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How Aggressiveness Relates to Success for NFL Teams

Introduction

This project was focused on trying to answer the question of how aggressiveness relates to success in various situations for NFL teams. The data set being analyzed was a play-by-play data set for the current 2019 NFL season, updated after each week of games. It logs every single play that happens during the season, and has columns for all sorts of things that happened during the play. These are things such as the entire description of the play, what type of play it was (run, pass), what "down" it is (first, second, or third), how many yards are needed for a first down, how far the ball traveled in the air, the offensive and defensive teams, and how many yards the play gained, among other things. Some of these columns that will be used and analyzed to see how they relate to a team's success. It is definitely a big data set that needed to be cleaned and filtered into only the plays and data needed to answer the question of how aggressive plays in different situations lead to success.

Are teams that throw the ball further more successful than those that throw it shorter? Does being aggressive and throwing the ball a lot in certain situations seem to have an effect on a team's overall success? If so, what situations are these? Is it better to throw the ball more/further on certain downs compared to others? These are all types of questions that this project aims to answer. In this new age of advanced analytics, it is no longer about just about analyzing which teams are successful, but also about looking at *how* they are successful. There are also plenty of new ways to accurately measure success rather than just wins and losses. Obviously, winning and losing is the ultimate measure of how well a team is doing, but a losing team is not always a bad team, and a winning team is not always a great team. A team's season can be broken down into each one of their plays and analyzed to see just how successful each team is and what is contributing to the success of the best teams.

Lit Review

Sports, particularly football, data analytics have become increasingly popular in recent years, and with this rise in analytics has come a number of new, advanced, "Next Gen" statistics that can be used to more accurately assess how a player or team is performing. Simple and basic statistics such as touchdowns and yards are being replaced by these more advanced stats that take

more context into an account and can aim to offer more accurate assessments on how well a team or player is doing. One of these statistics is "EP" which stands for expected points, and another one is "EPA", or expected points added. The "Advanced Football Analytics" website (advancedfootballanalytics.com) as well as ESPN.com both offer explanations for how these statistics are measured and why they are more reliable than traditional stats. The value of a football play has traditionally been measured simply by how many yards the play gained. However, not all yards are created equal; for example, 4 yards on 3rd & 2 are better than 7 yards on 3rd & 10 because the 4 yards gave you a first down. Also, yards gained down near the end zone are more valuable than yards gained in the middle of the field, since yards by the goal line are harder to come by due to having less space to work with. These types of things should be taken into account when measuring success, and context matters. Based on statistical analysis of NFL play-by-play data from the last 10 years, a formula has been created that gives each play an "expected points" (EP) value. This value has a general range anywhere between -3 and 7, and it is essentially a prediction of which team will score next and how many points that team will score based on the current situation. If the offense is running a 4th & 20 play from their own 1 yard line (where they are extremely unlikely to be successful), that play will have an EP value close to -3. In other words, it is expected that the other team will score next, and they will score 3 points. If the offense is running a play close to the goal line and they are about to score (they are likely to be successful), their expected points will be around 6, as they are expected to score next since they are already in a good position to do so.

Next, the actual play happens, and then the difference between the EP value of the next play and the EP value of the previous play is called EPA, or expected points *added*. So, for example, if a team has a 3rd & 20 from their own 5 yard line, it is not very likely that they will be expected to score next, so their EP for that play will be very low, probably negative. If, on that play, they then have a big play that gains 60 yards, their probability of being the next team to score skyrockets, and their EP for the next play will be much greater than that of the last. This change is the EPA. It sounds complicated, but essentially EPA is a way of judging success that takes into account the context of the game, and doesn't count all yards, turnovers, etc. as equal. Gaining 6 yards on 3rd & 4 and gaining a first down will be (as it should be) valued greater than gaining 10 yards on 3rd & 13 and not gaining a first. A turnover that puts the other team into a very good position to score will hurt a team more than a turnover that doesn't. The context matters greatly for every play that occurs during an NFL game, and these new statistics are a way of taking that into account to more accurately judge players and teams.

Methods

The first thing done with the data set was to filter out the unnecessary rows (or plays). For this project, the only plays that need to be kept are run and pass plays, and plays such as kickoffs and field goals can be left out. This is done because run and pass plays are plays where the team's offense is on the field, and thus these are the plays that need to be analyzed to look at an offense's aggressiveness. Plays where the offense is not on the field (kickoffs, field goals) are irrelevant to this discussion because the offense is what is being analyzed.

