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The Effect of Prime Time Football Game Pressure on Quarterback Performance in the National Football League



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by

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I hereby recognize and pledge to fulfill my responsibilities as defined in the Honor Code and to maintain the integrity of both myself and the College as a whole.

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Abstract

This research utilizes a regression analysis in order to determine whether pressure as a result of playing in a prime time game, which typically results in higher viewership, affects the performance of quarterbacks in the National Football League. The negative effects of pressure are documented in the literature across a wide variety of different sports. However, the focus of the literature is frequently on isolated high pressure moments and not pressure sustained across a whole game. Two main psychological theories are presented as an explanation for why athletes perform worse under pressure, providing a framework for the regression analysis to use. When using passer rating as a metric for quarterback performance, this research presents statistically significant evidence that playing in a prime time game results in a decrease in passer rating by 4.681 holding all else equal.

Chapter One: Introduction

Pressure and athletic competition tend to manifest in the same times and at the same places. Athletes hold themselves to high standards for performance, as they want to ensure that they have done everything they can to assist their team in winning. As a collegiate athlete, there have been numerous times where I have felt that pressure to perform myself. These instances were a result of either the situation that I faced in the game or the consequences of the outcome of the game, and these examples, while from a high level of the sport, are nowhere near the peak. For those that are at the pinnacle of their chosen profession, pressure tends to be amplified even further.

The internal desire that athletes have as competitors is not the only place that pressure can originate from. Professional athletes, particularly those that compete at the highest level of their respective sports (like the NBA for basketball or the Premier League or LaLiga for soccer), are seen as the absolute best at their sports due to the high level of competition in those leagues. Millions of people on a regular basis tune in to watch their favorite players and teams compete to win games and compete for championship trophies. As a result, these athletes can face a tremendous amount of outside judgment on their performance at any given moment. This has only become more prevalent in the age of social media, as opinions about player performance can be shared with people around the world with the push of a button. However, narratives on social media often become more noticeable with a league like the NFL, where specific games are held every week in “prime time”, which typically means games later in the evening when there are no other games to draw viewers' attention.

This has led to certain professional football players receiving reputations of performing worse in prime time games when more people tend to watch. One example of this, and pertinent to the topic of this paper, is Atlanta Falcons quarterback Kirk Cousins who, despite performing well, often receives criticism for his win-loss record in prime time games (Broyles, 2023). Cousins is certainly not the only player this has happened to, but it is also not entirely known if players actually perform worse in prime time or if the perceived lack of performance is an isolated incident made more prevalent due to the high viewership nature of prime time sporting events.

Furthermore, this becomes an important economics issue when trying to determine the appropriate values of players on a team. Specifically looking at the National Football League, there is a salary cap which prevents teams from spending as much money as they want on any player that they deem worthy. As a result, general managers and owners of NFL franchises need to ensure that the money they are paying players is being allocated in the most efficient manner possible. Typically, quarterbacks make up a large portion of the salary cap, with the average annual contract value of the median starting quarterback being $33.3 million (Spotrac). This amount is much higher than other valuable offensive positions, like the median starting wide receiver average annual contract value of $20 million or the median left tackle (the typical blindside blocker for the quarterback) average annual contract value of $4.9 million (Spotrac). If a quarterback is overvalued by a team and is paid more than they are worth while not being able to perform in big games, then both the owners and the team are hurt as a result. The owner is wasting money on a player that is not as good as the management thinks they are and the team suffers because money that could be used to make the rest of the team better is instead wasted on the quarterback.

In order to best understand the effects of pressure on quarterback performance in prime time games, multiple steps will be taken. First, I will research the effects of pressure in athletic competitions, not just football, to get a better understanding on how pressure may impact player performance, regardless of sport. Then, I will discuss potential theories that would explain why athletes could tend to perform worse in high pressure scenarios. After that, I will conduct a regression analysis on data taken from the National Football League to determine if pressure in prime time has a statistically significant effect on quarterback performance and what the effects of that pressure are. Finally, I will analyze the results that I get and conclude with my findings.

Chapter Two: Literature Review

2.1 Introduction

Quarterbacks, who are often displayed as the leaders of their respective football teams, must deal with the pressure to perform at a very high level at all times they are on the field. In order to understand how pressure affects quarterbacks as they play, the academic literature on the subject must be studied to build a framework for further testing. Unfortunately, there is only a limited amount of literature on how pressure affects players in the National Football League, so evidence from studies on other sports will also need to be reviewed in order to build a more complete picture. However, pressure still manifests itself in similar ways across athletics, meaning that evidence presented in other sports likely will translate to players in the NFL. This is especially true when comparing the NFL to other professional sports leagues, as they also can have hundreds of thousands if not millions of people watching a game. To ensure that the best understanding of how pressure affects athletes as a whole, the literature review will be separated into sections based on what is the cause of the pressure: the situation faced or the audience watching.

2.2 Situational Pressure

Situational pressure, in this context, refers to the pressure placed on an athlete or athletes due to the current situation of the game they are participating in. For example, this could mean in the closing seconds of a game or the regulation period when the two teams playing are very close

in score. These situations tend to result in higher pressure because the outcomes of the games can come down to individual performance in those moments. There is a sizable literature on this topic, although it typically only is applied to individual sports or moments in team sports in which a player is acting alone.

Basketball is a sport that allows for many different situations to develop that induce pressure on the athletes, with one such example being late game free throws. Free throws in the final minute of a close game are one of the highest pressure situations in basketball, as the outcome of the athlete's shots can directly affect the outcome of the game. Cao, Price, and Stone (2011) utilized free throw data from the NBA between 2002-03 to 2009-10 to illustrate this decline in performance. In the final minute of a game, losing by one point leads to a 4.1% decrease in free throw shooting percentage and losing by two points shows a 3.7% decrease when compared to a "low" pressure situation (Cao, Price, and Stone, 2011). That decline in shot performance in tight games becomes even more noticeable when there are fifteen seconds or fewer, with an 8.8% decrease when down by one point and a 6.3% decrease when down by two points, when compared to a "low" pressure situation (Cao, Price, and Stone, 2011). For these two comparisons, the "low" pressure situation refers to a team winning or losing by eleven or more points (Cao, Price, and Stone, 2011). Furthermore, this decline in free throw shooting percentage cannot be attributed to fatigue, as the deviation from "normal" shooting percentage only begins noticeably in the final thirty seconds (Cao, Price, and Stone, 2011). There is also more pressure placed on the losing team, as players taking free throws while ahead by one point only showed a decrease of 2.6% in the final minute and 4.2% in the final fifteen seconds (Cao, Price, and Stone, 2011).

