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REGRESSION ANALYSIS OF STRENGTH COACH SALARY AND ITS EFFECT ON ON-FIELD PERFORMANCE AND ACADEMIC PROGRESS RATE IN DIVISION 1 FOOTBALL

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REGRESSION ANALYSIS OF STRENGTH COACH SALARY AND ITS EFFECT ON ON-
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A THESIS APPROVED FOR THE DEPARTMENT OF
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Abstract

Finding an edge to increase the likelihood of success of their student athletes' is always at the forefront of college athletics administrators. Previous studies have investigated the relationship of coaching salaries and on field performance in college football. Athletic budgets, talent level, head coaching salary but none have looked at the relationship of the investment of strength and conditioning coach and how it relates to academic and on field performance. Many medical studies have shown that exercising has increased cognitive performance, but none have made the connection of how this plays a role into the success of our elite college athletes. This study looks into the relationship between not only strength coach salary but other contributing factors of State population, athletic budgets, conference affiliation, head football coach salary, and talent were all used as control variables. Performing a ordinary least squares regression analysis on averaged data from years 2016-2018, with a total of 267 observable groupings. An OLS Regression will also be performed on the same year but the average of the variables for each school. Initial correlational analysis showed promise of salary with on field performance. Talent was the strongest indicator of a higher winning percentage. While Strength and conditioning coach salary was not positively correlated with Academic Progress Rate, which is an annual four year average combined of GPA and graduation track of current athletes. While the relationship was not strong showing that funding a SCC does translate to on field performance will be key for this industry.

Chapter 1: Introduction

Introduction

At the elite levels of college football, each university looks for an edge to increase the success on the field. One strategic choice is the level of investment in strength and conditioning programs. Bigger and bigger facilities have been built with state-of-the-art weight rooms and recovery areas (Lawrence et al., 2014). However, the personnel they put in charge of these facilities may prove to be even more important. The strength and conditioning coach has been described by many as an indispensable person when it comes to preparing athletes to play even though the job role has only been around 50 years old within the college football realm, and it being a general fixture for 30 years (Massey et., al 2004). Overall, the return on of the total investment in a strength and conditioning program is not straight forward to evaluate, with small numbers of discrete wins and losses making effects difficult to identify. Other on-the-field, in addition to off-the-field achievements, also contribute to some overall definitions of the ‘success’ of a program. However, it is an open question whether the money invested in’ into the salary of a head strength coach and contributes to performance in any or all of these areas. This analysis will fill this knowledge gap by attempting to generate clear value estimates that university administrators can look at when deciding salaries and making other financial allocations toward the strength and conditioning departments. As much as the budgets vary for Division 1 Football Subdivision programs, the salaries of the strength coaches also vary substantially. For example, at many of institutions assistant strength coaches are earning more than head strength coaches at smaller Group 5 schools. According to USA Today (2019), the highest paid strength coach in the nation is Iowa’s Chris Doyle at \$800,000 annual salary, while the lowest publicly available

salary is Ohio's head strength coach who earns only \$54,500 per year. The scope of past studies does not explore the return on these investments.

There is a lack of apparent information the connection between strength & conditioning compensation and on-field performance. Available, but yet un-analyzed data from team performance and the salaries of these coaches may be able to show the value this position provides. Specific emphasis has previously been placed on the Head Coaches salary and the success of the team (Watson, 2014). The head strength coach might play the next biggest role. Football at nearly all institutions have separate strength staff and facilities. A 2014 survey also indicated that, 90.7% of the division 1 programs have football only facilities (Judge et al., 2014). This alludes to the fact that the head strength coach works only with the football team and in their own facility in which they are not likely share with other sports on campus.

Most research in the past only examined the strength coach's effect on the physical performance and physical development of college level athletes. Previous studies comparing groups of young athletes during resistance training has shown the benefits of having a coach present that extends past safety. The presence of a qualified strength and conditioning coach has been proven to increase strength and improve body composition in a greater way than those doing it on their own (Coutts et. al, 2004). Coaching efforts should have a relationship with not only wins and losses, i.e. athletes should perform better by being on teams with coaches who are paid more, but also potentially, but also academic performance.

