AN EXTENSION OF THE MASSEY-THALER SURPLUS VALUE APPROACH: THE ROLE OF VARIATIONS IN POSITIONAL WAGE MARKETS ON THE EFFICIENT VALUATION OF NFL DRAFT PICKS

by

Peter D. Smith

Submitted to the Distinguished Majors Program

Department of Economics

University of Virginia

April 15, 2019

Advisor: Ken Elzinga

Abstract

It has been over a decade since economists Massey and Thaler shocked the football world with their finding of inefficient behavior among draft decision makers in the National Football League. In the following paper, I test whether this finding still holds up under modified methodology and with improved player performance metrics. Additionally, I test for further inefficiencies based on differences in the relationship between player performance and compensation across playing positions and develop formulas to equate the value of performance across positions. Finally, I attempt to determine whether the current design of the draft could ever result in strictly decreasing draft pick value as the draft was designed to do. In my analysis, I find that draft decision makers not only incorrectly value their draft picks, but also fail to properly account for differences in positional wage markets when evaluating draft prospects. Furthermore, the draft itself seems to be fundamentally flawed in its design, as even if general managers are perfect decision makers, the value of draft picks is still not strictly decreasing in terms of draft order.

Acknowledgments

I would first like to thank my advisor, Professor Ken Elzinga, for his guidance and assistance in this process, as well as Professor Amalia Miller for her work in preparing me to undertake this journey. Additionally, I am indebted to Cade Massey and Richard Thaler for inspiring this paper with their invaluable contributions to the world of sports economics. Finally, I am grateful for my peers in the Distinguished Majors Program who proved to be a constant source of help and positive reinforcement.

I. Introduction

Super Bowls may be played in February, but the groundwork for success or failure is often determined by general managers in Aprils of years past at the annual National Football League (NFL) player draft. In recent years, NFL analysts have come to believe that the addition of a quality quarterback on a rookie contract can quickly propel a team to sustained success. This phenomenon is illustrated by the rapid emergences of the Seattle Seahawks, Los Angeles Rams, and Philadelphia Eagles as Super Bowl contenders following the teams' drafting of a starting caliber quarterback.[1] The rationale behind such thinking is based on exploiting differences between the rookie and veteran wage markets for quarterbacks in order to gain a competitive advantage by drastically underpaying for the most valuable asset in the sport: a quality quarterback. It appears as if draft decision makers have begun to understand, at least in part, that the true value of draft picks comes from their below market contracts. But how well have NFL general managers come to understanding how to properly account for the differences in positional wage markets when ranking draft prospects across different positions? NFL decision makers have time and time again seemed resistant to changes to conventional norms, regardless of the quality of evidence in favor of such a change. For example, Romer (2006) analyzed whether or not NFL coaches maximized their probability of victory through their decision making on fourth down.[2] He came to the conclusion that they do not, as attempting to advance the ball on fourth down yields a higher expected utility than choosing to punt or attempt a field

[1] The Seahawks drafted Russel Wilson in 2012 before winning the Super Bowl in 2013 and reaching it again in 2014. The Rams and Eagles drafted Jared Goff and Carson Wentz respectively with the first and second overall picks in the 2016 draft. The Eagles went on to win the 2018 Super Bowl, while the Rams advanced to the 2019 Super Bowl before losing.

[2] In the NFL teams have four downs to advance the ball ten yards or else possession shifts to the other team. Typically when a team reaches 4th down they will punt the ball to the other team or attempt to kick a field goal instead of trying to advance the ball as a punt will yield much worse field position to the opponent than failing to advance on 4th down.

goal more often than coaches' actual decision-making would suggest. In recent years, coaches have seemed to become more aggressive on fourth downs, although not anywhere to the extent Romer's analysis would advise. If coaches are slow to change inefficient decision making biases, then general managers may be as well.

Econometric analysis is useful in evaluating NFL decision making because of the League's unique labor structure. The interactions between firms, NFL franchises, and the labor, NFL players, is set by the Collective Bargaining Agreement (CBA), which is agreed upon by the NFL Players Union and the team owners. The current CBA was signed in 2011 and will last until 2021. One of the key provisions of the CBA is a salary cap restricting team spending on player wages. Unlike in some professional sports, such as baseball, this is a hard cap, meaning teams cannot spend even a dollar over the cap on player wages. The CBA also necessitates that a team spend at least 89% of the cap over a four-year period, although most teams spend closer to the maximum. Under the 2011 CBA, the salary cap is calculated as a percentage of the league revenue and rises proportionally as revenue does.[3] With the salary cap and floor in place, it is safe to assume that, when spending on player wages, teams are most concerned with how signing a player affects their probability of winning the Super Bowl, not only because this is the assumed goal of all NFL teams, but also because better performance typically leads to more team revenue. Even if a franchise values monetary profits more than team success, salary costs are relatively set, so the best way to maximize profits through roster construction is to maximize the probability of success. The salary cap essentially creates a system in which it is impossible to gain a competitive edge by outspending other teams. Hence, there is an opportunity cost to signing any player, as that cap space can no longer be used to make the team better elsewhere.

[3] Before the 2011 CBA the salary cap was not tied to league revenue.

Another feature of the CBA meant to protect competitive balance among teams is that the rights to employ new labor entering the League, typically college football players, are restricted by a seven round draft. In the draft, the thirty-two NFL franchises select the rights to employ certain players based on reverse order of their win-loss records in the previous season, with one draft pick allocated to each team per round.[4] The NFL instituted the draft to help maintain competitive balance in the League by theoretically providing the worse performing teams with an advantage in acquiring new labor talent. An important change in the 2011 CBA was the institution of a rookie wage scale, which effectively provides a set wage and contract length for all rookies based on their selection number in the draft. Previously, a rookie had the ability to negotiate the terms of his contract with the team that drafted him.[5] The rookie wage scale creates the opportunity to gain high-level talent at below the market rate, as, after the draft, rookies are locked into four-year contracts with no ability to renegotiate until the term of the contract ends.[6] Conventional NFL wisdom follows the long-held idea that the relative value of draft picks decreases exponentially as the draft progresses. Commonly accepted draft pick values are illustrated in the Jimmy Johnson Draft Chart, as seen in image I in the appendix. Former Dallas Cowboys head coach Jimmy Johnson created this chart in the 1980's to estimate the relative value of draft picks and similar charts are still used by numerous NFL franchises. The values assigned to draft picks have no meaning in a vacuum and only matter relative to one another. The chart indicates that the 1st pick in the draft is worth three times as much as the 16th pick and that a fair trade for the 1st overall pick would be the 3rd and 21st overall picks or the 23rd, 46th, and 60th

[4] There are sometimes rounds in NFL drafts with more than 32 draft picks due to the awarding of compensatory draft picks. The presence of compensatory draft picks does not alter any of the analysis.
[5] If a rookie does not sign a contract with the team that drafted him he must sit out the season and then can re-enter the draft the following year, although not signing a rookie contract is almost unheard of.
[6] First round contracts include a 5th year team option, although this 5th year carries a higher cap hit than the previous years, mitigating much potential for additional surplus value.

overall picks. If players are not selected in the NFL draft, any team is free to employ them, which helps to explain why the Chart places such little value on late draft picks.

