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Recruit Quality and College Football Team Performance in the CFP Era

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RECRUIT QUALITY AND COLLEGE FOOTBALL TEAM PERFORMANCE IN THE CFP ERA

by

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Abstract

Recruiting is a major component of college football. Teams compete for recruits since the quality of a recruiting class contributes to on-field success. Previous studies have investigated the relationship between recruit quality and on-field performance and have found that a positive relationship exists. This thesis contributes to the literature by empirically examining how recruit quality affects team performance in the College Football Playoff (CFP) era using various measures of success. Panel data econometric models are used to determine the effect of recruits between schools, as well as within both conferences and schools on team performance. It also considers the validity of the use of an *ex-ante* star recruit rating as well as the hypothesis that team success each year will affect future success since high quality recruits are expected to choose teams with a history of winning. The results show that a direct relationship exists between recruit quality and team performance. Moreover, the results support that the *ex-ante* star rating is a predictor of athletic performance at the collegiate level and that high-quality recruits affect revenues generated by football programs.

I dedicate this thesis to anyone that has been involved in shaping me to be the student I am today and to loved ones who are no longer here.

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1 Introduction

College football is a lucrative business, with some teams generating more than $100 million in revenue annually (Smith 2018). There are incentives for teams to perform well from administrators, boosters, and fans. Moreover, teams that make it to the postseason can receive large payouts which can be used to further fund a school's football program. How well a team performs is a function of the quality of its players, as found by Bergman and Logan (2016) in their analysis of the relationship between recruit quality and team performance in the BCS era.

Winning signals to potential recruits that a team is on a winning trajectory and therefore, winning teams are more likely to gain coveted high-ranked recruits, which can increase future success. This places much emphasis on recruiting by athletic departments and schools, with the goal of bringing in high-valued recruits. Recruiting is a competitive process that starts in high school, where recruiters observe player performance and make *ex-ante* predictions about the anticipated skill of a given player at the collegiate level. Players may then receive offers from various schools that use incentives such as scholarships, campus amenities, TV exposure and playtime to procure recruits. In October of 2019, the NCAA Board of Governors changed existing policy to allow student athletes to get compensated for their name, image, and likeness (Russo 2019). It is still yet to be observed how this will affect the recruiting process. Once recruits weigh their options, they decide which school's offer to accept. Given the resources exhausted for recruiting by schools and the desire of college football teams to succeed a new question arises regarding the relationship between team performance and the quality of recruits, as well as recruit

quality and revenues in the College Football Playoff (CFP) era. This thesis investigates the relationship between team performance and recruit quality in the College Football Championship era and the relationship between recruit quality and revenues.

Starting in 2014, the CFP is a playoff bracket used to determine the college football champion.[1] A CFP poll is conducted throughout the season to rank teams based on their performance; the top four teams in the poll by the end of the season then play in the College Football Playoff. The first ranked team plays the fourth ranked team and the second ranked team plays the third ranked team. The winners of these games play in a final game to determine the champion of the season. Prior to the CFP format, the Bowl Championship Series (BCS) format was utilized to determine a champion. Instead of using a playoff, the number one and two ranked teams played each other in a single game to determine the champion. While recruit performance is not expected to differ between the two eras, therefore affecting team performance, the CFP format allows for new measures of on-field success not previously available during the BCS era.

Data is collected spanning from 2014-2018 for all Division I FBS teams pertaining to the number of five-, four-, three-, and two-star recruits. Additionally, data was collected for various metrics of success in the regular season and post-season.[2] Further data is collected on team's total revenues, operational revenues, ticket revenues, and corporate revenues.

The next section discusses the relevant literature. Section 3 describes the data, and section 4 outlines the econometric models utilized for analysis for both conventional and monetary

[1] The CFP is not affiliated with the NCAA, but is instead organized by a coalition of selected members from participating schools.
[2] Division I football is divided into two subdivisions: Football Championship Subdivision (FCS) and Football Bowl Subdivision (FBS). The FBS is considered the more competitive of the two.

measures of success. The estimated results are discussed in section 5. Section 6 provides concluding remarks and discusses the implications of the results. The results indicate that recruit quality has a significant impact on team performance and that on-field success differs across recruit ratings. Additionally, the results indicate that teams with a history of winning persist in winning since they consistently recruit players with high *ex-ante* ratings. The impact of recruit quality on team performance is found to vary between schools, within schools, and within conferences. The analysis of the relationship between recruit quality and revenues indicates a direct relationship, namely, as recruit quality increases, so do the revenues generated annually. Moreover, higher-rated recruits increase the odds of postseason appearances and success.