There has been substantial work in exercise science establishing link between physical training (various exercises) and cognitive (and academic) performance. Exercise has been shown to improve cognition and prevent neurological and cognitive disorders (Gomez-Hanilla & Hillman 2013). Individuals who are more active or who have a high level of fitness are capable

of processing information quicker and put greater resources to their environment (Gomez-Hanilla & Hillman 2013). However, most of that research is laboratory based and doesn't examine how these findings translate into practice, nor do they consider variance in performance coach quality. Nevertheless, this body of literature substantiates the possibility that investments in training and performance staff may ultimately have an impact on the academic performance of sport team members through improved training, monitoring, and recovery as well as coached psychological improvements such as focus, self-regulation, and character building (Massey et al., 2004). Furthermore, NCAA regulations have strong prohibitions that prevent player interactions with position coaches. Strength coaches however are permitted to hold 'voluntary' and 'involuntary' training sessions year around. The strength coaches will potentially spend more time developing the players characteristics than any other coach (Staples, 2019).

Purpose

The purpose of the study is to investigate the marginal contribution of strength and conditioning lead personnel in terms of on and off the field performance of college football teams. Furthermore, this study aims to understand which performance areas are most significantly impacted by higher strength and conditioning coaching expenditures.

Research Question

The central research question will be, is there a positive relationship between performance coaching expenditures and team performance in Division 1 college athletics? The null hypotheses will be that there is no relationship between sport performance coach spending levels and team/individual performance metrics.

Significance

University athletic programs are continually looking for areas in which they can better allocate their resources while putting their athletes in the best position to compete. Additionally, programs are further evaluated and scrutinized for fulfilling the academic mission of their home institutions (Knight Commission). This study would provide concrete findings about whether monetary investment in head strength coaches actually pays off for program performance within their two central charges. Parties to the hiring and recruiting of sport performance personnel could also reference this study in labor market negotiations with administrators to make the connection between performance coach quality and higher levels of team performance both within the sports and academically.

From a different angle, recruits and athletes who are deciding among potential schools can also look at the strength program and hold it in higher regard. Prospects must weigh many factors when deciding to attend a specific school. By knowing how a head strength salary alone can play into his/her ultimate success on the field and/or academically, this may factor more significantly in their final decision, particularly if an athlete has not been well trained or developed up to that point. The way that high-profile recruits want to be coached is often an overlooked factor in their recruitment (Weathersby, 2013).

Delimitations

The titles of the coaches whose salaries will be used in this study limited to “Head Strength & Conditioning coach”, and “Director of Sports Performance” or minor variants/combinations. The study will include all Division 1 Football schools with publicly available data. There will be separate analysis on Power Five conference teams and Group of Five teams. There are five conferences considered to be a part of the ‘Power Five’, which are the

largest and most well-funded programs. Each of the last 20 Division 1 Football National Champions have been from the Power Five conferences. The Group of Five programs are the remaining Football Bowl Subdivision (FBS) schools that do not belong to the Power Five conferences. It is important to divide the two in some analysis because of the major budgetary differences.

Limitations

1. Lack of availability of assistant strength coach salaries
2. Private Schools do not release strength coach salaries
3. There may be some other factors that contribute to on field success not included as control variables, which could give rise to omitted variable bias.
4. Strength coaches can carry various titles and job responsibilities which may be reflected in compensation levels. These differences are not accounted for in this dataset.
5. Salaries will be drawn from four seasons.
6. Some also rely on incentives offered through bonuses based on team performance.
7. The variables Talent, Expenses, HC Total Pay, State Pop, and Salary are not normally distributed.

Assumptions

1. The USA Today's Database is an accurate representation of the variance in investment in strength and conditioning programs.
2. The job duties and performance are assured to be generally the same and the error variance across programs would be from random sources.

3. College Football teams have the goal of winning as many games in the season as possible.

Operational Definitions

Strength Coach – Athletics staff with role of programming workouts, supervising training sessions, coordinating nutritional advice, disciplinary of athletes (Lee et al., 2013).

Title of Coaches Analyzed – Head Strength & Conditioning Coach, Director of Performance.

Group of Five Conferences- Sun Belt, Midwestern Athletic Conference (MAC), Conference USA, American Conference, and Mountain West.

Power Five Conferences – Big Ten, Big 12, Pac 12, Southeastern Athletic Conference and Atlantic Coast Conference

Total Pay – “Sum of Actual School Pay and athletically related compensation receive from non-university sources” (College Football Strength)

School Pay – “base salary on an annualized basis; annualized income from contract provisions other than base salary that were to have been paid, or guaranteed, by the university or affiliated organizations, such as a foundation.” This also includes deferred payments that are acquired annually. One-time bonuses, housing allowances, and contractual expense accounts are also included if earned in current contract year. (College Football Strength)

SCC – Strength & Conditioning Coach abbreviation.