Free throws at the end of games are not the only moments in basketball that result in inferior performance. The effect of pressure can also be felt during the course of regular gameplay, as higher pressure moments arise as shot clocks or game clocks get close to expiring. Evidence from two different professional basketball leagues, the National Basketball Association (NBA) and the Basketball Champions League (BCL), was used. For those that are unfamiliar, the BCL is an international tournament backed by the Fédération Internationale de Basketball (FIBA, French for International Basketball Federation) between teams from different European nations, similar to the Union of European Football Associations (UEFA) Champions League for soccer. Scoring probability for different shot types at different moments in possessions or in-game situations were then calculated using the evidence gathered from the two leagues. Both leagues showed results that indicate worse performance later in shot clocks, quarters, and the game. Late in the shot clock two point shots were scored 41% and 44% for the BCL and NBA respectively, while shots at the middle end of the shot clock (6-10 seconds for the BCL, 6-13 seconds for the NBA) are scored 48% and 49% respectively (Metulini and Le Carre, 2019). However, pressure alone may not be the only explanatory factor for the decline in shooting performance, despite other factors not being discussed in their analysis. If a player has an open shot early in the shot clock, they are more than likely going to take it, leading to better performance on those shots. Then, as time winds down in the shot clock, it may be that instead of pressure, the defense is playing well enough to not allow a great shot opportunity, thus leaving the offense to take a bad shot right at the end of the shot clock. There are also results that show similarities to the results found in the previous paper. In the BCL, two point shots taken early in the shot clock (time remaining $\geq$ 17 seconds) with a score differential of less than +7 had a probability of being made of 60.6% compared to 69.5% if the score differential was greater than

+7 (Metulini and Le Carre, 2019). These results were also found in the NBA, as two point shots taken early in the shot clock (time remaining ≥ 20 seconds) with a score difference of between -2 and 4 were scored 57.9% of the time, compared to 61% if the difference was outside that range (Metulini and Le Carre, 2019). It is also important to note, like the example with the shot clock, that there may be other explanatory factors influencing shot performance. In blowout games, it is possible that defenses put in less effort than in close games, potentially making shots in close games harder than those in games with a high score differential. There are numerous common occasions in basketball that can arise which cause negative performance effects as a result of pressure. Understanding how and when these situations occur is important for understanding how and why players perform like they do.

Similar to basketball, there are also individual moments in soccer that result in high levels of pressure on an individual. The most salient moment is the penalty shootout. If the score is tied in an elimination soccer match after the first ninety minutes and the thirty minutes of extra time, the game goes to a penalty shootout to determine the winner. These result in high pressure for the penalty taker because their shots can directly impact the outcome of the match positively or negatively. The impact from pressure can also be compounded by a team history of poor performance in those high pressure situations. Utilizing a sample of all penalty shootouts in both the World Cup and the European Championships between 1976 and 2006, an analysis showed that teams that had a history of losing shootouts scored fewer shootout goals when compared to teams that had either won their last shootout or had no team history of shootouts: 65.7% compared to 85.1% and 76.4% respectively (Jordet, Hartman, and Jelle Vuijk, 2012). The difference is even greater for players that were directly involved in those past shootouts, as players that were on a team (either taking a penalty or just on the team) that lost their last

shootout scored on 63.2% of their shots compared to 87.2% of players that were on the team that won their last shootout (Jordet, Hartman, and Jelle Vuijk, 2012). The circumstances of these penalty kicks already lend themselves to high levels of pressure, but that effect is only exacerbated by having history with that pressure, either through direct involvement or being a new member of a team that has a history of losing shootouts. However, it is also important to consider that teams that are bad at shootouts could continue to perform poorly in those scenarios. This factor was not accounted for in this paper, meaning that some of the results could be attributed to some teams simply being less skilled at penalty shootouts than others.

Team history is not the only variable that can increase the situational pressure of a penalty shootout in soccer. Another similar instance is when soccer players have a measure of public status due to award recognition. Utilizing data from all penalty shootouts from the World Cup, European Championships, and Champions League between 1976 and 2007, the percentage of goals was compared between players who had received some measure of award recognition, players who had received award recognition after the time of the shootout, and players who had not received award recognition at the time the paper was written (Jordet, 2009). Award recognition was determined by placing in the top three for either the Ballon d'Or or FIFA World Player of the Year, winning the World Cup Gold, Silver, or Bronze Ball, winning UEFA Club Footballer of the Year, or winning South American Footballer of the Year (Jordet, 2009). Previously awarded players on average took their shots 2.5 years after receiving their award with a standard deviation of 1.5 years, compared to future awarded players receiving their award 1.4 years after taking their shots with a standard deviation of 1.9 years (Jordet, 2009). Those that received award recognition were shown to score less often, 65%, than those who would receive recognition in the future, 88.9% (Jordet, 2009). Having the additional expectations of public

recognition makes the situational pressure of a penalty kick higher. In turn, players experiencing those higher levels of pressure tend to perform worse. Again, the intensification of pressure for specific players, in this case public figures as opposed to teams with a history of losses, results in a significantly worse performance.

Another factor that affects pressure in soccer penalty shootout is the immediate result following the kick. Penalty shootouts are made up of five shots for each team, until either one team scores more goals than the other team can in those five shots or an additional round of shots is needed to determine a winner. In these situations, pressure is amplified when missing a penalty kick in a shootout results immediately in a loss for the athlete's team, as their actions are directly responsible for whether or not their team loses. All shootouts from the World Cup, European Championships, and Champions League between 1972 and 2006 were included as the authors tested the shot valence and its effect on performance (Jordet and Hartman, 2008). Shot valence, in this context, refers to the outcomes possible from any given shot in the shootout, with positive meaning the penalty taker's team immediately wins if the shot is made, negative meaning the team immediately loses if the shot is missed, or neutral for all other shots (Jordet and Hartman, 2008). When comparing positive valence shots to a baseline of negative valence shots, performance on positive valence shots was both significantly better and statistically significant (Jordet and Hartman, 2008). Negative valence shots were scored 61.8% of the time while positive valence shots were scored 92% of the time with a P-value of 0.016 (Jordet and Hartman, 2008). Neutral valence shots were also scored more than negative valence shots, 73.7% of the time, but the results were not statistically significant with a P-value of 0.145 (Jordet and Hartman, 2008). The results here indicate just how much additional pressure can impact a player's performance. The difference between shots where a miss results in a loss and a make

results in a win is over thirty percent. The pressure effect being this large makes it hard to refute how much an athlete can be affected by high stakes moments.