2 Literature Review

Each year, great pageantry arises around the college football recruiting process as fans get excited about potential new players that will shape their team's future. Additionally, schools spend large sums of money on their football programs, facilities, and recruiting. Teams face various recruiting constraints, such as their allotted budget, geographic region, and NCAA guidelines. Smaller market teams will face lower recruiting budgets relative to larger teams, which can limit the geographic extent to which a team can recruit potential players. The NCAA allows a school to provide up to 85 football scholarships to athletes on the team, but no more than 25 scholarships can be awarded to new players in a recruiting class. For example, if a team has 75 awarded scholarships to current athletes, only 10 new scholarships can be provided to athletes in the new recruiting class. Presented with these constraints, it is critical for schools to allocate funds appropriately. This raises the question, what are the impacts of a recruiting class on future team success?

Langlett (2003) investigated this question by analyzing the top 25 ranked teams according to the *Associated Press* (AP) poll and the *USA Today* poll from 1991-2001.[3] When a team has a recruiting class consisting of higher-rated recruits, on average, their number of wins in subsequent seasons was found to increase. Teams were found to receive the greatest benefit from recruits in their first season, with diminishing returns for each season that follows. Langlett also found evidence of a bi-directional relationship between the quality of a recruiting class and team

[3] The polls rank teams based on the number of wins and losses, strength of schedule, and score differentials. Polls are updated weekly.

performance. Not only do teams perform better as a result of high-quality recruits, but teams that win more have greater success recruiting high-quality athletes. This creates a positive feedback loop where teams in the top 25 stay in the top 25, whereas teams that are not in the top 25 will struggle to enter the rankings in following seasons.

The success of a football team affects academic life on campus as well, since the competitiveness of a team has been found to increase the number of applications to a school. This is advantageous for universities since a larger proportion of applicants have higher than average SAT scores following a successful football season (Pope and Pope 2009). Goidel and Hamilton (2006) found evidence radicating the tendency that the public believes a link exists between academic success and football success, which also influence admissions applications.

Dumond, Lynch, and Platania (2008) examined the incentives recruits face when determining what school to play for and the factors they consider when signing with a school. Recruits typically come from high school and are confronted by a decision of where to sign. Determinants that affect a recruit's decision consists of a team's on field success, facility quality, academics, playtime, and geographic distance from a recruit's home. Their findings indicate that recruits primarily place weight on geographic distance when deciding where to commit. Schools with greater media exposure, usually reflective of on-field success, recruited higher rated players more often than schools with less media exposure. This is consistent with Langlett's findings that successful teams tend to remain successful, while teams that struggle may face adversity if trying to improve.

The quality of a recruiting class in Langlett's study was measured using the average number of various star recruits a team signs in any given year.[4] The star ranking system is a measure of potential collegiate success for an athlete, which can be used to measure the expected success of a team, despite it being *ex-ante* (Meers 2013). However, using the quality of a recruiting class in a model of team performance has some shortcomings. Namely, this method aggregates all players recruited in a given year cross-sectionally causing aggregation bias.

Bergman and Logan (2013) used panel data econometric models in order to control for heterogeneity between schools, which helps to isolate the effects recruits have on team performance, *ceteris peribus*. By utilizing panel data models and differentiating by the number of each star recruit a team signs, a significant positive relationship was found between the quality of recruited players and team performance. The study also found that higher-rated recruits add more wins to a team then lower-rated ones, in addition to increasing the likelihood a team plays in a bowl game and ends the season high in the standings. Since schools earn several million dollars by appearing in various bowl games, a five-star recruit is worth over $150,000 to a program by adding to the probability (by about 7.5%) a school plays in such games.[5] Furthermore, a top tier recruit, on average, increases the donations received by an athletics department by $1.37 million (Borghesi 2017).

[4] Players are evaluated by scouts in high school who predict future performance based off a rubric and assign a star rating determined by a threshold value of points from the rubric. 5-star players are predicted to have the largest impact for success, followed by 4-star, 3-star, 2-star, and non-ranked athletes.

[5] As noted by Bergman and Logan, this is a back of the envelope calculation. This thesis will provide a more thorough and rigorous analysis of the relationship between revenues and recruit quality.

The existing literature about college football team performance and recruit quality has focused upon the BCS era. Extending the literature to the current CFP era is an obvious next step to see if the relationships between recruit quality and performance persist. This also allows for models with different response variables than those that have previously existed in the literature, such as if a team participated in the playoffs and if a team won the CFP championship. These measures of success did not exist in the BCS era as there was no playoff or CFP championship.

3 Data

3.1 Data Collection

To investigate the relationship between team performance and recruit quality, data was collected from the websites Rivals.com and 247sports.com and from the *College Athletics Financial Information Database*. The data spans the period 2014-2018 and includes overall wins and losses, conference wins and losses, win percentages, New Year's Six (NY6) bowl appearances, conference championships, standings, College Football Playoff (CFP) berth, the CFP champion, and the number of 5, 4, 3, and 2 star recruits for all FBS team. Data spanning 2014-2017 is also collected for team revenues for public universities and is adjusted for inflation using a feature provided by the *College Athletics Financial Information Database*.

