4-25-2024

NFL Rule Changes Favor Offenses; But Don't Defenses Win Championships?

Kipp Satterlee Ransome
Ursinus College, kippsr2002@gmail.com

NFL Rule Changes Favor Offenses; but Don’t Defenses Win Championships?

Kipp Ransome

April 25, 2024

Submitted to the faculty of Ursinus College in fulfillment of the requirements Honors in the Business and Economics Department

Abstract

The NFL's emphasis on favoring the offense through implementing new game rules is likely a significant factor in increasing a team's average points per game. Additionally, an increasing average points per game metric is likely a contributing factor to increasing real team revenue, as prior research indicates that higher-scoring games lead to higher fan satisfaction. Using game, team revenue, and rule implementation data from the 2002-2022 seasons, this author tests two new hypotheses that test whether specific rule changes targeting defenses or special teams increase a team’s average points per game and whether an increased points per game metric positively impacts real team revenue. As expected, certain rule changes positively impact average points per game, and an increase in average points per game leads to an increase in real team revenue.

Introduction

The game of football is changing. Gone are the days of the traditional kickoff NFL fans know and love, replaced by a hybrid kickoff model used by the former Extreme Football League (XFL) and now United Football League (UFL). Slated for a one-year trial run in the upcoming season, it will be the first time in NFL history the fundamental elements of the traditional kickoff play have changed. The updated kickoff is not the only change NFL players and fans will need to adjust to in the upcoming 2024 NFL season, as the hip-drop tackle (a form of tackle defensive players use to bring down strong ball carriers) will no longer be a legal form of tackling. Any player attempting to bring down a ball carrier with a hip drop technique will be automatically flagged by game officials, resulting in a 15-yard penalty and automatic first down for the offense.

Both changes align with the league's policy to alter game rules in order to increase player safety, while also maintaining or increasing the relative entertainment value of the game itself. The 2023 offseason is not the first instance the NFL applied significant changes to the official rulebook, as throughout the league's lifespan it has used two governing bodies to regulate and revise the rules of the game: the original Rules Committee and its successor the Competition Committee. The Rules Committee, created in 1932, differentiated the NFL from the enduringly popular sport of college football by altering several rules to encourage more offensive production, something leaders of the still-young league pushed for in hopes of eventually surpassing college football's popularity. The Competition Committee followed, replacing the Rules Committee in 1968, and continued the legacy of the Rules Committee by supporting rule alterations that maximized the entertainment value of the game as well as player safety. Today, the NFL is renowned for its overwhelming popularity, specifically in the United States, and

captivates millions of fans during the fall and winter months. Continued updates to the game's rulebook have pushed the game forward, allowing competitions to be fairer, safer, and more entertaining for modern fans. Without them, the league and the game of American football would look a lot different and potentially be less popular if the original rules remained in place.

Rule changes in professional sports leagues, which help the sport evolve, generally occur for two reasons. Some rule changes focus on player safety and decreasing injuries. Others seek to generate greater fan interest by creating a more exciting game, thereby retaining existing fans, and potentially attracting new fans to the improved sport. This paper seeks to uncover a third outcome from NFL rule changes, which is an increase in NFL revenues. Specifically, do changes to the NFL bylaws increase teams' points per game, thus generating more team revenue? It is hypothesized that recent rule changes such as increasing the complexity of the roughing the passer (RTP) penalty and increasing the distance of the extra point, making the two-point conversion play more relevant, increase teams' ability to score more points per game, directly contributing higher revenue totals for NFL teams.

Background

The NFL continues to provide competitions of American football to millions of fans. It broadcasts more than 200 regular season competitions amongst its 32 franchises, followed by a postseason that includes the top seven teams from its two conferences, the National Football Conference (NFC) and the American Football Conference (AFC). The culmination of the postseason ends with the NFL's championship game, the Super Bowl, where the remaining team from each conference clashes for the right to hoist the Lombardi Trophy and become the NFL's champion for that season. Recent seasons have been defined by stunning quarterback play, with the likes of Patrick Mahomes, Jalen Hurts, and Joe Burrow leading their team to respective Super

Bowl appearances in recent seasons. However, the NFL was not always defined by exceptional quarterbacks. The NFL's original rules in its framework made it virtually impossible to play the position as it is played today.

American football has changed drastically throughout the NFL's 103-year history. Countless rule changes throughout the league's history have transformed the sport from its modest rugby-like beginnings to the modern phenomena American football has become. If the NFL had never instituted rule modifications from its original framework, the beloved sport known today becomes almost unrecognizable. For example, the original rules prohibited multiple forward passes in a single series of downs. Similarly, the quarterback must be at least five yards behind the line of scrimmage to complete a forward pass. Otherwise, it would be a penalty. Dangerous tactics such as grabbing a player's facemask were legal, and player substitutions or communications from the sidelines were not allowed (NFL Football Operations, 2023, para. 1). Today that is no longer the case. Quarterbacks have no limit to the number of passes they can throw, nor do they have to be five yards behind the line of scrimmage to complete a throw. Grabbing facemasks are penalized to increase player safety, and communication between the players on the field and the sideline is the norm. American football did not just become the modern sport it is today overnight. Gradual rule changes applied by the original Rules Committee, as well as its successor, the Competition Committee, have allowed the game to shift from its original run-heavy approach to a more pass-happy playstyle.

In 1968, the NFL Competition Committee effectively replaced the Rules Committee, with the mission to maintain competitive balance and consistency throughout the league. Today, the Competition Committee comprises nine members who hold positions in the league such as head coach, front office executive, or team owner. The Competition Committee receives input from

various sources, including experts, players, other league committees, and the National Football League Players Association (NFLPA) during the season. This input directly impacts the Competition Committee's actions and whether or not a rule change is proposed. Proposals for new rules or modifications to existing rules are then presented at the annual meeting to NFL franchise owners, where any revision or rule must have the support of 75% of the owners to be adopted into the official NFL rules. Proposals may have immediate support from owners depending on the timeliness and severity of an issue being discussed and be implemented into the game the following season, or it can sit in the deliberative process for years (NFL Football Operations, 2023, para. 3). A proposal in discussion this offseason will be the infamous "Tush Push" play, mastered by Jalen Hurts and the Philadelphia Eagles offense, and whether or not this play design should be banned from in-game play. During the previous offseason, a ban was discussed amongst Committee members as well, but was ultimately allowed to stay in the game for the 2023 season. However, due to the Eagles' exceptional success rate with the play in the 2023 season as well as its resemblance to a rugby-styled play, it will again be a topic of conversation for the Competition Committee during the offseason. The debate over the "Tush Push" is one of many potential changes to the game the Competition Committee oversees on a yearly basis, emphasizing the Committee's importance to the league in keeping the game fair and entertaining for fans.

Safety-Related Rule Changes in the NFL and Other Leagues

Significant research has been conducted on the impact rule modifications can have on players' safety in professional sports. In 2011, the NFL made multiple changes to the kickoff, which disallowed running starts and moved the kickoff line to the 35-yard line. These changes successfully decreased the number of injuries that occur on the highest injury-prone play in the

league, dropping the injury incidence rate from 22.0 injuries per 1,000 kickoffs to only 10.0 injuries per 1,000 kickoffs (Ruestow et al., 2015). Other important safety provisions since 2002 include expanding the list of "defenseless players" to include long snappers and kick returners, eliminating the chop block, and prohibiting players from initiating contact with the crown of their helmets.

Player safety is emphasized across all professional sports leagues, not just the NFL. Several sports leagues such as the National Hockey League (NHL) and the National Rugby League (NRL), as well as the NFL, recognize the dangers of head trauma injuries, thus making concussion prevention a priority for all injury prevention strategies employed in their respective leagues (Emery et al., 2017). Although it is virtually impossible to eliminate all concussions from sports, concussion prevention strategies, such as rule modifications, can reduce the number and acuteness of concussions in sports. After the NHL adopted a zero tolerance to the head contact rule, the league saw a 36% decline in concussion risk. Similarly, youth hockey leagues that implemented policies disallowing body checks saw a 67% reduction in concussion risk (Emery et al., 2017). Across all sports leagues, rule modifications have played a significant role in decreasing injuries sustained by amateur and professional athletes alike.

Roughing the Passer Rule Changes

The origins of the RTP penalty start with the NFL's Rules Committee, created in 1932, which passed the first RTP rule in 1940. The rule was designed to protect quarterbacks from sustaining injuries while in the act of passing, as well as other players who acted as a passer in certain play packages. The RTP penalty was introduced along with other sweeping changes, such as legalizing a forward pass from any point behind the line of scrimmage, removing the penalty for throwing multiple passes in a series of downs, and aligning the hash marks on the field closer

to the field's center (NFL Football Operations, 2023). These specific changes made it easier for NFL offenses to throw the ball and thus made it more common for quarterbacks to throw it. Due to NFL offenses starting to prioritize the pass, and because the throwing motion puts a QB in a vulnerable state, the league created a rule to protect the passer from oncoming defenders trying to disrupt the pass (NFL Video Rulebook, 2023, para. 1). Since the introduction of the RTP penalty, several additions to its language have been made to protect the quarterback from different types of hits or tackles defenders use to tackle them to the ground.