Soccer is not the only sport that concludes games with a shootout, as hockey concludes all games that make it through an overtime period with a shootout as opposed to just elimination games. For this study, data was collected from every shootout conducted in the National Hockey League (NHL) from the 2005-2006 season to the end of the 2010-2011 season, providing a sample size of 956 shootouts (Depken, Sonora, and Wilson, 2012). In the sample measured, teams that shot first only won 48.6% of the time, even though, since the rules changed to make home teams decide who shoots first in 2006-2007, home teams chose to shoot first 76% of the time (Depken, Sonora, and Wilson, 2012). However, testing was not done on the statistical significance of shooting first, so it cannot be said outright that the team shooting first has a statistically different chance to win from 50%. Despite the overwhelming likelihood for the home team to shoot first, the probability of the home team winning goes down significantly when choosing to shoot first, displaying a decline of 29.8 percent significant at the 99% confidence level (Depken, Sonora, and Wilson, 2012). Furthermore, being the second shooter in a hockey shootout makes scoring probability increase significantly, with an increase between 19.7 and 20.6 percent across three different models, all significant at the 99% confidence level (Depken, Sonora, and Wilson, 2012). What these models indicate is where the pressure lies in a hockey shootout: not with the shooter like soccer, but instead with the goalie. Goalies in hockey are much more likely to save a shot when compared to soccer goalies. As a result, it is the goalies in hockey that face more pressure to perform, especially if they are the second goalie, as a missed save can result in their team falling behind or missing an opportunity to get ahead of their opponents.

Now, like the other examples given, there are moments in football where pressure arises in an isolated individual play. An important one is when a kicker takes field goals or extra points. Late game field goals in close games are typically seen as some of the highest pressure moments in the sport, with coaches even trying to strategize around these moments. “Icing” is a strategy used by head coaches where they call a timeout right before a kicker takes their field goal attempt to try and make the kicker feel even more pressure by giving them more time to think about the kick. However, icing is not the only factor that goes into the pressure felt by a kicker in that moment, as a playoff game or score difference can influence what a kicker might feel. On top of pressure, field goals and extra points are often more affected by other outside variables like weather and temperature when compared to other sports. When looking at kicks that took place in the NFL between 2000 and 2017, the following stood out from a logistic regression. Icing the kicker had a statistically significant negative impact on field goals, showing a decrease of 0.15 log-odds units with a P-value of less than 0.05 and situational pressure had a statistically significant negative impact on extra points, with a decrease of 0.27 log-odds units and a P-value of less than 0.01 (Hsu et al. 2019). Situational pressure, in this example, refers to a multitude of variables relating to time left in the game, score differential, and result following the kick. For example, a kick with less than two minutes in the fourth quarter with a score difference greater than eight likely will not have an impact on the outcome of a game and would be considered low pressure (Hsu et al. 2019). On the other hand, a kick in the final two minutes of the fourth quarter when down three points and the outcome of the kick determines if the team loses would be considered high pressure (Hsu et al. 2019). Other environmental variables also showed statistically significant effects, such as distance, temperature, playing surface, altitude, precipitation, and wind speed (Hsu et al., 2019). Despite the effect being smaller, it is important

to see that even with other variables unrelated to pressure affecting kicks, pressure still maintains its negative impact.

As football is a team sport, it is important to broaden the lens of choking from just those isolated individual moments in team sports, like free throws in basketball, or from individual sports, like golf, when it is possible. Athletics in a team setting are notably different from those examples because the athlete is not the only person working towards a goal, there are both people working with and against them. This can change the dynamics of choking by introducing variables that would otherwise not be present and are unique to team situations. In a qualitative study done in the United Kingdom on a small sample of competitive athletes at the club or county level with a self-described history of choking in team sports, themes such as individual responsibility and mental or physical errors were presented as reasons present leading up to the choke (Hill and Shaw, 2013). Moreover, it can even be the team itself that facilitates an athlete choking, as both poor team cohesion and a negative motivational climate were cited as influential factors in making a choke worse (Hill and Shaw, 2013). Being in a team environment when pressure overwhelms an athlete can both change how the choke begins and how pressure can be amplified by the situation, making the player's overall performance even worse.

The results that were found in these studies show consistent results across the board. Moments in games when the pressure is ratcheted up lead to a worse performance by the athletes as a direct result of that high pressure. Late game free throws when the score is close showed the same results as high stakes penalty shootouts at the end of important soccer games, which also showed the same results as goalie performance in hockey shootouts: high pressure due to a momentous in-game situation results in worse player performance in the form of choking. Even

when the moments do not occur as isolated individual plays (like a free throw) or isolated one on ones (like the soccer and hockey shootouts), pressure can still affect an athlete.

2.3 Audience Pressure

Pressure as a result of the situation an athlete finds themselves in is not the only source of pressure found in athletic events. Pressure can also stem from the number of eyes that are on the athlete at any given time. There are a number of studies that hypothesize the effects of audience size on player performance, even when that is not the focus of the study as a whole. For example, in a larger study concerning the effects of score differences and time remaining on free throw shooting in the NBA, statistically significant results were still found concerning the effects of attendance numbers on player performance (Cao, Price, and Stone 2011). The effect, while not large, was noticeable, as for every additional 10,000 people in attendance for a basketball game, free throw shooting percentage declined by 1.2% for both home and away players (Cao, Price, and Stone 2011). When thousands of fans are showing up for every game, this effect can be quite important, especially when more eyes are on an athlete in more important games.