Recruiting ratings were collected primarily from Rivals.com. If data were missing for a given team from Rivals.com, then 247sports.com was used. The star ratings of athletes provided by these sources uses a consensus among college scouts who utilize a time-consistent evaluation method. This is an important feature of star ratings for research purposes. Athletes are given ratings based on a scale that is fixed over time. In other words, for an athlete to be deemed a five-star recruit they must demonstrate a skill level beyond a threshold that does not vary between years.

The star ratings are also an *ex-ante* measure of quality. Team scouts observe various player characteristics and predict their potential success at the collegiate football level. A star rating is then assigned to a player out of high school based on observables. The rating is a signal to college football coaches on the athletic potential of a recruit at the collegiate level based on observed

attributes such as the strength of the athlete, athletic ability, video highlights from prior games, cognitive ability, and demeanor.

3.2 Summary Statistics

Table 1 contains descriptive statistics for pertinent variables utilized in the models estimated below. The mean number of wins a team earns in each season is 6.717. As teams play twelve regular season games, the average team therefore wins about half of them, contributing to a mean overall win percent of 0.518. Of the twelve games played in a season, eight or nine are played against conference opponents. The mean number of conference wins is 4.084, which again is about half of all conference games, leading to a mean conference win percentage of 0.502.

Of the 130 teams that participate in Division I FBS football, only twelve of them participate in a New Year's Six (NY6) Bowl game.[6] Additionally, four teams participate in the CFP playoff and eight teams are the champions of their conference (there are ten conferences but not every conference has a conference championship). FBS football is composed of 10 conferences; the American Athletic Conference (AAC), the Atlantic Coast Conference (ACC), the Big-Ten, the Big-12, Conference USA (C-USA), the Mid-American conference (MAC), the Mountain West Conference (MWC), the Pac-12, the Southeastern Conference (SEC), and the Sun-Belt. The historically best performing and most competitive conferences are known as the Power-5 and include the ACC, Big-Ten, Big-12, Pac-12, and SEC. Six teams are independent of any conference. Teams that realigned conferences during the span of the data are accounted for. Consequently, if

[6] A special group of six bowl games which are deemed the most competitive and usually contain the highest performing teams.

a team played in the MAC conference in 2016, but became independent in 2017, this change was made in the data to ensure proper conference alignment each year.

Table 1 also shows that approximately 24% of teams recruit at least one five-star athlete over then span of the data. However, 75% of five-star recruits are concentrated across 14 teams. The SEC, on average, has the highest concentration of five-star athletes with about 40% of them playing for an SEC team. The distribution of four-star recruits is relatively more uniform than five-star athletes but is still concentrated within the top performing conferences. Eighteen percent of FBS teams have at least 20 four-star recruits, while 64% of SEC teams, 21% of ACC teams, 20% of Big-12 teams, and 28% of Big-Ten teams signed at least 20 four-star athletes over the sample period. Three-star athletes are significantly more plentiful than five- or four-star athletes and appeal to teams at all levels of performance. Therefore, they are distributed uniformly across teams and conferences.

On average, a team had 0.269 five-star recruits, 2.797 four-star recruits, 9.546 three-star recruits, and 10.914 two-star recruits with the mean recruiting class consisting of 23.526 athletes. Since only select teams compete for five-star recruits and because of the relatively low frequency of five-star recruits, it is no surprise that they make up the smallest component of a recruiting class. Additionally, it is expected that as recruit quality diminishes, the relative availability of that caliber athlete increases and is more attractive as a recruit for less successful teams.

4 Methodology

Three classes of models are evaluated and include various relationships between recruit quality and team performance or revenues. In the first, the dependent variables are quantitative measures of team performance, including overall wins, conference wins, overall win percentage, and conference win percentage. The second class of models, discussed in section 4.2, measure team performance qualitatively. These models use appearance in a NY6 Bowl, participation in the CFP (CFP berth), the CFP champion, and the conference champion as measures of success. Thus, the second class of models will look at post-season success. The third class of models investigates the relationship between recruit quality and revenues and is discussed in section 4.3.

4.1 Quantitative Models

The first class of models is motivated by Langlett's (2003) model of team performance, where team performance is a function of the number of star rated recruits and expands upon Bergman and Logan (2016) by introducing alternative measures of team performance.

The model relating team success and recruit quality will be fit using OLS and is specified:

$$Y_{it} = \beta_0 + \beta_1 S_{5,it} + \beta_2 S_{4,it} + \beta_3 S_{3,it} + \beta_4 S_{2,it} + \mu_{it} \quad (1)$$

where Y_{it} is one of the measures of team performance for team *i* in year *t*, $S_{5,it}$ is the number of five-star recruits for team *i* in year *t*, and μ_{it} is the error term.