Contracts for NFL players tend to be composed of guaranteed and unguaranteed compensation. Guaranteed compensation means that the teams are required to pay the player that amount regardless of if he is cut from the roster before the end of the contract or suffers an injury, while unguaranteed compensation means that the player is only entitled to that money if he completes the terms of the contract. A Harvard study estimated that only 44% of NFL contracts are guaranteed, which is a major difference compared to other American sports leagues where contracts are almost all fully guaranteed.[7] While NFL contracts are typically reported as a combination of the guaranteed and unguaranteed portions of the deal, in reality, the real value of the contract is only the guaranteed portion, while the unguaranteed portion can be thought of as a team option. The unguaranteed nature of NFL contracts minimizes the risk of signing a player to a large contract and that player underperforming, as teams can terminate the deal early and free up the salary cap space to use on attracting and paying other players.

II. Literature Review

Massey and Thaler (2013) examined the efficiency of decision making among NFL general managers through an examination of draft pick valuation. Based on an analysis of how to properly value relative draft picks, the authors concluded that general managers behave inefficiently. The outcome of inefficient decision-making may not be too shocking in light of Romer's analysis, but the extent of the inefficiency is. The authors found a massive gap between what their model would advise and what the empirical evidence demonstrtated general manger

[7] https://deadspin.com/why-only-the-nfl-doesnt-guarantee-contracts-1797020799

behavior was. Moreover, their model claimed that picks at the beginning of the first round were actually less valuable than picks at the end of the first round or the beginning of the second round, and that the first overall pick had only marginally more value than the last overall pick.

Massey and Thaler reached their conclusions through an analysis of average surplus value by draft position. They define surplus value to be the difference between what a player's performance dictates his pay would be on the open market, which Massey and Thaler call his "performance value," and what his compensation is under his contract. Performance value is determined based on a non-linear regression analysis of the relationship between performance and wage for NFL veterans, as seen below. Cat_ñ is the weighted value of performance over the previous five seasons, I^P is a vector for playing position, and I^T is a vector for experience.[8]

$$Log(Comp_{i,t}) = \alpha + B Cat\_\tilde{n}_{i,t} + \Pi I_i^P + K I_{i,t}^T + \varepsilon_{i,t},$$

In order to measure player performance, Massey and Thaler split players into five categories based on statistics related to whether a player is employed by an NFL team, the number of games they start, and all-star selections. Once they estimate the parameters of this regression equation, they use it to determine the performance value of rookie players and subsequently calculate the surplus value of rookies. Their results can be seen in images II and III, provided in the appendix. Image II shows their calculation for average rookie performance value, compensation, and surplus value by draft pick position. Both performance value and compensation are strictly decreasing exponential functions, while surplus value increases for a period before becoming strictly decreasing. Even though it is true that the earlier a player is drafted, the more performance value he is expected to yield, players drafted earlier also

[8] Experience was found to be statistically insignificant in the regression.

command a larger wage, so there is a greater opportunity cost associated with higher draft picks. The higher opportunity cost of employing earlier draft picks explains why the surplus value function begins as increasing. Image III illustrates the difference between how NFL general managers value draft picks relative to the first overall pick, as determined by an analysis of draft pick trades that have taken place, and the relative value of draft picks based on the average surplus value they produce.

Massey and Thaler attempt to control for differences in the correlation between quality and compensation among positions with a dummy variable for player position, but different positions may need totally different models given the vastly different relationship between compensation and performance across playing positions. Provided below are some examples of salaries of different position groups to illustrate, taken from Spotrac.com. These examples illustrate that the NFL likely does not consist of a single wage market for talent, but rather is composed of a collection of smaller wage markets for talent at each position.

5th Highest Paid Player in Position Group	20th Highest Paid Player in Position Group
Quarterback- $27 Million per Year	Quarterback- $15 Million per Year
Running Back- $8 Million per Year	Running Back- $4 Million per Year
Defensive Back-$14 Million per Year	Defensive Back-$10 Million per Year
Defensive Lineman-$17 Million per Year	Defensive Lineman-$13 Million per Year

There are two major effects of the varied positional wage market that Massey and Thaler's model may not address accurately. The first is their calculation of the relationship between performance and market wage. The relationship between performance and wage may differ significantly by position with such varied wage markets. The second is the potential surplus of draftees by position. Rookie salaries are determined by draft slot, regardless of the

position the rookie plays, but there is clearly great discrepancy between what top players make at each position. Therefore, the potential surplus value a rookie can produce differs by playing position and, consequently, playing positon should be taken into account accordingly when deciding which player to draft. One would expect that differences in potential surplus would lead to differences in average surplus of a draft pick by playing position. Moreover, McCann and Paine (2015) showed that certain positions are more likely to meet the expectations of their draft position than others. Their results are shown in image IV in the appendix. McCann and Paine determined the average approximate value, a player rating metric developed by Pro-Football-Reference, a player selected in each round produced over his first five seasons in the NFL and compared that with the average approximate value produced by players chosen with the same pick. The dots in the shaded area mean a player selected in that position and round produces on average more approximate value in his first five seasons than players selected in that round as a whole. The dots in the non-shaded areas signify the reverse. Defensive backs, offensive linemen, and linebackers tend to perform above average, while quarterbacks, wide receivers, and running backs are less likely to meet the expectations of their draft position. With the probability of a rookie outperforming his draft position related to the position he plays, the average surplus value by position is likely to be affected also.

Borghesi (2008) examined cap allocation within the NFL and found that increased income inequality among a team's players correlates with worse team performance. This conclusion points to the importance of effective cap allocation to team success. The ability of players to increase their compensation through improved performance is directly related to their current levels of compensation, with lower compensated players able to experience much larger returns to performance than those with higher levels of compensation (Leeds and Kowalski

2001). This disparity in returns to performance points to a potential for superstar players to remain underpaid relative to their performance in the market equilibrium. Research in the correlation between player salaries in the National Basketball Association (NBA) and team success has demonstrated that NBA superstars are likely underpaid (Paine 2015). However, the NBA has maximum player salaries, while the NFL does not, so the underpayment of NBA superstars could be a function of a restriction on maximum salaries as opposed to a trend in professional sports for top players to be underpaid relative to their contributions.

III. Data and Methods

My data is drawn almost exclusively from two sources. The first is Spotrac.com, which provides the contract data for both the veteran and rookie samples. Rather than using the contract data in terms of dollar amounts as Massey and Thaler did, I have chosen to convert the dollar amounts to the percentage of the yearly salary cap that a player's wage constitutes. Given that after the institution of the 2011 CBA the cap has risen drastically each year, an increase of about 5-8% per year, using cap percentage makes more sense than dollar wage as a $2 million contract carries a different opportunity cost in 2012 than in 2018. On the other hand, a 2% cap hit in 2012 means the same as a 2% cap hit in 2018. For the purposes of this paper, a player's cap hit will be defined as (Wage)/(Total Cap). The second source is Pro-Football-Focus (PFF), which provides data on player performance. Player performance is measured in terms of player grade, a metric devised by PFF that equates the value of performance across various positions into one statistic for all positions. Player grades also attempt to distinguish individual contribution from team

success.[9] I believe player grade to be a superior metric for analysis than the categorical metrics Massey and Thaler used, as player grades allow for improved accuracy in evaluation and make subtler performance distinctions.