Similar to some of the previous research mentioned, free throws in the NBA were also used to study the effects of audiences on players, without a measure of situational pressure. As is to be expected, regardless of where a person is or what they are doing, if more people are watching them perform something, higher levels of stress emerge as a result. The same can be said about professional athletes in situations where all of the eyes in the venue are trained on them as they attempt some facet of their game. This was tested in the NBA using data from the 2007-2008 season up to the 2015-2016 season utilizing the measured metric of audience sizes:

ticket sales (Böheim, Grübl, and Lackner, 2019). Furthermore, to make the comparisons between arenas of different sizes easier, rather than using the strict ticket sales numbers, attendance was instead converted into a percentage based on the arena's maximum capacity (Böheim, Grübl, and Lackner, 2019). After converting attendance numbers into percentages of arena capacity, a statistically significant negative effect of attendance was found only for away teams (Böheim, Grübl, and Lackner, 2019). For every additional 10% of the arena was filled with people, the away team's free throw shooting percentage declined by 0.4%, significant at the 99% confidence level (Böheim, Grübl, and Lackner, 2019). An athlete feeling the weight of more eyes on them results in a worse performance.

The effect of audience size is not unique to basketball players. The same effect can be witnessed in the performance of professional baseball players. When going up to bat in a baseball game, that player is one of only two on the entire field that fans are paying most of their attention to at that time. As a result, performance tends to decline with the greater sense of people watching them. Pitch-by-pitch data was gathered for all regular season games from the 2015 to 2018 Major League Baseball (MLB) seasons and analyzed for the effect of attendance on batting performance (Jane, 2022). The models utilized in this study showed a significant negative effect of attendance on performance. In the random effects instrumental variable model, with every 10% increase in audience size, there was an expected decrease in probability of a "safety hit", or a single, double, triple, or home run, by 3.3% (Jane, 2022). Furthermore, the logistic regression model run showed an even greater effect of audience size on performance, with every increase of 10% in audience correlating to an expected decrease in probability of a safety hit by 8.45% (Jane, 2022). However, it was also found that "star players", or batters that had made the All Star team in the previous season, were not significantly affected by an increase in attendance

(Jane, 2022). This raises two interesting points as again, it is shown that having more eyes on a player negatively affects their ability to perform at a high level. But it also shows that the biggest names may also be able to perform better with that same pressure on them. However, it is important to note that pitcher quality was not accounted for in this study, meaning that some of the performance decline could have stemmed from pitching performance not being affected as much by pressure.

The results found across these studies are also relatively consistent: the more eyes on a player as they are expected to perform, the worse their performance ends up being. Whether that comes at the free throw line in an NBA game or from the batter's box in an MLB game, more eyes equates to more pressure. However, star players in the MLB showed that they were less susceptible to the effects of pressure due to larger audience sizes. That result will be important to keep in mind moving forward, as quarterbacks are frequently seen as the stars of their teams and receive the most attention.

2.4 Conclusion

The effects of pressure in sports is widely researched and is shown to have a negative effect on athletes across a variety of sports and situations. Whether the effect comes from the situation a player finds themselves in or comes from the number of people that are spectating an event, pressure will still find a way to influence a participant's ability to perform at the highest level. Now the question is to see how that pressure does or does not manifest itself in the performance of quarterbacks in the NFL during games when they have the most eyes on them and the highest pressure to perform.

Chapter Three: Theory

3.1 Introduction

Psychological theory has hypothesized two main ways that pressure can result in a decline in performance in athletics. This chapter will introduce these two theories and take steps to explain how those theories explain the actions resulting in worse performance. The two theories in question are the Distraction Hypothesis and the Automatic Execution Hypothesis. These concepts will then be applied to quarterback performance in an attempt to explain worse performance as a result of heightened pressure in prime time football games. It is important to note that these theories are based in psychology and not in economics. These were chosen in lieu of economic theories because they more directly relate to explaining the "why" when it comes to athletes' choking and there are no specific economic theories pertaining to this issue.

3.2 Distraction Hypothesis

The first of the two hypotheses that apply to poor performance in athletics due to pressure is the Distraction Hypothesis, proposed by sports psychologists. The Distraction Hypothesis states the following: pressure creates an environment that leads to distractions, which in turn results in the performers' attention being drawn away from skill execution (Yu, 2015). Focus, instead of being on the important task at hand, is instead pointed towards "task-irrelevant cues, such as worries about the consequences", preventing the individual from working or performing at an optimal level (Yu, 2015). An easy way to understand this is through the lens of an important

test or exam in school. If, while taking an exam, a student starts to worry about what the outcome may mean for their grade in the class, they begin to focus less attention on the actual task at hand. The result is less focus on the completion of the test and as a result, a worse performance in terms of what grade they receive. Compare this to a similar student who, instead of worrying about what grade they will receive, instead spends their time trying to answer the questions to the best of their ability. This student would focus thoroughly on the assignment and receive a grade representative of their work.

Now, this hypothesis needs to be translated to the realm of athletics in order to see how this may influence athletes over the course of a competition. To start, not every athletic event is experienced exactly the same. As it was explored in the literature review, certain scenarios, like the closing moments of a game close in score, tend to make athletes feel higher amounts of pressure. The distinction at this point between athletes that choke and those that do not is how they respond to that pressure. If an athlete starts to think about what the outcome of the event could be as pressure begins to get ratcheted up, that becomes the defining point in which performance may begin to decline. In the same manner as the test taker that spends too much time thinking about the consequences of a bad grade, the athlete that thinks about how a loss might affect their season may perform worse in those situations.

Looking more specifically at quarterbacks in football, pressure is something that is acutely experienced by those athletes any time they are around the sport. Advertising for upcoming games frequently promotes the starting quarterbacks and their performance is frequently praised or criticized depending on the performance of their team. Thus, if a quarterback begins to think negatively about how the outcome of a game might change their success for the season, they face the repercussions of the pressure from not only the game, but

also from those outside sources that pass judgment on them. The result is a potentially worse performance due to pressure from both the game and media surrounding the sport.

