Evaluating National Football League Draft Choices: The Passing Game

Key words: Sports economics, National Football League, Professional labor markets
JEL: L83 (Industry Studies, Services, Sports), J23 (Demand for Labor), J44 (Professional Labor Markets and Occupations)

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Abstract

Recruiting competent personnel is crucial for the success of any organization. This is quite apparent in competitive sports where the success of the team depends upon the quality of players selected. This paper examines whether football executives are able to identify the most promising quarterbacks and wide receivers. Our data base is constructed from the NFL drafts between 1974 and 1995, and we use a variety of measures to determine the success of the players who were selected in those drafts. We conclude that, although their ability to rank players is less than perfect, football executives are very successful in evaluating the talent of athletes. Moreover, teams that selected "well" also had competitive success.

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"Without question, one of the primary factors affecting success in the National Football League is having talented players...[T]he most important step in securing the players a team needs is evaluating the available talent pool..."

Bill Walsh (1998, p. 113)

I. Introduction

Personnel evaluation is important to all organizations. It is especially so in professional sports where a team's success depends on the talents of its players. The opening quote by Bill Walsh, a coach and later executive for the San Francisco 49ers, underscores this point. Numerous management and labor issues have been covered in the literature on professional football. These include principal-agent problems (Atkinson, et al. 1988), compensation systems (Bishop, et al. 1990), union member behavior (Gramm and Schnell 1994), managerial efficiency and tenure (Scully 1994), and contract negotiation strategies (Conlin 2002). Spurr (2000) evaluated baseball executives' ability to select players who will be successful, but the ability of the NFL executives to appraise talent has not yet been analyzed. As we explain below, we have developed an extensive data base that will permit us to partially answer the question: Do football executives have the ability to determine who will have a successful career in the NFL?

Our analysis focuses on one component of a professional football team's performance- the offensive passing game involving quarterbacks and wide receivers. This is, obviously, an important aspect of a NFL team's overall performance. Moreover, there are anecdotal statements that question whether NFL executives have the ability to evaluate quarterbacks and wide receivers when they enter the NFL draft. Commentators note that Joe Montana was drafted only in the third round in 1979, later than three other quarterbacks, each of whom had less successful careers than he did. Moreover, other

quarterbacks (such as Warren Moon and David Krieg) had very successful careers in the NFL but were not even selected in the draft. As for wide receivers, Jerry Rice, considered the best who ever played, was the third wide receiver chosen in 1985. Steve Largent, who ranks fourth in all-time receiving yardage, was only drafted in the fourth round after 16 wide receivers had already been selected.

Our data base consists of quarterbacks and wide receivers who were drafted by the NFL between 1974 and 1995. Since the individuals who are in the draft constitute the talent pool, we can compare the order in which they were drafted (which is a measure of the executives' appraisal of their ability) and their subsequent performance over the course of their careers.

Section II describes the draft system while Section III describes our data set and measures of performance. The next two sections present our methods of analysis and summarize our empirical findings with regard to associations between draft rank and performance. Section VI examines the frequency with which managers make mistakes by failing to draft players who turn out to be successful and by using early round picks for players who turn out to be unsuccessful. Section VII examines whether some teams are more successful at drafting than other teams. The last Section presents our conclusions.

II. The Draft: The Talent Pool

The draft is a method of allocating individuals who have not previously played in the NFL to the teams in the league. The new players are, almost without exception, men who have played football in college. Players who are "drafted" may only play for the team that has selected them unless the selecting team relinquishes or trades their rights to the player. If a particular player is overlooked in the

draft and is not selected by any team, that individual is considered a free agent and can negotiate with, and play for, any team in the league.

Teams select their future players in a predetermined order, based on the previous year's performances. The team with the worst record in the previous year makes the first selection, followed by teams in ascending order of their previous year's record. After the team with the best record has chosen its player, the first round of the draft is completed. This process is repeated through the n rounds of each year's draft.[1] While teams are free to choose players at any position, it is presumed that players who are chosen earlier have more potential than players who perform at the same position but are chosen in the later rounds of the draft.

There are numerous sources of information for assessing the talent of players. Scouts watch college football games or study films of the games, college coaches provide assessments, and combines administer physical and mental tests to invited athletes and provide opportunities for personal interviews. Finally, the most talented athletes are "worked out" by NFL coaches on their own college campuses. If the executives can use this information to evaluate players' abilities, there should be a relationship between the order in which players are chosen in the draft and their subsequent performance in the NFL. Those chosen earlier in each year's draft should outperform those taken later in the same draft.

It is not possible, however, to evaluate the executives' judgments or forecasts by simply

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[1]In the period that we examine, the number of rounds was not constant. In 1974-1976 there were 17 rounds; this was reduced to 12 rounds from 1977 to 1992, 8 rounds in 1993, and only 7 rounds in the subsequent years

comparing a player's position in the draft with some measure of his subsequent performance. The reason is that the selectees play different positions. In order to obtain meaningful results, one must compare draft selectees who play the same position. Since we are concerned with the offensive passing game, we do not evaluate the entire draft but concentrate on individuals who play two skill positions: quarterback and wide receiver. Because there are widely accepted measures of performance for those positions, we can determine whether there is a relationship between the order that players are selected and their subsequent performance.

III. Data and Performance Measures

A. Data

The source for our data is *Total Football II: The Official Encyclopedia of the National Football League* (Carroll, et al.1999). This reference includes comprehensive statistics on the performance of every player who has ever been involved in an NFL game through 1998. It also provides complete information about each year's draft, i.e. the round in which a player was chosen as well as the sequence in which players were taken. Our analysis is based on the drafts from1974 through 1995. Although *Total Football II* includes data for the 1996-98 drafts, those data are not included because there is insufficient information about these players to analyze their lifetime performance. By ending with the 1995 draft, at least three years' performance data on each player are available.

B. Performance Measures

1. Quarterbacks

We use three indicators to measure a quarterback's performance: (1) the number of years played, (2) the number of passes thrown, and (3) the quarterback rating. The length of a quarterback's

career measures how long coaches thought that he had the ability to perform in the NFL.[2] It also reflects his durability. This measure has the advantage that it is independent of the talent of players surrounding the quarterback and of the offensive style of his team. A quarterback on a run-oriented team will throw fewer passes than if he plays for a team without a good running back. The number of passes thrown measures the contribution a quarterback makes for the team and distinguishes between quarterbacks who are starters from those who back-ups.[3]

Finally, the quarterback rating (QR) was devised by a special study committee of the NFL in the 1970s and has been used to assess the performance of passers since then. The QR is positively related to the number of completions, yards gained per attempt, and touchdowns per attempt and inversely related to the number of interceptions per attempt (Carroll 1986). For players who were drafted but did not throw any passes, we have set QR equal to zero. Because the QR is a measure of the efficiency of a quarterback's passes, it is possible for the QR to be high and the number of passes thrown to be low.

