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Quarterback Value Forecasting and Fixing the NFL Draft's Market Failure

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by

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Abstract

The National Football League (NFL) is a business that is worth nearly $7 billion annually in revenue. That makes it the largest money making sport in the United States. The revenue earned by each franchise is dependent upon the repeated success of the team. A commonly held belief is that for a franchise to be successful you must have an elite Quarterback.

This thesis uses NFL data and for the 2000-2008 seasons to determine the role that Quarterback performance plays in team success. With the determination that Quarterbacks are important to NFL team success the question becomes how does a franchise effectively obtain the best player. The NFL player draft is the most commonly used method for teams to find their Quarterback of the future. The problem is that the success rate for drafting Quarterbacks is very low.

In this thesis I have determined a more statistical approach to determining whether a drafted Quarterback will be successful. The model shows that certain college statistics, such a passing completion percentage, are strong indicators of professional success at the Quarterback position. Use of the data may aid teams in effectively drafting Quarterbacks, thereby improving team winning percentage and profitability.

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Introduction

Since the inception of the salary cap in 1994 the National Football League (NFL) has shifted to a parity not seen before in the sport. Placing a maximum on the amount teams could spend on player salaries created a dramatic shift in how NFL teams were structured. Prior to the salary cap teams would provide the bulk of their personnel through free agency. The most successful teams had the necessary revenue to pay the contracts of the best free agents available. This competitive model can be seen in the personnel operations of the New York Yankees and Boston Red Sox in Major League Baseball. The salary cap has prevented the highest revenue teams from continuing this competitive model in the NFL. Now teams are forced to build their core around the draft and use free agency to fill needs.

The question then becomes what value should certain positions have in terms of an NFL team being competitive. Unlike the other major sports in the U.S., particularly baseball, football is not statistically driven, so there aren't many statistics available to compare player value when contrasting skill positions. Though there are basic numbers used for the skill positions it is still hard to determine which is more meaningful. Nevertheless it is commonly believed that the Quarterback position in the NFL is the most valuable position.

The Quarterback is considered the head of the offense and is quite often given credit for a team's winning ability. The statistics available show that the NFL has become more of a passing league so the Quarterback position has been given greater importance. Though there is some evidence available to show that Quarterbacks are important to an NFL team, there has never been a study to test the validity of this belief.

Since Quarterbacks are treated as the biggest investment for an NFL team it would seem to be a good idea to test whether they are as useful to a team as believed.

Once it has been determined that the commonly held belief of Quarterback importance holds then it is to be determined how to pick the best one available in the draft. The history of the NFL draft is littered with examples of top drafted busts, such as Tim Couch, Akili Smith, Joey Harrington, and Ryan Leaf. Each of these players were drafted to be the starting Quarterback and all were selected at or near the top of the draft. Though expectations were high for all of them, they each had short careers that were seen as failures. In the normal working world picking the wrong person usually doesn't have long lasting ill effects. Normally if someone is hired and then does a bad job they are fired, resulting in little or no serious repercussions to the employer. In terms of the NFL, with the salary cap in place, you could have negative repercussions from drafting the wrong Quarterback too high in the draft.

As shown by Masey and Thaler (1995) the NFL's method for drafting players is not efficient. The draft position valuation has caused first round draft picks to be severely overpaid in comparison to players selected in the later rounds. With the cap on players' salaries, and no hard slotting[1] for rookie salaries, missing on a top round Quarterback can have lasting negative repercussions for NFL franchises.

Each draft sees the rookies being paid more than previous years and the Quarterback position is paid more than any other in terms of rookie contracts. Examples

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[1] Hard slotting refers to how there is no fixed scale on rookie salaries and no cap on the max they can be paid.

of this are Jamarcus Russell who was drafted by the Oakland Raiders with the first overall pick in the 2007 draft and Sam Bradford who was drafted by the St. Louis Rams with the first overall pick in the 2010 draft. Jamarcus Russell's contract was a six year contract worth up to $61 million with $31.5 million guaranteed. Just three years later Sam Bradford's contract was also for six years, but worth $78 million with $50 million of it guaranteed. This is an increase of 24.5% for similar rookies' contracts in the span of three years. As shown by the example of Jamarcus Russell this can end up costing a team greatly, as the Raiders released him from the team after just three underwhelming seasons. In the end the Raiders lost $31.5 million in guaranteed money and were left with a losing record over that span and still no Quarterback to lead the team.

These examples of NFL franchises investing greater amounts of salary cap space into players that have no professional experience demonstrates the market's inefficiency. The success of first rounds Quarterbacks has been increasing as NFL scouting has improved but they still fail far more often than succeed. There are also plenty of examples of Quarterbacks that were drafted in later rounds or weren't even drafted at all that have enjoyed success. This shows that increased statistical analysis should be used to improve Quarterback valuation in the NFL draft.