One such addition to the RTP call was introduced in the 2009 season. After a low hit to the legs of then 2-time Super Bowl MVP Tom Brady ended his 2008 season, the Competition Committee updated the RTP penalty to prohibit defenders from diving at the quarterback's legs to secure a tackle (Foster, 2009, para. 3). This added more protection to quarterbacks while significantly decreasing the available target area for defensive players to legally hit the quarterback. Since defenders cannot target the head or neck area along with the added protection to a quarterback's lower body, they can only target the midsection without the immediate risk of penalization. However, correctly hitting the quarterback in the midsection can still lead to a RTP call in today's NFL due to the 2018 rule change the Competition Committee added to the RTP penalty.

In 2018, another alteration was made to the RTP penalty, which banned defenders from landing on the opposing quarterback with "most or all of his body weight" (NFL Video Rulebook, 2023, para. 3). Given the number of injuries among star quarterbacks in the 2017 season after a defender landed on them, such as future hall-of-famer Aaron Rodgers who missed multiple weeks, the Competition Committee implemented the 2018 RTP alteration to provide more protection to the QB, but at the significant cost to defensive players. The consequences of

this rule change were immediately felt by defenders in the following seasons, as there was an average of 4.25 RTP penalties called across all 32 teams in 2019. In 2020, it remained relatively high as well, at an average of 3.97 RTP penalties per team compared to the 2.78 RTP penalties called per team in 2016 (Jakobsen, 2021, p. 1). Figure 1, shown below, supports Jakobsen's conclusions as well. Figure 1 depicts the total number of RTP penalties called against all 32 NFL defenses from the year 2009 to 2022 but shows significant increases in RTP penalties called in the following 2-3 years after a RTP change was implemented.

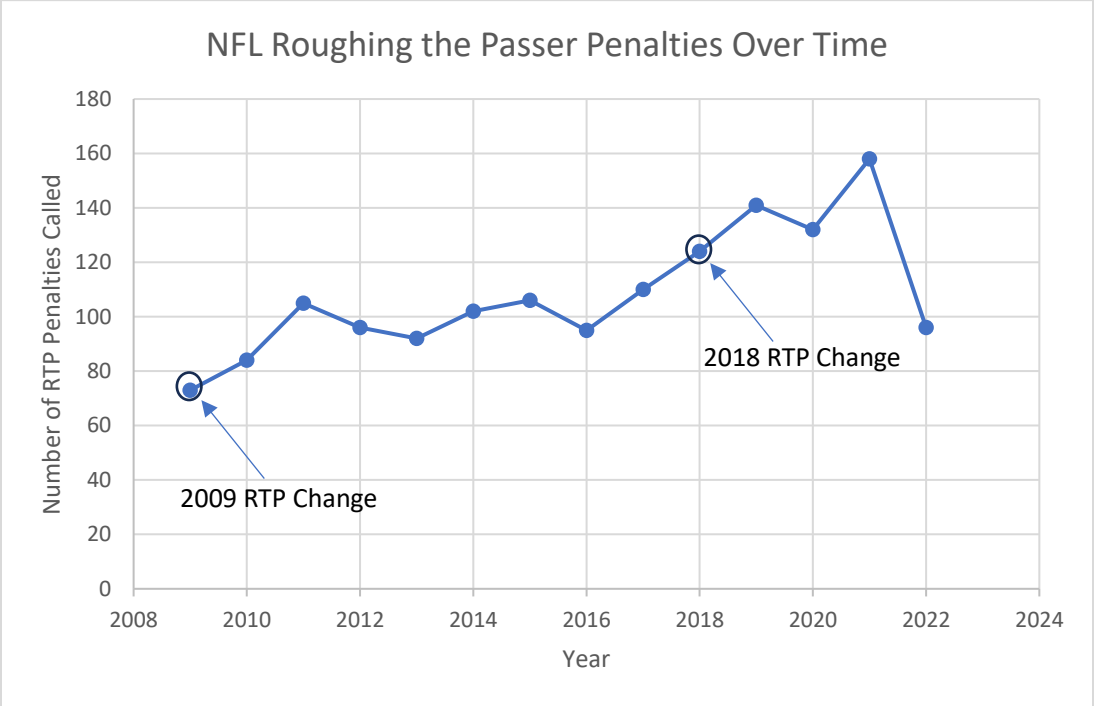

Figure 1: Total Number of Roughing the Passer Penalties Called per Season from 2009 to 2022

Rule Changes for Point After Touchdown and Two-Point Conversions

In 1974, the Committee passed a rule that moved the goalposts from the goal line to the end line instead. This new ruling drastically decreased accidental injuries stemming from players running into the goal posts while also decreasing the accuracy of placekickers. However, the success rate of point-after attempts gradually increased over time as placekickers got more

accustomed to the increased distance. By the turn of the 21st century, the average placekicker's conversion rate of point-after attempts hovered just above 98%-99%, specifically at 98.4% during the 2009-2015 seasons (Pelechrinis, 2016, p. 2).

In 1994, the Competition Committee introduced another impactful rule change that became the only alternative to the extra point following a touchdown score: the two-point attempt (Hoffman 2011, para. 22). Instead of lining up for an additional point kick, coaches could send their offensive unit out and run a play from the opponent's 2-yard line. If the offense found the endzone, they would score two additional points added to the six points scored from a touchdown. Moreover, the added two-point conversion gives the game more strategy as coaches have to decide when it is appropriate to go for two compared to playing it safe and kicking an extra point. In certain situations, such as being down by 14 points late in game, the two-point play can be seen as the optimal strategy because a successful conversion cuts the lead to only six points instead of the normal seven points. Even if the conversion fails, the lead will only be eight points, which still cuts the lead to a one possession score (Skugrud & Wenz, 2010, p. 2).

In 2015, the league passed a new rule which pushed back the extra point attempt, also known as point after touchdown (PAT), by 13 yards, from the 2-yard line to the 15-yard line. The newly implemented rule was designed to decrease the placekicker's success rate on extra point attempts, previously at a staggering 99.3% conversion rate during the 2014 season (NBC Sports, 2021, para. 4). The rule change successfully lowered the conversion rate of the PAT, decreasing the success rate by approximately 5%, from 98.4% to around 93%, during the 2015 season (Pelechrinis, 2016, p. 4). Figure 2 illustrates the effectiveness of the rule change, highlighting the stark drop-off in extra point conversion rates after the 2015 season. In the 2021 NFL season, placekickers had the lowest extra point success rate, at 92.5%, since the 1979 season.

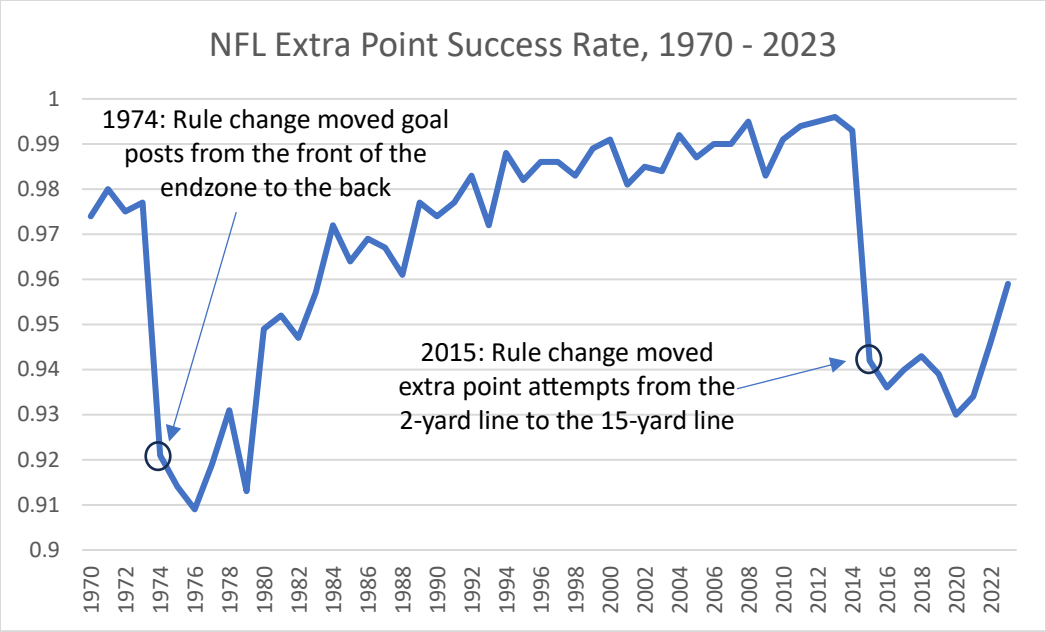

Figure 2: Success rate of extra point attempts from 1970 to 2023.

Furthermore, Rick Smith, former general manager of the Houston Texans, cited the league's desire to create a "more exciting play" as reason for the rule change. According to Smith, the league also hoped to see more two-point conversion attempts following the rule change (Williams, 2015, para. 12). Despite the two-point conversion rate holding at a significantly lower success rate, the league average being 45-50%, a successful conversion can give the converting team one additional point than a standard extra point attempt, making it a valuable asset to teams who find themselves down by seven or eight points. Given that the PAT attempt was no longer the guarantee it once was, this provided coaches and offensive play callers more incentive to attempt more two-point conversions despite the play's significantly lower success rate. The league seemingly achieved this objective, as between the years 2012 and 2022 the two-point conversion attempt per team increased by 49% (TeamRankings, 2023)

Depending on when a two-point play is called, it can prove to be pivotal moment in the game that significantly shifts the win probability in favor of the attempting team if they

successfully convert. Most coaches acknowledge the strategic aspect of two-point attempts and carry a card that highlights the optimal approach for a conversion attempt based off the in-game score. The "card" itself is a two-point conversion chart, originally created by legendary coach Dick Vermeil at UCLA in the early 70s, depicting an optimal strategy to go for two depending on the score differential of a game at a given time. For example, the card states the optimal strategy for a team trailing by 10 should attempt a two-point conversion play (Skugrud & Wenz, 2010). Despite the popularity of the two-point conversion card, it fails to acknowledge the amount of game time left which can be a limiting factor for coaches when considering a two-point play. While it was a rarity to see teams even attempt a two-point conversion prior to the 2015 change, Figure 3 shows that in recent seasons about one out of every ten touchdowns are followed by a two-point conversion attempt (Paine, 2018).