2. Wide receivers

For wide receivers, we measure performance by (1) the number of years in the league and (2) total yards of receptions. The number of years played is again independent of the offensive style of the team for which he plays and measures the receiver's ability to perform at high levels over a long period of time, either as a starter or as a backup third or fourth receiver or as a return specialist on special

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[2]Years played is one of the measures of a player's success used by Hendricks, et al., (2003).

[3]Passing yards is another potential measure. We found that the correlation between the number of passes thrown and passing yards was .997. We, therefore, only present our results for passes.

teams. Total yards of reception reflects the offensive contribution of a wide receiver to the team(s) for which he plays and distinguishes players who are starters from those who are back-ups.

IV. Methodology for Evaluating Performance and Draft Position

We use a number of different approaches for evaluating the relationship between the draft position of a player and his subsequent performance. The comparisons are done separately for quarterbacks and wide receivers.

A. Individual Draft Years

We first focus on each draft year (1974-1995) and examine the relation between draft rank and subsequent performance. The hypothesis is that there is a relationship between: (1) the order in which a player was drafted and (2) the order of the measure of his professional success. The Spearman rank order correlation coefficient is used to test this hypothesis. If football executives were able to forecast relative future success, then players picked earlier should have been the most successful and the Spearman Coefficient should be negative and significant. If the Spearman Coefficient is negative and significant we are implicitly rejecting the hypothesis that the ability of the executives is inferior to randomly selecting the quarterbacks and wide receivers. At a minimum, the executives' performance should exceed this benchmark or standard of comparison. It would have been preferable to compare the executives' performance with that of knowledgeable sports analysts. However such a data base was not available. Nevertheless, even this weak standard can yield interesting results, since the Spearman Coefficient accounts for both Type 1 and Type 2 errors that will be discussed below.

B. Pooling Across All Draft Years

In using the Spearman Rank correlation for *each individual year*, we are evaluating

the executives' ability to choose among those who were available in that particular draft. In ranking players only by the order of their selection, we are ignoring the *overall rank* of the player chosen. Two quarterbacks selected as the number 1 and 2 overall choices in a specific draft - not just among quarterbacks - would receive the same ranks as the first two quarterbacks who were the 50th and 55th overall selectees. However, players who are chosen earlier are considered to have more potential than those chosen later. If managers choose wisely, then one would expect that players chosen in the early rounds of the draft would be more likely to perform at higher levels than those selected in the later rounds.

To examine this hypothesis, we pooled the data from all the draft years. All of the quarterbacks selected as one of the top 30 players in **any** of the 22 drafts were placed in one group. While the number of teams in the NFL increased from 26 to 30 between 1974 and 1995, on average, this group would represent players who were teams' first selections in the draft. Hence, we refer to this group as Round 1 picks. Similarly, players who were the 31st to 60th selections in each draft were grouped together and are referred to as Round 2 picks. This process of creating groups of 30 continued until the 210th position was reached. All players selected later than 210 were grouped together and designated as *Round 8*.[4]

Although the use of pooled data permits us to compare performance measures across draft rounds, there is a complication: not all players had completed their careers by 1998. Of the players in

[4]What we have called *Round 8* differs from conventional usage because our *Round 8* encompasses players taken from the eighth draft round in one particular a year to as high as the 17th draft round in some other years.

the sample, 11.5% of the quarterbacks and 8.5% of the wide receivers were still active in 1998. Moreover, the percentage of players still active is correlated with the round in which they were drafted. Among quarterbacks, 26.3% of first round picks and 23.1% of second round picks were still active in 1998, while only 2.8% of eighth round picks were still playing.[5] As a result, *a simple comparison of (say) average years played by round picked would yield biased results by understating the performance difference.* Since few quarterbacks drafted in the eighth round or greater were still playing in 1998, for this group a simple average of the number of years played approximates completed career length. However, since more than one-quarter of first round quarterbacks were still active in 1998, the actual average number of years played by this group as of 1998 is an underestimate of the number of years that they will have played on average over the length of their *entire* careers. More formally, the sample is censored. We adopt two statistical methods that appropriately control for this censoring: life tables and a regression analysis that controls for censoring.

To analyze the number of years played, we constructed life tables by draft round that show the probability that a player taken in that round survives to play at least T years (S_T). The life tables are based on the Kaplan-Meier (or product limit) methodology (Kaplan and Meier 1958; Cleves, et al. 2002, pp. 89-92). Players' careers contribute to the calculation of survival probabilities until the time at which they are censored. An illustration of the Kaplan-Meier technique is described in Appendix A.

We also regressed performance measures on the rank at which a player was drafted. Because players taken in earlier rounds are more likely to be censored, ordinary least squares estimates

[5]Among wide receivers, 28% of first and second round picks were still playing, but only 1.4% of eighth round picks were still active in 1998.

yield biased estimates of the coefficients. We, therefore, estimated the relationships using a maximum likelihood censored regression technique. A description of the methodology is provided in Appendix B. In addition, because simple functions of performance and rank did not seem to capture adequately the relationship between these variables, we estimated regressions in which performance was related to a piecewise linear function (spline) of the rank at which a player was selected. The knots of the spline correspond to the endpoints of ranks used to define the rounds (e.g., the first linear segment corresponds to ranks 1-30). We also added a knot at 290, corresponding to the approximate median of rank of players drafted higher than a rank of 210.

V. Results

A. Performance and Draft Rank by Draft Year

1. Quarterbacks

The Spearman rank correlation coefficients between performance measures and draft order for quarterbacks and their statistical significance levels are presented in Table 1. With two exceptions, there is a negative relationship between the order in which players were selected and their subsequent performance.[6] When the quarterback rating is used as the measure of performance, the null that there is no correlation between the two orderings is rejected at the .05 level of significance for 12 of the 22 drafts. When either of the other two statistics is used as the performance measure for quarterbacks, the

[6]The exceptions are the drafts of 1993 (quarterback rating) and 1994 (years played). Many of the quarterbacks chosen in these drafts are still playing at this time. Their performance when evaluated over their full careers, which will be determined when they retire, may yet yield different results.

null is rejected an even larger percentage of the time - 16 times out of 22 for each measure.

The Spearman coefficients based on the QR are on average (Table 1) lower than for the other quarterback measures and reject the null the fewest number of times. There is an explanation for this finding. In some years, there were a number of quarterbacks chosen very late in the draft who had relatively high QRs but who threw very few passes over their careers and stayed in the league for only a small number of years.[7] When this occurred, the value of the Spearman statistic based on the QR measure was reduced relative to the same statistic based on the other performance measures.

Finally, we examined whether there are trends in the association between draft rank and performance by regressing the coefficients for each measure on time. There were no statistically significant coefficients of the time variable, indicating that ability to identify "good" players has not improved over time.