This thesis will utilize modern statistical analysis to determine the affect an elite Quarterback has on a team's probability of winning and whether college statistics can significantly forecast whether a Quarterback will be elite in the NFL. These two studies are meant to provide a more efficient manner of player evaluation and drafting for NFL teams. The next section of the thesis will focus on other important studies that pertain to this thesis. This is followed by a description of the data and methodology used. The next section provides results, followed by conclusions and opportunities for further research.

Literature Review

Since statistical analysis of the NFL is still a new idea there are relatively few economists researching player efficiency. Most studies have been published within the last ten years.

Hadley, Poitras, and Ruggiero (2000) used data on total offensive and defensive metrics from the 1969 to 1992 seasons to determine how much a coach influenced a team to win. In terms of new work this was the first paper to focus on NFL managerial ability and it referenced previous works that looked at Major League Baseball (MLB) managerial ability.

For this article they focused on 12 measurements of offensive production and 12 measurements of defensive production which were then condensed into four distinct categories: running, passing, kicking, and special teams. To measure the success of coaches they used experience of coaching in years and broke that into periods of years. Using a Poisson regression model they concluded that more experienced coaches were more efficient, increasing the number of wins by three to four games per season. It was also found that although more experienced coaches were more successful, this trend was increasing at a decreasing rate.

Borghesi (2007) evaluated player compensation differences between the pre-salary cap era and the salary cap era. Borghesi uses panel data to measure the relationship between player productivity and compensation. Then they use the difference of mean salary and actual player salaries in an OLS regression that analyzes player compensation and how it pertains to team performance. The conclusion of this article is that since the inception of the salary cap the salary dispersion amongst players has gotten larger. It found that justified and unjustified compensation for players had the expected results in relation to team performance[2]. Players that performed well and earned a high salary had a positive effect on team performance. Those players that were highly compensated and didn't perform well had a negative effect on team performance. It is also expected that teams will overvalue players brought in through free agency and that this causes much of the dispersion. Borghesi shows that teams that focus on "superstar" pay scales do not perform well overall and that there is an overall inefficiency in pay dispersion that negatively affects team performance.

Hendricks, DeBrock, and Koenker (2003) looked at empirical data regarding pre-employment evaluation and whether predictions were correlated with post hiring success. After they had determined a simple uncertainty model they applied it to the NFL draft to test their predictions. Their determination is that because of uncertainty in predicting future success of workers, employers will choose individuals from majority groups. There is also the idea that employers will choose more minority candidates as taking a risk on the possibility of that person becoming a "star." The evaluation of NFL drafting backs up these assertions when comparing similar candidates in the NFL. Franchises will choose the player from a better known college program because they are viewed as less of a risk. Over the course of the draft there are also examples of NFL teams taking risks on players with the possibility of being great in the later rounds. The conclusion

[2] According to Borghesi (2007) justified compensation is when a player's statistical performance is commensurate with his salary. Essentially his pay is different from the mean at the same percentage that his performance is different from the mean. Unjustified compensation is when the two percentages are not equivalent, which would mean the pay is higher than the performance.

shows that in the upper rounds of the draft, where players are compensated highly, NFL teams are more risk averse. In the latter rounds of the draft, where compensation is much lower, NFL teams are willing to become far more risky in picking players that have higher chances of not succeeding.

A more recent article published on the Football Outsiders website, a group that is dedicated to statistical analyses of the NFL, is " Intelligence and Football: Testing for Differentials in Collegiate Quarterback Passing Performance and NFL Compensation" by McDonald P. Mirable. This article compared certain aspects of a college Quarterback's performance and scouting data to NFL passer efficiency and rookie compensation. The key variables that are observed are the Wonderlic[3] score and college passing data. Through all phases of the models done in this article the Wonderlic score was found to be statistically insignificant at predicting either NFL Quarterback efficiency or NFL rookie salary. It did show that Quarterback data from college did have predicting power for NFL Quarterback efficiency and NFL rookie salary. The conclusion states that since the Wonderlic score was not significant, NFL franchises should focus more on developing different evaluations for draftable Quarterbacks.

Lastly Massey and Thaler (2005) use Tobit models to determine how NFL teams valuate positions in the yearly draft. The key concept they look at is whether draft position accurately determines a players overall value to an organization. To do this the variables they use are actual draft position by number and round, amount of games started in the NFL, number of seasons in the NFL over the rookie contract, and number of

[3] The Wonderlic score is an intelligence test given to college Quarterbacks as a measurement for the NFL Draft.

