	Away	Home
223766R	15	12/18/2022	Houston Texans	Kansas City Chiefs	627	-962	0.138	0.906	Away	0.275	0.725	Away	Away
223767R	15	12/18/2022	Denver Broncos	Arizona Cardinals	-127	106	0.559	0.485	Home	0.423	0.577	Away	Home
223768R	15	12/18/2022	Las Vegas Raiders	New England Patriots	-137	114	0.578	0.467	Home	0.607	0.393	Home	Home
223770R	15	12/18/2022	Tampa Bay Buccaneers	Cincinnati Bengals	153	-183	0.395	0.647	Away	0.46	0.54	Away	Away
223771R	15	12/18/2022	Washington Commanders	New York Giants	-206	172	0.673	0.368	Home	0.64	0.36	Home	Away
223772R	15	12/19/2022	Green Bay Packers	Los Angeles Rams	-367	292	0.786	0.255	Home	0.648	0.352	Home	Home
223773R	16	12/22/2022	New York Jets	Jacksonville Jaguars	-142	119	0.587	0.457	Home	0.451	0.549	Away	Away
223774R	16	12/24/2022	Chicago Bears	Buffalo Bills	310	-390	0.244	0.796	Away	0.289	0.711	Away	Away
223776R	16	12/24/2022	Kansas City Chiefs	Seattle Seahawks	-500	385	0.833	0.206	Home	0.727	0.273	Home	Home
223777R	16	12/24/2022	Minnesota Vikings	New York Giants	-220	182	0.688	0.355	Home	0.653	0.347	Home	Home
223778R	16	12/24/2022	New England Patriots	Cincinnati Bengals	135	-161	0.426	0.617	Away	0.412	0.588	Away	Away
223781R	16	12/24/2022	Tennessee Titans	Houston Texans	-176	147	0.638	0.405	Home	0.627	0.373	Home	Away
223782R	16	12/24/2022	San Francisco 49ers	Washington Commanders	-288	236	0.742	0.298	Home	0.727	0.273	Home	Home
223786R	16	12/25/2022	Los Angeles Rams	Denver Broncos	148	-179	0.403	0.642	Away	0.64	0.36	Home	Home
223787R	16	12/25/2022	Arizona Cardinals	Tampa Bay Buccaneers	285	-363	0.26	0.784	Away	0.646	0.354	Home	Away
223789R	17	12/29/2022	Tennessee Titans	Dallas Cowboys	570	-805	0.149	0.89	Away	0.239	0.761	Away	Away
223790R	17	1/1/2023	Atlanta Falcons	Arizona Cardinals	-291	237	0.744	0.297	Home	0.606	0.394	Home	Home
223791R	17	1/1/2023	Detroit Lions	Chicago Bears	-218	180	0.686	0.357	Home	0.777	0.223	Home	Home
223792R	17	1/1/2023	Kansas City Chiefs	Denver Broncos	-763	542	0.884	0.156	Home	0.761	0.239	Home	Home
223795R	17	1/1/2023	Philadelphia Eagles	New Orleans Saints	-229	190	0.696	0.345	Home	0.69	0.31	Home	Away
223796R	17	1/1/2023	Tampa Bay Buccaneers	Carolina Panthers	-199	165	0.666	0.377	Home	0.644	0.356	Home	Home