The next thing that needs to be done is to add columns that indicate type of play, as well as a column that indicates success. The data set already has a "play_type" column that is either "run", "pass", or "no_play" ("no_play" = a play that resulted in a penalty and ultimately didn't count). This column is flawed for this project, however, because plays that ultimately didn't count are labeled "no_play" and thus wouldn't be factored in if this column was searched for just run and pass plays. These plays should be included because penalties are part of what makes a team unsuccessful, and thus they should be included when assessing success. As a result, these penalty plays should be deemed either run or pass plays (depending on what type of play they actually were before the penalty happened) rather than just penalties, so that it can be seen which type of plays produce the most penalties. To do this, a column named "rush" and a column named "pass" are created. These columns are either a 0 or 1 value, and they search the "description" column for words that indicate either run or pass. If the description of the play includes words like "pass", "sacked", or "scramble", it is deemed a pass play. If it includes phrases like "up the middle", "left guard", "right end", it is deemed a run play, since those are words that are used in the description of runs. Lastly, a column is created to indicate whether each play is successful. This, once again, is either a 0 or 1 value and is based on another column, this time the "epa" column. If the EPA on a play is greater than 0, the play is considered successful, otherwise it is not.

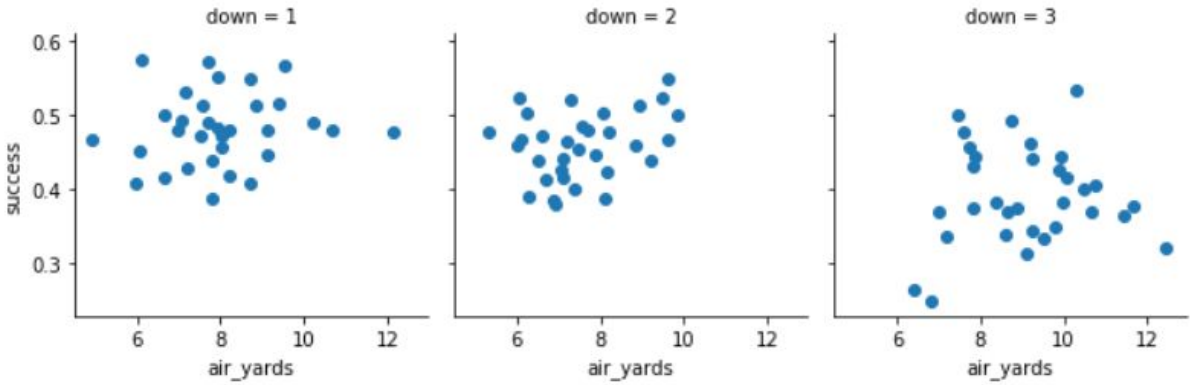
Once this is all done, the goal then becomes to focus on columns and create smaller data frames that are much easier to analyze and help group statistics by team. These small data frames are all grouped by the "posteam" column, which indicates the team on offense whose aggressiveness is being analyzed. This is done in order to break down the big data set of all plays into the plays for *each team*. Many small data frames are then created this way. For example, the data frame named "thirddown" is created, which filters the big data set into only third down plays and then is able to add columns for different statistics for *each team* ("posteam") on third down. A column labeled "thirddownsuccess" is added to this data frame, and it takes the average of the "success" column for each team on third down plays. Another column labeled "thirddownpass" is added, which takes the average of the "pass" column for each team on third down plays. The end result of this is a very small and simple data frame that shows how successful each team is on third down and how often each team is passing on third down. This is then done for many other situations, resulting in a lot of these small data frames. These data frames and their columns/statistics are then merged together to form a bigger data frame that has statistics for each team for all of these different situations. This grouping by team allows for the ability to do analysis on what makes *teams* successful rather than just what makes *plays* successful. Analysis of the relationship between a *team* doing something and how often that *team* is successful are then possible, which is the entire point of the project: to see how a team's aggressiveness relates to that team being successful.

The next goal then became to create visualizations that might potentially depict a significant correlation between variables/statistics. Some small multiples graphs in jupyter

notebook as well as some ggplot graphs in R were created to see any type of trends that could be tested for significance. The small multiples method was used to make graphs for success based on the down (either first, second or third). By using this method, it allowed for the ability to make side-by-side graphs for each down to more easily see how the relationship between aggressiveness and success varies for each down. If there looked to be a significant change or relationship on a certain down, that would then be tested using linear regression models to determine whether that correlation was significant.