Pro Bowl elections over the course of the rookie contract. The success rates of these different variables show that the valuation of draft picks corresponds best with the number of Pro Bowls during a rookie contract. Unfortunately, this valuation is inefficient because the ability to accurately predict drafted players as Pro Bowlers is quite low. The success rate in determining that level of return from drafted players doesn't justify valuing them in the given manner.

Massey and Thaler also show that through comparison of positional value and compensation versus player value the NFL draft is actually inefficient. Teams are able to properly determine which players are better and have the most value, but they overvalue the right to choose players at the top of the draft versus those that come later. There is also a tendency to greatly discount future draft picks versus those in the current draft. The draft value charts end up demonstrating that the right to choose now is worth much more than making the same choice in the future. Moreover, over time the NFL draft has actually moved towards steeper valuation of early draft picks, rather than the market correcting itself and proper valuation having occurred.

These articles show that modern statistical analysis has a place in the reviewing the operations of NFL teams. The article by Borghesi (2002) especially coincides with this project in that it focuses on proper compensation for players coming out of the draft when considering the effect it has on the salary cap. It also established that player compensation can affect team performance. This leads to trying to understand what positional players should be compensated the most and how to properly evaluate which players should be drafted.

Data and Methodology

In this thesis I will take a two part approach to player valuation and proper draft efficiency. The first step will be to test the hypothesis that Quarterbacks are an important player to a team in terms of winning. This will be based upon the commonly held belief that Quarterbacks are the head of a team and that they are compensated as such. The next step will be to then determine whether a Quarterback's success in the NFL can be predicted based upon his capabilities as a college Quarterback.

Table 1: 2000-2008 Season Variables

Variable	**Definition**	**Mean**	**Std. Dev.**
H-A	Dummy variable if team was home or away	0.5	0.5
Win	Dummy variable if team won or lost	0.5	0.5
RushTD	Number of rushing touchdowns by team	0.8	0.9
PassTD	Number of passing touchdowns by team	1.3	1.1
D/ST TD	Number of defense or special teams touchdowns by team	0.2	0.5
OppRushTD	Number of rushing touchdowns allowed by team	0.8	0.9
OppPassTD	Number of passing touchdowns allowed by team	1.3	1.1
OppD/ST TD	Number of defense or special teams touchdowns allowed by team	0.2	0.5
TOP	Amount of time team had possession of the ball	30.2	4.6
OppTOP	Amount of time opponent had possession of the ball	30.2	4.6
RushingAtt	Number of rushing attempts by team	27.8	8.0
RushingYards	Number of rushing yards by team	114.6	51.8
PassingAtts	Number of passing attempts by team	32.6	8.3
PassingComp	Number of passing completions by team	19.5	5.8
PassingYds	Number of passing yards by team	208.5	75.4
Ints	Number of interceptions thrown by team	1.0	1.1
Qbrating	Calculation of Quarterback attempts, completions, touchdowns and interceptions	80.0	28.4
ReturnYds	Number of kickoff return yards by team	35.9	34.8
PenYds	Number of penalty yards accrued by team	51.1	26.1
FumLost	Number of fumbles lost by team	0.7	0.9
SackYds	Number of yards lost by team to sacks during game	14.2	12.2
PuntYds	Number of punt return yards by team	202.9	86.5
OppRushingAtt	Number of rushing attempts by opponent	27.8	8.0
OppRushingYds	Number of rushing yards by opponent	114.6	51.8

OppPassingAtt	Number of passing attempts by opponent	32.6	8.3
OppPassingComp	Number of passing completions by opponent	19.5	5.8
OppPassingYds	Number of passing yards by opponent	208.5	75.4
OppPassingInt	Number of interceptions thrown by opponent	1.0	1.1
OppReturnYds	Number of kickoff return yards by opponent	35.9	34.8
OppPenYds	Number of penalty yards accrued by opponent	51.1	26.1
OppFumLost	Number of fumbles lost by opponent	0.7	0.9
OppPuntYds	Number of punt return yards by opponent	202.9	86.5

Table 1 provides the names, a brief description, and descriptive statistics of the variables used to determine player worth in relation to team performance. The data for the variables are official game statistics for all the games between the 2000 and 2008 NFL seasons for a total of 4,256 observations for each variable. A team's performance is best defined by the number of wins they attain. Since this is best denoted by a dummy variable, making a win a one and a loss a zero, the best model for predicting wins is the Probit model. For simplicity, this model will only focus on offensive success, therefore the Probit model will be fitted to only the offensive statistics. Another justification for this is the fact that the NFL has shifted its rules policy to protect the offensive players more than the defensive players[4]. As a result, over the past twenty years the NFL has seen an increase in scoring and other offensive statistics such as QB rating.