Due to the cross-sectional time-series nature of the data, fixed effects specifications are also estimated. Schools differ between each other, but within a school there exists effects that are

time consistent. Controlling for school heterogeneity across years could yield more accurate estimates by reducing omitted variable bias. The fixed effects specification is:

$$Y_{it} = \beta_0 + \beta_1 S_{5,it} + \beta_2 S_{4,it} + \beta_3 S_{3,it} + \beta_4 S_{2,it} + \theta_i + \mu_{it} \quad (2)$$

where θ_i is school *i*'s entity-specific intercept.

By comparing the estimates from the OLS and fixed effects models, differences in the effect of recruit quality on team performance within a school, between schools, and within a conference can be observed. Additionally, fixed effects models will be estimated to control for the homogeneity constant over time in a given conference by using conference specific intercepts. Without loss of generality, these models will take on the same form as the school fixed effects model, however, θ_i is conference *i*'s entity-specific intercept instead.

Lagged models will also be estimated to determine how success in the present influences recruit quality in the future. This model is used to investigate if teams with a history of winning have an advantage at recruiting higher-quality recruits, and as a result, continue their success, to support the positive feedback loop hypothesis of team success. A dummy variable representing if a school is in the Power-5 (P5) is included since schools in the Power-5 have amenities favorable to high-quality recruits such as better facilities and greater TV exposure (Dumond, Lynch, and Platania, 2008).

The models are estimated with fixed effects at the school and conference levels and are specified by:

$$Y_{it} = \beta_0 + \beta_1 X_{t-1,i} + \beta_2 X_{t-2,i} + \beta_3 P5_i + u_{it} \quad (3)$$

where $X_{(t-1),i}$ is the overall wins for school *i* in period *t*-1, and $P5_i$ is schools *i*'s Power-5 dummy.

4.2 Qualitative Models

For analysis of the qualitative dependent variables, such as CFP berth, participation in a NY6 Bowl game, conference champion, and CFP champion, logit models will be estimated by:

$$\Pr(Y_{it} = 1|\boldsymbol{X}) = \frac{1}{1 + e^{-(\beta_0+\beta_1 S_{5,it}+\beta_2 S_{4,it}+\beta_3 S_{3,it}+\beta_4 S_{2,it}+\beta_5 Wins_{it})}} \quad (4)$$

Where $Wins_{it}$ represents the number of conference or overall wins team *i* earns in year *t*. The model will also be estimated by OLS for comparison and direct interpretation of the coefficient estimates.

Teams earn revenue from postseason performance in the form of payouts for upwards of $9 million, while conferences receive $6 million for sending a team to a semifinal game and $4 million for each team they send to a non-playoff New Year's Six bowl game (CFP Revenue Distribution Policies). Accordingly, it is important to measure how recruit quality affects the odds of a postseason appearance as well as success. Teams can participate in the postseason in various ways. A team may qualify to play in the conference championship if it has the most conference wins (wins against teams within the same conference) in its division (a subset of the conference). Since conferences have at most two divisions, the two teams highest in their respective standings play each other in the conference championship.

Additionally, teams can compete in bowl games, which have conference ties. For example, in the Rose Bowl, one team is always from the Pac-12, and the other team is always a member of the Big-Ten. A special class of bowl games known as the New Year's Six Bowl's are reserved for the highest performing teams, and two of the six bowl games are the semifinals for the CFP

Championship game. The team that wins the CFP Championship is deemed college football's National Champion, attaining the pinnacle of success in the sport.

Linear probability and logit models are used to estimate the effect of recruit quality on the probability of appearing in a New Year's Six bowl appearance, winning a Conference Championship, being one of the four teams to play in the CFP playoff (CFP Berth), and winning the CFP Championship. The number of wins is used as a covariate in these models to account for omitted variable bias since postseason appearance is a function of regular season performance.[7]

4.3 Revenues Models

The third class of models examine the relationship between revenues and recruit quality and will be used to determine the marginal revenue associated with a given level of athlete. It is important to note that certain forms of revenue are independent of team performance and heterogenous amongst schools depending on conference affiliation, among other factors. The NCAA distributes revenue to Division I members based on the quantity of athletic scholarships, the number of NCAA sponsored sports, and most importantly the performance of a member schools conference. In addition to the NCAA, conferences also distribute revenues to member schools (Bukstein 2016).

More precisely, the revenue distribution in the CFP era is as follows: every conference receives $300,000 when a school's football team participates in a post-season game in addition to

[7] Conference wins are used for the Conference Champion models since attending the conference championship is determined by the number of wins against opponents in the same conference. Overall wins are used for the other three measures of postseason success since total wins has weight in deciding a team's appearance in these types of games.

a base pay of $66 million for teams who participate in major bowl games. Further revenue distributions are subsidized from the CFP to conferences to cover expenses for post-season participation ($2.43 million) (CFP Revenue Distribution Policies). These distributions are independent of individual team performance and will therefore be controlled for. This will be discussed further in section 5.5. The forms of revenue that are used are reflective of football team performance and include revenues from ticket sales, corporate sponsorships, and operations. This third class of models will be fit by OLS and fixed effects at the conference and school levels.