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Game ID	Wk	Date	Home Team	Away Team	Home ML	Away ML	Home IP	Away IP	Pred.	Home IP	Away IP	Pred.	Outcome
223798R	17	1/1/2023	Houston Texans	Jacksonville Jaguars	159	-190	0.386	0.655	Away	0.386	0.614	Away	Away
223799R	17	1/1/2023	Las Vegas Raiders	San Francisco 49ers	356	-459	0.219	0.821	Away	0.432	0.568	Away	Away
223800R	17	1/1/2023	Seattle Seahawks	New York Jets	104	-124	0.49	0.554	Away	0.613	0.387	Home	Home
223801R	17	1/1/2023	Green Bay Packers	Minnesota Vikings	-176	146	0.638	0.407	Home	0.646	0.354	Home	Home
223803R	17	1/1/2023	Baltimore Ravens	Pittsburgh Steelers	-118	102	0.541	0.495	Home	0.605	0.395	Home	Away
223804R	18	1/7/2023	Las Vegas Raiders	Kansas City Chiefs	325	-411	0.235	0.804	Away	0.682	0.318	Home	Away
223805R	18	1/7/2023	Jacksonville Jaguars	Tennessee Titans	-276	226	0.734	0.307	Home	0.024	0.976	Away	Home
223806R	18	1/8/2023	Atlanta Falcons	Tampa Bay Buccaneers	-251	207	0.715	0.326	Home	0.655	0.345	Home	Home
223807R	18	1/8/2023	Buffalo Bills	New England Patriots	-384	305	0.793	0.247	Home	0.878	0.122	Home	Home
223808R	18	1/8/2023	Chicago Bears	Minnesota Vikings	234	-285	0.299	0.74	Away	0.88	0.12	Home	Away
223809R	18	1/8/2023	Cincinnati Bengals	Baltimore Ravens	-641	471	0.865	0.175	Home	0.976	0.024	Home	Home
223810R	18	1/8/2023	Indianapolis Colts	Houston Texans	-151	127	0.602	0.441	Home	0.951	0.049	Home	Away
223811R	18	1/8/2023	Miami Dolphins	New York Jets	-215	179	0.683	0.358	Home	0.965	0.035	Home	Home
223812R	18	1/8/2023	New Orleans Saints	Carolina Panthers	-186	155	0.65	0.392	Home	0.903	0.097	Home	Away
223813R	18	1/8/2023	Pittsburgh Steelers	Cleveland Browns	-152	128	0.603	0.439	Home	0.136	0.864	Away	Home
223814R	18	1/8/2023	Denver Broncos	Los Angeles Chargers	-275	222	0.733	0.311	Home	0.836	0.164	Home	Home
223815R	18	1/8/2023	Philadelphia Eagles	New York Giants	-1536	860	0.939	0.104	Home	0.66	0.34	Home	Home
223816R	18	1/8/2023	San Francisco 49ers	Arizona Cardinals	-1072	706	0.915	0.124	Home	0.851	0.149	Home	Home
223817R	18	1/8/2023	Seattle Seahawks	Los Angeles Rams	-242	199	0.708	0.334	Home	0.974	0.026	Home	Home
223818R	18	1/8/2023	Washington Commanders	Dallas Cowboys	270	-343	0.27	0.774	Away	0.378	0.622	Away	Home
223819R	18	1/8/2023	Green Bay Packers	Detroit Lions	-244	201	0.709	0.332	Home	0.328	0.672	Away	Away
223820P	19	1/14/2023	San Francisco 49ers	Seattle Seahawks	-493	373	0.831	0.211	Home	0.282	0.718	Away	Home
223821P	19	1/14/2023	Jacksonville Jaguars	Los Angeles Chargers	114	-135	0.467	0.574	Away	0.342	0.658	Away	Home
223822P	19	1/15/2023	Buffalo Bills	Miami Dolphins	-993	670	0.909	0.13	Home	0.828	0.172	Home	Home
223823P	19	1/15/2023	Minnesota Vikings	New York Giants	-150	126	0.6	0.442	Home	0.162	0.838	Away	Away
223824P	19	1/15/2023	Cincinnati Bengals	Baltimore Ravens	-428	327	0.811	0.234	Home	0.967	0.033	Home	Home

					164								
					Bettin	g Lines	Spor	tsbook N	Iodel	Developed Model			
Game ID	Wk	Date	Home Team	Away Team	Home ML	Away ML	Home IP	Away IP	Pred.	Home IP	Away IP	Pred.	Outcome
223826P	20	1/21/2023	Kansas City Chiefs	Jacksonville Jaguars	-506	389	0.835	0.204	Home	0.954	0.046	Home	Home
223827P	20	1/21/2023	Philadelphia Eagles	New York Giants	-378	302	0.791	0.249	Home	0.877	0.123	Home	Home
223828P	20	1/22/2023	Buffalo Bills	Cincinnati Bengals	-257	211	0.72	0.322	Home	0.917	0.083	Home	Away
223829P	20	1/22/2023	San Francisco 49ers	Dallas Cowboys	-193	160	0.659	0.385	Home	0.183	0.817	Away	Home
223830P	21	1/29/2023	Philadelphia Eagles	San Francisco 49ers	-154	130	0.606	0.435	Home	0.908	0.092	Home	Home
223831P	21	1/29/2023	Kansas City Chiefs	Cincinnati Bengals	-133	112	0.571	0.472	Home	0.946	0.054	Home	Home
223832S	22	2/12/2023	Philadelphia Eagles	Kansas City Chiefs	-120	101	0.545	0.498	Home	0.396	0.604	Away	Away

Appendix K

Comparison of 2022 Weekly Model & Financial Returns

The following tables compare the standardized returns of each sports betting strategy to the returns observed in the financial markets during the 2022 NFL season. Note that all returns are indexed to the initial investment made during Week 0. Additionally, due to the two week gap between the conference championship games and the Super Bowl (i.e., Week 21 and 22), no returns were observed on February 10, 2023. For greater clarity, reference the following notes regarding the information captured in the tables:

- "Wk" is abbreviation for week of the NFL season.
- "ML" is abbreviation for the moneyline bet type.
- "TotPts" is abbreviation for the total points bet type.
- Additional background on each sports betting strategy can be found in Chapters 5 and 6.