The general structure of my methodology follows that of Massey and Thaler rather closely. My estimations for the relationship between performance and compensation are calculated through a regression analysis of the sample of NFL players age 26 or older from 2011-2018 NFL seasons, those governed by the current CBA.[10] I chose 26 as the age cutoff since most players enter the NFL at age 21 or 22, so by age 26 an athlete should have completed the four seasons under his rookie contract.[11] The players are then split into ten position groups: quarterback (QB), running back (RB), wide receiver (WR), tight end (TE), guard/center (G/C), tackle (T), defensive end (DE), defensive tackle (DT), defensive back (DB), or linebacker (LB). Guards and centers are grouped together because they are the interior offensive line positions and, as such, are compensated similarly. Ideally I would be able to split linebackers into outside and inside linebackers and defensive backs into cornerbacks and safeties, but I cannot because draft prospects are listed as defensive backs or linebackers without further distinction.[12] The performance statistic is a five year weighted average of player grade, with more recent years weighted more heavily. The most recent year has a multiplier of 1, with the multiplier decreasing each subsequent year by a value of .2. I tested various levels of memory decay and settled upon

[9] Traditional statistics do nothing to distinguish between a ten yard completion to an open receiver and a ten yard completion in a tight window on third down, even though the latter is much more impressive than the former.
[10] Any players who post player grades of zero as their five year weighted average were removed from the data set to prevent the presence of a clustering at zero from skewing the results. Kickers and punter are also excluded from the data set.
[11] Some may be concerned about the relevancy of recent performance on wages for players in the sample who are in the later stages of their contract, however the unguaranteed nature of NFL contracts allows for this methodology. Since the back end of contracts tend to have very little, if any, guaranteed money associated with those years, teams should, in theory, cut players whose performance is not living up to their contract.
[12] This limitation will affect the results, as in my analysis I find safeties are compensated at a higher rate than cornerbacks and outside linebackers are better compensated for their performance than inside linebackers.

this yearly weighting because it best fit the data based on the adjusted R squared values. The regression equation is provided below.

$$Log(caphit_{i,t}) = \alpha(PG_{i,t}) + \beta$$

This regression equation calculates the performance value of a given player based on the market rate for his performance. The logarithmic transformation of cap hit allows for increasing returns to performance, where the higher a person's player grade is, the greater the effect of an increase in performance on compensation rates. The analysis of the veteran player sample provides the estimates of alpha and beta for each position specific equation, illustrated in table I in the appendix.

The coefficient estimates calculated from the veteran player sample enable me to determine the performance value of players on their rookie contracts. The sample of rookie players includes those drafted from 2006-2015.[13] Since the 2011 CBA effectively established a system in which the compensation for a draft pick is set based on where in the draft the player was selected, the 2018 adjusted cap hits of each draft position will be used as the yearly wage for a rookie selected in any year. Using 2018 rookie adjusted cap hits universally prevents any effects of rookie contracts negotiated before the institution of the 2011 CBA from skewing the results. The 2018 adjusted cap hit is calculated by taking the average salary over the four years of the rookie contract and dividing that by the average salary cap over the four years of the contract.[14] The 2018 and 2019 salary caps are already determined, while the 2020 and 2021 caps are estimated assuming a six percent yearly cap increase, an estimate in line with the increases in

[13] 2006 is the furthest back player grade data goes and 2015 is the most recent draft class that has completed four seasons in the NFL.

[14] Player wage and the salary cap vary year to year over the course of a contract. In my opinion, the adjusted cap hit provides the best estimate of the average yearly cap hit of a given draft position.

the salary cap over the past few years. The surplus value of a rookie in a given season is his performance value less the adjusted cap hit associated with his draft position. The surplus values of each of the first four seasons of a player's career are summed together in order to calculate the surplus value generated by that draft pick.

Rather than simply splitting rookies into the typical seven draft rounds for analysis, I have chosen to instead split them into nine groups. The additional groups are generated by second round draft picks being split into two groups, the first half of the round and the second half, and the first round being split into two groups, the top ten draft picks and the rest of the first round. The earlier rounds are split into two groups because of the substantial marginal decreases in compensation and performance value in the first two rounds.

IV. Results

The first question I set out to answer was whether the use of player grades as the performance metric and the addition of player specific modeling would substantially change the findings of Massey and Thaler. I uncovered little evidence to suggest their findings are incorrect. As seen in figure I in the appendix, surplus value still begins as increasing before peaking in the mid second round and then becoming decreasing thereafter. The results actually show top draft picks producing even less surplus value than Massey and Thaler estimated; draft picks in group one, the first ten picks of the draft, produce negative surplus value on average. Rather than providing talent at below market rate, the high wages associated with group one draft picks actually cause franchises to pay more on average than these players' performance is worth on the free market. While some group one rookies still produce positive surplus value, teams do not seem to be accurate enough on average in their talent assessment to make up for the wage

premium paid to these top draft picks. As such, the overarching conclusion of Massey and Thaler remains true under my analysis; the best way to maximize surplus value is to exploit the inefficiency in the overvaluation of first round draft picks by trading down in the draft. NFL franchises are extremely overconfident in their abilities to evaluate talent. In reality, the draft is less an accurate science and more blindly throwing darts at a board in the hope one will stick. As long as teams continue to overvalue high draft picks relative to their expected surplus value, the best way for a general manager to exploit that inefficiency is to place an emphasis on volume of draft capital rather than quality.

When rookies are grouped according to their playing position, the same surplus value trend as the combined sample generally holds true for most position groups, however, as you can see in figure II in the appendix, the magnitudes of the average surplus values generated are clearly different. Quarterbacks produce substantially more surplus value on average than other positions, with tackles and defensive ends the next largest producers of surplus value. Running backs, on the other hand, seem to be a poor use of draft capital. Interestingly, quarterback is the only position to produce positive surplus value on average for group one draft picks.[15]

One of the most informative conclusions from my research is the creation of a perfect draft template, table III in the appendix, based on the relationship between average performance values and the order in which a player is drafted relative to others at his playing position. Given that rookie wages are not related to playing position but merely draft position, maximizing the surplus value of a given draft pick means finding the player who will produce the greatest performance value. For each year, players are ranked based on the order they were drafted at their positions, i.e. QB1, QB2, QB3, and RB1, RB2, RB3. The regression analysis endogenously

[15] No centers in the sample were drafted with group one picks.

accounts for the wage market disparities between positions as well as the relative success rates for draftees at each position and the accuracy of draft evaluation for those positions. The regression equation can be seen below, with total performance value over the four-year life of the rookie contract as the dependent variable.

$$TPV_i = \Psi(posorder_i) + \tau$$

Results of the regression analysis are provided in table II in the appendix. Obviously this template is not exact year to year as the quality of draft classes at each position will vary year to year, but it can serve as a general guide. The results demonstrate the significant effect variations in positional wage markets should have on draft decision-making. The model recommends that six quarterbacks, eight tackles, and ten defensive ends should be selected in the first round. Given that there are only 32 draft picks in a given round, this would mean just three positions would compose 75% of the first round draft picks. Furthermore, these positions would constitute the first sixteen picks in the draft. Including wide receivers in the group, these four positions would exclusively compose the first thirty picks. The surplus value maximizing draft template recommendations are shockingly different from the results of recent NFL drafts. In 2018, the three high surplus value positions of QB, T, and DE made up only ten of the first thirty-two draft picks. In 2017, they composed eleven of the thirty-two, and, in 2016, they made up just eight of the first round draft picks. Naturally, the differences in player selection at the top of the draft tickle down and lead to substantially different later round results.