5 Results

5.1 Interpretation and Intuition Behind OLS and Fixed Effects

Several models in this thesis are estimated using the standard OLS framework with no fixed effects, schools fixed effects, or conference fixed effects. This subsection discusses the intuition in estimating models using these three specifications and how to interpret coefficients using the models given the context of the data.

The OLS models with no fixed effects will be the base model. This model measures the between school effects of recruit quality since it does not account for the homogeneity present in a given school over a given period. There exists heterogeneity between schools in the way of athletic culture, coaching style, and athletic facilities, so the OLS models measure the effects of recruits between schools on team performance. In other words, the base model does not control for unobserved heterogeneity between schools or the homogeneity within schools.

The school fixed effects models control for the unobservable factors that affect team performance but are constant over seasons. The unobservables are hard to quantify and therefore include in the models, so by including fixed effects, the effects of omitted variable bias can be mitigated. Therefore, the coefficients for school fixed effects models are interpreted as the effect of a recruit within a given school.

Similar to school fixed effects models, the conference fixed effects models control for the unobserved similarities within a conference which are constant over time, and therefore measure the effect of a recruit on team performance within a conference. Conferences compete for the same recruits since a significant determinant for recruits is geographic region. Additionally, the level of

competition between teams in a conference is generally homogenous, while the competition between conference varies, so by controlling for the homogeneity within a conference, more accurate coefficients can be estimated independent of omitted variable bias (Bergman and Logan, 2016).

5.2 Effect of Recruit Quality on Wins

Tables 2 and 3 report the estimation results of the regressions on the relationship between recruit quality and wins. Across models, the conference fixed effects coefficients are greater than the school fixed effects and the base model. Only one of the within school effects is significant over all models, showing that within schools, two-star recruits have a negative impact on conference wins. Five-star recruits have the most substantial impact in determining success between schools and within conferences compared to any other level of recruit. For four-star recruits, the largest effect is felt with overall wins controlled on the conference level. Four-star recruits also contributed positively and significantly at the conference level for both the base and conference fixed effects models. Three-star recruits only had a significant effect in determining overall wins. Two-star recruits have minimal positive effect on overall wins in the base and conference fixed effects models, and a negative effect on conference wins across the three models. However, none of the coefficients are significant except for conference wins when estimated with schools fixed effects.

Similar results are found when using the winning percentage as a measure of success instead of wins. Again, coefficient estimates in the conference fixed effects model are greater than that of the base model and schools fixed effects model, suggesting that within conference effects are greater than within school effects and between school effects. In this class of models, five-star

recruits still have the most sizeable impact over any other level of recruit for both conference win percent and overall win percent. On average, a five-star recruit is estimated to increase the overall win percent by about 3.36% between schools and 3.77% within conferences. Five-star recruits also increased the conference win percent, on average, by 3.88% between schools and 4.70% within conferences. Four-star recruits have a positive effect on overall and conference win percent, but it is not as substantial as the effect of a five-star recruit.

Three-star recruits have a small significant effect on overall win percent within conference and between schools. On average, a three-star athlete will increase the conference win percentage of a team by 0.662% within a conference and decrease conference win percent by -0.072% between schools, though the latter is not significant. Recruiting two-star athletes had an adverse effect on overall and conference win percent at the conference level and a small positive effect on both win percentages in the base models. No estimates for two-star recruits are significant.

The results support the use of *ex-ante* recruit ratings as a measure of anticipated athletic success at the collegiate level. Since higher-rated recruits are expected to perform better than lower-rated recruits, it is estimated that higher-rated athletes will contribute greater to team performance, as reflected by the larger estimate coefficients. The results support this for the base models and conference fixed effects models for overall wins and win percentage.

5.3 Postseason Models

The results for the qualitative post-season models are reported in Table 4. Five-star recruits have a sizeable and significant effect on all the measures of postseason success estimated by the linear probability model. For the logit specification, five-star recruits have a negative effect on

New Year's Six bowl appearance and CFP berth, but an additional five-star recruit increases the probability of being both the conference champion and CFP champion. However, the logit models indicate no significant effect from recruiting an additional five-star athlete. Four-star recruits improve a team's probability in both the logit and linear probability models for participating in a New Year's Six bowl, as well as Conference Champion, CFP Berth, and CFP champion (only in the logit model), but the latter are not significant.

Wins have the largest effect on postseason appearance and success across most models. It can be concluded that postseason success is strongly related to regular season performance relative to the quality of a team's recruits. Fixed effect models are not used in this section because of the nature of the data. In a given year, most teams do not make it to a New Year's Six bowl game, let alone win the CFP Championship. Therefore, the vector of response variables mostly contains elements that are zero. A result of this is that there is no way to control for heterogeneity between schools and conferences over time.

5.4 Does Past Success Help Secure Quality Recruits in the Future?

In section 5.2, the relationship between recruit quality and success is discussed, specifically what impact does recruit quality have on team success in a given year. However, to consider if success each year affects future recruit quality, a model with lagged values of the number of wins is estimated.