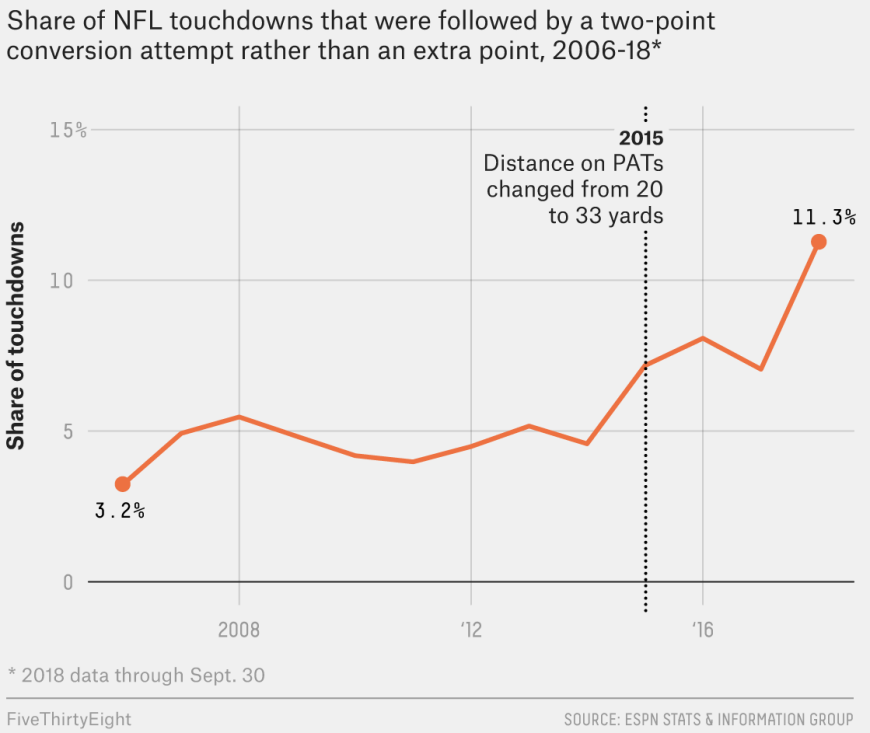

Figure 3: Two-point conversion attempts following a touchdown from 2006-2018.

More Defensive Rule Changes and the NFL's Favoritism Towards Offense

The Competition Committee has continually pushed rule changes that favor NFL offenses. In fact, a 2012 Competition Committee report indicates the league's preference for offense, stating "if someone wants to accuse the [NFL] of promoting offense to make the game more exciting, [the committee] believes the league should plead guilty" (NFL Football Operations, 2023, para. 17). In its time, the committee has passed changes including the RTP penalty, and its modifications added in 2009 and 2018, legalized the forward pass to occur on multiple downs in one drive, and even altered the shape of the game ball to make it more pass friendly (NFL Football Operations, 2023). Similarly, in 1978, the Competition Committee passed another rule which limited defensive players capabilities to stop the offense. Specifically, it outlawed defenders from maintaining contact with a receiver past five yards from the line of scrimmage. This significantly increased the receiver's catch success rate and thus increased quarterback accuracy, which made the passing attack more utilized across the league. While this benefitted the offensive passing game, it was another blow to the defensive side, making defending pass catchers more difficult. Defending receivers would only stand to get more difficult, as in 2011 the Competition Committee passed a new ruling that decreed a receiver in a catching position as a defenseless player, banning any contact made once the receiver was in an extended position to make a play (Hoffman, 2011).

Literature Review

Rule modifications serve various purposes, such as achieving league specific objectives including maximizing the entertainment value of each game, or changes can be geared towards fostering fan engagement and maintaining the game's appeal for years to come. The use of rule modifications in the NFL aligns with its ongoing mission "to protect players from injuries as

much as possible while keeping the game fair, competitive, and exciting" (NFL Football Operations, 2023, para. 24). Maintaining the game's competitive and exciting nature allows for the league to sustain several different revenue streams such as broadcast deals, ticket sales, and merchandizing sales which keeps the league and its 32 franchises profitable. Previous literature examines how rule changes in different sports increase fan interest, how uncertainty of outcome and competitive balance affects fan satisfaction, and how fan interest impacts NFL revenues.

Rule alterations are a common way for sports leagues to continue to evolve the game into a more attractive spectacle for fans and athletes. Throughout the NFL's 103-year history, the league passed several rule changes with the intent to either increase or maintain game's entertainment value to fans. These changes stem from the league's openness to "make any change it believes will benefit the game, its players or its fans… whether for fairness, safety, or entertainment…" (NFL Football Operations, 2023, para. 28). Changes such as reducing penalty yardage from 15 yards to 10 yards on minor offensive penalties (i. e. holding, tripping, and illegal use of hands) committed by offensive players, creating a possession change after a missed field goal, and other alterations have made an offense's job easier by either reducing the consequences of offensive penalties or giving them a shorter field to work with to potentially score more points (Glanville, 2017).

Another historically successful sports league, Major League Baseball (MLB), sought to increase fan enjoyment by altering certain rules of the game to combat declining attendance rates across the league for the fifth straight season in 2022 (excluding COVID-19 affected years). The national conversation about baseball centered around complaints of its slow game pace and lack of action and before the 2022 offseason, the MLB had a dreary outlook on its future. That was until MLB commissioner Rob Manfred made changes to the MLB rule book that helped boost

offensive production. The emergence of a pitch clock and the banning of the defensive infield shift have drastically altered the outlook for professional baseball in America. Since these changes, the average length of the game has decreased by 26 minutes, offensive statistics such as batting average, runs, and stolen base success rates have all increased, and most importantly, the attendance of regular season games is up 8.3% along with increased social media engagement which is up 25% (Bacharach, 2023). Through rule modification, Manfred successfully boosted the spectacle that baseball provides to its fans and drastically altered the future outlook of the sport into a more positive one.

Professional sports leagues, like the NFL, prioritize their sports 'enjoyment factor' in order to keep fans satisfied with the current state of the sport. NFL franchises are heavily reliant on their fans to have several engagements with the team (i.e., purchase tickets, buy team merchandise, luxury box sales, television viewership, etc.) in order to provide necessary revenue to teams operating season to season. According to Paul et al. (2011), NFL fans have shown a preference for closely contested games and higher scoring games as opposed to lower scoring games (p. 220). Using data from an NFL post-game rating survey, asking fans to rate the games from 0-100 (least memorable to most memorable), Paul finds the statistically significant correlation between fan rating and the total points scored is 0.503, meaning for every additional point scored in the game it is expected to increase the fan rating by 0.503. These findings align with previous research done by Paul and Weinbach (2007), suggesting close games between high quality teams and high scoring games positively impact Nielsen ratings for Monday Night Football broadcasts (p. 210). Using two regression models, one measuring the Nielsen ratings at the start-of-game and the second measuring the Nielsen ratings change within-game, Paul and Weinbach found that uncertainty of outcome (measured by margin of victory at the end of the

game), the quality of teams, and the expected point totals were all found to have statistically significant effects on the Nielsen ratings at the start of game. Additionally, the half-time score differential, number of points scored, and sum of winning percentages of both teams were found to have significant effects on the Nielsen ratings within-game (p. 210). Furthermore, previous research conducted by Gober (2009) finds that a quarterback's yards per pass attempt is statistically significant and positive in relation to their team's points per game metric (p. 33). If a quarterback's yards per attempt increases points per game, it seems likely that high scoring games will include above average passing yard metrics from quarterbacks participating in the match.

Most sports fans, including NFL fans, value sports leagues with a high amount of competitive balance. To accommodate fan interests and to introduce more parity into the league, NFL owners presented two new concepts in the 1994 season: player free agency and a hard salary cap. The introduction of free agency allowed players with four or more seasons accrued in the NFL to choose their next team and offer their services to the highest bidder. In contrast, the salary cap system was designed to create a hard limit on the amount of money NFL clubs could spend on player contracts in a given year. Instituting both free agency and a hard salary cap helped instill more parity across the league. Evidence from Larson et al. (2006) finds that the implementation of both free agency and the salary cap increased overall competitive balance in the NFL (p. 388).

Today, the NFL remains the most successful league attaining "the highest degree of competitive balance…" (Clopton, 2013, p. 210). Several mechanisms used to instill competitive balance across the league include a reverse best-to-worst draft order, a higher degree of revenue sharing amongst clubs, as well as the aforementioned additions of free agency and the hard

salary cap all of which contribute to the league's competitive balance in a positive manner. Specifically, the draft and the league's revenue sharing make the NFL stand apart from other leagues, who might use a lottery draft system instead or a soft salary cap in which team owners can decide to go over and pay a luxury tax. Furthermore, the phrase "any given Sunday", popularized by NFL fans, emphasizes the leagues competitive balance as well, insinuating any team can win or lose on any day regardless of team record. Despite the league's highly balanced nature and perceived randomness on Sundays, prior research conducted by Onwuegbuzie (1999) found certain team-specific traits, such as redzone efficiency and turnover differential, are statistically significant and positively effect a team's winning percentage (p. 155).