NFL general managers are clearly not perfect decision makers; Massey and Thaler found that there is only a 52% chance a player chosen at a given draft precision performs better than the next player chosen. But, if we imagine a world in which general managers are perfect evaluators

of draft talent and take into account positional wage markets in their talent evaluation, would draft pick valuation look more efficient? I set out to test this question by redrafting the 2006-2015 NFL drafts. In this redraft, players are taken in order of their performance value over their first four seasons in the NFL and given the corresponding cap hit for the draft position they are taken in the redraft. The results, shown in figure III in the appendix, point to the idea that the NFL draft is fundamentally broken in design under the current rookie wage scale. If the draft functioned as it was designed to then surplus value would be strictly decreasing in draft position. Yet, surplus value is increasing over most of the first two rounds before displaying the decreasing trend that is expected.

Even when teams are perfect talent evaluators, the negative effect of increased wages outweighs the positive effect of increased performance value at the top of the draft. There are two easy solutions to fixing this problem that the NFL could address in the 2021 CBA negotiations, both of which deal with the rookie wage scale. The first solution involves decreasing the wages of first round draft picks to an extent that the positive performance value effect outweighs the negative wage effect, thereby increasing the surplus value of these early picks. The other option is to increase the wages of second, third, and fourth round draft picks as to decrease their average surplus value. The two options have drastically different effects on the importance of the draft; decreasing first round wages would cause the draft to become even more important, as there would be more opportunity to uncover surplus value, while decreasing middle round wages would have the opposite effect.

V. Applications for Draft Analysis: Case Studies

The results of my work can easily be utilized to help NFL general managers make more efficient draft decisions. To demonstrate the applicability of my research, I will use my work to guide an analysis of some contentious draft disagreements.[16] We shall start with the 2018 NFL draft, in which the New York Giants selected running back Saquan Barkley with the second pick of the first round. Drafting a running back second overall in the modern NFL era is almost unheard of, but, the Giants, along with many others, believed Barkley to be such a transcendent running back talent he was worth such an early draft pick. Barkley's rookie season proved he was indeed a truly special NFL player, as he won the offensive rookie of the year while posting a player grade of 85.9, the fourth highest by a running back in the 2018 season and less than two points away from the positional leader. This player grade corresponds to a performance value for Barkley of .03039. With the adjusted cap hit of the 2nd overall draft pick coming out to .03977, Barkley produced a surplus value of -.00938 his rookie season. This result illustrates that the wage market for running backs is so depressed that even when a rookie running back has an exceptional season, his performance value can still not match his cap hit. In order to produce the same surplus value as Barkley, a rookie quarterback would only need to have a player grade of 60.3, which would make him the 41st highest performing quarterback in the 2018 NFL season, right between Matt Barkley and Colt McCoy. When one frames Saquan Barkley's season in terms of his performance statistics, 1,307 yards rushing and another 721 yards receiving, his selection seems like a smart move for the Giants. However, when examined with regards to veteran wage markets, Barkley is a net negative at that draft selection and essentially equivalent in performance value to Colt McCoy, a career journeyman backup QB.

[16] In the following examples, we will assume the team is committed to keeping their draft pick, as otherwise the overarching recommendation would always be to trade a top draft pick for a collection of picks with higher expected surplus value.

Our next case study involves the dilemma the Arizona Cardinals are facing in the 2019 NFL draft. The Cardinals possess the first overall pick in the draft and must decide whether or not to use it on top quarterback prospect Kyler Murray. Complicating the decision for the Cardinals is the fact that in the 2018 draft, the Cardinals selected quarterback Josh Rosen with the tenth overall pick. Drafting a quarterback with a first round pick in back-to-back drafts is nearly unprecedented, much less using back-to-back top ten draft picks. Rosen had a less than stellar rookie year, although did show some signs of potentially developing into an NFL starter. For the Cardinal's general manager, drafting Murray would be embarrassing, as it would be a clear signal he failed on his prior first round draft pick. However, this opinion is heavily reliant on the idea that drafting college football players is an exact science, which, given the high rates of first round draft pick failure, does not seem to be an accurate assumption. Opponents to drafting Murray argue that it would be wasteful to use high draft picks on quarterbacks in back-to-back drafts, yet these skeptics may be operating under a sunk cost fallacy. Just because a team spent a high draft pick on a quarterback one year should not prevent that team from drafting a quarterback the next year if they believe he is the better option moving forward. No other position offers close to the same potential surplus value as quarterback does. Employing a quality quarterback on a cheap rookie contract is possibly the greatest competitive advantage an NFL franchise can possess, and there is no shame in taking multiple swings to find the right option.

VI. Extensions

My research, as well of that of Massey and Thaler, has limited the utility of a draft pick to be the surplus value generated over a player's rookie contract, however, evidence exists to

suggest that this may not be the case in reality. NFL veteran players sign two types of contracts: a free agent contract or an extension to their contract with their current team. As players can only negotiate extensions with their current teams, there is a strong possibility that those who sign an extension are receiving below market compensation for their level of performance. A level of surplus value may be generated from the exclusive ability to negotiate extensions given to the current employer. Elite NFL performers rarely hit free agency, so the top of the market tends to be set by the merely good players who do hit free agency and are able to benefit from a bidding war between multiple teams (Clark 2016). Hence, players who sign extensions may be signing for below market value.

Contract extensions are most commonly given to top-level performers, so there may exist an elite player underpayment. Since elite players rarely hit the free market, the typical way to gain the rights to an elite player is through the draft. Thus, there may be a long-term benefit to drafting elite talent through the surplus value generated from extensions signed at below-market rates. NFL franchises certainly operate as if they believe this too to be true, as evidenced by the 2018 trade between the Chicago Bears and the Oakland Raiders for star pass rusher Khalil Mack. In this trade, the Raiders sent Mack to the Bears, along with second and fifth round draft picks in 2020, in exchange for first and sixth round picks in 2019 along with first and third round picks in 2020. At the time of the trade, Mack was entering his fifth year in the league and was only under contract for the next season through the fifth year player option from his rookie contract. Immediately after the trade, Mack and the Bears agreed to a historic six-year, $141 million dollar contract, making him the highest paid defensive player in NFL history. While the Bears certainly gained some surplus value from Mack's play under his rookie contract team option, given the substantial amount of capital they gave up to attain him, it makes sense to assume they saw some

value in acquiring the rights to exclusively negotiate an extension with Mack before he hit the free market. The existence of systematic elite player underpayment may serve to mitigate some of the overvaluation of first round draft picks in two major ways. The first is that there is additional surplus value generated from drafting an elite rookie through the ability to sign him to an extension. The second is that the marginal returns to performance for elite players would increase, thereby increasing the performance value of elite rookies. Since average performance value is strictly decreasing in terms of draft order, a change in elite player compensation would have the largest effect on early draft picks as they have the greatest probability of becoming elite players. However, given the extent of the inefficiency, it is doubtful any elite player underpayment would come close to fully explaining the inefficiency.

