Predicting NFL Success in College Quarterbacks

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I. Intro

Growing up I was always into sports. As I got older my focus began to narrow on football. By the time I was in high school I was hooked, football had become my passion. Now as I complete college and enter the economics world I put a lot of thought into being able to combine my two passions. Luckily, the analytics movement that is running through the sports world is the perfect avenue to continue this exploration.

While analytics has its strongest hold in baseball currently since the advent of the movie "Moneyball", its impact on the game of football is steadily growing. Companies like Pro Football Focus and NFL Next Gen Stats by Amazon are fully committed to evaluating the game of football analytically from every angle, both at the college and professional level. However there is still an issue plaguing the sport both in the analytics and traditional camps, evaluators can't seem to figure out what makes a good quarterback in college a good quarterback in the NFL?

My project takes another shot at tackling this problem. There must be some set of player statistics that we can look at that can have some correlation with success in the NFL. I aim to find this correlation with statistical regression. With this technique we cannot prove direct causation, but we can determine levels of covariances that show correlation between a dependent Y variable and any number of X variables.

We need to define our Y variable first. What is success in the NFL? And how can we quantify it? Even further, regular measures of success like super bowl rings or MVPs are too dependent on any number of factors out of a Quarterback's hands that these are not easily quantifiable. Take the highest level of success in the sport, winning the Super Bowl. Why have some of the best quarterbacks in the NFL consistently place in the top 5 of NFL categories year after year but don't win super bowls? Because football is the ultimate team sport. Winning the ultimate prize is truly about the whole being more than the sum of the individual parts. Different teams win in so many different ways and quarterbacks have different levels on involvement in any given winning season. So basing a Quarterbacks success to a team accomplishment simply will not work. We need an objective quantifiable number that reflects how valuable an organization sees its quarterback to its teams success. For the purpose of this paper, that number is the Annual Value of a Quarterbacks second contract in the NFL

Let's break this down and explain why this number will be used. First and foremost, the contract a team gives to their player is the most basic measure of their perceived value to the organization. And since teams are (mostly) free to sign their players to any terms they can agree on, the contracts offered and sign are a good reflection of how good or bad the team thinks a player is at his job. But why the second contract? A couple reasons, first and foremost, no matter how good a player was in college or how good a team projects him to be as a rookie his contract is based on a sliding scale of his draft position. So there is no liberty to measure this by. The second contract eliminates these problems. Should a player make it to the second contract, he has proven that he's been successful in the league and up to this point the team made a good decision

to draft him. Furthermore, since the team and player are free of the contract restrictions that the rookie deals come with, the contract value is a good measure of just how "successful" a player has been in the NFL. Thus our Y variable is the annual value of the second contract, given that he has made it to free agency or the second contract by playing throughout the entirety of his first one.

If we are talking about a Quarterbacks second contract, why then are we regressing them on his college statistics? For a few reasons but the main thinking is this, if I am a GM on draft day, what statistics can I look at that will translate to being a good investment for my team in the long run. Teams are taking flyer on players when they draft them since they have no idea how god they will actually be once they're at the professional level. But once they make it to the second contract they've proven their worth and that their draft selection was a good choice, now being rewarded with the long term deal that every NFL draftee covets. And we look at college statistics to project from college whether a player is a long term solution, or whether he'll flame out after a few years in the league.

II. Literature Review

What, if anything has been written about this topic already? Both David J. Berri and Rob Simmons (2011) took a similar approach to this same question that really helped frame my viewpoint and focus my approach. Their main regression is NFL Performance =B0+B1Height+B2BMI+B3BMI^2+B4Wonderlic+B540-yddashtime+B6 Dummy for non D-1A QB+B7Collegeperformance. Where "Performance" is measured as Win Produced per 100 plays; QB rating;Completion Percentage;Interceptions Per attempt; and passing yards per attempt. This

was the only paper that aimed to answer my direct question. But the fact that they took a different approach shows that the question and methods to try and answer it are valid. Their regression is not the same as mine but does use some of the same variables. Their regression could not find statistically significant variables and makes mention that a lot of evaluation comes down to “intangibles” like leadership and the ability to perform under pressure.