The NFL is a well-established business operation with a plethora of different revenue streams which makes its business model one of the most successful sports leagues in the United States. In the beginning, it's only source of revenue came from the ticket and concession sales of fans attending the game; however, today that is far from the case. While NFL teams still collect revenue from ticket sales and concessions today, the NFL as a corporate entity receives revenue from lucrative league-wide television broadcast deals, several corporate sponsorships, and merchandising revenue generated from officially licensed NFL memorabilia (Clopton, 2013, p. 211). However, it is likely TV broadcast deals are the most important revenue source for the league and its 32 franchises because these deals typically generate above half of the league's revenue (Tainsky, 2010, p. 632). Therefore, it is very important the league remains one of the most watched and highly rated programs on broadcast television in order to increase the value of future media contracts, which would then increase future revenue for each NFL franchise through the league's revenue sharing program. According to Brown et al. (2004), the NFL shares 70% of all its proceeds through its revenue sharing plan (p. 228). This includes an equal

distribution of national broadcasting contracts, as well as a 60/40 split of the home/visitor ticket revenue (Brown et al., 2004, p. 228). Thus, it seems likely that the NFL and its franchises highly value their existing broadcasting deals and strive to provide an entertaining product that not only maintains high viewership but also continually pulls in high TV ratings to maximize potential profits from future broadcasting contracts.

Additionally, previous literature finds that returns to winning, stadium age, and the metropolitan area size all impact league revenue differently across different North American professional sports leagues. Specific to the NFL, Bradbury (2016) observed returns from winning, measured by a team's score differential, had no effect on revenue for NFL teams despite its positive and significant impacts in other North American professional leagues such as the NBA, NHL, MLB (pp. 5-6). Despite Bradbury finding no direct link between winning and revenue, a conflicting report from Biner (2009) indicates the home team's winning percentage is positive and significant in relationship to stadium attendance, increasing the stadium attendance by 5% for every one unit increase in win percentage (p. 17).

Similarly, Spenner et al. (2004) found an NFL team's winning percentage is positive and statistically significant at the 1% level in relation to home-field attendance (p. 18). While the NFL rarely struggles with in-person attendance numbers, with average attendance typically over 90% capacity (Fischer, B., & Broughton, D.), increasing attendance closer to 100% would likely increase individual team revenues for both the visiting and home team. Moreover, Bradbury (2016) also determined returns from stadiums were highest when newly built for all professional American sports leagues, further supporting the "honeymoon effect" for new stadiums described in other studies (p. 18). Lastly, the market size of different franchises had a separate, positive

effect on revenue, but multiple team markets negatively impacted revenue for both the NFL and NHL while the NBA and MLB were unaffected (Bradbury, 2016, p. 18).

Professional sports leagues prioritize fan satisfaction in order to maintain and potentially create new revenue streams to support the league and its separate franchises. Rule alterations in the NFL help serve this purpose, as some rule changes are designed to make the game more entertaining for fans. Despite the league's stated purpose regarding rule changes, little to no previous research analyzes the impact rule changes have on fan enjoyment. This paper will try to bridge this gap in knowledge by attempting to uncover another possible outcome stemming from rule modifications in the NFL, which is: have recent rule changes in the NFL enabled team offenses to score more points per game, thus increasing fan enjoyment, leading to higher team revenue totals? It is hypothesized that recent rule changes such as increasing the complexity to the roughing the passer penalty and increasing the distance of the extra point to decrease its average success rate has increased a team's ability to score more points per game, thus increasing overall fan utility, increasing team revenues.

Theoretical Model

Average Points Model

According to the official NFL Football operations website (operations.nfl.com) the NFL "has championed rule changes that promote more scoring and more exciting plays" (NFL Football Operations 2023). It is this ongoing philosophy that has influenced the framework of the Average Points scored models shown below. Equation 1a will examine the impact the two RTP changes in 2009 and 2018 had on a team's average points per game (APPG). Equation 1b will analyze the effect the PAT change in 2015 had on APPG. The separation of these key variables will help distinguish the different impacts the RTP changes and the PAT change had on a team's APPG.

$$APPG_{it} = \beta_0 + \beta_1 RTP2009_{it} + \beta_2 RTP2018_{it} + \beta_3 AvgPassyds_{it} + \beta_4 Redzone_{it} + \beta_5 Thirddownconversion_{it} + \beta_6 NetTurnovers + \varepsilon_{it} \quad (1a)$$

Table 1. Variable Definitions for Equation 1a.

Variable Name	Definition
$APPG_{it}$	Average points per game scored for team i in season t
$RTP2009_{it}$	Dummy variable for the 2009 change to the roughing the passer penalty, 0 from 2002-2008, then becomes 1 during the period 2009-2017, then goes back to 0 for 2018-2022.
$RTP2018_{it}$	Dummy variable for the 2018 change to the roughing the passer penalty, 0 from 2002-2017 then becomes 1 for 2018-2022 seasons
$AvgPassyds_{it}$	Average pass yds per game for team i in season t
$Redzone_{it}$	Redzone scoring efficiency for team I in season t
$Thirddownconversion_{it}$	Third down conversion rate for team I in season t
$NetTurnovers_{it}$	Total turnovers lost subtracted from total turnovers generated by team i in season t

It is hypothesized that both RTP2009 and RTP2018 will have a positive impact on the average points per game. Both rule changes negatively impact the defense, and if called in a game, award the offense 15 yards as well as a complete reset of downs. Thus, if the offense failed to convert on a crucial down (i.e., 3rd or 4th down), this penalty effectively gives them a second chance for a successful offensive drive by resetting the downs back to 1st down. Furthermore, both rule changes added more complexity to the preexisting framework of the RTP penalty language in the NFL rule book, disallowing certain techniques players had previously used to tackle the quarterback. It is likely players would experience an adjustment period after the updated rule changes, and mistakenly hit the quarterback in a recently outlawed manner, leading to a penalty called on the defense. More RTP penalties called will benefit the offense, and their ability to score points, leading to the expected signs of both B1 and B2 to be positive.

Likewise, the variables AvgPassyds, Redzone, Thirddownconversion, and NetTurnovers are all hypothesized to be positively related to average points per game. According to Gober (2009), a one unit increase in a quarterback's pass yards per attempt increases points per game by 3.34 (p. 33). Consequently, it is likely a quarterback's average passing yards in a game impacts average points per game in a similar manner. Furthermore, the ability to convert on third downs and in the redzone directly contribute to their team's average points per game. A higher third down conversion rate indicates an offense's proficiency to 'move the chains' downfield and potentially score points. A higher redzone efficiency rating signifies an offense's ability to score touchdowns inside the redzone, which is a football term to describe the area between the opponent's 20-yard line and the goaline.

Prior research conducted by Onwuegbuzie (1999) found that a team's redzone efficiency rating was statistically significant to the team's winning percentage. Teams with high winning percentages have to outscore opponents to win, thus redzone efficiency may also contribute to average points per game. Similarly, Onwuegbuzie (1999) found that turnover differential positively impacted a team's winning percentage. The more turnovers generated by a team's defense than lost by the offense will lead to more opportunities to score, potentially increasing a team's average points per game, while also increasing the likelihood of a team's victory (p.155).

Keeping the framework from equation 1a, the next APPG model includes the dummy variable for the 2015 PAT rule change while removing the RTP dummies found in Table 1. Table 2 includes all relevant variable definitions for equation 1b and is shown below.

$$APPG_{it} = \beta_0 + \beta_1 PAT2015_{it} + \beta_2 AvgPassyds_{it} + \beta_3 Redzone_{it} + \beta_4 Thirddownconversion_{it} + \beta_5 NetTurnovers + \varepsilon_{it} \quad (1b)$$

Table 2 – Variable Definitions for Equation 1b.

Variable Name	Definition
$APPG_{it}$	Average points per game scored for team i in season t
$PAT2015_{it}$	Dummy variable for the 2015 point after touchdown rule change
$AvgPassyds_{it}$	Average pass yds per game for team i in season t
$Redzone_{it}$	Redzone scoring efficiency for team i in season t
$Thirddownconversion_{it}$	Third down conversion rate for team i in season t
$NetTurnovers_{it}$	Total turnovers lost subtracted from total turnovers generated by team i in season t

All identical variables in Equation 1b are assumed to have the same expected impact on APPG as in Equation 1a. Additionally, the newly included variable PAT2015 is hypothesized to have a positive impact on average points per game. Despite the rule change increasing the difficulty of the extra point attempt by increasing its distance (thus potentially decreasing point totals), it is assumed this new change increased the number of two-point conversions attempted by NFL teams. While the two-point conversion has a considerably lower success rate than the extra point, the expected increase in two-point attempts is hypothesized to offset the lower success rate enough for this variable to positively influence a team's average points per game.

Total Team Revenue Model

The second step of this study is to determine if a team's points per game positively impact total team revenue. If indications point to both higher scoring games and better-quality matchups increasing fan satisfaction and TV ratings, the NFL will likely pursue solutions to continue providing games that fit those categories in order to maximize current and future revenue streams. Using information from previous literature and the current hypothesis for this study, the total revenue model is stated below as Equation 2:

$$revlog_{it} = \beta_0 + \beta_1 APPG_{it} + \beta_2 Winpercent_{it-1} + \beta_3 Probowl_{it} + \beta_4 AvgMV_{it} + \beta_5 Playoffs_{it-1} + \varepsilon_{it} \quad (2)$$

Table 3. Variable Definitions for Equation 2.