VII. Conclusions

Under my new methodology, the main conclusion of Massey and Thaler's groundbreaking paper, the existence an overvaluation of high draft picks by NFL decision makers, remains true. Surplus value reaches a maximum in the late second round, even though Massey and Thaler's analysis of the trade market for NFL draft picks shows teams value draft picks exponentially less as the draft continues, with early first round draft picks being of significantly higher value than any other draft asset. However, contrary to Massey and Thaler, I found that the highest draft picks actually tend to produce negative surplus value over the life of their rookie contract. Additionally, I discovered a new inefficiency in draft decision-making. Decision makers do not fully take into account the differences in positional wage markets when evaluating talent across different position groups. As a result, they undervalue lesser talents at high value positions and overvalue higher talents at low value positions. Moreover, even though

it may seem like NFL franchises are constantly searching for the next great quarterback in the draft, they are still far from properly valuing a quarterback prospect in light of their drastically different wage market. Even just an average rookie quarterback will produce more surplus value than all but the most elite of players at a few positions. Running backs, on the other hand, seem to be overvalued in the draft. Running backs are compensated so poorly in the NFL that it is nearly impossible to gain surplus value from highly drafted running backs. The position specific performance value equations provided in this paper could be useful in evaluating talent across positions as they provide a methodology to compare the value of a good player at one playing position to a great player at a different playing position. Finally, and perhaps most importantly, the current NFL draft seems to be flawed in design if its true goal is to protect competitive balance in the League by providing the worst teams with the most valuable draft capital. Even when teams are perfect decision makers, the picks at the beginning of the first round are not the most valuable ones in the draft in terms of expected surplus value. If the NFL wishes to fix this issue, it must address the flawed design of the rookie wage scale, namely that wage increases more rapidly than performance value when moving from the second to the first round. Under the current format, no matter how accurate NFL general managers may be in evaluating draft talent, the draft picks that are designed to be the most valuable are not.

References

Borghesi, R. (2008) "Allocation of scarce resources: Insight from the NFL salary cap." Journal of Economics and Business, 60(6), 536-550.

Clark, K. (2016). "The NFL's Superstar Inefficiency." The Ringer, Retrieved November 4th, 2018 from https://www.theringer.com/2016/7/12/16077290/nfl-superstar-salary-cap-free-agency-1d452d4db8a4

Leeds, M. A., & Kowalewski, S. (2001). "Winner Take All in the NFL: The Effect of the Salary Cap and Free Agency on the Compensation of Skill Position Players." *Journal of Sports Economics*, *2*(3), 244–256.

Massey, C., & Thaler, R. H. (2013). "The Loser's Curse: Decision Making and Market Efficiency in the National Football League Draft." Management Science, 59(7), 1479-1495.

McCann, A., & Paine, N. (2015). "Are Some Positions Riskier to Pick Than Others in the NFL Draft." FiveThirtyEight, Retrieved November 04, 2018, from https://fivethirtyeight.com/features/are-some-positions-riskier-to-pick-than-others-in-the-nfl-draft/

Paine, N. (2015). "No Matter How Much They Make, the Best Players in the NBA are Vastly Underpaid." FiveThirtyEight, Retrieved December 03, 2018, from https://fivethirtyeight.com/features/kawhi-leonard-like-all-the-best-nba-players-is-vastly-underpaid/

Romer, D. (2006). "Do Firms Maximize? Evidence from Professional Football." Journal of Political Economy, 114(2), 340-365.

Appendix

Image I

Draft Pick Value Chart

Used to Determine the Value of Traded Picks

Round 1		Round 2		Round 3		Round 4		Round 5		Round 6		Round 7		Additional Rounds	
1	3000	33	580	65	265	97	112	129	43	161	28	193	15.2	225	2.9
2	2600	34	560	66	260	98	108	130	42	162	27.6	194	14.8	226	2.8
3	2200	35	550	67	255	99	104	131	41	163	27.2	195	14.4	227	2.7
4	1800	36	540	68	250	100	100	132	40	164	26.8	196	14	228	2.6
5	1700	37	530	69	245	101	96	133	39.5	165	26.4	197	13.6	229	2.5
6	1600	38	520	70	240	102	92	134	39	166	26	198	13.2	230	2.4
7	1500	39	510	71	235	103	88	135	38.5	167	25.6	199	12.8	231	2.3
8	1400	40	500	72	230	104	86	136	38	168	25.2	200	12.4	232	2.2
9	1350	41	490	73	225	105	84	137	37.5	169	24.8	201	12	233	2.1
10	1300	42	480	74	220	106	82	138	37	170	24.4	202	11.6	234	2
11	1250	43	470	75	215	107	80	139	36.5	171	24	203	11.2	235	1.9
12	1200	44	460	76	210	108	78	140	36	172	23.6	204	10.8	236	1.8
13	1150	45	450	77	205	109	76	141	35.5	173	23.2	205	10.4	237	1.7
14	1100	46	440	78	200	110	74	142	35	174	22.8	206	10	238	1.6
15	1050	47	430	79	195	111	72	143	34.5	175	22.4	207	9.6	239	1.5
16	1000	48	420	80	190	112	70	144	34	176	22	208	9.2	240	1.4
17	950	49	410	81	185	113	68	145	33.5	177	21.6	209	8.8	241	1.3
18	900	50	400	82	180	114	66	146	33	178	21.2	210	8.4	242	1.2
19	875	51	390	83	175	115	64	147	32.6	179	20.8	211	8	243	1.1
20	850	52	380	84	170	116	62	148	32.2	180	20.4	212	7.6	244	1
21	800	53	370	85	165	117	60	149	31.8	181	20	213	7.2	245	0.95
22	780	54	360	86	160	118	58	150	31.4	182	19.6	214	6.8	246	0.9
23	760	55	350	87	155	119	56	151	31	183	19.2	215	6.4	247	0.85
24	740	56	340	88	150	120	54	152	31.6	184	18.8	216	6	248	0.8
25	720	57	330	89	145	121	52	153	31.2	185	18.4	217	5.6	249	0.75
26	700	58	320	90	140	122	50	154	30.8	186	18	218	5.2	250	0.7
27	680	59	310	91	136	123	49	155	30.4	187	17.6	219	4.8	251	0.65
28	660	60	300	92	132	124	48	156	30	188	17.2	220	4.4	252	0.6
29	640	61	292	93	128	125	47	157	29.6	189	16.8	221	4	253	0.55
30	620	62	284	94	124	126	46	158	29.2	190	16.4	222	3.6	254	0.5
31	600	63	276	95	120	127	45	159	28.8	191	16	223	3.3	255	0.45
32	590	64	270	96	116	128	44	160	28.4	192	15.6	224	3	256	0.4

Image II

Panel A: Performance, Compensation & Surplus. Summary lowess curves for player performance value, compensation and surplus (performance value less compensation) in the player's first 5 years. Underlying observations are player-seasons, 1994-2008. n=16,502. Reported in 2008 dollars.

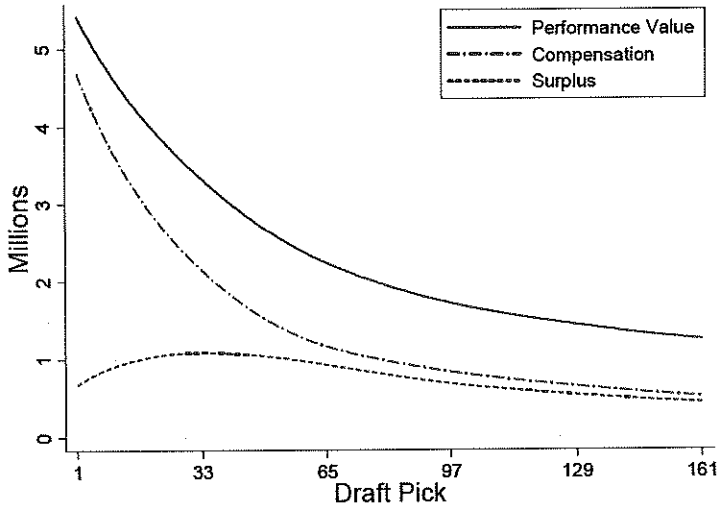

Image III

Panel B: Surplus vs. Trade Value. "Expected Surplus" is the lowess curve for the relationship between estimated surplus value and draft order (Figure 3). Observations are player-seasons. The sample is for the 1994-2008 seasons, including all drafted payers in their first five years in the NFL, excluding punters and kickers. "Trade Market" is the Weibull estimated from draft-day trades (Figure 1).