Wk	Date of Return	ML	Spread	Total Points	Cumulative	3 Leg Parlay	ML and Spread	ML and TotPts	Spread and TotPts
0	9/9/2022	100	100	100	100	100	100	100	100
1	9/16/2022	101.17	95.47	99.34	95.97	77.89	103.39	98	96
2	9/23/2022	102.11	95.1	95.99	93.21	67.87	105.2	94	96
3	9/30/2022	100.29	92.53	92.46	85.27	71.2	105.2	92	94
4	10/7/2022	99	88.99	92.84	80.82	60.52	105.02	90	92
5	10/14/2022	101.27	92.34	92.21	85.82	58.72	109.81	96.08	92
6	10/21/2022	100.27	96.57	92.75	89.59	60.8	113.29	94.08	89.39
7	10/28/2022	99.22	96.98	92.31	88.5	47.73	113.29	92.08	94.62
8	11/4/2022	97.34	95.63	89.91	82.88	50.94	111.09	88.08	92.62
9	11/11/2022	97.44	92.24	87.64	77.33	46.87	115.08	88.08	86.62
10	11/18/2022	93.59	86.98	85.29	65.86	36.72	111.08	84.08	84.62
11	11/25/2022	95.42	84.56	84.86	64.84	15.72	110.93	86.25	89.93
12	12/2/2022	99.79	80.07	84.24	64.1	14.95	106.93	98.58	87.93
13	12/9/2022	101.95	82.48	85.55	69.98	23.67	106.93	99.09	87.93
14	12/16/2022	104.09	79.25	88.9	72.24	5.67	106.82	101.66	87.93
15	12/23/2022	104.15	78.79	93.01	75.96	48.58	104.82	96.45	91.19
16	12/30/2022	106.7	83.91	92.55	83.16	47.42	110.64	98.74	92.51
17	1/6/2023	108.62	87.04	93.89	89.54	47.03	108.64	104.65	95.68
18	1/13/2023	105.84	81.57	93.24	80.65	18.87	104.64	102.65	95.68
19	1/20/2023	105.43	77.6	89.14	72.17	3.87	104.64	102.65	93.68
20	1/27/2023	103.9	75.53	88.95	68.38	2.9	104.64	102.65	93.68
21	2/3/2023	105.3	77.43	88.86	71.6	8.35	104.64	102.65	93.68
22	2/17/2023	106.31	78.33	87.86	72.51	5.35	104.64	102.65	93.68

Standardized Sports Betting Returns During the 2022 NFL Season

Wk	Date of Return	S&P 500	Dow Jones	Nasdaq 100	Nasdaq Composite	Wilshire 5000
0	9/9/2022	100	100	100	100	100
1	9/16/2022	99.06	98.79	98.73	99.12	99.32
2	9/23/2022	95.21	95.74	94.76	94.89	95.24
3	9/30/2022	91.46	92.24	91.35	91.31	91.38
4	10/7/2022	93.41	94.31	92.57	92.77	93.63
5	10/14/2022	90.37	93.06	88.21	88.53	90.57
6	10/21/2022	92.78	96.36	90.56	90.64	92.88
7	10/28/2022	96.21	101.11	93.12	93.03	96.28
8	11/4/2022	95.12	102.29	89.71	89.99	95.34
9	11/11/2022	96.9	104.83	91.51	91.26	96.9
10	11/18/2022	99.34	106.1	95.36	94.74	99.34
11	11/25/2022	100.28	107.65	95.31	94.5	100.09
12	12/2/2022	100.99	108.09	96.23	95.44	100.88
13	12/9/2022	99.1	106.37	94.4	93.51	98.82
14	12/16/2022	99.01	106.24	94.14	93.15	98.72
15	12/23/2022	96.16	104.36	90.01	89.24	95.88
16	12/30/2022	95.86	104.61	88.23	87.74	95.57
17	1/6/2023	96.36	104.99	88.57	88.18	96.18
18	1/13/2023	99.05	107.18	92.26	91.97	99.18
19	1/20/2023	98.93	105.51	93.29	93.1	99.27
20	1/27/2023	101.16	106.77	97.2	96.63	101.6
21	2/3/2023	102.9	107.3	100.45	99.77	103.61
22	2/17/2023	103.2	107.37	101.8	100.72	104