Though there is a concern that using Quarterbacks statistics may have an endogeneity problem, there are statistics from the NFL that don't back up that claim. There is first the issue of Quarterback statistics being dependent upon the success of their receivers. The average drop rate (% of passes that are dropped by the receiver) hovers

[4] The "Brady" rule following the 2008 season to protect a Quarterback from hits below the knees, increased penalty yards assessed from pass interference, and the penalties to prevent blows to the head are examples.

around 7%. The worst receivers in terms of drop rate barely exceed 10% of all passes thrown to them. For a drop to count the ball has to actually reach the receiver, so as long as the Quarterback is able to get the receiver the ball the worst case scenario shows that it will be caught 90% of the time. In terms of offensive line protection being responsible for a Quarterbacks success there are many instances that show it to be less than accurate. The two Quarterbacks that had the highest sack rate last season were Aaron Rodgers and Ben Roethlisberger. They both had time of ball held numbers around league average, which showed that their offensive line play was poor. Despite the poor offensive line play these Quarterbacks received they put up passing numbers that led them into the Pro-Bowl. Good Quarterbacks have been able to make offensive lines look better as well, such as Peyton Manning or Kurt Warner. These two are both elite Quarterbacks who have quick reads and get the ball out quickly which prevents defenders from having the time to get around their protection. These factors show that while there may be some level of endogeneity involved in Quarterback passing statistics, it should not have a significant impact.

Once a well fit Probit model has been established the next step will be to run marginal effects on different statistics at above mean value. A commonly held idea on Quarterback value is that an elite Quarterback will gain 220 yards per game on average and have a touchdown to interception ratio of 2 to 1. This would calculate out to a Quarterback rating of roughly 90. Another major statistical key is that elite running backs can average around 5 rushing yards per attempt. The mean number of attempts is approximately 28 rushing attempts per game. The mean number of rushing yards per attempt is roughly 4 yards. So to show the difference between average and elite running backs I multiplied the rushing attempts by the yards per attempt and found that on average an elite running back will get roughly 140 yards per game. These commonly viewed statistical points can be used to calculate the marginal effects and determine how they would affect a team's ability to win. The new planned Probit model will only include those offensive metrics that have the most significance to the overall win.

(1) $Win_{j.t.} = (\beta_0+\beta_1 ha_{j.t.}+\beta_2 rushingyards_{j.t.}+\beta_3 qbrating_{j.t.}+\beta_4 returnyards_{j.t.}$ $+\beta_5 penyards_{j.t}+\beta_6 fumlost_{j.t}+\beta_7 sackyds_{j.t.} +\beta_8 puntyds_{j.t.}+\beta_9 top_{j.t.}+\varepsilon)$

The variables used in equation (1) were those offensive statistics that showed the most significance in forecasting the probability of winning. $Win_{j.t.}$ is a dummy equal to one if team j won the game played at time t. $HA_{i.t.}$, is a dummy variable denoting whether the team was playing a home game or an away game. This was included because it is commonly believed that there is a home field advantage for sports teams. Rushing yards is the total number of yards gained by team j through running the ball during the course of the game. The Quarterback rating is a statistic that is calculated using the touchdowns thrown, interceptions thrown, total yards in passing, and passes completed when measured against the number of passes attempted. Return yards are the total number of yards gained on kickoff returns. Penalty yards are the total yards lost during a game from committing penalties. The fumbles lost are the total number of times a team loses possession of the ball during a game as a result of fumbling. Sack yards are the total yards lost during a game from the Quarterback being sacked by the opposing defense. Punt yards are similar to return yards in that they are the total yards gained from a team returning a punt. Lastly there is time of possession which accounts for the total amount of clock time during the game where the team has the ball on offense.

Table 2: Quarterback Dataset Variables

Variable	Definition	Mean	Std. Dev.
DYAR	Yardage gained or lost over the course of a season	115.365	366.995
rushydsatt	Rushing yards gained per attempt	0.909	2.245
rushtdatt	Rushing touchdowns gained per attempt	0.040	0.026
passperc	Percentage of passing completions per attempt	0.580	0.046
ints	Interceptions thrown over college career	28.130	12.689
ints2	Total interceptions squared	951.061	872.438
pass_yds	Passing yards thrown over college career	6968.773	2981.106
tds	Touchdowns thrown over college career	51.326	25.316
tds2	Total touchdowns squared	3270.371	3050.623
weight	Players listed weight	219.917	12.977
wonderlic	Score from the Wonderlic IQ test	25.881	7.141
starts	Number of games played by Quarterback in college	35.526	9.142

Once the position value of the Quarterback has been established the next step will be to use the following OLS regression to predict player value based upon college statistics.