Nelson Chung (2016) from BYU documented his schools approach to introducing analytics into its football program. His findings at one of the most “old-school” programs in the nation showed that there is in fact benefit to be gained from analytics such as “objective tools for evaluating team performance, the importance of a long-ignored position, and factors affecting recruiting”. Without analytics the BYU football program might have fallen into obscurity even though they clearly had the talent and coaching around to keep them relevant in the football landscape. If a school like BYU can benefit from it other programs can too.

A little bit of a tangential approach was taken by WJ Hurley, A Pavlov and W Andrews (2012). They don’t seek to use analytics to evaluate performance, they set to turn the valuation of the actual draft slots upside down. Most teams go off “the chart”, a table that equates different draft slots for comparison when it comes to trading up or down draft spots on draft day. However they found that the chart was wildly inaccurate when taking into account the actual number of games played by players drafted in their given positions. They made a new chart and while it has not been put in use, it does go to show that NFL GMs are miscalculating the importance of reaching for players at certain draft spots. This could cause GM’s to reach for players they may

not feel strongly about or pass on players they do simply because their projected draft spots don't align.

My last two papers focus on analytics as they relate to team successes. Wayne L. Winston (2009) used regression analysis to predict which team variables contribute most to wins and losses. Using things like pass yards per attempt or penalty differential they regressed a teams season scoring margin on their set of variables. They found statistically significant results on all their variables. This gives me confidence that regression analysis is indeed a valid method of evaluating performance in football. If it works at the team level, there must be something we can find at the individual level that will prove to be significant.

The last paper used analytics to find that a good head coach can account for an extra three to four more wins than an equivalent team with an average coach. Lawrence Hadley, Marc Poitras, John Ruggiero and Scott Knowles (2000) used a Poisson regression to come to this conclusion. This contributes to my paper because a the impact of a coach is probably the most immeasurable thing one has. They don't play, they don't collect stats, they don't throw or run the ball. All they account for are the wins and losses a team attains. So even though they used a different regression model, the fact that they were able to measure individual intangible performance means that there must be a way for me to do it as well.

III. Data

My data comes from three main sources. www.Spotrac.com is a website that has contract information for every player from all the major sports. This is where we get the value for every Y_i. www.sport-reference.com contains statistics from every sport for which they have recorded stats. This is where we get the all the X_is as they pertain to the observable statistics that we will use to find correlations to success in the NFL. The variables in this case are a QB's aggregated statistics for his entire career

	Name	YearlyAmountofSecondContract	GamesStarted	Cmp	Att	Pct	Yds	YA	YASquared	TD	Int	Big12
1	Mitchell Trubisky	2500000.0000	31	386	572	67.500000000	4762	8.3000000000	68.890000000000001	41	10	0
2	Patrick Mahomes	50300000.000	32	857	1349	63.500000000	11252	8.3000000000	68.890000000000001	93	29	1
3	Deshaun Watson	44375000.000	38	814	1207	67.400000000	10168	8.4000000000	70.560000000000000	90	32	0
4	DeShone Kizer	.0000000000	25	422	695	60.700000000	5805	8.4000000000	70.560000000000000	47	19	0
5	Davis Webb	.0000000000	35	841	1367	61.500000000	9852	7.2000000000	51.840000000000000	83	34	0
6	C.J. Beathard	2500000.0000	40	454	782	58.100000000	5562	7.1000000000	50.410000000000000	40	19	0
7	Joshua Dobbs	.0000000000	37	614	999	61.500000000	7138	7.1000000000	50.410000000000000	53	29	0
8	Nathan Peterman	.0000000000	35	398	662	60.100000000	5236	7.9000000000	62.410000000000000	47	17	0
9	Brad Kaaya	.0000000000	38	720	1188	60.600000000	9968	8.4000000000	70.560000000000000	69	24	0
10	Chad Kelly	.0000000000	27	513	803	63.900000000	6858	8.5000000000	72.250000000000000	50	21	0
11	Jared Goff	33500000.000	37	977	1568	62.300000000	12195	7.8000000000	60.840000000000000	96	30	0
12	Carson Wentz	32000000.000	42	392	612	64.100000000	5115	8.4000000000	70.560000000000000	45	14	0
13	Paxton Lynch	.0000000000	38	758	1205	62.900000000	8863	7.4000000000	54.760000000000001	59	23	0
14	Christian Hackenberg	.0000000000	38	693	1235	56.100000000	8457	6.8000000000	46.240000000000000	48	31	0
15	Jacoby Brissett	15000000.000	39	499	839	59.500000000	5723	6.8000000000	46.240000000000000	46	15	0
16	Cody Kessler	.0000000000	51	851	1261	67.500000000	10339	8.2000000000	67.240000000000000	88	19	0
17	Connor Cook	.0000000000	43	673	1170	57.500000000	9194	7.9000000000	62.410000000000000	71	22	0
18	Dak Prescott	40000000.000	49	734	1169	62.800000000	9376	8.0000000000	64.000000000000000	70	23	0
19	Cardale Jones	.0000000000	23	166	269	61.700000000	2322	8.6000000000	73.960000000000000	15	7	0
20	Kevin Hogan	.0000000000	51	727	1103	65.900000000	9385	8.5000000000	72.250000000000000	75	29	0
21	Nate Sudfeld	.0000000000	38	593	983	60.300000000	7879	8.0000000000	64.000000000000000	61	20	0
22	Jake Rudock	.0000000000	38	666	1080	61.700000000	7836	7.3000000000	53.290000000000000	54	27	0
23	Brandon Allen	.0000000000	42	583	1016	57.400000000	7463	7.3000000000	53.290000000000000	64	26	0
24	Jeff Driskel	.0000000000	42	607	1000	60.700000000	7437	7.4000000000	54.760000000000001	50	28	0