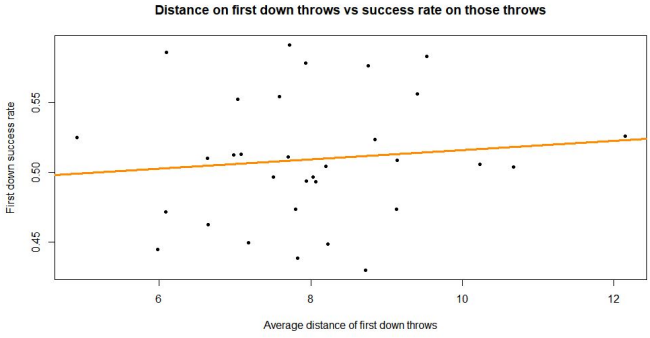
Results

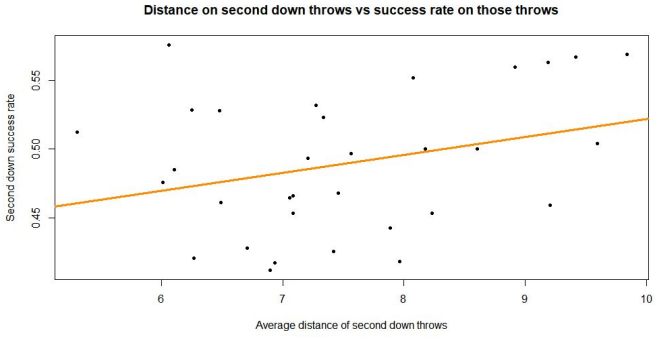
Figure 1: Average distance on passes vs average success rate for teams based on down

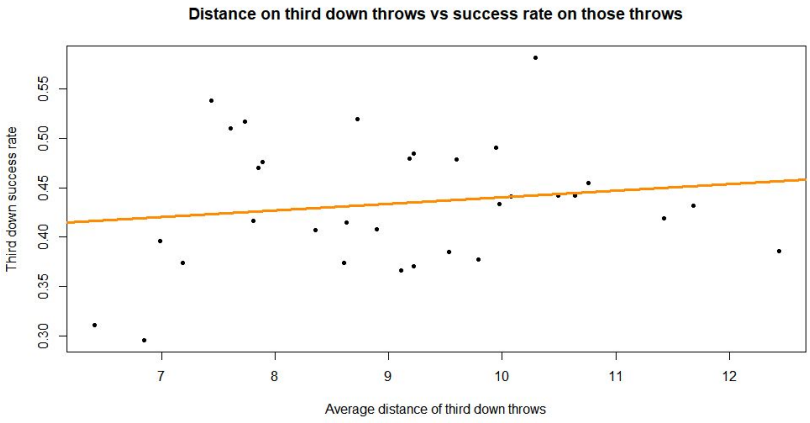


The first thing to be analyzed was if there seem to be correlations between aggressiveness and success on different downs. Figure 1 shows each team's average pass distance (air_yards) and how often they are successful (success) based on what down it is. Downs 2 and 3 seem to possibly have a significant positive correlation between throw distance and success, and this would then be tested using a linear regression test.

Figures 2-4: Linear regression models for air yards vs success rate on 1st, 2nd, and 3rd down