3.3 Automatic Execution Hypothesis

The second of the two hypotheses that apply to athletes choking under pressure is the Automatic Execution Hypothesis, proposed by social psychologists. The Automatic Execution Hypothesis states that as anxiety tends to increase, an athlete allocates more conscious attention to executing their movements, which then interferes with the otherwise automatic nature of movement execution, resulting in a decline in performance (Gröpel and Mesagno, 2019). For example, breathing is an unconscious action for basically every living being on the planet. Everyday, billions of people breathe without putting any thought into the action itself. However, the moment that a person starts to think about the act of breathing, the process becomes interrupted and is not executed in an optimal manner.

The same execution problem found with breathing can also be found in the realm of sports. Many actions can be drilled into an athlete through hours and hours of practice, such as taking a free throw in basketball, fielding a ground ball in baseball, or kicking a short field goal in football. When performing these actions in practice settings, they can become automatic, an athlete does not need to think at all about what goes into these actions in order to perform them. However, when put into the same situation in a game scenario, everything changes. There is a higher level of stress and pressure, as those are the moments that all of the practice has gone into. Instead of automatically going through the necessary steps to complete the action, each step is individually thought about, preventing an optimal completion of these steps. Evidence found in

the literature review also mirrored this idea, with evidence of free throw shooting percentage decreasing late in close basketball games. While it cannot be said for certain that this was the cause of the decline in shooting percentage, it is consistent with the explanations of why performance might decline in high pressure situations.

Similarly to the first hypothesis, it is also important to understand how this theory could affect quarterback performance specifically. There is a distinct difference between the situations that quarterbacks face when compared to basketball players at the free throw line. When a basketball player steps to the line, it is always the same circumstances: it is always the same distance from the hoop and there is no defense. In normal play of football, change is made every play: the distance needed for a first down or points changes, the defensive scheme changes, and what play the offense chooses to run changes. However, there are still things that a quarterback does every play, regardless of the situation. Dropbacks in passing plays are the same, the throwing motion of the arm is typically very consistent, and the reads for the play run are always the same. If additional thought is introduced into these steps, automatic processes may be interrupted, resulting in actions not being performed as quickly or mistakes being introduced to the process. If those automatic processes are no longer completed automatically, performance may tend to decline.

3.4 Conclusion

These hypotheses on why athletes may end up choking under pressure provide a good baseline to further research on why quarterbacks could perform worse under the pressure of a prime time football game. Both theories provide explanations as to why athletes could choke

under higher pressure circumstances. This relates back to being an economic issue from here because of how athletes are compensated. NFL team owners pay players millions of dollars in order to build the best team they can while trying to stay under the salary cap. However, if a large amount of that money is allocated towards a quarterback and they aren't playing well in prime time moments, that money is being wasted when it could be spent on other roster positions making the rest of the team better. From this point, the data will be analyzed to determine if pressure has a significant negative effect on quarterback performance in prime time games.

Chapter Four: Empirical Analysis

4.1 Introduction

Across the previous chapters, evidence has been provided that starts to explain that high level athletes have shown tendencies to choke in high pressure situations within their respective sports. This has included both statistically significant examples from a wide variety of different sports and some of the psychological explanations for why those athletes did not perform to the best of their abilities. This chapter will look to determine if maintained levels of high pressure as a result of prime time games exhibits a similar negative effect in football that is shown in other sports. This will be achieved by estimating two separate regression analyses. The first group of regression models will focus on showing what effect, if there is any at all, prime time games has on quarterback performance in the NFL. The second regression model will focus on determining how certain in-game factors affect performance specifically in prime time games.

4.2 Summary of Data

In order to adequately compare quarterback performance, a common metric will be used: Passer Rating. Used in the NFL for decades, this metric provides a simple way to determine the passing performance of a quarterback in a given game, which is calculated through an equation utilizing pass attempts, completions, passing yards, touchdowns, and interceptions. This equation results in a scale from 0 to 158.3, where a higher number equates to a better performance. Data for this analysis was found primarily through Pro Football Reference, which is a comprehensive

database for football statistics going back to 1920. Data on game date and location, teams involved, quarterback statistics, defensive rating, and prime time or playoff status were all pulled from this website. This was supplemented by weather data from NFLWeather.com, which provided both the temperature and the weather conditions (including if a stadium is domed), and FantasyPros.com, which provided additional information on quarterback performance.

The first dataset used for this analysis was taken from the 2022-23 and 2023-24 NFL regular seasons. In order for a performance to be included in this data set, the quarterback must have thrown at least 10 passes in a given game for that game's performance to count. Due to the large number of games played in an NFL season, this provides a large sample size for this dataset, with 1,130 data points included.

The second dataset only looks at prime time game performances, including playoffs, from the 2020-21 season up to the 2023-24 season. Similar to the first dataset, there were requirements for a quarterback's season to be included in this sample. The quarterback must have either started in 6 games or played in 10 games while attempting at least 100 passes over the course of the season the game took place in. More seasons were included in this sample due to the smaller number of prime time games over the course of a season, but that still leaves 505 data points to work with.

By using data from only a small range of recent seasons, the effect of changes in the sport of football over time, specifically in style of offense and quarterback quality, are limited. Importantly, this still provides the regression with a strong sample of primetime games.

The Basic Passer Rating Model and the Quarterback Controlled Passer Rating Model are both run using passer rating as the dependent variable, as it was explained earlier to be a standard metric by which quarterback performance is measured. Using the sample of all regular season

games from 2022-23 and 2023-24, a number of factors that are utilized for the calculation of passer rating or have an effect on quarterback performance are included in the summary statistics of these models. The first two independent variables are Age and AgeSquared, which are included to capture the typically parabolic path of performance in professional sports. The next variable is Opponent Pass Defense Rank, which is a number from 1-32 showing the season total of expected points contributed by the defense that is faced by the quarterback. For this variable, the value 1 indicates the defense with the most points contributed for the season while the value 32 indicates the defense with the least points contributed for that season. The final two independent variables are both dummy variables focused on the time and place of the game. The variable Prime Time indicates whether or not a game takes place in a prime time slot, where games in prime time are labeled 1 and all other games 0. The variable Home shows whether a game took place at home, with 1 indicating a home game and 0 indicating non-home games.