(2) $DYAR = \beta_0+\beta_1 rushydsatt+\beta_2 rushtdatt+\beta_3 passperc+\beta_4 ints+\beta_5 ints2+ \beta_6 pass\_yds +\beta_7 tds +\beta_8 tds2+\beta_9 weight+\varepsilon$

Table 2 defines and provides descriptive statistics of the variables. The variables were gathered from college and professional statistics from 132 different Quarterbacks who started NFL games between 1993 and 2008. This allows the study to stick specifically with the salary cap era where the NFL has become a more passing dominated league.

The professional variable that will be the dependent variable for this part of the study is DYAR. This is an advanced metric developed by the statistical group the Football Outsiders. DYAR (Defense-adjusted Yards Above Replacement) is a seasonal total of all yards gained or lost by a Quarterback. To determine the stat they break down all footage of each player and compare how players perform in regards to the traditional statistics. By breaking it down to each individual play it increases sample size of player performance rather than just using statistics from one game. Since all players don't face every team with only sixteen games a season they use the footage to also break down opponent strength. This is to remove any endogeneity issue that can come from the difficulty level of the defenses faced by the Quarterback. The Football Outsiders have only worked their advanced metrics as far back as 1993 so this will leave some total career value out for Quarterbacks who played games prior to the 1993 season. To account for this I will use average DYAR for each of the 132 Quarterbacks from the season available.

A commonly used statistic for evaluating draftable Quarterbacks is the Wonderlic test which measures intelligence. The Wonderlic test score is measured in terms of the number of correct answers out of 50 the individual is able to answer over the course of 12 minutes. According to Mirabile (2009) the Wonderlic test has been previously shown to have no value in predicting NFL Quarterback value. Since this project is using a different dependent variable, and a slightly different data set, I decided to test the validity of the Wonderlic again. The overall data set was compiled from multiple different sources and all variables were not found. There were even some prominent NFL Quarterbacks, such as Tony Romo and Randall Cunningham, whose college Quarterback data could not be located. The model is attempted to obtain the best possible fit, with the available data, considering the missing observations.

Results

The two different models generally fit the data well. In the case of the Probit model a very strong fit was found. For the OLS model the fit wasn't nearly as good, but it did have some explanatory power and had the expected affects from the different variables. The following tables and explanations show the final results.

Table 3: Wins Probit Model

win	Coef.	Std. Err.	z	P>z
ha	0.2899342	0.0496223	5.84	0
rushingyards	0.0082159	0.0005902	13.92	0
qbrating	0.0255562	0.0010946	23.35	0
returnyds	0.0136471	0.0008061	16.93	0
penyds	-0.0065239	0.0009709	-6.72	0
fumlost	-0.3092113	0.0308486	-10.02	0
sackyds	-0.0230184	0.0022761	-10.11	0
puntyds	0.0016362	0.0003196	5.12	0
top	0.0846791	0.0066076	12.82	0
_cons	-5.617553	0.2318232	-24.23	0
Observations	4256	Psuedo R^2	0.4318	

The Probit model came out to be a sufficient one with a pseudo R^2 of 0.4318. Moreover, the model fit the data well enough that it was able to correctly predict the outcome of 82.03% of the games. All of the coefficients came out to be significant at 1%. The signs of the coefficient are as expected with positive movements in yardage enhancing the ability to win while negative movements in yardage decrease the ability to win. It also shows that penalties, turnovers, and sacks allowed are all detrimental to a team's ability to win. The two major special teams measurements, kick return yards and punt return yards, both increase chances of winning, but kick return yards have a greater effect. These two measures are indicative of a team's starting field position when they take possession of the ball. So in this case it is more important to have improved starting field position on a kick return than on a punt return.

Table 4: Wins Probit Model Marginal Effects

variable	**dy/dx**	**Std. Err.**	**z**	**P>z**
ha*	0.1152613	0.01959	5.88	0
rushin~s	0.0032776	0.00024	13.92	0
qbrating	0.0101953	0.00044	23.35	0
return~s	0.0054443	0.00032	16.93	0
penyds	-0.0026026	0.00039	-6.72	0
fumlost	-0.1233554	0.01231	-10.02	0
sackyds	-0.0091829	0.00091	-10.11	0
puntyds	0.0006527	0.00013	5.12	0
top	0.0337815	0.00264	12.81	0
Probability	0.5022			

The marginal effects of the model had a probability of prediction of 0.50229342, which shows that if two teams of average ability face each other they each have a 50% chance of winning. The base test also showed that scoring touchdowns and limiting turnovers had the greatest single change to the probability of winning. Other marginal effects tests showed some significant and interesting results. The aforementioned home field advantage increased a team's chances of winning by 11.5%. For every extra minute of time of possession the chances of winning a game for a team are increased by 3.3%.