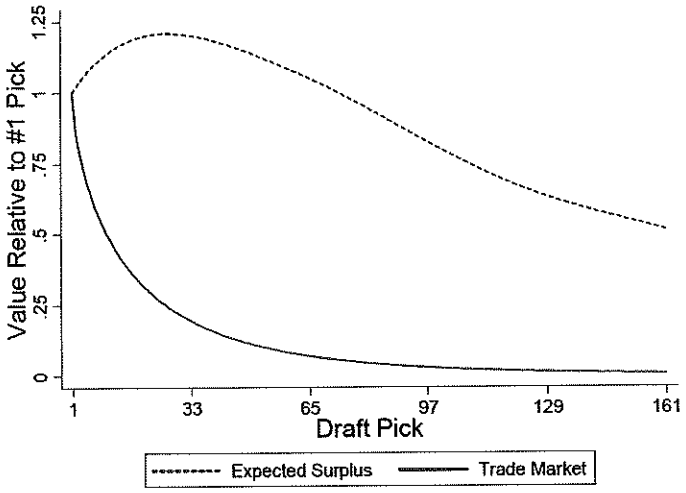

Image IV

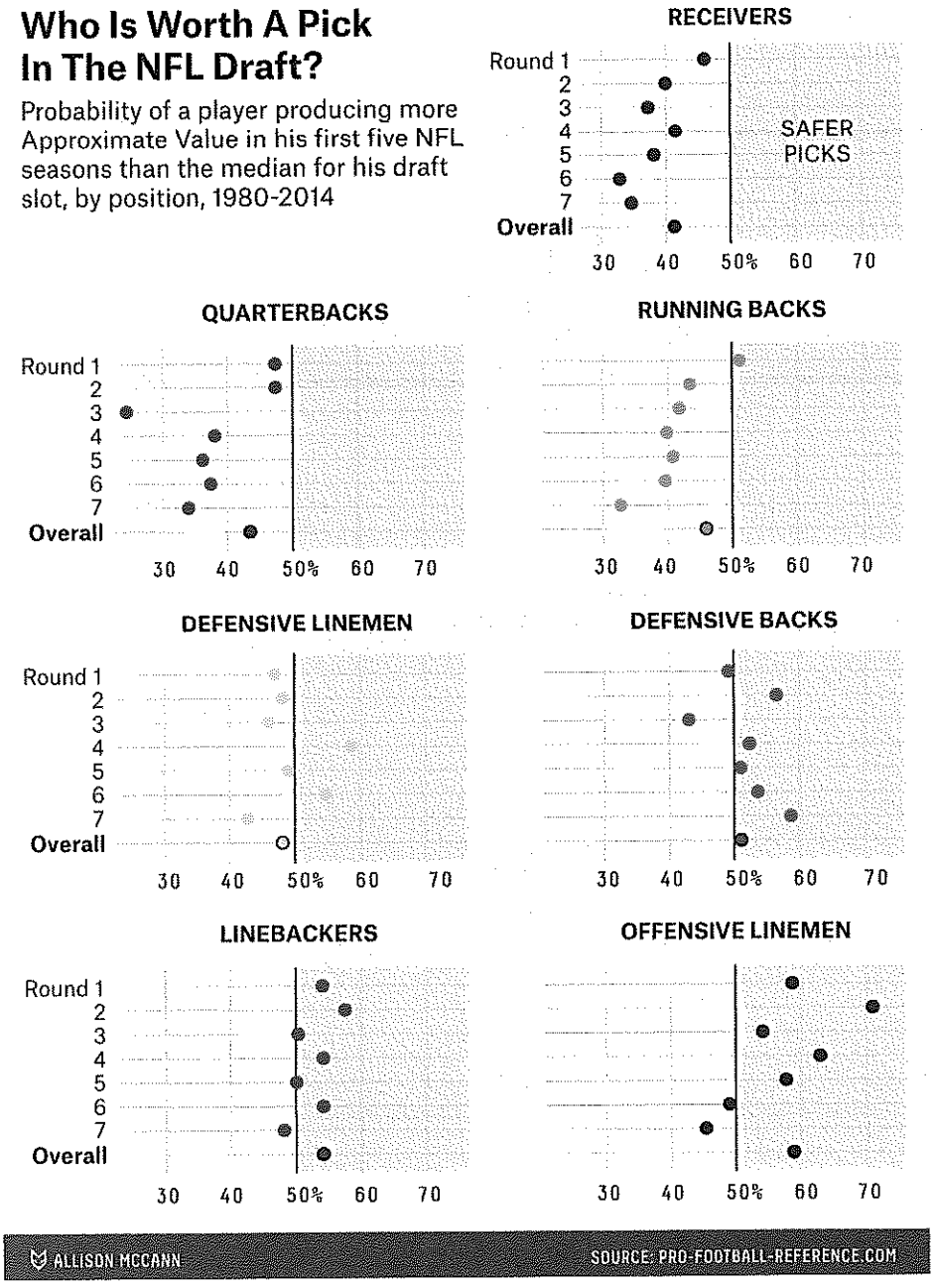
Who Is Worth A Pick In The NFL Draft?
Probability of a player producing more Approximate Value in his first five NFL seasons than the median for his draft slot, by position, 1980-2014
RECEIVERS
QUARTERBACKS
RUNNING BACKS
DEFENSIVE LINEMEN
DEFENSIVE BACKS
LINEBACKERS
OFFENSIVE LINEMEN
Round 1
2
3
4
5
6
7
Overall
SAFER PICKS
30
40
50%
60
70
ALLISON MCCANN
SOURCE: PRO-FOOTBALL-REFERENCE.COM

Figure I
Surplus Value by Round Grouping

This bar chart displays the average surplus value for a player taken with a draft pick in a given round grouping. The round groupings are displayed on the horizontal axis, while the surplus value totals displayed on the vertical axis correspond to the total surplus value produced over the four-year life of a rookie contract.