Variable Name	Definition
$revlog_{it}$	The natural log of total team revenue, adj. for inflation, measured as in-season revenue net of revenue sharing and stadium debt service, of team i in season t
$APPG_{it}$	Average points per game scored for team i in season t
$Winpercent_{it-1}$	Winning percentage of team i in the season t - 1
$Probowl_{it}$	The number of probowlers on team i in season t
$AvgMV_{it}$	The average margin of victory for team i in season t
$Playoffs_{it-1}$	Dummy variable indicating if team i made the playoffs in season t - 1

APPG is expected to be positively correlated to real team revenue. For this study, real team revenue was calculated using CPI data to transform all nominal team revenues into 2022 dollars. Previous research conducted by Paul et al. (2011) and Paul & Weinbach (2007) suggest NFL fans prefer higher scoring games and higher scoring games positively influence TV ratings. More engaged fans and higher TV ratings could translate into higher real team revenue sales through increased merchandise sales, ticket sales, and higher TV viewership totals, leading to the expected positive relationship between average points per game and total team revenue.

Winpercent lagged is expected to positively impact total team revenue as well. According to Spenner et al. (2004), a team's current winning percentage positively impacts home-field attendance. A similar result is expected from the win percentage of team i in the season prior (season t – 1), as it sets high expectations for the team to meet or exceed the success of last season. Likewise, the variable Playoffs lagged is expected to be positively correlated with real

team revenue as well. Teams who make the playoffs in the season prior may be expected to make the playoffs again next year, which enables teams to raise game and venue prices as demand increases. Depending on the team expectations, fans may be more inclined to attend games, purchase merchandise, or tune in to their broadcasts to watch the team play, all of which can contribute to real team revenue.

Similarly, Probowl is expected to have a positive relationship with total team revenue. The players represented in the NFL's Pro Bowl are voted in by the fans, suggesting players who either perform well that season or are 'fan favorites' are well represented in the annual Pro Bowl. Teams that have multiple players voted into the Pro Bowl suggest fan's familiarity with players, which may lead to higher merchandise sales such as Pro Bowl player jerseys, shirts, etc., leading to more team revenue generated.

Conversely, AvgMV (average margin of victory) is expected to have a negative relationship with total team revenue. Past literature, including Paul et al. (2011) and Paul & Weinbach (2007), supports this conclusion. According to Paul & Weinbach, fans prefer closely contested games, which is shown through higher average Nielsen ratings than games that are blowouts. Thus, the smaller AvgMV, the more uncertain the final outcome is. Furthermore, closely contested games could bring in more viewers over other substitutes. More views and more invested fans may lead to increases in real team revenue, thus the expected sign for AvgMV is negative.

Data

The data used for this study was collected from Pro Football Reference, TeamRankings.com, as well as the Official National Football League Record & Fact Book. Panel data was collected from all 32 NFL franchises from 2002 to the 2023 NFL season. Additionally,

the average place-kicking success rate was recorded for each year since the 1970 season, to illustrate the two rule changes that impacted kicking accuracy over the past 50+ seasons. A dataset including all the relevant variables of interest from this study (see Table 1 & 2 above) spanning 21 NFL seasons (2002-2023) was created with a total of 640 observations. Both the 2020 season and the 2023 season were removed from dataset due to outlier concerns and missing information respectively. In 2020, the COVID-19 pandemic placed several states under strict regulations related to public gatherings, consequently affecting in-person fan attendance for most of the regular season which in turn deflated team revenue numbers league wide. Furthermore, at the time of this study, despite the completion of the 2023 NFL season, team revenue numbers have not been identified and thus excluded from the analysis. Descriptive statistics for all variables of interest are shown below in Table 4[1].

APPG varies by quite a large margin over this 20-year span, with the minimum being a mere 10.50 APPG achieved by the 2006 Oakland Raiders while the 2013 Denver Broncos, led by legendary quarterback Peyton Manning amidst his record-breaking season, averaged a blazing 37.90 PPG. It was Peyton Manning's 2013 season that also achieved the league-high average pass yards per game, at 340.2 yards per game, a mark that beats out the 20-year league average of 227.50 by over 100 yards. The redzone efficiency league average hovers right above 50%, sitting at 53.45%, where the league minimum and maximum were achieved by the same franchise, the Kansas City Chiefs in 2012 and 2003 respectively.

Table 4. Descriptive Statistics

	Minimum	Maximum	Mean	St. Dev.
$APPG_{it}$	10.50	37.90	22.09	4.4078

[1] Dummy variables are excluded from Table 4 due to their only listed values of 0 or 1. All variables listed in Table 4 have 640 observations.

$AvgPassyds_{it}$	118.60	340.20	227.50	118.0505
$Redzone_{it}$	0.27	0.778	0.5345	0.0842
$Thirddownconversion_{it}$	0.24	0.567	0.3881	0.0509
$NetTurnovers_{it}$	-28	28	0.0406	9.299
$RealRev_{it}$	205,003,891	1,188,081,180	398,100,000	134,067,588
$revlog_{it}$	19.14	20.90	19.75	0.3034
$Winpercent_{it-1}$	0.00	1.00	0.5005	0.1899
$Probowl_{it}$	0	13	3.505	2.4154
$AvgMV_{it}$	-16.4	19.7	-0.0028	6.2321

Additionally, the league average for third down conversions was around 39%. Above average teams, such as the 2002 Oakland Raiders, cleared the 50% conversion mark while struggling teams like the 2006 Dallas Cowboys failed to reach a 25% conversion rate. The 56.7% conversion rate for the Raiders helped pave the way for a Super Bowl Appearance during the 2002 season, whereas the Cowboys struggles continued throughout the 2006 season, leading them to a subpar record and a top pick in the 2007 draft. Net Turnovers, often referred to as a team's turnover differential, signifies a team's capabilities to keep the ball safe on offense while also generating turnovers on the defensive side of the ball to give their respective offense extra possessions. Despite the near zero league average, over this 20-year period the league saw both inept offensive play and incredible defensive performance from respective teams. The 2017 Cleveland Browns, arguably one of the worst teams in NFL-history, gave up 41 offensive turnovers while only generating 13 on defense, leading to a league-worst -28 net turnover margin as well as 0-16 record. Conversely, the 2011 San Francisco 49ers generated 38 defensive

turnovers while only giving up 10 offensive turnovers to achieve a +28 turnover differential as well as the 1st seed in the NFC with a 13-3 record.

Furthermore, the league has seen an increase in real revenue during this 20-year period, excluding 2020, leading to a league average around $400 million per season. The league minimum was set by the 2002 Cardinals, only bringing in an estimated $205 million for the season. In contrast, the 2021 Dallas Cowboys brought in over $1 billion in revenue to achieve the maximum result seen. The Cowboys are the only team in the NFL to gross over $1 billion dollars of real revenue (in 2022 dollars) in six seasons (2016-2019; 2021-2022).

Despite the league average for win percentage remaining slightly above .500, specifically at 0.5005, the league witnessed historical feats by three separate teams during this 20-year period. The 2007 Patriots led the second-ever perfect regular season campaign, finishing an astonishing 16-0, which led to a league-maximum win percentage of 1.00. On the other hand, two franchises contributed to the league minimum win percentage of 0.00, that being the 2008 Detroit Lions and the previously mentioned 2017 Cleveland Browns team.

The final two variables, the number of probowlers on a team's roster as well as average margin of victory, typically are strong indicators of how competitive a team is for that given season. Similar to win percentage, the league saw a wide range of probowlers on a roster, the league minimum being 0 as seen most recently in this dataset with the 2022 New York Giants and the league maximum set at 13 by the 2019 Baltimore Ravens. The minimum average margin of victory as seen above (-16.4) was achieved by the 2009 St. Louis Rams who would end up finishing a mere 2-14 and the rights to the 1st overall pick in the 2010 draft. However, the league best at 19.7 was none other than the perfect 2007 Patriots, who beat their opponents on average by more than two possessions each game during the regular season, an astonishing feat that has

not been done since. Despite the wide margin between the minimum and maximum average margin of victory, the league average is near zero, at -0.0028, signifying the league's highly competitive nature.

Results

To test the factors that impact a team's average points per game as well as team revenue, a fixed-effect model was used to account for the individual-level heterogeneity observed in all 32 NFL franchises. Unobserved, team specific characteristics exist for all teams in the NFL and vary across the board. Positional value, offensive and defensive philosophies, outdoor or indoor stadiums, team travel policy, and many more characteristics differentiate between each team. Using a fixed effects model helps control for this heterogeneity amongst teams which reduces bias in the estimation while improving the accuracy of the results. A fixed effect model is also beneficial to use when using panel data as it controls for time-invariant factors that could influence the dependent variable while remaining constant among the independent variables in the study. Furthermore, a fixed effects model helps mitigate endogeneity which occurs when the explanatory variables are correlated with the error term. Moreover, a Hausman test was run in order to determine if the specific models run in this study should use a fixed effects or random effects approach. The results rejected the null hypothesis, indicating that the fixed effects approach was favored for this study.