Table 4.1 - Passer Rating Model Summary Statistics

Variable	Obs.	Mean	Std. Dev.	Minimum	Maximum
Age	1130	27.99	4.64	21	45
AgeSquared	1130	805.11	287.06	441	2025
Opponent Pass Defense Rank	1130	16.48	9.24	1	32
Prime Time	1130	0.205	0.404	0	1

Completions	1130	20.49	6.57	3	43
Attempts	1130	31.86	9.19	10	68
Completion%	1130	64.24	9.64	27.3	92.9
Yards	1130	224.12	78.81	9	481
Yards/Att.	1130	7.08	1.82	0.9	15.3
Touchdowns	1130	1.31	1.08	0	6
Interceptions	1130	0.726	0.862	0	4
Passer Rating	1130	88.82	25.17	0	158.3
Home	1130	0.497	0.500	0	1

The table above shows the summary statistics for the variables necessary to build out the Basic Passer Rating Model and the Quarterback Controlled Passer Rating Model. The first thing that stands out is the inclusion of the factors Completions, Attempts, Completion%, Yards, Yards/Attempt, Touchdowns, and Interceptions. These variables were not included in the regression models, but were still necessary to include in the summary statistics because they were used to calculate passer rating. There is also an important discussion point that appears when looking at the data in this table. That being the prime time variable mean of 0.205 here tells us that about 20.5% of all NFL games are considered prime time games. Therefore, any potential results found about a decline in quarterback performance in prime time would affect roughly 20 percent of all games played in the NFL regular season.

The Factors Impacting Prime Time Passer Rating Model also uses passer rating as the dependent variable. However, this model uses the sample of all prime time games from 2020-21 through the 2023-24 seasons. The variables in the second model are all factors that could influence the performance of a quarterback in a given game. The first independent variable is Location, which is a dummy variable where 0 indicates a home game and a 1 indicates a non-home game. Similar to the summary statistics from the other models, Age and AgeSquared are included in order to see a clearer effect of aging on athletic performance. The next variable is Season Average Passer Rating, which is a measure of control for the quality of quarterback. By including this variable, the model has a comparison to the quality of play from the rest of the season the game took place in. The next variables, Temperature and Weather, go hand in hand as they describe the conditions the game took place in. Temperature simply is the value, in degrees Fahrenheit, of the temperature at the start of the game. Weather is a dummy variable, where a 0 indicates clear weather or playing within a dome and a 1 indicates poor weather conditions (either rain or snow). Scoring Defense Rating is a control for the quality of the opposing defense on a scale from 0 to 31, where 0 indicates the team with the fewest points against for that season and 31 indicates the team with the most points against for that season. Finally, playoffs is a dummy variable showing the playoff status of the game being played, 0 means a regular season game and 1 means a playoff game.

Table 4.2 - Factors Impacting Prime Time Passer Rating Summary Statistics

Variable	Obs.	Mean	Std. Dev.	Minimum	Maximum
Location	505	0.517	0.4497	0	1

Age	505	28.82	5.57	21	45
Age Squared	505	861.85	357.32	441	2025
Season Average Passer Rating	505	94.75	10.02	68.7	121.5
Temperature	505	56.08	18.79	-2	100
Weather	505	0.0495	0.217	0	1
Scoring Defense Rating	505	13.07	8.895	0	31
Playoffs	505	0.19	0.392	0	1

The summary statistics for the Factors Impacting Prime Time Passer Rating Model also display interesting talking points. The summary statistics show two particularly important values, those being the means of weather and playoffs. The weather mean of 0.0495 indicates that about five percent of all prime time games over the last four NFL seasons have been played in poor weather conditions, namely rain or snow. As a result, while the effect of poor weather could be noticeable, the number of games in which this factor will appear is limited. Moving to the playoffs variable, this mean of 0.19 shows that nineteen percent of all prime time games played over the past four seasons have been playoff games. Playoffs make up a much larger percentage

of prime time games compared to those with adverse weather conditions, so any significant effect that playoffs have on performance would affect a much larger portion of games.

4.3 Regression Models and Results

The results of the regression models assist in answering the focal question of how pressure as a result in playing in prime time football games affects the performance of quarterbacks. Backed by the evidence provided through the literature review and the theory sections of this paper, the hypothesis that will be tested is as follows: quarterbacks playing in prime time football games will perform worse when compared to non-prime time games as a result of the added pressure of playing in prime time. Results indicating that would be consistent with the findings across other sports but showcase an important distinction, as pressure in prime time is across an entire game as opposed to isolated high pressure moments.

The Basic Passer Rating Model is run using passer rating as the dependent variable, with prime time, age, age squared, home, and opponent pass defense rank as the independent variables. This model was the first step in determining the effect of pressure on quarterback performance and it returned the following results.

Table 4.3 - Basic Passer Rating Model

R-Squared = 0.0575

Variable	Coefficient	P-Value
Prime Time	-2.635	0.145

Age	2.004	0.183
Age Squared	-0.029	0.230
Home	6.205	0.000***
Opponent Pass Defense Rank	0.511	0.000***
Intercept	45.265	
Sample Size	1,130	

* Significant at 90% level ** Significant at 95% level *** Significant at 99% level

Initially, it may seem that the presented hypothesis that quarterbacks playing in a prime time football game do not perform worse compared to regular games. The variable prime time, while having a noticeable negative effect with the coefficient of -2.635, is not statistically significant, as the p-value of 0.145 means that there is no significance even at the 90% confidence level. However, this model does not account for one critical factor when it comes to prime time football games: quality of quarterback. Typically, when scheduling prime time games, the NFL tends to create matchups that will draw the most attention in order to ensure the highest viewership possible. One of the easiest ways for the league to accomplish this is by putting two teams together that have star quarterbacks that perform better than an average player. Therefore the results here could be skewed, as a performance in a prime time game could still be worse than the average for a star, but still be better than the performance of a mediocre quarterback on a team that doesn't play frequently in prime time. In order to account for this, a further advanced

model was created, where each individual quarterback is controlled for through a series of dummy variables.

Beyond the results for the prime time variable, there are also other important talking points that this model provides. First being that the r-squared value is only 0.0575, meaning that only 5.75 percent of the variance in passer rating is explained by this model. As a result, it can be said that this model does not have a lot of predictive power in determining the outcome of passer rating.