(2) Wide Receivers

Spearman rank correlation coefficients for wide receivers for the two measures of success, years played and reception yards, are statistically significantly different from zero at the .01 level for all years. The average values of the Spearman correlation coefficients for the two measures of success are identical and similar in magnitude to the average values of the correlation coefficients for quarterbacks.. The similarity in the average value of the correlation coefficients for wide receivers and quarterbacks combined with the narrower dispersion of the coefficients among wide receivers suggests that the

[7]For example, Mike Buck, who was drafted by the New Orleans Saints in 1990 and threw 92 passes, has the fourth highest quarterback rating in our sample, just behind Brett Favre and just above Dan Marino.

differences in levels of statistical significance of the measures for the two types of players is attributable to differences in sample sizes. In any given year, more than twice as many wide receivers are chosen as there are quarterbacks who are selected. As in the case of quarterbacks, there is no evidence that the magnitudes of the Spearman coefficients have changed over time.

Overall, the magnitudes of the Spearman correlation coefficients and their levels of statistical significance suggest that managers can effectively rank both the future performance of quarterbacks relative to each other and of wide receivers relative to each other in a given year's cohort of players.[8] Their ability to do so is, however, less than perfect.

B. Do Players Taken in Earlier Rounds Have Greater Success? Pooled Data

(1) Quarterbacks

(a) Years Played

We first examine life tables of quarterback careers by the round in which they were drafted and then we present the results of the censored regression showing the relation between years played and the *rank* at which the player was selected.

Table 2A contains the life tables showing the relationship between the round in which a quarterback is drafted and the probability that he will still be playing T years after he was drafted. The results indicate that, in general, the proportion of quarterbacks surviving to play any given number of years is higher the earlier the round in which the quarterback is drafted. The differences in survival probabilities are quite large. For example, among quarterbacks taken in Round 1, more than half play

[8]This result is consistent with Spurr's (2000) finding with respect to the baseball draft: the earlier a player is selected in the draft, the more likely he is to reach the major leagues.

9 or more years, while in Round 2 only 39% have careers of this length. Less than 30% of those taken in Round 8 play at least one year. Five of the 38 players taken in Round 1 played more than 13 years; only five among the 285 players taken after Round 2 had careers of this length.

Table 3 reports the pairwise significance levels of logrank tests of the equality of survival functions among rounds (Cleves, et al. 2002, pp. 107-108). The survival functions of first round picks are statistically significantly different from second round quarterbacks at the 5% level and differ from those of other rounds at better than the 1% level. In general (although there are several exceptions), the greater the difference in rounds the higher is the probability that the survival functions differ statistically from one another.

Table 4 (Column 1) presents the results of the censored regressions in which the number of years played is related to the splines of draft rank. The results are consistent with the hypothesis that players taken later in the draft (within and across rounds) have shorter careers. This hypothesis implies that the coefficients should be negative and, in fact, eight of the nine coefficients of the linear segments are negative. Figure 1 (a) displays the predicted values of the regression. Predicted years played drops sharply in the first round. A quarterback chosen first in the draft would play on average 9.5 years compared to only 7.3 years for one chosen at the top of the second round (i.e., 31st in the draft).

(b) **Other Performance Measures: Quarterback Ratings and Passes**

Column 2 of Table 4 reports the censorred regressions of the quarterback rating on the splines of ranks at which players were drafted. Column 3 reports a similar regression for passing attempts. Predicted values from the regressions are shown in Figure 1 (b,c). The results indicate that the earlier a quarterback is drafted, the better is his performance and that there is a sharp drop from the first to the

second round. Quarterbacks chosen first in the draft have ratings nearly 23 points higher and throw over 780 more passes than those taken 31st The number of passes thrown also declines markedly from the top of the second round to the top of the third round, although the quarterback rating for a quarterback taken 31st is nearly identical to that of one drafted 61st.

(2) Wide Receivers

(a) Years Played

The life tables for wide receivers (Table 2B) yield results that are even stronger than those obtained for the quarterbacks. More than 90% of first round picks play at least four years and over half play at least eight years. Only about 70% of second round picks play four or more years and slightly less than 40% play at least eight years. Less than one-quarter of round 8 picks even play two years. The logrank statistical tests (Table 3) show that the survival functions of first round picks are significantly different from those of other rounds at the 1% level. Among those taken later in the draft, survival functions of picks in adjacent rounds are, with one exception, statistically significantly different at (or close to) the 10% level.

Turning to the censored regressions relating the number of years played to the splines of the draft rank (Table 4, Column 4), we note that the results are similar to those obtained for the quarterbacks. Predicted values are shown in Figure 2(a). A wide receiver taken as number one is expected to play nearly ten years, while one taken at the top of the second round is expected to play only seven years and one taken at the top of the third round slightly more than five years.

(b) Pass Reception Yards

Table 4 Column 5 presents the censored regression of pass reception yards, with the predicted

values shown in Figure 2(b). Eight of the nine coefficients of the splines of ranks are negative and pass receptions decline sharply with draft rank in the first and second rounds. A number one draft pick can be expected to have 7,100 receiving yards compared to only 3,800 yards for one taken at the top of the second round and only 2,100 yards for one taken at the top of the third round.

C. Summary of Findings

In sum, the evidence for both quarterbacks and wide receivers indicates that players taken in earlier rounds have longer careers, with those taken in the first round and second rounds being much more successful as measured by all of the criteria that we have selected to represent performance. This suggests that football executives are very successful in evaluating the talent of athletes.

VI. How Often Do Managers Make Mistakes?

The preceding empirical results indicate that, on average, players taken early in the draft have measurably better performance than those taken later in the draft. Nonetheless, the Spearman rank order correlations between draft position and subsequent performance among players taken in a given year are all less than one. Moreover, the fairly low pseudo-R^2s in the regression analyses suggest that much of the variation in player performance is not explained by draft rank. In short, while managers pick well on average, they also make mistakes. Mistakes can be viewed either as failing to draft a high quality player early or using an early draft pick to pick a player who turns out not to be successful. We look at these two types of errors in Sections A and B, respectively.

A. Top Players Who Are Overlooked

The first type of error is exemplified by players who have extraordinarily successful careers but

were not drafted as high picks or even drafted at all. A prescient manager should have picked such players earlier. To investigate the frequency with which top players were overlooked in the draft, we performed two types of analyses. The first analysis examined whether there were any players whose subsequent performance was better than those taken in the first two rounds of a *given* year. The second analysis examined the frequency with which the very best players at each of the two positions were overlooked.

1. Cohort Comparison

To determine how many players in a given year were drafted too low, we first examined the records of those drafted in the first two rounds. We then determined whether there were other players who were drafted in the same year and had superior records to those taken in the first two rounds. For quarterbacks, we used the number of passes thrown as our index of "quality". As an example, in 1986 there were three quarterbacks drafted in the first two rounds; two of the other 13 quarterbacks drafted threw more passes than two of the three taken in Rounds 1 and 2. Thus, we would count two mistakes in that draft year.

From 1974 to 1995, there were 65 quarterbacks who were taken in the first two rounds, and there were 28 quarterbacks, taken in later rounds, who outperformed their first two round cohorts, yielding an error rate of 43%. The results for wide receivers were similar. There were 138 wide receivers drafted in the first two rounds and 67 of those drafted in later rounds in the same year had superior performance as measured by receiving yards, yielding an error rate of 49%.