Table 5, shown below, displays the regression results of the explanatory variables used from Equation 1a[2]. The results show that the 2009 RTP rule change positively impacts a team's

[2] All regressions equations have the control variable "factor(Code)" to act as a dummy for all 32 teams but due to the elongated results provided when including the variable Code in the regression, its results are not shown for any of the output tables (results with factor(code) can be found in the appendix). The teams are set in alphabetical order, and begin with factor(Code) #2 which is the Atlanta Falcons and continues down until factor(Code) 32 which is the Washington Commanders.

average points per game and is significant at the 1% level; however, the 2018 RTP rule change is insignificant. According to the model, when the 2009 RTP change goes into effect, it increases a team's average points per game by 0.7621. While the number may seem insignificant at first glance, in a league where the average margin of victory is less than a point (-0.0028), a single point could be the difference between a win or loss. Furthermore, the variables Avgpassyds, Redzone, Thirddownconversion, and NetTurnovers are all significant at the 1% level and positively effect APPG. For each additional average pass yard, it is expected to increase average points per game by 0.0029. However, the calculation for both Redzone and Thirddownconversion are slightly different due to both variables being in ratio format, or a value between 0-1. Thus, using an additional increase of 0.1 reflects more accurate interpretation of both variable impacts on the dependent variable. That being said, a 0.1 increase in Redzone efficiency is expected to increase APPG by 1.75 points. Similarly, a 0.1 increase in a team's third down conversion rate is expected to increase APPG by 3.38 points. Furthermore, the adjusted r-squared is 0.7133, indicating that in this first model 71.33% of the variability in a team's average points per game can be explained by the explanatory variables included in the model.

Table 5. Regression Results – RTP Rule Changes and Other Determinants of Average Points per Game

	Dependent variable:
	APPG
RTP2009	0.7621 (0.2119)***
	t = 3.5966
RTP2018	0.1713 (0.2707)
	t = 0.6330
Avgpassyds	0.0029 (0.0008)***
	t = 3.4708
Redzone	17.5224 (1.3398)***
	t = 13.0787
Thirddownconversion	33.8215 (2.2952)***
	t = 14.7360
NetTurnovers	0.1511 (0.0110)***
	t = 13.7221
Observations	640
R^2	0.7299
Adjusted R^2	0.7133
Residual Std. Error	2.3602 (df = 602)
F Statistic	43.9626*** (df = 37; 602)
Note:	*p<0.1; **p<0.05; ***p<0.01

Similarly, Table 6 displays the regression output of the variables used in equation 1b. The results show that the 2015 rule change is insignificant in relation to APPG, indicating there is no real impact felt from this rule change. However, each variable included from the first regression remain positive and significant at the 1% level, with minimal changes to each variable's impact on APPG. Moreover, the model shown in Table 6 displays the adjusted r-squared is 0.7073, indicating that 70.73% of the variation in APPG can be explained by the independent variables

included in the model. This adjusted r-squared is slightly less than the first APPG model, showcased in Table 5, suggesting that this model is slightly worse than the previous model.

Table 6. Regression Results – PAT Rule Change and Other Determinants of Average Points per Game

	Dependent variable:
	APPG
PAT2015	-0.1703 (0.2042) t = -0.8341
Avgpassyds	0.0030 (0.0008)*** t = 3.6119
Redzone	18.0099 (1.3508)*** t = 13.3333
Thirddownconversion	33.5151 (2.3180)*** t = 14.4589
NetTurnovers	0.1500 (0.0111)*** t = 13.4831
Observations	640
R^2	0.7238
Adjusted R^2	0.7073
Residual Std. Error	2.3847 (df = 603)
F Statistic	43.8897*** (df = 36; 603)
Note:	*p<0.1; **p<0.05; ***p<0.01

Finally, Table 7 presents the regression results from the real revenue function, or equation 2. The results show that APPG and AvgMV are significant at the 1% level, where APPG shares a direct relationship with RealRev while AvgMV is inversely related. Additionally, Probowl is positive and statistically significant at the 5% level in relation to real team revenue. According to the model, an additional average point per game is expected to increase real team revenue by 0.0268, or 2.68%. Likewise, an additional player named to the probowl is expected to increase

real revenue by 1.39%. Conversely, an additional point increase in a team's average margin of victory is expected to decrease real team revenue by approximately 1.82%. Moreover, the adjusted r-squared value is 0.1906, meaning that 19.06% of the variation seen in the natural log of real team revenue can be explained by the independent variables included in the model shown below. It is important to note that Table 7 displays results without correcting for the standard errors, which minimizes potential errors within the model such as heteroskedasticity or serial correlation. Table 11, shown in the appendix, displays the regression results with robust standard errors as well as the full. Despite Table 11 correcting for the issues inherent in Table 7, none of the signs or statistical significance of the explanatory variables change, signifying each variable's importance to real team revenue.

Table 7. Regression Results – Average Points per game and Other Determinants of Real Team Revenue

	Dependent variable:
	revlog
APPG	0.0268 (0.0047)*** t = 5.6627
Winpercentlagged	0.0491 (0.0928) t = 0.5293
Probowl	0.0139 (0.0068)** t = 2.0373
AvgMV	-0.0182 (0.0037)*** t = -4.9557
Playofflag	-0.0137 (0.0348) t = -0.3926
Observations	639
R^2	0.2363
Adjusted R^2	0.1906
Residual Std. Error	0.2723 (df = 602)
F Statistic	5.1733*** (df = 36; 602)
Note:	*p<0.1; **p<0.05; ***p<0.01

Conclusions

The NFL's philosophy of favoring the offense in regard to its implementation of new game rules is likely a very important component in a team's average points per game. Additionally, it is also likely more points scored per game leads to higher real revenue totals for individual teams because fans receive more satisfaction from higher scoring games. In the years 2009, 2015, and 2018, the NFL introduced changes that negatively impacted the defense or special teams, in favor of more offensive production. The rule changes in 2009 and 2018 increased the complexity of the preexisting language for the RTP penalty, while the 2015 change aimed to decrease PAT success rate enough where more teams would attempt two-point conversion plays. Game data collected over a 21-year span (2002-2023) was used to test the two hypotheses of this study: do rule changes increase average points per game, and does an increase in average points per game increase real team revenue? The first hypothesis is supported by the regression results displayed in Table 5, using APPG as the dependent variable and the pair of RTP dummy variables along with several important offensive statistics as the independent variables. The RTP2009 variable was found to have a positive and significant effect on average points per game, suggesting rule changes do increase a team's offensive production.

Furthermore, the second hypothesis is supported by the regression output shown in Table 7, using the log of real team revenue as the dependent variable and average points per game as one of the independent variables. Average points per game was found to have a positive and significant impact on the log of real revenue, suggesting that more points scored does lead to higher real revenue totals for NFL franchises. While it cannot be said that the impact of APPG on real team revenue is fully attributed to the RTP rule changes, given the impact of RTP changes on

APPG and the impact APPG has on real team revenue, the RTP rule changes could be a cause of higher real revenue over time.

However, it is important to note the limitations and potential biases present in this study. Using dependent variables average points per game and the log of real team revenue poise potential problems, specifically trying to ensure the inclusion of all relevant variables that could have an impact on either dependent variable. Points per game and team revenue have several contributing factors, many of which could not be included in this study due to time constraints, thus leading to the specification error issues seen in both APPG models. Additionally, the real revenue model suffers from both serial correlation and heteroskedasticity errors. To correct for these issues, a coeftest was run to transform the standard errors of coefficients into robust standard errors to reduce the level of bias in the model itself, as seen in Table 11 in Appendix C. Future research conducted on this topic could look to analyze other changes within the NFL that negatively impacts the defense or apply it to other professional sports leagues such as the NBA, MLB, or NHL. Given the results of this study, the findings suggest NFL Competition Committee members should continue favoring rule changes that specifically benefit the offense. The more offensive-friendly rule changes are put into place, the more likely NFL games will produce higher point totals, which would increase the real revenue generated by teams as well.

Appendix A

Econometric Testing

All models in this study were subjected to several different econometric tests to check for errors such as multicollinearity, serial correlation, heteroskedasticity, and specification error. VIF tests were run for each model, and each variable reported back a value less than 5, indicating no models suffer from multicollinearity. A correlation matrix was run as well for each model to ensure no variables were too highly correlated; however, results from the matrix show that average margin of victory and win percentage share a correlation of 0.909, well above the 0.80 threshold. Conversely, no variables in either APPG model demonstrated a strong enough correlation to warrant a concern. Additionally, Durbin-Watson tests were run on all three models as well to test for serial correlation error. No serial correlation was found in equation 1a; however, results from the Durbin-Watson test for equation 1b were inconclusive while results from equation 2 found serial correlation present in the model. To rectify the inconclusive results from equation 1b, a Breusch-Godfrey test was used on equation 1b to confirm if serial correlation was present. The results of the Breusch-Godfrey test did find serial correlation to be present in the model as well. To correct for serial correlation in equations 1b and 2, a coeftest was run in order to correct for serial correlation as well as heteroskedasticity if it were found in the model(s).

To determine if heteroskedasticity was present in the models, White tests were run across all three equations (1a, 1b, 2). The results of the White test found both APPG models (equations 1a and 1b) were free of heteroskedasticity but found it to be present in the real team revenue model (equation 2). The same coeftest mentioned previously was used in order to correct for

heteroskedasticity and left all variables of interest that were statistically significant prior to the correction the same, indicating each variable's significance on real team revenue. Finally, Ramsey Reset tests were run for each model to determine if there is specification error present in any of the models. The results indicate no specification error is present in the real team revenue model; however, specification error does exist in both APPG models. This is likely due to omitted variable bias, as there are several other variables that could impact a team's points per game that are not included in this model, thus this result was expected and should not warrant significant concern.