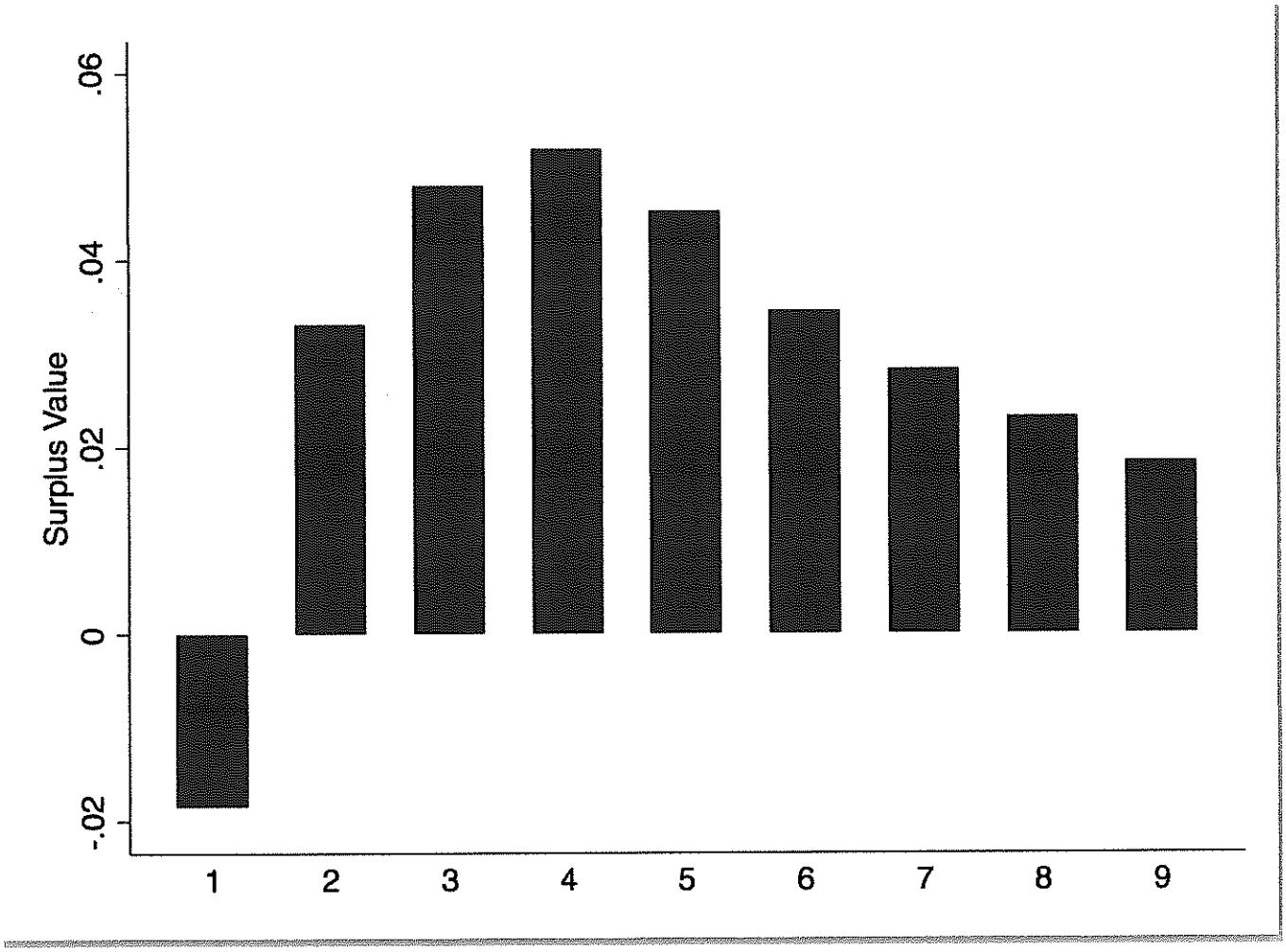

Figure II
Surplus Value by Position Group

The bar chart displays the average surplus value for a player taken with a draft pick in a given round grouping for a given position group. The round groupings are displayed on the horizontal axis, while the surplus value totals displayed on the vertical axis correspond to the total surplus value produced over the four-year life of a rookie contract.

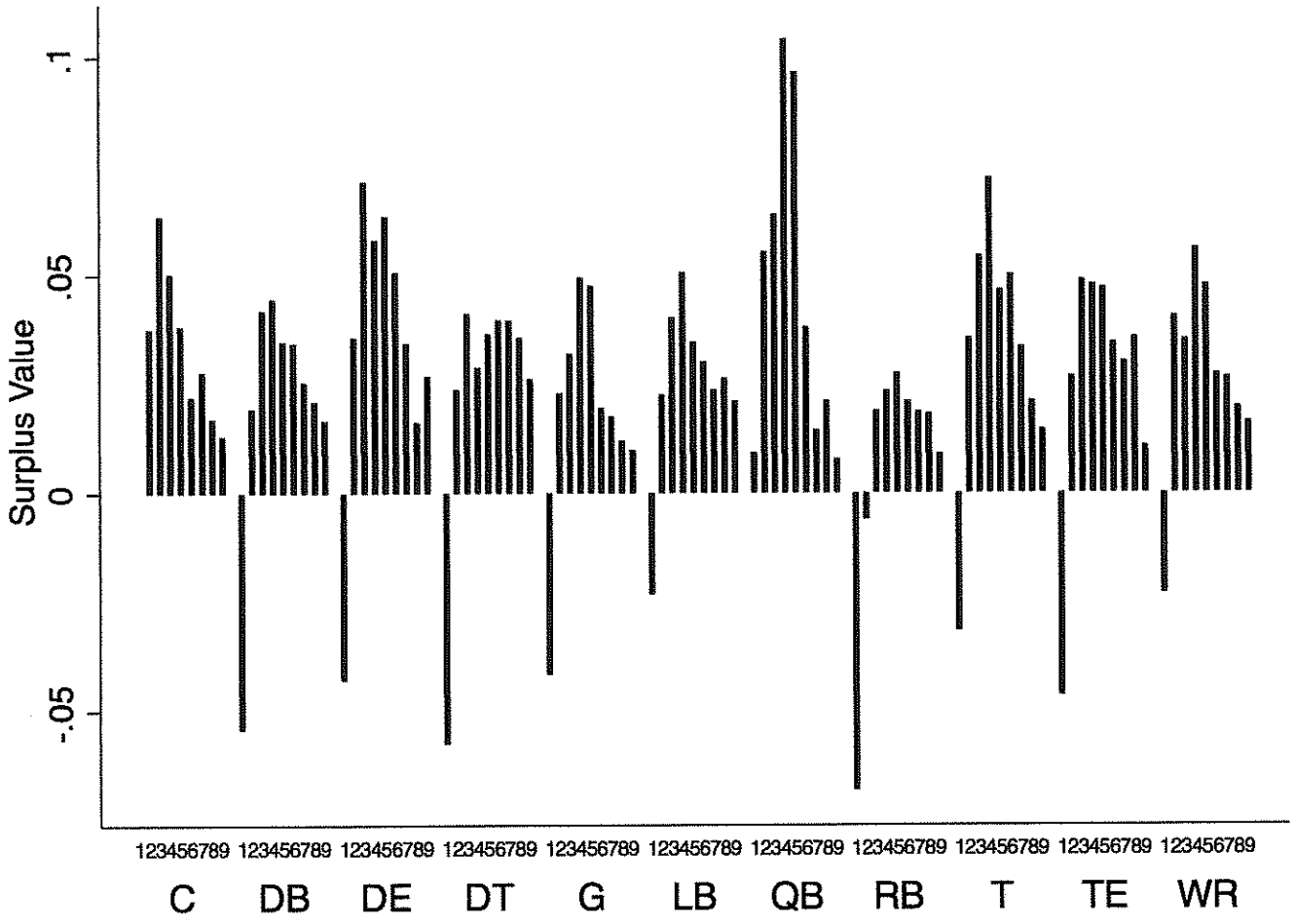

Figure III
Surplus Value in the Redraft

Scatterplot for the relationship between average surplus value of a player and their draft position in the redraft for players drafted 2005-2016. Surplus value is measured in terms of the total amount produced over the four-year life of a rookie contract.