Next is that the only two factors included that have a statistically significant effect on quarterback performance were playing in a home game, which resulted in an increase in passer rating by 6.2 points, and the opponents' quality of pass defense, which showed an increase of 0.511 points for every additional step worse in the pass defense rankings. These factors being significant makes sense, as playing in front of a home crowd means more support for the home team, and by extension the home quarterback, and that as an opposing team's passing defense gets better, passing performance against them would be worse.

Also, despite them being insignificant, the age and age squared variables reflect the initial expectation that performance follows an inverse-u shape, with poor performance at the start and end of a career and better performance in the middle.

The next regression model run, the Quarterback Controlled Passer Rating Model, is run using the same dependent variable (passer rating) and the same independent variables (prime time, age, age squared, home, and opponent pass defense rank), with the notable addition of dummy variables for each quarterback that played a game in this dataset. By including these dummy variables, the quality of quarterback playing in each game is accounted for. It is

important to note that these dummy variables are omitted from the table, as they don't measure the outcomes the model is testing for. The results from this model are as follows.

Table 4.4 - Quarterback Controlled Passer Rating Model

R-Squared = 0.2476

Variable	Coefficient	P-Value
Prime Time	-4.681	0.008***
Age	-18.878	0.112
Age Squared	0.301	0.156
Home	5.995	0.000***
Opponent Pass Defense Rank	0.482	0.000***
Intercept	361.715	
Sample Size	1,130	

* Significant at 90% level ** Significant at 95% level *** Significant at 99% level

The most important change from the Basic Passer Rating Model to this Quarterback Controlled Passer Rating Model is the change in the prime time variable. The coefficient has become a larger negative number, now at -4.681, and is now statistically significant at the 99% confidence level with a p-value of 0.008. What this shows is that the proposed hypothesis is correct, in that playing in a prime time football game results in worse performance by the

quarterback. This even accounts for other factors that may influence the performance of a quarterback, like the quality of the defense, location of the game, and age of the quarterback. These results are consistent with the literature, in that pressure can negatively affect the performance of athletes, but also can affect performance across large portions of an athletic event, not just in the critical situations the literature focuses on.

Another important change to factor in is the increase in predictive power of the Quarterback Controlled Passer Rating Model. The r-squared value for this model increased to 0.2476 from 0.0575 in the Basic Passer Rating Model. This shows that the Quarterback Controlled Model explains almost 20% more of variance in passer rating compared to the Basic Model.

Other changes to the independent variables also show interesting changes in this model The previously mentioned inverse-u parabolic shape that age and age squared displayed has flipped into a u-shaped parabola. This would represent quarterback performance to be at its highest at the start and the end of a player's career, which is the opposite of what would be expected from an actual player's career trajectory. The explanation for this change is unknown, but it is possible that, by controlling for quarterback skill, more weight is placed on the quarterbacks that perform at the highest levels late into their careers, like Aaron Rodgers (39 years old in the games played in this dataset) or Tom Brady (45 years old in this dataset).

The last two variables, home and opponent pass defense rank, are both slightly smaller than they were in the first model. The coefficient for home decreased from 6.205 to 5.995 while the coefficient for opponent pass defense rank decreased from 0.511 to 0.482. Both still show the increase expected with their variables, as players are expected to perform better at home and

against worse defenses. This decrease is likely due to variation being picked up by the dummy variables for each quarterback.

The final regression model run, the Factors Impacting Prime Time Passer Rating Model, utilizes the same dependent variable as the previous two models: passer rating. However, this model is different from those due to the change in dataset used. This model uses data from all prime time performances, including playoffs, from 2020-21 through 2023-24. The independent variables are also different in this model, using location, age and age squared, season average passer rating, temperature, weather, scoring defense rating, and playoffs. This allows the model to test what effects certain factors have on quarterback performances specifically in prime time games.

Table 4.5 - Factors Impacting Prime Time Passer Rating Model

R-Squared = 0.1612

Variable	Coefficient	P-Value
Location (0 = Home)	-2.273	0.269
Age	2.103	0.269
Age Squared	-0.036	0.226
Season Average Passer Rating	0.850	2.28e-14***
Temperature	0.028	0.638
Weather	-13.959	0.003***

Scoring Defense Rating	0.450	0.0001***
Playoffs	2.729	0.363
Intercept	-24.444	
Sample Size	505	

* Significant at 90% level ** Significant at 95% level *** Significant at 99% level

The results from this model show a few important points of discussion, with the first noticeable one being the change in significance to the location variable. In the models represented in Tables 4.3 and 4.4, the variable home showed a statistically significant positive effect on passer rating of about 6 points. However, when only looking at the location variable in Table 4.5, the effect for playing at home is only about 2.3 points and is not statistically significant. What this indicates is that support from home fans or additional pressure from opposing fans has no statistically significant effect on quarterback performance in prime time.

The next two variables also show an interesting change from the previous model. Age and age squared return back to the inverse-u parabolic shape that was initially anticipated from them, despite them continuing to not be statistically significant. Despite the results not showing any significance, this still provides some credence to the performance of quarterbacks being at their worst at the start and end and at its best in the middle of their careers.

The first statistically significant variable from this model is the season average passer rating of the quarterbacks, significant at the 99% confidence level. While not the same as controlling for the specific quarterback like the previous model does, this variable provides a control for the quality of the quarterback involved in the game. What this variable indicates is

that for every one point increase in season average passer rating, the expected passer rating in a prime time game increases by 0.85 points.

The next two variables go hand in hand, as they both pertain to the weather conditions of the game being played. First is temperature, which shows no significance with a p-value greater than 0.6. Combined with the small positive coefficient of 0.028, it can be concluded that temperature does not have an effect on quarterback performance. This does tend to make sense, as temperature would not be a limiting factor in the ability to throw a football. The other variable, weather, shows both a high level of significance and a large effect on performance. The weather variable has a coefficient of -13.959 significant at the 99% confidence level. These results are consistent with expectations, as the poor weather conditions indicated by the variable, meaning rain or snow, create a difficult environment to throw a football in, namely by making the ball slick and harder to hold. This effect also could be compounded through worse receiver performance, as a slick ball would also be more difficult to catch.