Each single yard lost from allowing a sack only decreases a team's chances of winning by 0.9%.

Table 5: Marginal Effects w/ Increased Rushing Yards

variable	**dy/dx**	**Std. Err.**	**z**	**P>z**
ha*	0.1126609	0.01918	5.87	0
rushin~s	0.0032032	0.00022	14.58	0
qbrating	0.0099637	0.00043	23.42	0
return~s	0.0053206	0.00031	16.98	0
penyds	-0.0025435	0.00038	-6.72	0
fumlost	-0.1205531	0.01206	-10	0
sackyds	-0.0089742	0.00089	-10.04	0
puntyds	0.0006379	0.00012	5.12	0
top	0.0330141	0.00263	12.56	0
Probability	0.5849			

When holding all other variables at the mean value and increasing rushing yards to 140, to simulate an elite rushing game, the model predicted a win probability of 0.58490545. Thus, and elite rushing game increases a team's overall chance of winning, certis paribus, by 8.4%.

Table 6: Marginal Effects w/ Increased QB Rating

variable	dy/dx	Std. Err.	z	P>
ha*	0.1113916	0.01896	5.88	0
rushin~s	0.0031668	0.00023	14.01	0
qbrating	0.0098506	0.0004	24.77	0
return~s	0.0052603	0.00031	17.05	0
penyds	-0.0025147	0.00037	-6.73	0
fumlost	-0.1191854	0.0119	-10.01	0
sackyds	-0.0088724	0.00088	-10.04	0
puntyds	0.0006307	0.00012	5.13	0
top	0.0326395	0.00258	12.67	0
Probability	0.6035			

The most significant result of all was when the elite Quarterback numbers were input into the marginal effects. To do this a QB rating of 90 was used, which is considered the standard for elite Quarterbacks. The model showed that an elite Quarterback would improve a team's probability of winning to 0.603. So a team that drafted the right Quarterback would increase their chances of winning by 10.3%. For the two most important offensive skill positions, Runningback and Quarterback, the one that has the greatest impact on a team's chances of winning is the Quarterback by an extra 2% at the elite level.

Is this additional 2% worth the additional cost? In terms of compensation the top 25 highest paid Quarterbacks in 2009 made an average of $11.4 million dollars. The top 25 highest paid Runningbacks in 2009 made an average of $5 million dollars. The reason for the disparity is that teams carry more Runningbacks than Quarterbacks. Even teams that have elite Runningbacks have at minimum one extra to be a change of pace back. The punishment Runningbacks receive by carrying the ball makes them more injury prone. Also, the total number of rushing yards used in the model is from all players that ran the ball in a given game, which are usually two or more players. On the other hand all of the data from the Quarterback rating for each game came from the one player who throws the ball throughout the game. In sum, the total compensation paid is approximately equal between the two positions.

Now that it is established that a Quarterback is justifiably the most sought after and compensated player for an NFL team the question is can we accurately forecast a college Quarterback's success at the NFL level. Table 7 provides estimates of equation (2).

Table 7: DYAR OLS Model

dyar	**Coef.**	**Std. Err.**	**t**	**P>t**
rushydsatt	-16.37137	19.31702	-0.85	0.399
rushtdatt	2855.519	1701.103	1.68	0.096
passperc	2150.814	933.9346	2.3	0.023
ints	26.73792	10.00518	2.67	0.009
ints2	-0.3188908	0.1258034	-2.53	0.013
pass_yds	0.0629571	0.0405493	1.55	0.123
tds	-19.99482	6.520086	-3.07	0.003
tds2	0.0894806	0.0432036	2.07	0.041
weight	3.803235	2.643844	1.44	0.153
_cons	-2240.01	778.7976	-2.88	0.005
Observations	121	Adjusted R2	0.1759	

The fitness of this model can be called into question not just because of the significance of the variables, but also because of the adjusted R^2 which is 18.5. So this model only describes approximately 18% of the overall variation in DYAR. The missing variables for some of the 132 different Quarterbacks dropped the overall observations used in this model to 121. In the initial versions of the model there were problems with heteroskedasticity, so a robust standard error was used. Also some of the variables showed signs that did not intuitively make sense and so non-linear versions were used to make a better fit.

All but three of the independent variables used in this model were significant to at least 10%. Only passing touchdowns during the college career and interceptions thrown were significant at the 1% level. The overall completion percentage of passes during college and the squared versions of touchdowns and interceptions were all significant at 5%. The total number of rushing touchdowns in college was significant at 10%. The Quarterbacks average weight and college rushing yards per attempt are no significant. I left in the last two because, though their coefficients were not significantly different from zero, they did improve the adjusted R^2. This improvement to the overall fitness of the model convinced me to leave them in.