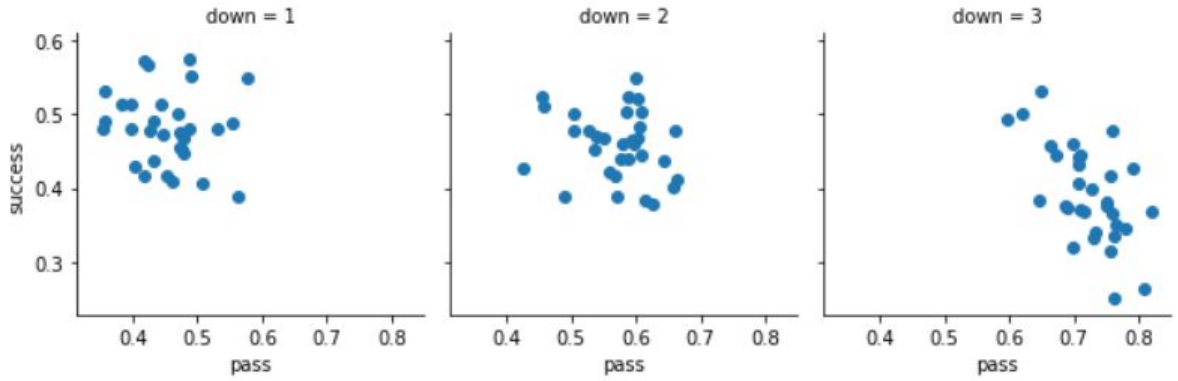






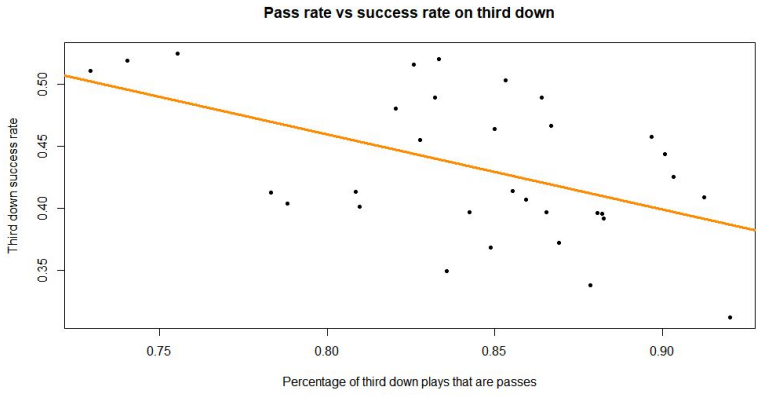
The tests revealed no statistically significant correlations for first, second, or third down. Second down was the closest to significant with a p-value of .09, but was not below .05 and therefore could not be claimed as a significant correlation.

Figure 5: Percentage of pass plays vs average success rate for teams based on down



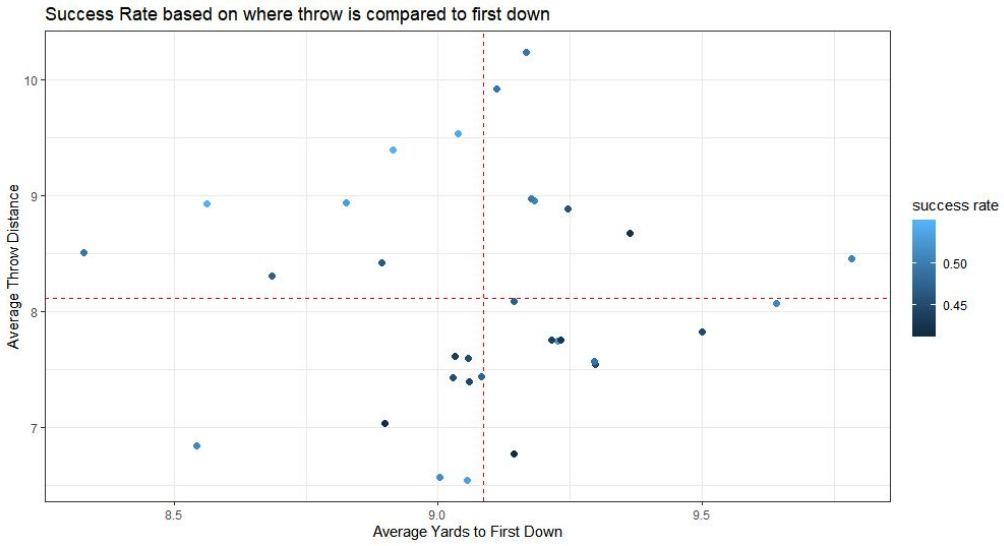
The next thing to analyze was how aggressive play *calling* on different downs affects success, rather than aggressive play style. Figure 1 shows each team's percentage of pass plays on each down compared to their success on that down. The difference in these graphs is much more noticeable, as the 3rd down graph on the right has a clear negative correlation compared to the other two. These would then also be tested for significant correlations using the linear regression test.

Figure 6: Linear regression test for pass rate on third down vs success on third down



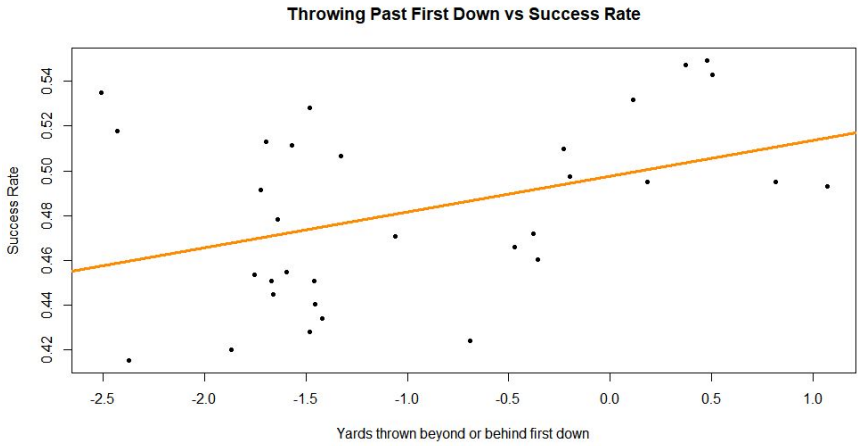
This linear regression test revealed a significant negative correlation between the percentage of pass plays a team calls on third down and their success on that down. The p-value for this test was .003, and the BP test was also run for it to make sure it is not heteroscedastic. That BP test resulted in a p-value of .72, which confirms that it is not heteroscedastic.