Results for these models are reported in Table 5. Overall wins lagged one year are significantly related to five-, four-, and two-star recruits on both the school and conference level. For all levels of recruit quality, the coefficients for the conference fixed effects are greater than

those for the school fixed effects, suggesting that overall wins lagged one year has a larger impact on recruiting within conferences than it does within schools. The same holds when overall wins are lagged two years; however, only the conference fixed effects for five- and four-star athletes, as well school fixed effects for five-star recruits, are significant.

Overall wins lagged one year have the most profound positive impact for four-star athletes at the conference level, with an additional win in the prior year estimated to, on average, bring in 0.287 more four-star recruits. At both the school and conference level, lagged wins have a larger effect on four-star athletes than five-star athletes. This could arise from there being more four-star recruits than five-star recruits. Lagged overall wins has a negative relationship with two-star recruits, meaning that as a team wins more games, they will recruit less two-star athletes, substituting them for higher caliber players. This relationship is only significant when lagged one year.

Whether a school is in a Power-5 conference or not is the largest determinant for what level of recruit a team will sign. All the Power-5 dummies are significant at the 1% level, but being in the Power-5 had the greatest effect on signing three-star players (7.083 within schools, 7.029 within conferences), followed by four-star (4.875 within schools, 4.159 within conferences), then five-star (0.468 within schools, 0.398 within conferences). This could be attributed to the quantity of three- and four-star athletes available relative to five-star. Being a member of a Power-5 conference, on average, was estimated to decrease the number of two-star recruits by about 13.749 within schools and 13.657 within conferences. In other words, being in the Power-5 creates a predisposition for recruiting higher quality athletes then not being a member of the Power-5. In all cases, when fixed effects are controlled on the school level, a more profound impact is measured

then than conference level fixed effects, suggesting that being in a Power-5 conference has a greater effect within schools than within conferences.

5.5 Results Revenues Models

The results discussed in section 5.1 indicate that higher-quality recruits improve on-field team performance. Since it is reasonable to expect that college football programs behave in a manner to maximize profits, it is a realistic question to ask what is the revenue generated by various quality recruits?

A series of models are estimated using various measures of revenue in order to obtain estimates on the relationship of recruit quality and revenue, which are displayed in Tables 6 and 7. In the base model and conference fixed effects model, a five-star recruit on average, added $2 million in total revenue. However, these estimates are not significant. A four-star recruit adds about $6 million in revenue between schools and about $3.77 million within a conference. A two-star recruit is associated with a loss of about $888,000 in revenue between schools. The total revenue model may suffer from aggregation bias since other variables not included in the model contribute to variations in total revenue.

To try to mitigate the effect of aggregation bias, other measures of revenue are implemented in models to yield more accurate results on how recruit quality effects revenue. At this juncture it should be noted that teams can earn revenue from various sources. Some forms of revenue are independent of how a team performs in each season (and as a result independent from the quality of recruits they have) such as competition guarantees and conference distributions. The former is money a team receives for playing particular away games and neutral site games, while

the latter is a conference specific "bonus" teams receive for being affiliated with their respective conference. A series of models are estimated using revenue streams that can be associated with team performance and by extension, recruit quality.

Operational revenue is revenue that comes from the sale of novelty items, parking, concession sales, and other revenue generators of the like. The intuition behind this form of revenue being a function of recruit quality is that more successful teams tout higher-rated recruits and will sell more merchandise and have a higher volume of fans who attended games resulting in increased parking and concession revenue. Five-star recruits increase operational revenue more than any other caliber of recruit. On average a five-star athlete will increase operational revenue by $743,260 between schools and $911,700 within conferences, while a four-star athlete will increase revenue by $618,872 between schools and $460,090 within conferences.

Corporate revenue is revenue that comes from licensing and corporate sponsorships. As a team realizes more success, corporate sponsors have greater incentive to sign sponsorships with that team. The coefficients for five-star and three-star recruits are not significant for this series of models. Four-star recruits increase corporate revenue by about $737,000 in the base model and by $672,257 in the conference fixed effects model. Two-star athletes will decrease corporate revenue by almost $120,000 between schools. Due to the lack of significant coefficients, no relationship exists between recruit quality and corporate revenues.

An even better measure of how various quality recruits affect revenue is by investigating the relationship between ticket revenue and recruit quality. Since fans have a more considerable incentive to attend games if their team has "exciting" high-quality athletes, it can be expected that ticket revenue increases as the quality of a recruit increases. Additionally, since high-quality

recruits perform better on the field, teams with a relatively large number of quality recruits will see greater on field success, further incentivizing fans to attend games. A marginal four-star recruit will increase ticket revenue by about $2 million. Similar to total revenues and operational revenues, a positive relationship exists between ticket revenues and recruit quality.