There were some interesting overall trends shown in the model as seen by the direction of interceptions and touchdowns. The number of college interceptions comes out to have a positive effect on NFL DYAR while college touchdowns have a negative effect on NFL DYAR. This seems counter intuitive since one would assume that doing positive actions such as throwing a touchdown would increase the chance of professional success and doing negative actions such as turning the ball over by throwing interceptions would decrease the chance of professional success.

However, based on the coefficients for interceptions and interceptions squared the positive influence of interceptions on DYAR peaks at 41.9 college interceptions. For Quarterbacks who have thrown 42 or more interceptions in their college career then you start to see a negative effect on DYAR as would be expected. One possible reason for this is that there are few instances of Quarterbacks with college interception totals in the lower ranges so it wouldn't have the most accurate initial effect. Also, those that throw lower totals may have not played nearly as much so their overall Quarterback statistics are lower.

Similarly, when examining touchdowns thrown in college the negative influence on DYAR peaks at 111.7 touchdowns. This shows that until a college Quarterback throws 111.7 touchdowns each touchdown throw will actually decrease his professional value. What makes this statistic so interesting is that the average number of touchdowns thrown over a college career by the players in this study was 51, less than half the peak number from the first order condition. This could be explainable that first at the lower levels, much like with interceptions, you are seeing Quarterbacks with less experience. Another possible effect is that Quarterbacks who throw average numbers of touchdowns have very little value in the NFL. Now the average number of games started by the players in the data set is roughly 35.5 games, so to get to the 111.7 they would have to throw roughly three touchdowns per game. The elite Quarterbacks in college regularly have games where they throw three or more touchdowns.

Two of the more significant coefficients in the model were the number of rushing touchdowns per attempt and the passing completion percentage. They are both not only significant in terms of their predictive ability, but also in the amount that they influence the dependent variable. The passing completion percentage is highly significant in previous studies and is found to be so in this model as well. In terms of predictive power it is significant at 5% and shows that for every increase in passer efficiency the player's professional value in terms of DYAR will increase by 2150.8. An NFL Quarterback would increase their average yearly DYAR by 2150.8 with just a small increase in efficiency. For the touchdowns per attempt we see that an increase of one touchdown per attempt will see NFL DYAR increase by 2855.5. Now the average number of touchdowns per attempt in the dataset is 0.04 so as to increase it by a total of one touchdown per attempt would seem impossible. Of the two statistics the one to focus on the most when evaluating a college Quarterback would be pass completion percentage.

Tables 8 and 9 provide estimates of the same basic model but include two variables that are thought to be significant in terms of player scouting. The two variables in question are the players Wonderlic test score and the total number of games played at the college level. The Wonderlic test is administered to draft eligible players months before the NFL draft. It is meant to determine a player's intelligence and is considered a key variable when scouting Quarterbacks. The second is number of games played and it is used to determine a players overall experience as a Quarterback. It has long been held by NFL scouts that the more a player starts, the better he will be able to handle the professional game. As can be seen from the new models neither are significant, despite what intuition may tell us.

Table 8: DYAR OLS Model w/ Wonderlic Score

dyar	Coef.	Std. Err.	t	P>t
rushydsatt	-20.12032	21.94248	-0.92	0.362
rushtdatt	1929.226	2009.446	0.96	0.34
passperc	3126.347	1191.397	2.62	0.01
ints	23.7935	13.57802	1.75	0.083
ints2	-0.2729324	0.1833343	-1.49	0.14
pass_yds	0.070483	0.0460486	1.53	0.13
tds	-18.81047	8.044436	-2.34	0.022
tds2	0.0733977	0.0493801	1.49	0.141
weight	7.465968	2.812061	2.65	0.01
wonderlic	-1.143088	4.734348	-0.24	0.81
_cons	-3575.109	898.5511	-3.98	0
Observations	93	Adjusted R2	0.1428	

As can be seen from this study the Wonderlic test score has no predictive ability regarding a Quarterbacks success in the NFL. In terms of anecdotal evidence this would seem obvious, as you see Quarterback greats, such as Dan Marino, score in the low teens. Just when glancing at the Wonderlic test scores aligned with the different Quarterbacks you can see there doesn't seem to be any obvious correlation. As the Wonderlic test score is insignificant, it also didn't add any predictive power to the model as the adjusted R^2 actually got smaller with its inclusion.