Similar to the previous two models, the ability of the opposing defense has a statistically significant effect on the performance of the quarterback. In this model, instead of expected points contributed by the defense being the defensive metric, it is overall scoring defense rank. Even with this change, the coefficient remains consistent with the other two models, as it now shows a 0.45 point increase in passer rating as scoring defense gets one rank worse, compared to a 0.511 and 0.482 point increase in passer rating as passing defense gets one rank worse in the previous models. Quarterback performance increasing as a result of defenses getting worse is not surprising, as better defenses limit the production of opposing offenses. Therefore, the consistent effect and continued significance makes sense in the context of the sport of football.

The final variable included in this model is playoff status. While important to include, there may be a wide variety of factors that influence this variable into being statistically insignificant, having a p-value of 0.363. The first reason is that the quarterbacks that make the playoffs tend to be better, as they are able to consistently lead their team to wins in the regular season. This also could explain the comparatively large positive coefficient of 2.729. However, there is also the effect of the team itself, as playoff teams tend to have a good offense, a good defense, or both. This could make it hard to isolate the specific effect that being in the playoffs has on performance.

It is also important to mention that the r-squared value of the Factors Impacting Prime Time Passer Rating Model is 0.1612. This shows that the model has a reasonable level of predictive power, as just over 16 percent of the variance in passer rating is explained by this model. However, the variables used in this model display a much different picture than those in the models shown in Tables 4.3 and 4.4, as the significance and coefficient size of the variables has changed.

4.4 Conclusion

The regression models presented in this chapter provide enlightening evidence into the effects of pressure on quarterback performance. When controlling for the quality of quarterback playing, prime time games saw a decrease in passer rating by 4.681 points, significant at the 99% confidence level. This coefficient indicates a strong negative effect, with the only significant variable with a similar coefficient size, home, having a 5.995 point increase in passer rating

playing home games as opposed to non-home games. The r-squared value of 0.2476 on this model also indicates a high level of predictive power held by this model.

There were also interesting results found for the effect of game factors in prime time games on quarterback performance. The strongest statistically significant effect came from weather, indicating that passer rating decreases by 13.959 points when playing in rain or snow, significant at the 99% confidence level. Season average passer rating and scoring defense rank also showed statistical significance at the 99% confidence level, with every 1 point increase in season average passer rating indicating a 0.85 point increase in prime time game passer rating and every one rank worse scoring defense faced indicating a 0.45 point increase in prime time game passer rating.

Overall, the findings found by the regression models used in this chapter support the hypothesis that playing in prime time football games results in worse quarterback performance when compared to non-prime time games.

Chapter Five: Conclusion

Narratives around professional athletes not being able to perform under the bright lights are consistently talked about, especially in the era of instant communication through the internet. While these narratives can be entertaining, it can be hard to discern the actual effect that playing in prime time games has on these athletes.

There is a large body of academic literature on the subject of pressure in sports, which formed the basis of this research. However, there was a consistent theme across the majority of papers discussing this subject: pressure manifesting in isolated circumstances, not across the entirety of an athletic event. Even though there was, across a variety of sports, statistically significant evidence of pressure resulting in athletes performing worse at their respective tasks, there was little to indicate a performance decline across the length of a game. This paper attempts to fill this gap in the literature, as it seeks to determine the effect of playing in a prime time game on quarterback performance. This is an important issue, as pressure does not start and end in the high pressure, closing moments of a game. By determining the effect of continuous pressure in one sport, it opens the doors to further research on how sustained pressure affects performance in other sports. What this could then indicate is a wider trend of pressure affecting performance outside of the late game scenarios that are most typically associated with choking.

Research showing this evidence of pressure was expanded upon by finding psychological theories associated with the process of choking, namely the Distraction Hypothesis and the Automatic Execution Hypothesis. Both of these theories provide a framework for why athletes perform worse as a result of pressure being placed on them.

Through a series of regression analyses, statistically significant evidence is found showing that prime time game passer rating is 4.681 points worse when compared to non-prime time games. Without context this may not seem like much, but the only statistically significant variable of similar size was the home variable. What this indicates is that the negative effect of playing in a prime time football game is similar to the effect of playing an away game. When it comes to discussions of sports, this is a very important comparison. Being the home team is typically associated with a multitude of benefits, like the support of the fans, familiarity with the venue, and acclimation to typical weather conditions (if playing an outdoor sport). Therefore, the effect of playing in prime time is very consequential if the effect of prime time is comparable to all the negatives associated with playing an away game.

There are also different economic outcomes that this information could influence. First and foremost is that the National Football League is a business and as such, their primary goal is to generate revenue. Prime time games assist in this goal by providing a window of time where a large number of viewers will tune in to watch a game. Getting people to watch is also typically aided by the selection of the teams playing in prime time games. The NFL tends to schedule winning teams with high end quarterback talent, as quarterbacks are often the face of their franchises, to play in prime time. As a result, selecting teams in this fashion may not be the optimal way, as the NFL could instead look to determine which quarterbacks handle playing in primetime games better. If this results in a better viewing experience, the number of viewers could increase, generating more revenue for the league by making television stations pay more for TV deals. The results from this paper also have economic ramifications from a team management perspective. General managers are expected to build successful teams through the college draft and free agency all while staying within the salary cap limits to avoid penalties.

Due to the fact that quarterbacks, especially starting ones, typically receive contracts larger than an average player, general managers need to be sure that the talent they are acquiring is a worthwhile investment of their funds. If there is a talented quarterback that struggles when the lights are brightest, it could be a better option for GMs to spend less on a quarterback in order to spend more elsewhere, making the rest of the team better.

However, there are a number of ways through which this paper can still be improved and expanded upon. The first is through an expansion of the sample size. This paper finds a negative impact on quarterback performance in prime time using a sample of only the two most recent NFL seasons. While this does provide a sizable sample to conduct the regression analysis with, the inclusion of more years of data would be able to confirm that this trend is consistent across time and not just an anomaly in the last two seasons. Furthermore, the inclusion of some of the variables in the Factors Impacting Prime Time Passer Rating Model (like weather, temperature, and playoffs) in the Quarterback Controlled Passer Rating Model would allow for a single model to provide a more complete picture of the effects variables have on passer rating. This could not be accomplished in this paper due to the way that the datasets were built, so future work on this topic should look to construct a dataset combining the important aspects of both datasets.

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