It should be noted that this criterion has some weaknesses in identifying draft errors. First, the number of identifiable potential mistakes is constrained by the number of players taken in Rounds 1 and

2. For example in 1988, no quarterbacks were drafted in these rounds, so that the criterion leaves no room for errors in this year. Second, not all of the errors identified with this procedure are serious. It may be that the performance of the overlooked player is close to that of a player mistakenly picked in the first two rounds. In addition, not all overlooked players had careers that were much more successful than those of players chosen earlier. For this reason, we also examined the best performers at each position.

2. Best Performers

To obtain the frequency of serious errors in drafting, we looked at the records of the top performers. We examined the performance of the 52 quarterbacks who played nine or more years and the 56 wide receivers who played ten or more years. We also looked at the records of the top 50 players of each type as ranked by the number of passes thrown by quarterbacks and the reception yards for wide receivers (*Total Football II*, 1999, pp. 1709-1710, 1713). These measures reflect long-run performance characteristics that reflect achievement among the players drafted in the early years of our sample. That is, a quarterback drafted in 1995 could not have played nine years[9]

Table 5 presents the percentage distribution by round of all quarterbacks (and wide receivers) drafted and the percentage distributions among the best performers. The table indicates that top performers are disproportionately represented in the first two rounds of the draft. Depending on the years of the sample, only 17-18% of all drafted quarterbacks were chosen in those two rounds.

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[9]To analyze the performance of the top performers, we, therefore, only examine the 1974-1990 quarterback drafts and the 1974-1989 wide receiver selections. Similarly, quarterbacks who threw at least 1545 passes were all selected in the drafts of 1974-1994. Similar reasoning determined the sample years of the wide receivers.

However, 48% of the quarterbacks who played nine or more years and 58% who threw at least 1545 passes were selected in those rounds. On the other hand, half or more of the best performing quarterbacks were selected in later rounds.

In order to assess the error rate of the NFL executives, it is necessary to adjust these figures for the number of quarterbacks drafted in later rounds. There were 285 quarterbacks drafted between 1974 and 1990 who could have played nine or more years, with 47 drafted in the first two rounds and 238 in the later rounds. There were 28 later round picks among the 53 who played nine or more years. Thus the executives had an error rate of about 12% (= 100% x 28/238) of failing to recognize a quarterback who would be successful as measured by the number of years played. The error rate is even lower if passes thrown is the measure of success.

Similar results are observed for wide receivers. While 15%-16% of all wide receivers were taken in the first two rounds, nearly half of those who played 10 or more years and nearly two-thirds of those with a large number of pass receptions yards were taken in these rounds. As measured by pass reception yardage, the incidence of draft mistakes is smaller than among quarterbacks. Only one-third of the top 50 according to this measure were drafted later than the second round and only 24% were drafted later than the third round. We again adjust these figures for the number of wide receivers drafted in the later rounds. Only 28 of the 566 drafted in the third and later rounds were not recognized as potential top performers. This is an error rate of only 5%.

3. All Time Top Performers

The above figures omit players who were not drafted at all, but who were later successful. Thus, they understate the incidence of failure to draft high quality players. We can provide some

evidence on how this omission affects our results. *Total Football II* (1999, pp. 1709-1710) lists all quarterbacks who threw more than 2080 passes. In this list, there were five quarterbacks who were eligible to be drafted but were not taken during the period covered by our sample. These quarterbacks and the number of passes thrown in parentheses were: Warren Moon (6786), Dave Krieg (5311), Jim Zorn (3149), Bobby Hebert (3121), and Erik Kramer (2158). In our sample, of the 36 quarterbacks who threw more than 2080 passes, 12 were drafted later than the second round. Consequently, among the top 41 quarterbacks eligible to be drafted, 17 (or 42%) were undrafted or were drafted later than the second round. However, we cannot calculate the error rate here because there are no data on the number of quarterbacks who were eligible to be drafted but were not selected.

Total Football (1999, p.1713) also lists wide receivers with more than 6306 yards of receptions. Over the period covered by our sample, only J.T. Smith (6974 yards), Ricky Sanderson (6477 yards) and Stephone Paige (6341 yards) were not drafted. In our sample, there are 46 receivers having more than 6306 receiving yards and 17 of these were drafted later than the second round. Hence, among the top 49 wide receivers, 23 (or 47%) were undrafted or were taken later than the second round.

One way to view these results is that managers make a substantial number of mistakes. That is, every team had two chances to draft players who would eventually be among the best performers in the NFL and did not take them. The other way to interpret these results is that most teams felt that particular athletes did not have the potential to perform well in the NFL and consequently were not willing to take the risk of using an early draft round pick to choose them. If these draft intentions became public knowledge, a team with superior or inside information could afford to wait until the third

or later rounds to take the "risk" of drafting this individual. This could be a possible explanation for the success of players who were chosen in the later rounds of the draft. It does not explain why a small number of very successful players were never chosen. However, it must be remembered that there were only a handful of successful quarterbacks and wide receivers who were not drafted at all.

B. Top Draft Choices Who Were Unsuccessful

The figures given in the previous section for overlooked players also help identify choices that were unsuccessful. Of the 65 quarterbacks taken in the first two rounds, 28 had fewer passes than the number thrown by those taken in subsequent rounds in the same year, and 67 of the wide receivers among the 138 taken in the first two rounds had fewer reception yards than others taken in the same year. Of course, this measure would identify taking Jeff Hostetler (Round 2, 2338 passes) in the second round of 1984 as a mistake because he threw fewer passes than Jay Schroeder (Round 3, 2808 passes).

To get at serious mistakes, we looked at the percentage distributions by round of players who did not play or played fewer than three years. These figures are shown in Table 5. Relative to the percentage distribution of all quarterbacks or wide receivers drafted, those taken in Rounds 1 through Round 5 are underrepresented among those who played fewer than three years. Among quarterbacks drafted in the first two rounds, only one second round pick Gene Bradley drafted in 1980) did not play at all. Only 5 of 64 (or 7.8%) of those taken in the first two rounds played fewer than three years. All first or second round wide receivers played at least one year, and only 19 of 140 (or 13.5%) of wide receivers taken in these rounds played fewer than three years. From these data, we conclude that very

few serious blunders occurred in the first two rounds of the draft.[10]

VII. Do Teams Differ in Draft Success?

Having found that NFL executives were relatively successful in identifying superior players, we then investigated whether some organizations had greater success than others. Over the period 1974-1995, teams changed owners, general managers, personnel directors, and coaches, so that we can not identify individuals with greater personnel evaluation abilities. However, we can determine whether some organizations had superior or inferior drafting capabilities. Our method for evaluating organizational competence in player selection is to regress measures of player performance on the rank of the player drafted and a set of dummy variables taking on the value 1 if a player is drafted by that team and 0 otherwise. The Vikings are the excluded category. Players drafted by the two expansion teams, the Jaguars and Panthers, are excluded from the regression, because of the limited number of observations for these teams. By including the rank at which a player was drafted, we measure the effect of a team's ability to spot talent given the rank at which it is drafting. .