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Yearly Amount of Second Contract	120	.0000000000	50300000.0	5828712.51	10951211.7
Games Started	118	20	55	39.56	8.058
Cmp	131	166	1403	693.08	225.355
Att	131	269	2183	1110.79	340.438
Pct	131	.580000000	70.4000000	60.7966680	10.0076111
Yds	131	2322	16646	8675.83	2682.378
Y/A	131	6.30000000	10.0000000	7.84394974	.804730968
TD	131	15	131	65.85	24.872
Int	131	7	60	27.65	10.538
Valid N (listwise)	118				

IV. Regressions

The first and main regression that we start with in trying to find any insights is Yi=B0+B1Comp+B2Pct+B3Yds+B4TD+B5Int+B6Big12+B7SEC+B8ACC+B9Pac-12+B10Big 10+E. The first five variables are the main stats that Quarterbacks are judged at any level. How many times they complete a pass, their overall percentage, how many yards touchdowns and interceptions they throw for are the main measures of Quarterback success. The next 5 variables are dummy variables for the conference in which they played in college. To avoid the dummy variable trap I left out the dummy for playing in a non-power 5 conference.

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	176457.407	7560554.166		.023	.981
	Cmp	2088.056	19515.250	.044	.107	.915
	Pct	47995.866	119800.867	.040	.401	.689
	Yds	-169.538	2051.660	-.042	-.083	.934
	TD	115134.677	103708.155	.269	1.110	.269
	Int	-217674.040	140789.328	-.226	-1.546	.125
	Big 12	1670556.830	3553904.564	.050	.470	.639
	SEC	560599.708	3139775.795	.020	.179	.859
	ACC	2454090.811	3043140.533	.088	.806	.422
	PAC-12	1589738.423	3212105.981	.054	.495	.622
	Big 10	472082.282	3404503.249	.015	.139	.890

a. Dependent Variable: Yearly Amount of Second Contract

Parameter	B	Std. Error
(Intercept)	176457.407	2938966.58
Cmp	2088.056	13994.1466
Pct	47995.866	49181.4658
Yds	-169.538	1676.8253
TD	115134.677	97986.6905
Int	-217674.040	116754.8423
Big 12	1670556.830	4146379.54
SEC	560599.708	3115936.89
ACC	2454090.811	2993680.72
PAC-12	1589738.423	2952445.67
Big 10	472082.282	2748602.85
(Scale)	9.975E+13[a]	1.2987E+13

As you can see, my regression did not yield any statistically significant results, even when accounting for robust standard errors. The closest variables that came close were touchdowns and interceptions, which led me to my next inquiry.

My intuition told me to then just regress the Contract amount on Touchdowns and interceptions. This time I did achieve statistically significant results. When accounting for just Touchdonws and interceptions there is a statistically significant correlation to future success in

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	5001307.327	3132846.670		1.596	.113
	TD	111468.751	45492.991	.248	2.450	.016
	Int	-232591.002	102415.396	-.230	-2.271	.025

a. Dependent Variable: Yearly Amount of Second Contract

the NFL. For every touchdown a QB throws in his college career he can expect an extra $111,468.75 per year in his second contract should he make it to that point. For every interception thrown however he can expect to lose $232,591 per year on his second deal.