Table 9: DYAR OLS Model w/ Starts

dyar	Coef.	Std. Err.	t	P>t
rushydsatt	-15.38378	19.85292	-0.77	0.44
rushtdatt	2827.742	1909.053	1.48	0.142
passperc	2365.489	965.4586	2.45	0.016
ints	20.08674	11.20912	1.79	0.076
ints2	-0.1918429	0.1537185	-1.25	0.215
pass_yds	0.0364993	0.0471019	0.77	0.44
tds	-15.26383	7.552357	-2.02	0.046
tds2	0.0629773	0.0490804	1.28	0.202
weight	2.228905	3.070886	0.73	0.47
starts	2.164155	4.340385	0.5	0.619
_cons	-1999.312	802.0671	-2.49	0.014
Observations	112	Adjusted R2	0.054	

This last model uses the base model and only includes the added variable of number of college games played by the Quarterback. Though it is seen as an important statistic in terms of determining player experience it is shown to be insignificant in this model. As with the Wonderlic model it also had no added predictive power in the overall model as the adjusted R^2 got smaller. Unlike the Wonderlic, which has been shown to have little value previously, the start is still considered to be a highly reliable predictive statistic. One possible explanation for its failure in this model is that the other variables use total numbers, such as touchdowns, interceptions, and passing yards. All of these statistics are representative of total experience over a college career, and so the variation in DYAR that is explained by experience would be included there rather than in total games played.

Conclusion

The first model shows that the commonly held belief that the Quarterback is the most important player to the offense is accurate. These significant results show that the importance of drafting the right Quarterback can make or break a team's chances of winning. When the increased percent chances of winning are factored into a 16 game season the elite running back only improves an average team to 9 wins, which is only occasionally good enough to make the playoffs. An elite Quarterback's numbers on the other hand improve an average team's win total to 10, which only a small number of teams have missed the Playoffs with a ten win season. As previous works have shown the Quarterback position is highly valued so a poor draft pick on one could set back an NFL franchise by years. The model is not entirely complete as was seen by the number of variables. To fully utilize the salary cap era another few thousand entries need to be made to cover the 1994 to 1999 seasons. Also the model did not utilize the number of field goals made by a team. There have been instances where a team was outscored in touchdowns but won by the large number of field goals made. This could account for some of the 17.97% error rate in the models predictions.

The second model was not nearly as strong as the first, so though we know that picking the best Quarterback is essential, we still can't guarantee that it is possible with this model. It did have some explanatory power though and certain key variables, such as pass completion percentage, were identified. The problems in the model could very easily be attributed to the lack of quality data on the NFL Quarterbacks' performance during their college careers. The data had to be located for each individual Quarterback from a few different websites that document these numbers. There were even some examples of good Quarterbacks, such as Randall Cunningham and Tony Romo, that didn't have college stats available. Any subsequent study on this material should include the statistics on a larger collection of Quarterbacks. Another key issue is that the DYAR variable is only dated back to the 1993 season and so it is impossible to get a definitive career value variable. If all Quarterbacks used in the data set could have their DYAR for every season played it would make it easier to figure career value. Also there are some Quarterbacks used in this study that are currently playing in the NFL so their overall career value would still be incomplete in comparison to retired players.

A continuation of this study should not only include a more complete collection of the data used here, but should also use other observable variables. One possible new variable would be looking at spatial effects in regards to player value. The question here is, are players from different regions of the country more prone to success in the NFL as Quarterbacks. Possible ways to look at this variable are to use dummy variables based upon where the player came from, such as state or city. Another possible regional effect would be to use a dummy variable for which school they came from and if that has any bearing on their NFL success. If enough of a data set can be obtained then a comparison of concentrations of different players would be worthwhile in determining regional effects.

There is also the possibility of including other variables such as whether the Quarterback in question played in a pro-style offense in college and does that have any bearing on success. In college football you see types of offenses, such as the "option" or "run and shoot" and certain "spread" offenses that are not effective at the professional level and are not used. A dummy variable on whether they used a college or professional style offense could help determine whether that makes a difference.

Lastly there is the all the different scouting data that is compiled before the draft that could be used in this model. This includes different passing drills and measurable such as 40 yard dash time that college Quarterbacks are tested on during the NFL Combine or during their universities pro-day. The pro-days are conducted at the university in question where scouts run players through the same measurables as those at the NFL combine. These variables could also have some bearing at predicting overall Quarterback value at the professional level.

Overall this model had some decent predictive power to it, and the small amount of success it has indicates that there may be merit in pursuing the study further. Since the data set only looks at Quarterbacks that have played in the NFL there is the possibility of selection bias. A more complete data set including college Quarterbacks that were not drafted would allow for a Heckman model to compensate for the selection bias. With a more complete data set with a larger base of observations, and a few more added variables, a better model could be fit that would help NFL teams evaluate college Quarterbacks with a higher degree of success.

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