Table 6 (columns 1-3) reports the censored regression estimates for quarterbacks for the three measures of quarterback performance. In the years played and quarterback ratings equations, the sets of coefficients of the team dummy variables are statistically significantly different from zero at the .03 level, thus indicating differences among teams in their drafting ability along these dimensions of

[10]An alternative explanation is that, having chosen players in the first two rounds, coaches were felt compelled to keep them on the roster. Staw and Hoang (1995) report that National Basketball Association teams retained highly drafted players longer and gave them more playing time even controlling for their performance on the court.

quarterback performance.[11] However, in the passes equation, the set of coefficients of the team dummy variables is not significantly different from zero at the .25 level. Some of the individual differences among coefficients for some teams are quite large and are highly statistically significantly different from each other. Quarterbacks drafted by the Vikings play 6.0 years more than those drafted by the Cardinals (Column 1), have a quarterback rating 37.3 points above those drafted by the Browns (Column 2), and throw nearly 1,200 more passes than those drafted by the Cardinals (Column 3).[12] These differences are statistically significant at the .01 level. The patterns of coefficients of the team dummy variables are similar across equations. Table 7 shows the correlation coefficients derived from correlating of the coefficients of the team dummy variables using the three measures of quarterback performance. All are positive and statistically significantly different from zero at the .01 level.

The results for wide receivers (Table 6, columns 4-5) are somewhat different from those for quarterbacks. In particular, neither set of coefficients of the dummy variables in the two equations is statistically significantly different from zero, suggesting that teams do not differ in their ability to identify high quality receivers. However, some of the differences in the individual coefficients are large and statistically significant different from each other. For example, wide receivers drafted by the Raiders or

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[11]This result is in contrast to those of Spurr (2000), who finds no statistically significant difference in teams' ability to select in the baseball draft.

[12]For the years covered by our sample, the Vikings drafted four quarterbacks who played ten or more years. Only one of these (Tommy Kramer) was a first round pick. The four quarterbacks (with the number of years and draft rank in parentheses) were: Tommy Kramer (14, 27), Steve Dils (10, 97), Steve Bono (13, 142), and Wade Wilson (17, 210). Brad Johnson, drafted number 227 in 1992, was still active in 1998 and had the seventh highest quarterback rating in our sample.

the Rams play nearly two and one-half years longer than those taken by the Seahawks (statistically significant at the .01 level). Wide receivers taken by the Dolphins average nearly 1,400 yards more reception than those drafted by the Seahawks (statistically significant at the .03 level). The simple correlation of the coefficients of the team dummy variables in the two wide receiver equations (Table 7) is large (.85) and statistically significant at the .01 level.

Are teams that are successful in drafting quarterbacks the same teams that are successful in drafting wide receivers? The correlations among the coefficients in the quarterback equations and those in wide receiver equations are all positive and range from .18 to .31, but none are significant at the .05 level. We also examined whether teams that were successful in drafting quarterbacks and wide receivers were also successful teams as measured by their percentage of games won over the 1975-1995 seasons. The simple correlations of coefficients of the dummy variables in the equations shown in Table 6 with winning percentage (Table 7, final row) are above .30 with the exception of the coefficients from the equation for passes thrown by quarterbacks. The correlation coefficients above .30 are statistically significant at the .10 level. Thus, we conclude that (1) there are differences among teams in their ability to identify quarterbacks who will have successful careers; (2) taken as a group, teams do not differ in their ability to identify successful wide receivers, (3) there are some indications that some of the organizations are better (or worse) at drafting both types of players, and (4) there is some (but relatively weak) evidence that teams that drafting ability (as regards the passing game) is correlated with an overall measure of organizational success.

VIII. Conclusion

We used a variety of techniques to evaluate football executives' ability to determine the relative

performance of quarterbacks and wide receivers in the NFL. The analysis was based on the order in which players were selected in the NFL Draft and several measures that assessed their subsequent performance. We concluded that the NFL executives can, on average, effectively rank the future performance of players relative to each other. However, their ability to do so was less than perfect because they sometimes chose players early in the draft when later draftees had better subsequent records. They sometimes also failed to draft players who later performed extremely well. Teams that selected personnel "well" also had competitive success as measured by the percentage of games won.

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Appendix A.

The life tables show the probability that a player taken in a given round survives to play at least T years (S_T). The life tables are based on the Kaplan-Meier (or product limit) methodology (Kaplan and Meier, 1958; Cleves, et al., 2002, pp. 89-92). Players careers contribute to the calculation of survival probabilities until the time at which they are censored. The following illustration for first round quarterbacks shows how the Kaplan-Meyer estimator is calculated for the first five years of play for quarterbacks drafted in the first round.

38 quarterbacks were drafted in the first round. The following chart shows the number of quarterbacks playing for various number of years (column 1), the number who exit the sample because they have completed play (column 2), the number who leave the sample because they are censored (that is, the number still active in 1998) and who may play additional years (column 3), and the estimate of the proportion surviving to play T years (column 4).

Example. Calculation of the Kaplan-Meier Estimate of the Proportion of Round 1 Quarterbacks Surviving to Play T Years

	(1)	(2)	(3)	(4)
Years (T)	Number Playing	Finished Career	Censored	Proportion Surviving (S_T)
1	38	0	0	1.000
2	38	1	0	1.000
3	37	2	0	.974
4	35	5	2	.921
5	28			.782

Of the 38 quarterbacks initially drafted, all play at least two years. Hence, the proportion of those surviving to play one year or two years (S_1 and S_2) both equal 1.000. One player exits football after having played two years, leaving 37 players who play at least three years. Consequently, the proportion who survive to play three years (S_3) is .974 (= 37/38). After the third year, another two players leave football. The proportion surviving to play at least 4 years (S_4 = .921) is product of the proportion playing at least three years (.974) times the proportion progressing from year three to year four (.946 = 35/37). At the end of four years, five players complete their careers and two players are censored. That is, two players were drafted in 1996 and continued to play through the 1998 season. These two players may have played in subsequent years, but we have no data on their subsequent performance. Of the players still in the sample after year four, the proportion progressing from year four to play year five was .848 (= 28/33). The proportion of players estimated to survive to play year five (S_5) equals .782, which is the product of the proportion surviving to play four years (S_4 = .921) times the proportion progressing from year four to year five (.848). Note that the experience of censored players contributes to the calculation of survival probabilities up until they point they are censored. The implicit assumption is that the censored players in subsequent years would have the year-to-year progression probabilities of those who remain in the sample. Consequently, the figure .782 can be interpreted as the proportion surviving to play five years in a hypothetical cohort of players who are drafted and observed until all complete their careers.