But this is across the board regardless of the teams said Quarterback played against. So next I decided to control for competition. The SEC has long been considered the NFL's "9th division" because of how good it is year in and year out. The athletes there are bigger stronger and faster than the rest of the country. Since the BCS era in 2001 there have been 24 National champions, the SEC has 14 of those including the last three in a row. Meanwhile no non-power 5 conference has won and the pac 12 only has one. So there must be a difference in touchdowns thrown against the likes of Alabama vs Touchdowns thrown against the likes of Oregon State. Unfortunately that is not the case. While touchdowns and interceptions remain statistically significant, all of the conferences are not. Still the only significant statistics that a GM can look at when evaluating a quarterback are his touchdowns and interceptions.

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	2723820.557	3721160.447		.732	.466
	Big 12	1920239.114	3439216.640	.058	.558	.578
	SEC	715567.641	3021860.884	.026	.237	.813
	ACC	2688133.124	2941016.135	.097	.914	.363
	PAC-12	1870269.453	3088777.132	.063	.606	.546
	Big 10	635091.219	3334092.133	.020	.190	.849
	TD	119481.736	45788.466	.279	2.609	.010
	Int	-219906.957	102481.263	-.229	-2.146	.034

a. Dependent Variable: Yearly Amount of Second Contract

Let's now back up a little bit. Up to this point I have tried to answer the question of what makes a quarterback in college successful in the NFL. I've gone about this issue by using regression analysis and trying to figure out what Beta's will explain my Y. But I have not done the traditional method of picking one "main" Beta1 and trying to remove bias from that single variable removing secondary betas from the error term and putting them in my regression. My main reason for that is because I believe that all the variable thus far have similar if not equal weights when predicting success. But this creates a problem for my 2 stage least squares regression I would like to run.

This is where I introduce a new variable that I believe if I had to pick only one, would be the best predictor of success: Games Started. For any player but especially a quarterback, you need a certain number of reps at a given level before you are ready to move on to the next one. It does not matter whether is Pop Warner, high school, or college. You need to get reps in at the level you're at over and over again to get that game experience and mastery before you can be good enough to move up. As famed author Malcolm Gladwell popularized "it take 10,000 hours of intensive practice to achieve mastery of complex skills and materials.". Obviously no one will

achieve 10,000 hours before moving on to a given level but if we take "mastery" as being successful in the NFL then 10,000 hours on the way to that point starting from youth is not out of the question. So, the more reps you get in at a given level the more prepared you will be when you move on to the next.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	6286996.351	4873244.189		1.290	.200
	Games Started	-18299.072	120729.863	-.014	-.152	.880

a. Dependent Variable: Yearly Amount of Second Contract

These results are surprising, not only is my variable statistically insignificant, but it is negative as well. Let's pause for a minute and just assume that it is in fact statistically significant. What then does it mean that the Beta coefficient is negative? The only explanation that I can come up with is that recently more and more players are drafted as underclassmen either leaving after their third playing year or second playing year if they took a redshirt. If you end up playing through all four years you probably just weren't good enough to go to the NFL because of you were you would have left as soon as you are eligible, so staying and playing your senior year becomes something that you do because once you leave your school your football career is over. But again, the results are insignificant so this is purely speculation.

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I do think however that I have a bias problem. Football is an extremely qualitative sport, regardless of how much we try to bring analytics into it. One huge factor that is biasing both how much money he makes and how many games a quarterback will start is how athletic he is.

There's a reason why Lamar Jackson' archetype is taking over the league while the Tom Brady's and Peyton Manning's are slowly being phased out. However, I do not think that athleticism in and of itself have direct links to Quarterback success. The most athletic players on the field are rarely quarterbacks, but quarterbacks who are athletic tend to do better than ones who are not. But what determines "athletic", and how do we quantify it? This is another one of those things where we try to quantify a qualitative measure.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Height	115	70.63	79.13	75.2438	1.58363
Weight	115	195	253	224.74	10.346
40 yd dash	107	4.33	5.24	4.8182	.17048
Vertical Jump	96	21.5	39.0	30.927	3.3662
Broad Jump	97	99	126	111.38	6.701
5-10-5 Shuttle	97	3.98	4.68	4.3252	.15572
3 Cone	93	6.66	7.65	7.0952	.21144
Valid N (listwise)	88				