6 Conclusion

College football is a high stakes industry with teams spending increasingly large sums of money on recruiting. This thesis finds support that schools attract higher quality recruits by winning, which creates a positive winning feedback loop since winning teams sign better players, which further perpetuates a trend of success. Support was also found suggesting that by having a larger number of high-quality recruits, teams will perform more favorably, consistent with Bergman and Logan (2016), and Langlett (2003). By using fixed effects models, this study controlled for unobserved heterogeneity across schools and conferences but constant within schools and conferences over time. This also allowed for a comparison between the coefficient estimates with the OLS and fixed effects models.

This thesis found that as recruit quality increases, a given athlete will increase a team's on field performance. This provides support for the use of an *ex-ante* star rating system for the prediction of a recruit's success out of high school at the collegiate level. Additionally, as recruit quality increases, so does the probability of success in the post-season.

The quality of a team's recruits also influences their revenues generated. Several different measures of revenues were used to account for NCAA and conference revenue distributions that are independent of team performance, and to control for aggregation bias. A positive relationship was found to exist between total, ticket, and operational revenues.

Ultimately, this thesis found that recruit quality does have an impact on team performance, and vice versa in both the regular season and postseason, while also effecting a team's revenues. Research can be extended beyond this thesis by investigating how the new NCAA athlete likeness

compensation policy will affect the incentives of recruits and the process by which universities recruit athletes. Additionally, the relationship between recruit quality and expenditures is yet to be discussed in the literature.

7 Appendix

Table 1. Summary Statistics on Recruit Quality and On-Field Success from 2014-2018

Variables	Mean	Standard Deviation
Regular Season Performance		
Overall Wins	6.717	3.044
Overall Win Percent	0.518	0.216
Conference Wins	4.084	2.205
Conference Win Percent	0.502	0.264
Postseason Performance		
Percent of Teams in New Year's Six Bowl	9.317	---
Percent of Teams in CFB Playoff	3.106	---
Percent of Teams that are CFB Champion	0.776	---
Percent of Teams that are Conference Champions	6.677	---
School Level Recruit Statistics		
Five-star Recruits	0.269	0.921
Four-star Recruits	2.797	4.309
Three-star Recruits	9.546	5.687
Two-star Recruits	10.914	10.086

N=130

Table 2. OLS and Fixed Effects Regressions for Conference Wins

	Conference Wins			Conference Win %		
Recruit Rating	Base Model	School Fixed Effects	Conference Fixed Effects	Base Model	School Fixed Effects	Conference Fixed Effects
5 Star	0.286**	-0.022	0.375***	3.881***	-0.453	4.696***
	(0.117)	(0.132)	(0.115)	(1.412)	(1.606)	(1.391)
4 Star	0.065**	-0.046	0.160**	0.935***	-0.734	1.956***
	(0.026)	(0.049)	(0.032)	(0.351)	(0.595)	(0.392)
3 Star	-0.015	-0.034	0.044	-0.072	-0.494	0.662**
	(0.020)	(0.024)	(0.023)	(0.242)	(0.291)	(0.279)
2 Star	-0.020	-0.046**	-0.022	0.079	-0.581	-0.240
	(0.015)	(0.021)	(0.015)	(0.180)	(0.251)	(0.186)
Observations	627	627	627	625	625	625
R^2	0.071	0.505	0.142	0.060	0.494	0.125

Note: Standard errors are in parentheses; winning percentages are reported as percents. Base Model is OLS with no fixed effects.

***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Table 3. OLS and Fixed Effects Regressions for Overall Wins

	Overall Wins			Overall Win %		
Recruit Rating	Base Model	School Fixed Effects	Conference Fixed Effects	Base Model	School Fixed Effects	Conference Fixed Effects
5 Star	0.566***	-0.72	0.621***	3.360***	-0.657	3.773***
	(0.153)	(0.179)	(0.156)	(1.092)	(1.280)	(1.111)
4 Star	0.180***	-0.035	0.231***	1.324***	-0.232	1.676
	(0.037)	(0.066)	(0.043)	(0.260)	(0.471)	(0.306)
3 Star	0.064**	-0.042	0.098***	0.492***	-0.240	0.754***
	(0.025)	(0.032)	(0.031)	(0.181)	(0.231)	(0.220)
2 Star	0.008	-0.041	0.001	0.065	-0.298	-0.002
	(0.017)	(0.027)	(0.018)	(0.118)	(0.193)	(0.126)
Observations	639	639	639	639	639	639
R^2	0.152	0.522	0.164	0.144	0.513	0.156

Note: Standard errors are in parentheses; winning percentages are reported as percents. Base Model is OLS with no fixed effects.