Appendix B. Censored Regressions

A discussion of the estimation of censored regression models is provided in Greene (1990, pp. 727-739) and the *Stata Reference Manual, Volume 4* (2001, pp. 174-188). Assume that the model is $\mathbf{y} = \mathbf{X\$} + \mathbf{,}$, where $\mathbf{y}$ is a vector of continuous outcomes, $\mathbf{X}$ is a matrix of independent variables, $\mathbf{\$}$ is a vector of coefficients, and $\mathbf{,}$ is a vector of disturbances terms with $\mathbf{,} \sim N(\mathbf{0}, \sigma^2 I)$. For observations j $\in$ C, y_j is observed. Observations j $\in$ R are right censored. That is, the unobserved y_j is less than or equal to y_{Rj}. The log-likelihood function *(Stata Reference Manual 4*, 2001, p. 187) is:

$$L = \left(\frac{1}{2}\right)\sum_{j \in C}\left[\left(\frac{y_j - x\beta}{\sigma}\right)^2 + \log(2\pi\sigma^2)\right] + \sum_{j \in R}\left[\log\left(1 - \Phi\left(\frac{y_{Rj} - x\beta}{\sigma}\right)\right)\right],$$

where $\Phi()$ is the standard cumulative normal. In our sample, an observation is identified as censored if the player was still playing in 1998.

Table 1. Spearman Rank Order Correlation Coefficients (ρ) and Levels of Statistical Significance (p) between Draft Rank and Performance for Quarterbacks and Wide Receivers, 1974-1995

Year		Quarterback							Wide Receivers				
		Years		Rating		Passes				Years		Yards	
	N	ρ	p	ρ	p	ρ	p		N	ρ	p	ρ	p
1974	19	-.55	.01	-.36	.13	-.55	.02		47	-.53	.00	-.58	.00
1975	19	-.56	.01	-.61	.01	-.50	.03		48	-.50	.00	-.50	.00
1976	25	-.64	.00	-.60	.00	-.64	.00		58	-.77	.00	-.73	.00
1977	18	-.24	.33	-.36	.14	-.23	.35		37	-.59	.00	-.61	.00
1978	15	-.28	.31	-.13	.65	-.19	.49		42	-.74	.00	-.63	.00
1979	15	-.64	.01	-.75	.00	-.78	.00		37	-.50	.00	-.52	.00
1980	17	-.55	.02	-.39	.12	-.61	.01		39	-.54	.00	-.48	.00
1981	17	-.33	.19	-.38	.13	-.50	.04		42	-.42	.01	-.46	.00
1982	15	-.70	.00	-.79	.00	-.75	.00		36	-.65	.00	-.58	.00
1983	16	-.81	.00	-.74	.00	-.83	.00		44	-.45	.00	-.35	.02
1984	15	-.56	.03	-.39	.15	-.49	.06		39	-.58	.00	-.64	.00
1985	11	-.58	.06	-.53	.05	-.67	.02		41	-.42	.00	-.40	.01
1986	16	-.62	.01	-.68	.00	-.61	.01		39	-.68	.00	-.73	.00
1987	19	-.77	.00	-.73	.00	-.79	.00		36	-.46	.01	-.49	.00
1988	12	-.66	.02	-.65	.02	-.66	.02		40	-.68	.00	-.68	.00
1989	16	-.74	.00	-.62	.01	-.76	.00		40	-.60	.00	-.66	.00
1990	20	-.83	.00	-.66	.00	-.85	.00		46	-.48	.00	-.49	.00
1991	12	-.76	.00	-.56	.06	-.68	.02		46	-.67	.00	-.68	.00
1992	21	-.54	.01	-.17	.45	-.42	.06		44	-.50	.00	-.53	.00
1993	8	-.62	.10	+.19	.65	-.50	.21		27	-.77	.00	-.82	.00
1994	9	+.07	.86	-.03	.93	-.28	.46		28	-.75	.00	-.76	.00
1995	14	-.74	.00	-.64	.01	-.69	.01		29	-.60	.00	-.75	.00
Average		-.58		-.48		-.59				-.59		-.59	

Table 2A. Kaplan-Meier Estimates of the Proportion of Quarterbacks Surviving to Play T Years by Round Drafted								
	Round Drafted							
Year (T)	1	2	3	4	5	6	7	8+
1	1.000	0.962	0.906	0.813	0.786	0.857	0.630	0.297
2	1.000	0.846	0.875	0.688	0.607	0.571	0.407	0.221
3	0.974	0.846	0.688	0.625	0.536	0.381	0.326	0.172
4	0.921	0.731	0.625	0.500	0.499	0.381	0.326	0.159
5	0.786	0.609	0.497	0.371	0.460	0.238	0.279	0.138
6	0.700	0.522	0.431	0.336	0.384	0.191	0.279	0.114
7	0.640	0.435	0.331	0.336	0.345	0.136	0.210	0.070
8	0.580	0.435	0.296	0.261	0.345	0.136	0.140	0.061
9	0.549	0.387	0.257	0.261	0.305	0.000	0.140	0.061
10	0.455	0.387	0.214	0.218	0.261		0.070	0.044
11	0.354	0.331	0.171	0.163	0.119		0.070	0.035
12	0.318	0.331	0.171	0.082	0.119		0.070	0.028
13	0.239	0.276	0.103	0.082	0.119		0.070	0.028
14	0.239	0.138	0.103	0.082	0.119		0.070	0.009
15	0.143	0.000	0.103	0.082	0.119		0.070	0.009
16	0.096		0.000	0.082	0.000		0.070	0.009
17	0.096			0.000			0.070	0.009
18							0.070	0.000
Number Drafted	38	26	32	32	28	21	27	145

Table 2B. Kaplan-Meier Estimates of the Proportion of Wide Receivers Surviving to Play T Years by Round Drafted								
	Round Drafted							
Year (T)	1	2	3	4	5	6	7	8+
1	1.000	1.000	0.929	0.850	0.736	0.714	0.521	0.367
2	0.985	0.907	0.833	0.775	0.639	0.452	0.411	0.236
3	0.954	0.787	0.714	0.650	0.500	0.333	0.288	0.182
4	0.923	0.720	0.583	0.525	0.403	0.286	0.206	0.148
5	0.860	0.597	0.485	0.421	0.316	0.238	0.192	0.116
6	0.776	0.567	0.408	0.337	0.239	0.191	0.178	0.086
7	0.666	0.467	0.341	0.292	0.173	0.155	0.121	0.071
8	0.531	0.391	0.284	0.231	0.137	0.119	0.061	0.047
9	0.409	0.327	0.267	0.169	0.095	0.107	0.026	0.033
10	0.344	0.282	0.153	0.105	0.041	0.082	0.026	0.026
11	0.233	0.165	0.095	0.035	0.041	0.027		0.015
12	0.181	0.137	0.076	0.017		0.014		0.007
13	0.181	0.137	0.057	0.017		0.000		0.007
14	0.151	0.069	0.038	0.017				0.007
15	0.118	0.069	0.013	0.000				0.000
16	0.118	0.069						
17	0.000	0.069						
Number Drafted	65	75	84	80	72	84	73	352

Table 3. Significance Levels of Logrank Tests Comparing Equality of Survival Functions by Round

A. Quarterbacks

Round	1	2	3	4	5	6	7
1							
2	.067						
3	.002	.255					
4	.000	.066	.489				
5	.001	.192	.705	.932			
6	.000	.001	.011	.072	.074		
7	.000	.006	.033	.134	.161	.797	
8	.000	.000	.000	.000	.000	.057	.048