Standardized Financial Returns During the 2022 NFL Season

BIBLIOGRAPHY

- Andersen, J. V. (2010). Detecting anchoring in financial markets. Journal of Behavioral Finance, 11(2), 129-133.
- Bailey, M. (2000, June). Identifying arbitrage opportunities in AFL betting markets through mathematical modelling. In Proceedings of the Fifth Australian Conference in Mathematics and Computers in Sport (pp. 37-42).
- Banz, R. W. (1981). The relationship between return and market value of common stocks. Journal of Financial Economics, 9(1), 3-18.
- Basu, S. (1983). The relationship between earnings' yield, market value and return for NYSE common stocks: Further evidence. Journal of Financial Economics, 12(1), 129-156.
- Bikhchandani, S., & Sharma, S. (2000). Herd behavior in financial markets. IMF Staff Papers, 47(3), 279-310.
- Black, F. (1986). Noise. The Journal of Finance, 41(3), 528-543.
- d'Astous, A., & Di Gaspero, M. (2015). Heuristic and analytic processing in online sports betting. Journal of Gambling Studies, 31, 455-470.
- Dare, W. H., & Holland, A. S. (2004). Efficiency in the NFL betting market: modifying and consolidating research methods. Applied Economics, 36(1), 9-15.
- Fama, E. F. (1965). Random Walks in Stock Market Prices. Financial Analysts Journal, 21(5), 55–59. http://www.jstor.org/stable/4469865.
- Fama, E. F. (1970). Efficient Capital Markets: A Review of Theory and Empirical Work. The Journal of Finance, 25(2), 383–417. https://doi.org/10.2307/2325486.
- Fama, E. F., & French, K. R. (1988). Dividend yields and expected stock returns. Journal of Financial Economics, 22(1), 3-25.

- FantasyData. (n.d.). *Fantasy football stats and season leaders*. FantasyData. Retrieved from https://fantasydata.com/nfl/fantasy-football-leaders.
- Federal Reserve Bank of St. Louis. (n.d.). Federal Reserve Economic Data: Fred: St. louis Fed. FRED. Retrieved March 20, 2023, from https://fred.stlouisfed.org/.
- Fellner, G. (2009). Illusion of control as a source of poor diversification: Experimental evidence.The Journal of Behavioral Finance, 10(1), 55-67.
- Fish, M. (2015, February 6). Meet the world's most successful gambler. ESPN. Retrieved from http://www.espn.com/espn/feature/story/_/id/12280555/how-billy-walters-became-sportsmost-successful-controversial-bettor.
- French, K. R. (1980). Stock returns and the weekend effect. Journal of Financial Economics, 8(1), 55-69.
- Golec, J., & Tamarkin, M. (1991). The degree of inefficiency in the football betting market: Statistical tests. Journal of Financial Economics, 30(2), 311-323.
- Gray, P. K., & Gray, S. F. (1997). Testing market efficiency: Evidence from the NFL sports betting market. The Journal of Finance, 52(4), 1725-1737.
- Hosmer, D. W., Lemeshow, S., & Sturdivant, R. X. (2013). *Applied Logistic Regression* (3rd ed.). John Wiley and Sons.
- Hubacek, O., Sourek, G., & Zelezny, F. (2019). Exploiting sports-betting market using machine learning. International Journal of Forecasting, 35(2), 783-796.
- Hubacek, O., Sourek, G., Zelezny, F., & Uhrin, M. (2021). Optimal sports betting strategies in practice: an experimental review. IMA Journal of Management Mathematics, 32(4), 465-489.

IBM. (n.d.). *What is overfitting?* IBM Cloud. Retrieved from https://www.ibm.com/topics/overfitting.

- Lacey, N. J. (1990). An estimation of market efficiency in the NFL point spread betting market. Applied Economics, 22(1), 117-129.
- Levitt, S. D. (2004). Why are gambling markets organized so differently from financial markets?. The Economic Journal, 114(495), 223-246.
- OddsShark. (n.d.). NFL Football Odds & Handicapping Database. OddsShark. Retrieved from https://www.oddsshark.com/nfl/database.