I used a two-staged least squares regression model to try and remove the bias that athleticism will have on the number of games started. To do this I will use our combine stats recorded from each quarterback (Ht,Wt, 40, 3 cone, shuttle) as instruments to remove the bias from games started. All other things equal, a more athletic quarterback should start more games in college. When comparing skillsets, the athlete who is bigger, faster, and/or stronger than his counterparts will get more reps in practice and should get more reps on the field. But that is not to say that athleticism has a direct correlation to our Y variable and should be included in the

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	35984111.2	52049541.19	0.69134348	0.4913511	-67597777	139565999	-67597777	139565999
Predicted Ga	-905585.45	951750.8887	-0.9514942	0.34421946	-2799630.1	988459.183	-2799630.1	988459.183
Cmp	-6803.3997	36460.93683	-0.1865942	0.85245118	-79362.976	65756.177	-79362.976	65756.177
Att	-668.90996	40865.21893	-0.0163687	0.98698102	-81993.287	80655.4674	-81993.287	80655.4674
Yds	371.055219	5107.255287	0.07265257	0.94226393	-9792.7067	10534.8171	-9792.7067	10534.8171
Y/A	230129.935	4710105.667	0.04885876	0.96115363	-9143279.1	9603538.93	-9143279.1	9603538.93
TD	199338.751	134338.2341	1.48385717	0.14177618	-68002.855	466680.357	-68002.855	466680.357
Int	-227529.03	205420.4883	-1.1076258	0.27134262	-636328.83	181270.772	-636328.83	181270.772

regression. Athleticism is an auxiliary variable that helps explain why a quarterback will start more games, but a more athletic player in and of himself will not be more successful. Michael Vick was one of the most athletic quarterbacks of all time, and Tom Brady one of the least. But one look at their respective resumes is all you need to see to know that athleticism has no direct correlation on NFL success. Using this 2 stage least squares model, with all the combine stats as instruments for games started and then using the predicted games started variable back in my original regression I was still not able to find any statistically significant results.

V. Conclusions

So what conclusions, if any can we draw from this? First and foremost it seems that from the most common measures of statistical success in college, there is no way to predict success in the NFL, at least not in the way in which we have defined it here. Taken on their own, touchdowns and interceptions have statistical significance, but this decreases drastically when trying to control for other factors that affect Quarterback play.

This pumps the brakes a little bit on the analytics movement that is taking over the sports world. Regression analysis is by no means a simple or easy science, but one would believe that we should be able to find some direct links between certain variable that seem to have obvious connections like we do in other disciplines (e.g. wages and education). The fact that the most commonly recorded statistics across the board could only find two connections to success goes to

show just how far we still need to go before analytics becomes the norm in the NFL. Maybe good quarterback evaluation really comes down to the “eye test” and evaluation from film study and in person workouts. This paper focuses on quarterback success, but taking a step back and looking at team success as a whole, Nick Saban and Bill Belichick are far and away the most successful football coaches in their respective levels and they are both self-proclaimed very old-school. Between them they have 12 Championship rings to their names. They have been very outspoken on their aversion to introducing analytics into the game of football and this just gives them and everyone else in the “old school” camp more ammunition against the new school.

VI. Reflection and next steps

So now what? Where do we go and what do I wish I could have done different. First and foremost I wish I was able to collect more intangible data. Things like release time, or ball velocity or how quickly a Quarterback can make his reads are just some of the things that I believe have more effect on a Quarterbacks success than the ones discussed in this paper. However, these are just not easy to get. Not only does every team not even record these metrics, the ones that do rarely publish them. If budget was not an issue I also would like to have collected data from sources like pro football focus or NFL next gen stats. These are the two companies at the forefront of the analytics movement and they have many different numbers to look at, however they require paid subscriptions that were beyond the scope of this class. The biggest weakness of this paper is that the stats I used are so basic. Yes I did expect to find some statistical significance in even the most basic of statistics but football being a team sport there is just so much in that error term that is hard to remove because to be honest, I’m not even sure we even know where to look. I will call my two significant variables strengths however. If nothing

else I can give this message to GM's everywhere: when comparing two similar quarterbacks in similar draft spots on draft day, pick the one with a better TD/INT ratio. You will literally get a better return on your investment.

Appendix

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