Figure 7: Plotting yards to go vs throw distance vs success rate



This plot revealed a potential trend between a team making aggressive throws and that team being successful. This looks at how many yards are needed for a first down on a pass play, and then how far the team threw the ball on that play, and the color represents how successful the team is. The most successful teams seem to all show up in the top left corner, which is the part of the graph that represents teams that make deeper, more aggressive throws that travel past the first down line. Another linear regression model would be used to test the significance of this.

Figure 8: Linear regression test for success rate based on where a pass is compared to the first down line



The linear regression test for this relationship resulted in a significant p-value of .02, showing that there is a significant positive correlation between a team making more aggressive throws that go near or beyond the first down line and their success.

Discussion

These results showed that there do seem to be certain situations where aggressiveness positively relates to success, and there are certain aggressive play styles that seem to also lead to success. There was not a significant correlation between how far a team's passes are on a certain down and their success on that down, and thus there was no specific down that it seems a team should be making deeper passes on. The current down does not seem to have an impact on whether teams should be making more aggressive style play calls, as Figures 2-4 show. The implications of this might be that there doesn't seem to be a specific time where teams (or quarterbacks) should try to make the deepest, most aggressive passes possible. Perhaps those that try to be aggressive only at certain times become too predictable and easy to stop, and therefore it is probably best for quarterbacks to balance their aggressive decision-making into different downs and situations to avoid this. Another possibility is that teams and quarterbacks who are too aggressive can make more mistakes. This could be a reason why always being aggressive doesn't have a big effect on how successful a team is, as teams that do this get the bad along with the good and it balances out.

Instead of focusing on just making the deepest passes possible whenever they can, it seems that it is better for teams to make aggressive throws only when they actually need to. Figures 7 and 8 revealed a significant correlation between teams throwing past the first down line and them being successful. The effects of this are that teams should be trying to make throws that travel past the first down line as much as possible -- if they need a lot of yards for a first

down, try to make deep passes, otherwise if they only need a few yards, a shorter throw will suffice as long as it is still at or beyond the first down line. Teams being required to make passes that travel past the first down line could show that they cannot rely on yards after the catch as much as they want to. Teams that throw the ball significantly short of the first down line seem to be less successful. It is not good enough for quarterbacks to consistently throw the ball short of the first down marker and hope that their receivers can gain yards after the catch and turn a short gain into a big gain for them -- the quarterbacks actually have to make deep passes and get the ball past the first down line themselves in order to be successful. This seems to confirm the common notion that the most responsibility seems to fall on the quarterback's shoulders.

Another possible conclusion that can be made is that although there doesn't seem to be a specific down where being an aggressive play *style* is a huge advantage or disadvantage (Figures 2-4), there does appear to be a down where aggressive play *calling* might be a disadvantage (Figures 5-6). On 3rd down, there was a statistically significant negative correlation between how often a team passes and their success. As teams call more pass plays on third down, their third down success rate goes down. The implications of this could be that teams have begun to expect third down passes, since third down is when teams get the most desperate for first downs and are almost always passing. Teams might be becoming too predictable on third down, and it might be a good idea for them to mix in some surprise run calls on third down when they only need 4 or 5 yards. Teams are always going to be passing when they need 8 or more yards because it is much more likely to get more yards by passing the ball, but when it is a manageable third down, teams should consider trying to run the ball and surprise the defense, and this might lead to them being more successful. Predictability is a big factor in football, and outsmarting the opponent by being unpredictable is a way to get a big advantage. One possible way to do this could be by utilizing more run plays (less aggressive plays) on third down when the other team is expecting a pass.

Conclusion

Analytics in football have become increasingly popular and accessible, and there are many new ways to judge the success of NFL teams and players based on various statistics. EPA is one of the most reliable statistics there is to judge success, and by analyzing each play of a season to see how and when a team's EPA is positive (their successfulness), certain tendencies and relations can be observed. This project's goal was to analyze how aggressiveness relates to a team's success in different situations, downs, and play calls. It was discovered that there are certain situations where making more aggressive decisions (passing the ball more, throwing further passes) are significantly correlated to either being successful or not being successful. These correlations can then be used to develop data-driven decisions about when and how a team should try to be aggressive in its play calling and play style.

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