B. Wide Receivers

Round	1	2	3	4	5	6	7
1							
2	.012						
3	.000	.122					
4	.000	.002	.113				
5	.000	.000	.001	.056			
6	.000	.000	.000	.010	.478		
7	.000	.000	.000	.000	.018	.089	
8	.000	.000	.000	.000	.000	.000	.068

Table 4. Censored Regression Estimates of Spline Functions Relating Performance to Draft Rank, Quarterbacks and Wide Receivers*							
Column:		(1)	(2)	(3)		(4)	(5)
		Quarterbacks				Wide Receivers	
Variable	Ranks	Years	Rating	Passes		Years	Yards
Constant		9.554[a] (1.006)	81.205[a] (7.816)	2741.2[a] (273.6)		9.822[a] (.891)	7252.3[a] (588.9)
R_1	0<Rank≤30	-.075 (.053)	-.777[c] (.440)	-25.8[c] (15.4)		-.089[b] (.041)	-114.7[a] (26.5)
R_2	30<Rank≤60	-.021 (.056)	.010 (.436)	-37.6[a] (14.2)		-.060[b] (.026)	-55.4[a] (17.3)
R_3	60<Rank≤90	-.044 (.051)	-.213 (.395)	1.3 (14.2)		-.015 (.023)	-9.7 (15.5)
R_4	90<Rank≤120	-.027 (.052)	-.606 (.402)	-12.5 (14.4)		-.03 (.024)	-26.6[c] (16.0)
R_5	120<Rank≤150	-.001 (.052)	.093 (.411)	5.5 (14.7)		-.025 (.025)	-8.8 (16.7)
R_6	150<Rank<180	-.109[b] (.052)	-.670[c] (.406)	-18.5 (14.5)		-.032 (.025)	-.2 (16.7)
R_7	180<Rank≤210	.078 (.048)	.622 (.375)	15.0 (13.4)		.008 (.021)	-10.0 (14.2)
R_8	210<Rank≤290	-.030[b] (.012)	-.339[a] (.097)	-6.0 (3.5)		-.017[a] (.006)	-3.0 (4.2)
R_9	Rank > 290	-.009 (.009)	-.047 (.072)	-.4 (2.6)		-.003 (.005)	-.2 (3.4)
Pseudo-R^2		.07	.05	.02		.08	.02

*Standard errors in parentheses; levels of statistical significance: a = .01, b = .05, c = .10

Table 5. Percentage Distribution by Draft Round for Top and Bottom Performers among` Quarterbacks and Wide Receivers

A. Quarterbacks

Draft Years:	1974-90		1974-1994		1974-1995		
Draft Round	All	Years ≥ 9	All	Passes > 1545	All	Did not Play	Played < 3 years
1	9.8	34.0	10.8	44.0	10.9	0.0	0.5
2	6.7	13.2	7.2	14.0	7.5	0.8	2.1
3	9.8	11.3	9.0	12.0	9.2	2.3	5.2
4	7.4	11.3	8.7	12.0	9.2	4.6	6.2
5	9.5	13.2	8.1	6.0	8.0	4.6	6.7
6	6.3	0.0	6.0	4.0	6.0	2.3	6.7
7	6.3	3.8	7.5	2.0	7.7	7.6	10.4
8	44.2	13.2	43.0	6.0	41.6	77.8	62.2
Number	285	53	335	50	349	131	193

B. Wide Receivers

Draft Years:	1974-1989		1974-1992		1974-1995		
Draft Round	All	Years ≥ 10	All	Yards > 5849	All	Did Not Play	Played < 3 Years
1	7.1	28.6	6.7	40.0	7.3	0.0	0.6
2	7.8	21.4	7.9	24.0	8.5	0.0	3.2
3	8.9	14.3	9.5	12.0	9.5	1.9	4.8
4	9.0	10.7	8.4	6.0	9.0	3.8	5.6
5	7,5	1.8	7.9	4.0	8.1	6.0	7.2
6	9.9	10.7	9.4	4.0	9.5	7.5	11.1
7	7.4	0.0	7.6	2.0	8.3	11.0	10.3
8	43.9	12.5	42.7	8.0	39.8	69.9	57.3
Number	665	56	801	50	879	319	503

Table 6. Censored Regressions Estimates of Team Success in Drafting Quarterbacks and Wide Receivers*

Column:	(1)	(2)	(3)		(4)	(5)
	Quarterbacks				Wide Receivers	
Variable:	Years	QR	Passes		Years	Yards
Constant	11.6[a] (1.3)	74.73[a] (10.1)	2303[a] (396)		6.46[a] (.58)	3090.0[a] (407)
Rank	-.02[a] (.002)	-.19[a] (.01)	-5.41[a] (.54)		-.019[a] (.000)	-10.68[a] (.70)
Dummy Variables for Teams:						
49ers 1	-3.4[c] (1.7)	-16.0 (13.3)	-245 (523)		.12 (.84)	368 (585)
Bears 2	-2.4 (1.6)	-12.9 (12.4)	-612 (483)		-.63 (.79)	-486 (554)
Bengals 3	-5.5[a] (15)	-30.4[a] (11.6)	-983[b] (456)		.42 (.78)	161 (542)
Bills 4	-5.5[a] (1.5)	-33.3[a] (12.1)	-934[b] (474)		-.27 (.76)	-253 (532)
Broncos 5	-4.1[b] (1.7)	-23.8[c] (13.6)	-1127[b] (530)		-.07 (.78)	107 (549)
Browns 6	-5.8[a] (1.6)	-37.3[a] (12.8)	-1116[b] (501)		.46 (.74)	208 (518)
Buccaneers 7	-4.1[a] (1.6)	-22.4[c] (12.2)	-509 (474)		.16 (.81)	172 (567)
Cardinals 8	-6.0[a] (1.7)	-29.2[b] (13.3)	-1210[b] (518)		-.12 (.76)	77 (532)
Chargers 9	-3.7[b] (1.6)	-5.3 (12.7)	-706 (497)		.07 (.76)	-42 (530)
Chiefs 10	-5.3[a] (1.6)	-32.4[a] (12.7)	-1112[b] (496)		-.48 (.75)	-388 (525)
Colts 11	-2.8[c] (1.6)	-19.2 (12.5)	-76 (486)		.25 (.78)	279 (549)
Cowboys 12	-1.9 (1.6)	-2.5 (12.4)	-271 (484)		.91 (.80)	619 (562)
Dolphins 13	-2.6[c] (1.5)	-14.8 (12.2)	-110 (475)		1.13 (.80)	769 (559)
Eagles 14	-4.9[a] (1.9)	-29.6[b] (14.6)	-720 (567)		-.68 (.85)	-395 (597)
Falcons 15	-4.2[b] (1.7)	-27.2[b] (13.0)	-510 (508)		.63 (.78)	131 (547)
Giants 16	-3.6[b] (1.6)	-22.5[c] (12.8)	-579 (498)		.68 (.78)	-270 (549)
Jets 18	-1.9 (1.7)	-6.1 (13.1)	-223 (514)		-.10 (.75)	42 (528)
Lions 19	-4.4[a] (1.7)	-21.3 (13.0)	-868[c] (508)		-.58 (.76)	-227 (528)
Oilers 20	-4.3[b] (1.7)	-13.1 (13.1)	-624 (511)		1.06 (.72)	485 (508)
Packers 21	-4.8[a] (1.5)	-19.0 (12.0)	-828[c] (469)		.50 (.77)	434 (538)
Patriots 23	-1.6 (1.7)	-4.2 (13.0)	-281 (508)		-.09 (.75)	-49 (528)
Raiders 24	-4.1[a] (1.6)	-19.4 (12.5)	-810[c] (488)		1.52[c] (.85)	544 (591)
Rams 25	-3.0[c] (1.6)	-7.1 (12.6)	-676 (490)		1.46[c] (.75)	559 (528)