OddsWarehouse. (2023, February 14). NFL Historical Sports Betting Odds Database. OddsWarehouse. Retrieved from https://www.oddswarehouse.com/product/nfl-historicalsports-betting-odds/.

- Peters, K. (2022, September 14). Prediction market definition. Investopedia. Retrieved January 27, 2023, from https://www.investopedia.com/terms/p/prediction-market.asp.
- Purdum, D. (2022, November 6). 'Mattress Mack' wins historic \$75M payout off Astros' title. ESPN. Retrieved from https://www.espn.com/chalk/story/_/id/34964211/mattress-mackwins-historic-75m-payout-astros-title.
- Rakesh, H. M. (2013). Gambler's fallacy and behavioral finance in the financial markets: a case study of Bombay stock exchange. International Journal of Business and Management Invention, 2(12), 1-7.
- Reinganum, M. R. (1981). Misspecification of capital asset pricing: Empirical anomalies based on earnings' yields and market values. Journal of Financial Economics, 9(1), 19-46.
- Schwert, G. W. (2003). Anomalies and market efficiency. Handbook of the Economics of Finance, 1, 939-974.

- Shefrin, H., & Belotti, M. L. (2007, June). Behavioral finance: biases, mean-variance returns, and risk premiums. In CFA Institute Conference Proceedings Quarterly (Vol. 24, No. 2, pp. 4-12).
- Sports Reference. (n.d.). *Pro Football Stats, history, scores, standings, playoffs, Schedule & Records*. Pro Football Reference. Retrieved from https://www.pro-football-reference.com/.
- Thaler, R. H. (1987). Anomalies: the January effect. Journal of Economic Perspectives, 1(1), 197-201.
- Thaler, R. H., & Ziemba, W. T. (1988). Anomalies: Parimutuel betting markets: Racetracks and lotteries. Journal of Economic Perspectives, 2(2), 161-174.
- Williams, L. V. (1999). Information efficiency in betting markets: A survey. Bulletin of Economic Research, 51(1), 1-39.
- Woodland, L. M., & Woodland, B. M. (1994). Market efficiency and the favorite-longshot bias: The baseball betting market. The Journal of Finance, 49(1), 269-279.
- Woodland, L. M., & Woodland, B. M. (2001). Market efficiency and profitable wagering in the national hockey league: Can bettors score on longshots?. Southern Economic Journal, 67(4), 983-995.
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- Network with firm professionals and clients to learn about advisory best practices and gain insurance industry knowledge

Brvce Jordan Center

Concession Stand Manager & Head Cashier

- Supervise a team of 8-15 employees and concessions volunteers in a fast-paced, team-oriented environment to provide quality • service for up to 15,000 guests during athletic contests, concerts, and other events
- Manage stand inventories through stocktaking and oversee transactions of up to \$18,000 with accuracy
- Collaborate with senior management to identify opportunities for organizational transformation, optimal performance targets, and efficiency improvement for upcoming events through the analysis of transaction data and inventory levels

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Nittany Lion Consulting Group

Associate, Senior Associate, Alumni Relations Consultant

- Advise the Penn State Smeal College of Business on how to leverage experiential learning as the college's competitive advantage through administrative centralization with an emphasis on enhancing online offerings and presence
- Advise a federal supply chain consultancy on process automation through software by recommending Coupa and Power BI platforms in order to best improve internal supply chain analysis for clients
- Actively engage in professional development sessions on consulting best practices, advanced frameworks, data analytics, leadership, project management fundamentals, and other topics

IvyLine Capital Group

Investment & Derivative Program, Cohort Member

- Selected amongst a competitive and international applicant pool to participate in IvyLine Capital's cohort
- Actively participate in educational sessions surrounding the fundamentals of Python, security analysis, capital management, • technical analysis, derivative valuation, and other financial management concepts
- Engage in weekly lectures and speaker events with industry professionals and business leaders

Schrever Honors College

SHO Time Mentor & Orientation Leader

- Collaborate closely with a committee of 13 current scholars to develop an effective and efficient orientation program by improving upon previous versions, increasing engagement, and speaking on a professional development discussion panel
- Participate in monthly workshops focused on leadership development and the creation of a diverse and inclusive culture
- Mentor a group of 12 new Schreyer Scholars to develop valuable connections and contribute to student success by providing recommendations and giving back to the community through a campus cleanup and volunteering at an animal shelter

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- Alteryx Designer Core Certification, achieved July 2022 .
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