Appendix B

Full Stargazer HTML Output Tables with Factor(Code)

Table 8. *Regression Results – RTP Rule Changes and Other Determinants of Average Points per Game*

	Dependent variable:
	APPG
RTP2009	0.7621
	(0.2119)***
	t = 3.5966
RTP2018	0.1713
	(0.2707)
	t = 0.6330
Avgpassyds	0.0029
	(0.0008)***
	t = 3.4708
Redzone	17.5224
	(1.3398)***
	t = 13.0787
Thirddownconversion	33.8215
	(2.2952)***
	t = 14.7360
NetTurnovers	0.1511
	(0.0110)***
	t = 13.7221
factor(Code)2	-0.6638
	(0.7548)
	t = -0.8794
factor(Code)3	0.5226
	(0.7515)
	t = 0.6954
factor(Code)4	-0.0421
	(0.7483)
	t = -0.0562
factor(Code)5	-0.6018
	(0.7477)
	t = -0.8049
factor(Code)6	-0.3332
	(0.7476)
	t = -0.4457
factor(Code)7	-0.6219
	(0.7489)
	t = -0.8305
factor(Code)8	-1.7320
	(0.7542)**
	t = -2.2963
factor(Code)9	0.3616
	(0.7510)
	t = 0.4815
factor(Code)10	1.1268
	(0.7468)
	t = 1.5089
factor(Code)11	-0.2873
	(0.7472)
	t = -0.3844
factor(Code)12	0.5276
	(0.7576)
	t = 0.6964

factor(Code)13	(0.7469) t = -1.4528
factor(Code)14	-0.5752 (0.7599) t = -0.7570
factor(Code)15	-1.5601 (0.7468)** t = -2.0890
factor(Code)16	0.2694 (0.7529) t = 0.3578
factor(Code)17	-0.6170 (0.7470) t = -0.8261
factor(Code)18	0.4146 (0.7565) t = 0.5481
factor(Code)19	0.0823 (0.7470) t = 0.1101
factor(Code)20	-0.9122 (0.7470) t = -1.2212
factor(Code)21	0.3872 (0.7492) t = 0.5168
factor(Code)22	1.7369 (0.7655)** t = 2.2691
factor(Code)23	0.9152 (0.7619) t = 1.2012
factor(Code)24	0.8115 (0.7471) t = 1.0862
factor(Code)25	-1.0111 (0.7482) t = -1.3513
factor(Code)26	1.5864 (0.7503)** t = 2.1144
factor(Code)27	-0.1024 (0.7533) t = -0.1359
factor(Code)28	0.1010 (0.7492) t = 0.1348
factor(Code)29	0.3354 (0.7513) t = 0.4464
factor(Code)30	-1.1879 (0.7480) t = -1.5881
factor(Code)31	-0.9246 (0.7489) t = -1.2346
factor(Code)32	-1.1561 (0.7465) t = -1.5488
Constant	-1.3011 (1.0189) t = -1.2770
Observations	640
R^2	0.7299
Adjusted R^2	0.7133
Residual Std. Error	2.3602 (df = 602)
F Statistic	43.9626*** (df = 37; 602)

Table 9. Regression Results – PAT Rule Change and Other Determinants of Average Points per Game

	Dependent variable:
	APPG
PAT2015	-0.1703
	(0.2042)
	t = -0.8341
Avgpassyds	0.0030
	(0.0008)***
	t = 3.6119
Redzone	18.0099
	(1.3508)***
	t = 13.3333
Thirddownconversion	33.5151
	(2.3180)***
	t = 14.4589
NetTurnovers	0.1500
	(0.0111)***
	t = 13.4831
factor(Code)2	-0.6521
	(0.7627)
	t = -0.8551
factor(Code)3	0.5455
	(0.7593)
	t = 0.7184
factor(Code)4	-0.0237
	(0.7561)
	t = -0.0314
factor(Code)5	-0.6032
	(0.7555)
	t = -0.7985
factor(Code)6	-0.3298
	(0.7553)
factor(Code)7	
	(0.7567)
	t = -0.8222
factor(Code)8	-1.7396
	(0.7621)**
	t = -2.2828
factor(Code)9	0.3556
	(0.7588)
	t = 0.4686
factor(Code)10	1.1202
	(0.7545)
	t = 1.4847
factor(Code)11	-0.3011
	(0.7550)
	t = -0.3987
factor(Code)12	0.5249
	(0.7655)
	t = 0.6857
factor(Code)13	-1.0828
	(0.7546)
	t = -1.4349
factor(Code)14	-0.5797
	(0.7678)
	t = -0.7551
factor(Code)15	-1.5522
	(0.7546)**
	t = -2.0569

	0.2698
factor(Code)16	(0.7608)
	t = 0.3546
	-0.6169
factor(Code)17	(0.7547)
	t = -0.8175
	0.4089
factor(Code)18	(0.7644)
	t = 0.5350
	0.0933
factor(Code)19	(0.7547)
	t = 0.1237
	-0.9194
factor(Code)20	(0.7547)
	t = -1.2182
	0.3909
factor(Code)21	(0.7569)
	t = 0.5164
	1.7340
factor(Code)22	(0.7734)**
	t = 2.2420
	0.9027
factor(Code)23	(0.7698)
	t = 1.1726
	0.8214
factor(Code)24	(0.7548)
	t = 1.0882
	-0.9917
factor(Code)25	(0.7560)
	t = -1.3118
	1.5834
factor(Code)26	(0.7581)**
	t = 2.0888
factor(Code)27	(0.7611)
	t = -0.1185
	0.1180
factor(Code)28	(0.7569)
	t = 0.1559
	0.3366
factor(Code)29	(0.7591)
	t = 0.4434
	-1.1820
factor(Code)30	(0.7557)
	t = -1.5640
	-0.9399
factor(Code)31	(0.7567)
	t = -1.2422
	-1.1571
factor(Code)32	(0.7542)
	t = -1.5342
	-1.0408
Constant	(1.0264)
	t = -1.0140
Observations	640
R^2	0.7238
Adjusted R^2	0.7073
Residual Std. Error	2.3847 (df = 603)
F Statistic	43.8897*** (df = 36; 603)
Note:	*p<0.1; **p<0.05; ***p<0.01

Table 10. Regression Results – Average Points per game and Other Determinants of Real Team Revenue

	Dependent variable:
	revlog
APPG	0.0268 (0.0047)***
	t = 5.6627
Winpercentlagged	0.0491 (0.0928)
	t = 0.5293
Probowl	0.0139 (0.0068)**
	t = 2.0373
AvgMV	-0.0182 (0.0037)***
	t = -4.9557
Playofflag	-0.0137 (0.0348)
	t = -0.3926
factor(Code)2	0.0012 (0.0875)
	t = 0.0134
factor(Code)3	0.1327 (0.0888)
	t = 1.4938
factor(Code)4	0.0180 (0.0876)
	t = 0.2057
factor(Code)5	0.0823 (0.0875)
	t = 0.9409
factor(Code)6	0.1400 (0.0875)
	t = 1.5993
factor(Code)7	-0.0053 (0.0876)
	t = -0.0603
factor(Code)8	0.1185 (0.0880)
	t = 1.3460
factor(Code)9	0.5553 (0.0886)***
	t = 6.2704
factor(Code)10	0.1242 (0.0878)
	t = 1.4145
factor(Code)11	-0.0272 (0.0879)
	t = -0.3094
factor(Code)12	0.0712 (0.0888)
	t = 0.8014

factor(Code)13	0.2255 (0.0874)** t = 2.5803
factor(Code)14	-0.0098 (0.0882) t = -0.1114
factor(Code)15	0.0589 (0.0880) t = 0.6689
factor(Code)16	-0.0064 (0.0881) t = -0.0731
factor(Code)17	-0.0432 (0.0877) t = -0.4922
factor(Code)18	-0.0368 (0.0881) t = -0.4178
factor(Code)19	0.0246 (0.0873) t = 0.2816
factor(Code)20	0.1154 (0.0874) t = 1.3193
factor(Code)21	-0.0445 (0.0877) t = -0.5071
factor(Code)22	0.3698 (0.0924)*** t = 4.0036
factor(Code)23	-0.0043 (0.0887) t = -0.0480
factor(Code)24	0.1690 (0.0874)* t = 1.9331
factor(Code)25	0.1598 (0.0876)* t = 1.8232
factor(Code)26	0.1417 (0.0883) t = 1.6048
factor(Code)27	0.0984 (0.0890) t = 1.1053
factor(Code)28	0.0973 (0.0874) t = 1.1135
factor(Code)29	0.0834 (0.0884) t = 0.9436
factor(Code)30	0.0835 (0.0874) t = 0.9556
factor(Code)31	0.0495 (0.0874) t = 0.5664
factor(Code)32	0.3840 (0.0874)*** t = 4.3932

Constant	18.9957 (0.1289)*** t = 147.3538
Observations	639
R^2	0.2363
Adjusted R^2	0.1906
Residual Std. Error	0.2723 (df = 602)
F Statistic	5.1733*** (df = 36; 602)
Note:	*p<0.1; **p<0.05; ***p<0.01