Redskins 26	-3.8[b] (1.6)	-13.6 (12.6)	-541 (492)		.72 (.84)	534 (590)
Saints 27	-5.5[a] (1.8)	-16.3 (14.5)	-1058[c] (565)		-.02 (.77)	161 (540)
Seahawks 28	-4.8[a] (1.7)	-21.5 (13.6)	-918[c] (530)		-.91 (.83)	-602 (581)
Steelers 29	-2.0 (1.7)	0.4 (10.1)	-383 (511)		.70 (.74)	205 (518)
Pseudo-R^2	.087	.055	.020		.073	.014

*Standard errors in parentheses; levels of statistical significance: a = .01, b = .05, c = .10

Table 7. Correlations and Significance Levels (in Parentheses) of Team Dummy Variable Coefficients from Censored Regressions*

	Quarterbacks Years	Quarterback Rating	Quarterback Passes	Wide Receiver Years	Wide Receiver Yards
Quarterback Rating	.846 (.00)				
Quarterback Passes	.862 (.00)	.676 (.00)			
Wide Receiver Years	.184 (.35)	.266 (.17)	.258 (.19)		
Wide Receiver Yards	.183 (.35)	.306 (.11)	.317 (.10)	.854 (.00)	
Team Winning Percent	.340 (.08)	.330 (.09)	.207 (.29)	.330 (.09)	.323 (.09)

*Note: The excluded team (Minnesota Vikings) is assigned a coefficient of zero.

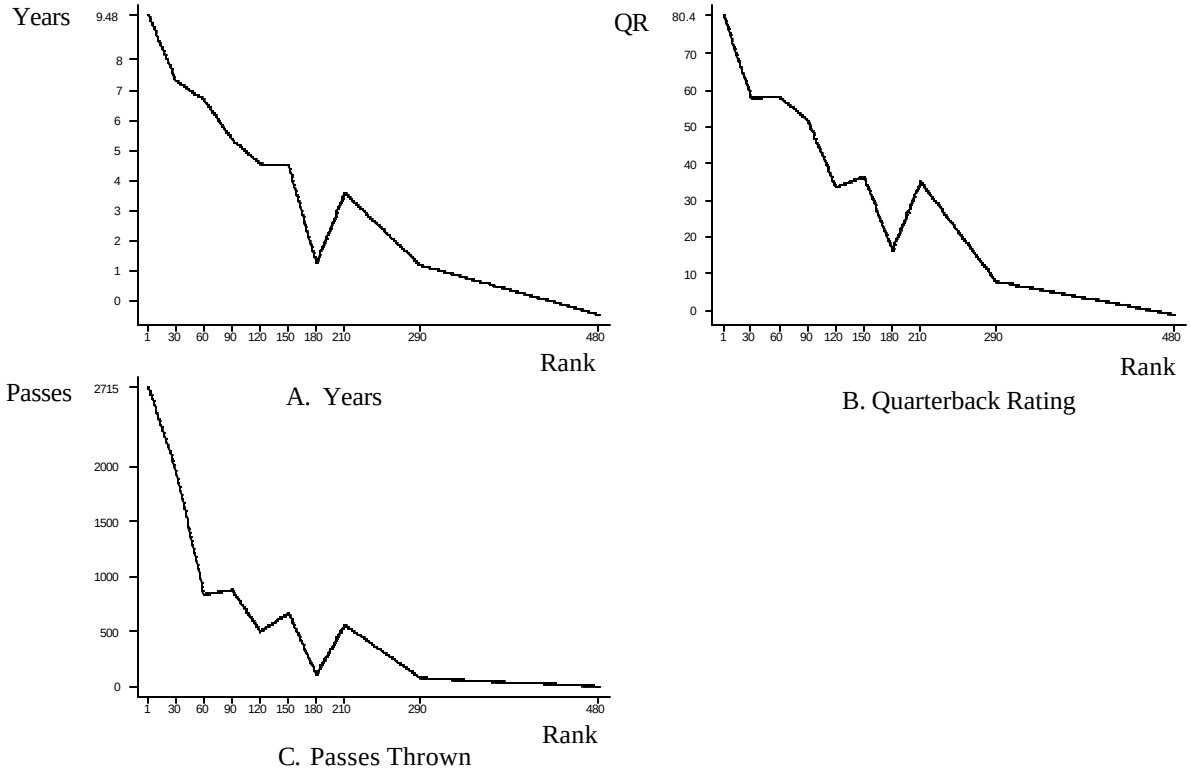

Figure 1. Predicted Values of Performance Measures for Quarterbacks

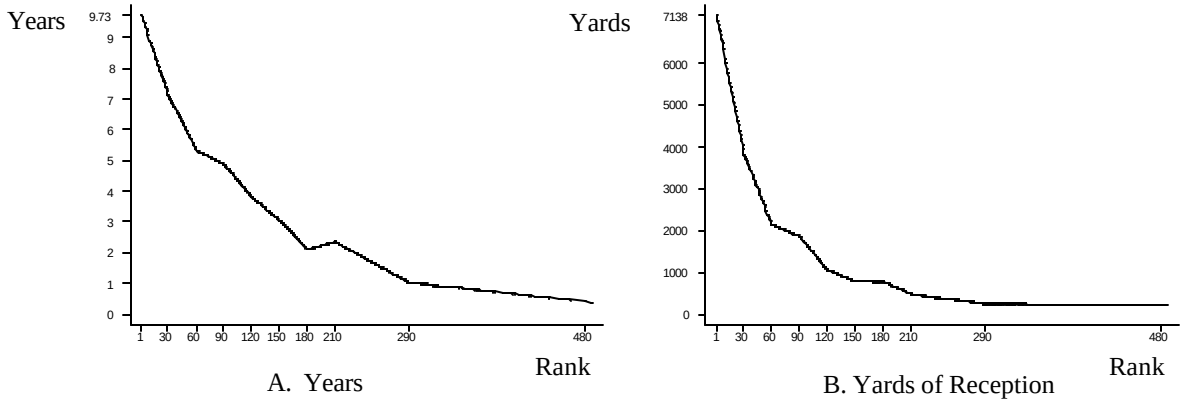

Figure 2. Predicted Values of Performance Measures for Wide Receivers