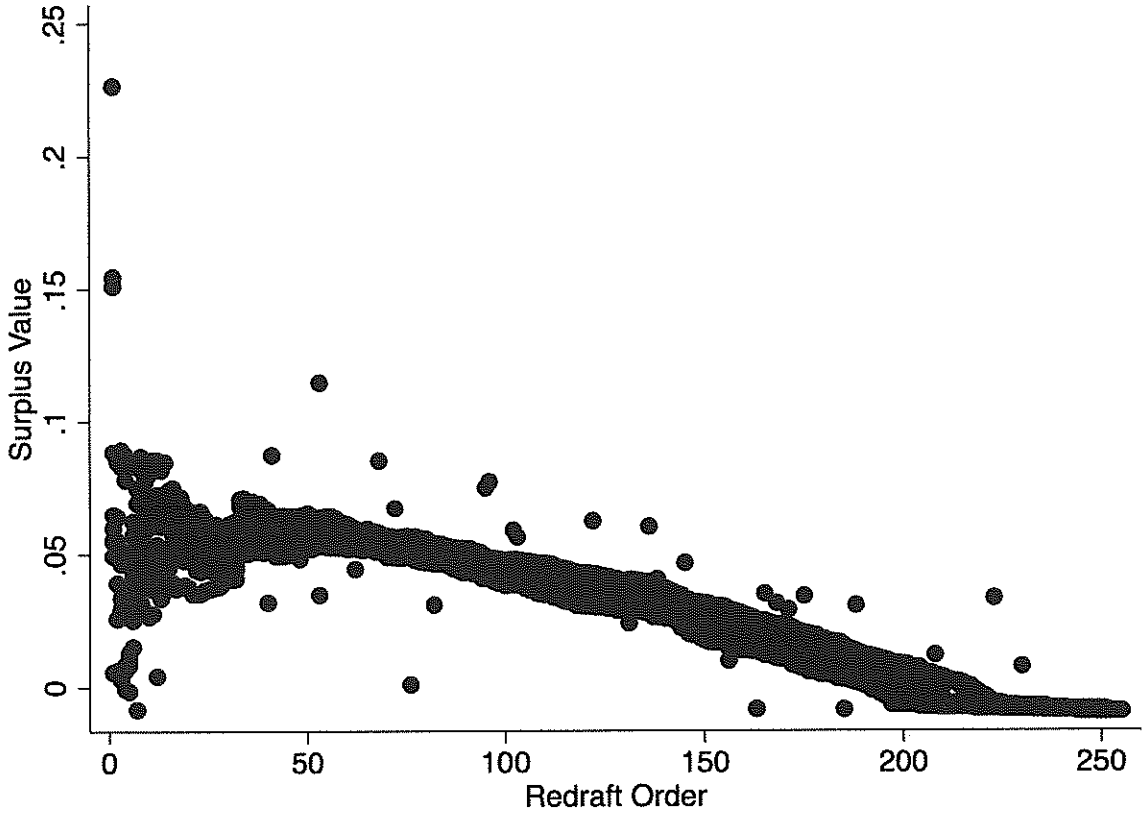

Table I
Performance Value Models

Non-Linear regression results for the relationship between performance and compensation among NFL players aged 26 and older from 2011-2018. The dependent variable is the natural log of player compensation, measured by the percentage of the salary cap a player's wage makes up, and the independent variable if the five-year weighted average of player grade for that player.

Position	Alpha	Beta	R^2
QB	.0504174 (.0023694)	-6.535493 (.1364906)	.5254
RB	.0362581 (.0030953)	-6.608378 (.177764)	.2653
WR	.040997 (.0030953)	-6.64403 (.114144)	.4373
TE	.0381763 (.0024314)	-6.56973 (.1427355)	.3575
G/C	.0358061 (.00144181)	-6.416195 (.0892404)	.4311
T	.0432761 (.0024068)	-6.725524 (.1264528)	.4744
DE	.0503249 (.0024068)	-7.015034 (.1429286)	.4433
DT	.0431242 (.0030264)	-6.740459 (.1774065)	.2872
DB	.0433442 (.0016832)	-6.812373 (.0999722)	.3536
LB	.0433117 (.001836)	-6.785326 (.1086501)	.3467

Table II
Positional Draft Pick Model

Regression results for the relationship between positional draft pick order and performance over the first four seasons in the league for players drafted 2006-2015. The dependent variable is total performance value while the independent variable is a player's draft position relative to those in the same playing position

Position	Psi	Tau	R^2
QB	-.0119281 (.0017876	.1562649 (.0131876)	.2809
RB	-.0015414 (.0001947)	.0590081 (.0027509)	.2171
WR	-.0023428 (.0002014)	.0965279 (.0038542)	.2984
TE	-.003139 (.0004655)	.0796432 (.0046254)	.2302
G	-.0037345 (.0004678)	.0755305 (.0044732)	.3068
C	-.0086451 (.0017412)	.0849556 (.008083)	.2715
T	-.0046109 (.000413)	.119338 (.0053515)	.3714
DE	-.0033784 (.0004004)	.1100554 (.0058149)	.2341
DT	-.0020869 (.0004232	.0827156 (.005221)	.1074
DB	-.0011368 (.0000933)	.0805134 (.0027854)	.2276
LB	-.0017386 (.001836)	.0825059 (.0042534)	.1637

Table III
Surplus Value Maximizing Draft

The following table represents how the NFL draft would play out if players were drafted in order of their expected performance value based on the results of NFL drafts from 2006-2015.

Pick #	Round 1	Round 2	Round 3	Round 4	Round 5	Round 6	Round 7
1	QB1	WR7	LB7	WR15	DE18	C4	TE13
2	QB2	DB1	DB9	DB17	DT14	LB21	DB37
3	QB3	LB2	TE3	DE16	DB24	G8	G10
4	T1	DT2	DT6	QB8	G6	DB31	WR25
5	DE1	DB2	DB10	TE6	LB17	T16	RB14
6	T2	DE11	LB8	G4	RB4	DT18	DB38
7	QB4	WR8	WR12	DB18	DB25	RB9	DE23
8	DE2	T9	T11	LB13	WR19	TE11	LB26
9	T3	LB3	DT7	DT11	DT15	WR22	QB10
10	DE3	DB3	G2	WR16	TE9	LB22	DT22
11	DE4	TE1	DB11	T13	RB5	DB32	C5
12	T4	DT3	DE14	DB19	LB18	DE21	DB39
13	DE5	DB4	TE4	LB14	DB26	RB10	T18
14	QB5	LB4	DB12	DB20	DE19	DT19	RB15
15	T5	WR9	LB9	DT12	DB27	DB33	TE14
16	DE6	C1	WR13	TE7	T15	WR23	WR26
17	WR1	DB5	DT8	DE17	RB6	LB23	LB27
18	WR2	DE12	DB13	RB1	WR20	RB11	DB40
19	DE7	DT4	C2	G5	LB19	TE12	DT23
20	T6	LB5	LB10	WR17	G7	G9	G11
21	WR3	DB6	DB14	DB21	DT16	DB34	RB16
22	DE8	TE2	DE15	LB15	QB9	DT20	DE24
23	WR4	WR10	G3	C3	DB28	LB24	LB28
24	T7	T10	TE5	RB2	TE10	DB35	WR27
25	WR5	QB7	DT9	DT13	RB7	DE22	RB17
26	QB6	DB7	WR14	DB22	LB20	T17	DT24
27	DE9	DT5	T12	LB16	DB29	RB12	TE15
28	WR6	LB6	DB15	TE8	DE20	WR24	LB29
29	T8	G1	LB11	RB3	WR21	DB36	T19
30	DE10	DB8	DB16	T14	DT17	LB25	RB18
31	LB1	DE13	DT10	DB23	RB8	RB13	WR28
32	DT1	WR11	LB12	WR18	DB30	DT21	G12