Appendix C
Coeftest Results

Table 11. Real Revenue Regression Output with Robust Standard Errors

```
> coeftest(logrevfixed,vcovHC(logrevfixed, type = "HC1"))

t test of coefficients:

                   Estimate Std. Error  t value  Pr(>|t|)
(Intercept)      18.9957215  0.1199792 158.3251 < 2.2e-16 ***
APPG              0.0268476  0.0043529   6.1678 1.271e-09 ***
Winpercentlagged  0.0491079  0.0898210   0.5467 0.5847663
Probowl           0.0138825  0.0065539   2.1182 0.0345667 *
AvgMV            -0.0182096  0.0033547  -5.4281 8.268e-08 ***
Playofflag       -0.0136650  0.0364317  -0.3751 0.7077296
factor(Code)2     0.0011751  0.0891695   0.0132 0.9894896
factor(Code)3     0.1326857  0.0794179   1.6707 0.0952953 .
factor(Code)4     0.0180167  0.0823935   0.2187 0.8269841
factor(Code)5     0.0823487  0.0781647   1.0535 0.2925216
factor(Code)6     0.1400043  0.0871017   1.6074 0.1084984
factor(Code)7    -0.0052817  0.0825051  -0.0640 0.9489786
factor(Code)8     0.1184836  0.0742858   1.5950 0.1112439
factor(Code)9     0.5553064  0.1208162   4.5963 5.243e-06 ***
factor(Code)10    0.1241605  0.0878152   1.4139 0.1579132
factor(Code)11   -0.0271971  0.0796249  -0.3416 0.7327977
factor(Code)12    0.0711777  0.0917067   0.7761 0.4379681
factor(Code)13    0.2255144  0.0821197   2.7462 0.0062099 **
factor(Code)14   -0.0098257  0.0859885  -0.1143 0.9090636
factor(Code)15    0.0588750  0.0836471   0.7039 0.4817979
factor(Code)16   -0.0064366  0.0831248  -0.0774 0.9383044
factor(Code)17   -0.0431531  0.0873848  -0.4938 0.6216076
factor(Code)18   -0.0368058  0.0836239  -0.4401 0.6599974
factor(Code)19    0.0245881  0.0916007   0.2684 0.7884624
factor(Code)20    0.1153685  0.0795666   1.4500 0.1475901
factor(Code)21   -0.0444562  0.0921036  -0.4827 0.6295012
factor(Code)22    0.3697859  0.0958831   3.8566 0.0001273 ***
factor(Code)23   -0.0042531  0.0874004  -0.0487 0.9612047
factor(Code)24    0.1690189  0.0985981   1.7142 0.0870031 .
factor(Code)25    0.1597778  0.0890468   1.7943 0.0732649 .
factor(Code)26    0.1416707  0.0828760   1.7094 0.0878868 .
factor(Code)27    0.0984148  0.0835850   1.1774 0.2394921
factor(Code)28    0.0973455  0.1012080   0.9618 0.3365181
factor(Code)29    0.0833853  0.0850641   0.9803 0.3273496
factor(Code)30    0.0835198  0.0711475   1.1739 0.2409007
factor(Code)31    0.0494971  0.0799222   0.6193 0.5359423
factor(Code)32    0.3840252  0.0674883   5.6902 1.982e-08 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Works Cited

Bacharach, E. (2023, July 10). Rules Changes Are Driving a Revival for MLB, and the Sport Has the Attendance and Viewership Gains to Prove It. *Sports Business Journal* www.sportsbusinessjournal.com/Journal/Issues/2023/07/10/Upfront/baseball.aspx.

Biner, B. (2009). Equal Strength or Dominant Teams: Policy Analysis of NFL. *Munich Personal RePEc Archive* https://mpra.ub.uni-muenchen.de/17920/

Bradbury, J. C. (2016, November 7). Winning and Other Determinants of Revenue in North America's Major Professional Sports Leagues. Kennesaw State University.

Brown, M., Nagel, M., McEvoy, C., & Rascher, D. (2004). Revenue and wealth maximization in the national football league: the impact of stadia. Sport Marketing Quarterly, 13, 227-235.

Baker, K. (2021, December 10). NFL Extra Point Success Rate Plunges to 92.4%, Lowest since 1979. *Axios.com.* www.axios.com/2021/12/10/nfl-kickers-extra-point-success-rate. Accessed 24 Oct. 2023.

Clopton, A. (2013). Profit-maximizing and win-maximizing in the national football league. *Journal of Contemporary Athletics*, *7*(4), 209.

Emery, C. A., et al. (2017). What strategies can be used to effectively reduce the risk of concussion in sport? A systematic review. *British Journal of Sports Medicine, 51*(12), 978–984.

Evolution of the NFL Rules: NFL Football Operations.(n.d.). *NFL Football Operations*, operations.nfl.com/the-rules/evolution-of-the-nfl-rules/. Accessed 3 Oct. 2023.

Fischer, B., & Broughton, D. (2023 January 16). NFL per-game attendance makes big jump. *Sports Business Journal*.

Foster, D. (2017, October 3). How the 'Brady Rule' Will Kill Football. *Bleacher Report*. bleacherreport.com/articles/160081-how-the-brady-rule-will-kill-football#:~:text=The%20so%2Dcalled%20%22Brady%20Rule,for%20the%20entire%202008%20season.

Giatsis, G. (2003). The effect of changing the rules on score fluctuation and match duration in the FIVB Women's Beach Volleyball. *International Journal of Performance Analysis in Sport*, 3(1), 57–64. DOI: 10.1080/24748668.2003.11868275.

Gober, J. M. (2009). *A Points Per Game Rating For NFL Quarterbacks* (Master's thesis, The Ohio State University).

Hartley, J. (2017). Going for two: Optimizing between extra points and two-point conversions in the NFL. SSRN Electronic Journal. DOI: 10.2139/ssrn.2915402.

Hoffman, R. (2017, October 3). NFL Rankings: The 16 Best NFL Rule Changes in History. *Bleacher Report*. bleacherreport.com/articles/748241-nfl-rankings-the-16-best-nfl-rule-changes-in-history.

Jakobsen, T. T. (2021, May 31). Seeking Causal Effects from a Rule Change. How Did Changing the 'Roughing the Passer Rule' in 2018 Affect Salaries for Quarterbacks in the NFL? *Munin, UiT Norges arktiske universitet*munin.uit.no/handle/10037/22570?locale-attribute=en.

NBC Sports. (2021, December 9). Extra point success rate down to 92.5 percent, lowest since 1979. *NBC Sports*. https://www.nbcsports.com/nfl/profootballtalk/rumor-mill/news/extra-point-success-rate-down-to-92-5-percent-lowest-since-1979

NFL Health and Safety Related Rule Changes since 2002. (2019, September 26). *NFL.com*. www.nfl.com/playerhealthandsafety/equipment-and-innovation/rules-changes/nfl-health-and-safety-related-rules-changes-since-2002.

NFL Team Two Point Conversion Attempts per Game. (2023, February 13). *TeamRankings.com.* www.teamrankings.com/nfl/stat/two-point-conversion-attempts-per-game?date=2023-02-13. Accessed 24 Oct. 2023.

Onwuegbuzie, A. J. (1999). Defense or offense? Which is the better predictor of success for professional football teams?. *Perceptual and motor skills*, *89*(1), 151-159.

Paine, N. (2018, October 2). NFL Coaches Are Going for Two More than Ever. (It Took Them Long Enough.). *FiveThirtyEight*. fivethirtyeight.com/features/nfl-coaches-are-going-for-two-more-than-ever-it-took-them-long-enough/.

Paul, R. J., Wachsman, Y., & Weinbach, A. P. (2011). The Role of Uncertainty of Outcome and Scoring in the Determination of Fan Satisfaction in the NFL. Journal of Sports Economics, 12(2), 213-221. https://doi.org/10.1177/1527002510376789

Paul, R. J., & Weinbach, A. P. (2007). The uncertainty of outcome and scoring effects on Nielsen ratings for Monday Night Football

Roughing the Passer - 2022 - View by Teams. *NFL Penalty Stats Tracker.* www.nflpenalties.com/penalty/roughing-the-passer?view=team&year=2022. Accessed 24 Oct. 2023.

Roughing the Passer: NFL Football Operations. operations.nfl.com/the-rules/nfl-video-rulebook/roughing-the-passer/. Accessed 26 Oct. 2023.

Rottenberg, S. (1956). The Baseball Players' Labor Market. *Journal of Political Economy*, *64* (3), 242–258. DOI: 10.1086/257757

Ruestow, P. S., et al. (2015). Effects of the NFL's Amendments to the Free Kick Rule on Injuries during the 2010 and 2011 Seasons. Journal of Occupational and Environmental Hygiene vol. 12 (12), 875–882. DOI: 10.1080/15459624.2015.1072632

Skugrud, J., & Wenz, M. G. (2010, March 31). Status Quo Bias and Two Point Conversions in Football. SSRN: https://ssrn.com/abstract=1582638 or DOI: 10.2139/ssrn.1582638.

Spenner, E. L., Fenn, A. J., & Crooker, J. (2004). The demand for NFL attendance: A rational addiction model. *Colorado College Economics and Business Working Paper*, (2004-01).

Tainsky, S. (2010). Television Broadcast Demand for National Football League Contests. *Journal of Sports Economics, 11*(6), 629-640.

Williams, E. D. (2015, May 19). NFL Changes PAT Rule for 2015. *ESPN*. https://www.espn.com/nfl/story/_/id/12915634/nfl-change-extra-point-kicks-longer-distance.