***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Table 4. OLS and Logit Regressions for Postseason Success

	New Year's Six Bowl		Conference Champion		CFP Berth		CFP Champion	
Covariates	OLS	Logit	OLS	Logit	OLS	Logit	OLS	Logit
5 Star	0.028**	-0.158	0.040***	0.273	0.049***	-0.168	0.034***	0.678
	(0.013)	(0.292)	(0.012)	(0.191)	(0.008)	(0.270)	(0.004)	(0.721)
4 Star	0.019***	0.249**	0.004	0.061	0.006***	0.135	-0.001	1.097
	(0.003)	(0.109)	(0.003)	(0.071)	(0.002)	(0.127)	(0.001)	(0.860)
3 Star	-0.005**	-0.022	-0.002	-0.014	-0.002	-0.042	-0.001	0.143
	(0.002)	(0.085)	(0.002)	(0.067)	(0.001)	(0.159)	(0.001)	(0.569)
2 Star	-0.002	-0.302***	0.001	0.063	0.000	-0.365	0.000	0.408
	(0.001)	(0.108)	(0.002)	(0.055)	(0.000)	(0.237)	(0.000)	(0.342)
Wins	0.037***	2.306***	0.044***	2.004***	0.014***	1.992***	0.004***	8.326
	(0.003)	(0.378)	(0.004)	(0.304)	(0.002)	(0.473)	(0.001)	(5.831)
Observations	639	639	627	627	639	639	639	639
R^2	0.375	---	0.218	---	0.257	---	0.158	---

Note: Standard errors are in parentheses. Wins represent conference wins for the conference championship columns, and overall wins otherwise.

***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Table 5. Fixed Effects Regressions for Lagged Wins

	Five Star		Four Star		Three Star		Two Star	
Overall Wins	School Fixed Effects	Conference Fixed Effects	School Fixed Effects	Conference Fixed Effects	School Fixed Effects	Conference Fixed Effects	School Fixed Effects	Conference Fixed Effects
1-Year Lag	0.034***	0.062***	0.112***	0.287***	0.048	0.070	-0.149**	-0.320***
	(0.010)	(0.012)	(0.028)	(0.045)	(0.058)	(0.064)	(0.070)	(0.107)
2-Year Lag	0.024**	0.039***	0.036	0.148***	-0.059	-0.076	-0.021	-0.046
	(0.010)	(0.012)	(0.028)	(0.045)	(0.057)	(0.063)	(0.068)	(0.106)
Power Five	0.468***	0.398***	4.875***	4.159***	7.083***	7.029***	-13.749***	-13.657***
	(0.111)	(0.120)	(0.510)	(0.701)	(0.549)	(0.681)	(1.227)	(1.671)
Observations	637	637	637	637	637	637	637	637
R^2	0.150	0.163	0.368	0.402	0.386	0.384	0.448	0.451

Note: Standard errors are in parentheses.

***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Table 6. OLS and Fixed Effects Regression for Revenues (Part I)

	Total Revenue			Operational Revenue		
Recruit Rating	Base Model	School Fixed Effects	Conference Fixed Effects	Base Model	School Fixed Effects	Conference Fixed Effects
5 Star	2,290,953	943,227	2,017,652	743,260***	243,536	911,700***
	(1,609,721)	(1,053,259)	(1,171,599)	(268,729)	(214,946)	(234,221)
4 Star	6,302,332***	182,257	3,768,055***	618,872***	79,132	460,090***
	(409,806)	(349,071)	(338,568)	(68,413)	(71,237)	(67,685)
3 Star	1,524,403***	-50,063	-329,999	186,104***	23,983	52,238
	(274,227)	(166,312)	(226,418)	(45,779)	(33,940)	(45,264)
2 Star	-888,184***	81,885	-243,422	-51,690	26,999	8,337
	(218,692)	(164,519)	(187,603)	(36,508)	(33,574)	(37,504)
Observations	429	429	429	429	429	429
R^2	0.718	0.961	0.862	0.487	0.894	0.639

Note: Standard errors are in parenthesis. Base Model is OLS with no fixed effects.
***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Table 7. OLS and Fixed Effects Regressions for Revenues (Part II)

	Corporate Revenue			Ticket Revenue		
Recruit Rating	Base Model	School Fixed Effects	Conference Fixed Effects	Base Model	School Fixed Effects	Conference Fixed Effects
5 Star	-84,584	289,857	318,351	227,725	165,990	316,990
	(311,319)	(182,656)	(277,088)	(539,250)	174,321	(444,586)
4 Star	737,629***	387.530	672,257***	2,212,711***	-16,301	1,608,336***
	(79,256)	(60,536)	(80,072)	(137,283)	(57,773)	(128,476)
3 Star	92,062	-30,891	-45,116	389,108***	-8,367	-24,769
	(53,035)	(28,841)	(53,548)	(91,864)	(27,525)	(85,919)
2 Star	-119,037***	-6,627	-49,461	-246,713***	-21,191	-92,202
	(42,294)	(28,531)	(44,368)	(73,260)	(27,229)	(71,189)
Observations	429	429	429	429	429	429
R^2	0.446	0.939	0.593	0.699	0.989	0.810

Note: Standard errors are in parenthesis. Base Model is OLS with no fixed effects

***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

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