Total Allocated – “The sum of student fees, direct and indirect institutional support and state money allocated to the athletics department, minus certain funds the department transferred back to the school. The transfer amount cannot exceed the sum of student fees and direct

institutional support that the department receives from the school. (Under NCAA reporting rules, any additional money transferred to the school cannot be considered part of the department's annual operating revenues or expenses.)” (College Football Finance).

Chapter 2: Literature Review

Research Problems/Research Questions

The continuing goal of each athletic department is to increase the success of their football teams while also providing an environment that puts student athletes in a great position off the field. Each department allocates their budgets in areas that fulfill both of those goals. We see year after year new facilities and bigger salaries provided to head football coaches. One area of college football coaches' salaries that are not as focused on by the media is the strength and conditioning coach salary. These salaries have a great variance across the power five conferences and group of five institutions. Strength coach salaries also vary greatly across the Division 1 landscape. Understanding the origins of these structures may be attained through this research.

This chapter will consist of a general review of the state of on the subject, particularly in terms of scholarly sources. Keywords that were used during the research of this specific subject were “strength and conditioning”, “division 1 football strength”, ‘athletic coaches and performance” and various combinations of these terms. All available literature from GoogleScholar, and SportsDiscus databases were screened for inclusion in the review. 24,374 potential sources were identified, and sources included in the review described coaches duties, studies that included strength coach described supervision, and those that described coaches. A majority of the papers included in the literature review were peer reviewed.

First, some initial background on the intercollegiate athletics context will be provided with information generally drawn from scholarly textbooks and peer-reviewed journal articles.

The chapter will proceed with sections reviewing material for determinants of college athletic programs; general metrics to measure performance of an athlete; roles of strength and conditioning staff; and job analysis of the strength coach position. A discussion of peer reviewed studies on the effect direct supervision of a strength coach has on strength in athletes will follow. The next section will discuss the breakdown of Division 1 College Athletic Department budgets. This will lead into a discussion of the current pay structure and landscape of strength coach salaries in the Football Bowl Subdivision. Then the final section will discuss the responsibilities of SCC's and analysis of the current situation of the industry as a whole.

College Sports

College sports in the United States of America are broken down into four divisions. Three are under the supervision of the NCAA (National Collegiate Athletic Association), while one is under their own rule NAIA. Housed in the NCAA are three divisions, Division 1, Division 2 and Division 3. Across these three divisions are 1,000 schools and 102 conferences (Drozdowski, 2020). One of the factors that separates college sports from professional leagues like the National Football League is that the college players are not directly paid for their sport performances in terms of competitive salary. Instead they are given scholarships of various amounts to cover tuition and fees and other costs of attendance. In Figure 1 the number of institutions per division is displayed with median enrollment of member institutions alone. When it comes to football, Division 1 is broken down further into two separate categories. Football Bowl Subdivision (FBS) and Football Championship Subdivision. Divisions 1 also has member institutions who do not bear a football program.

Division Division 1 Division 2 Division 3

<i>Member Universities</i>	350	310	438
<i>Median Undergrad Enrollment</i>	8,960	2,428	1,740
<i>Students Who Are Athletes</i>	1 in 23	1 in 10	1 in 6

Table 1. Source Ncaa.org/resources.

Despite bringing in millions of dollars in revenue from television contracts, ticket sales, and donations, most athletic departments are losing money due to equally large operating expenses (Brown, et.al., 2016). Only 25 of the Power Five institutions reported a positive net generated revenue in 2019. Among those reporting a profit, the median profit was \$7.9 million, and of those who lost money, the median loss was \$15.9 million (Drozdowski, 2020). All Group of Five institutions lost money in 2019, with the loss being \$23 million per institution.

Program Performance Factors

Coaching Salaries, facilities, scholarship allotment, location of university are just to name a few reasons why a college team may succeed (Watson, 2014). It has been shown that spending money on coaches' salaries and recruiting budget will result in a higher winning percentage in Division 1 (Watson, 2014). The arms race of facilities continues to be a major concern for bringing and developing top-level talent to campus. Between 2009-2014 over \$3.9 billion was raised for new college sport facility projects and renovations (Judge et al., 2014). This creates a large strain on organizations that typically do not generate a surplus. The current trajectory of

college sports finances concerns a large number of presidents and administrators (Colbert and Eckard, 2015). The large coach salaries also reflect the recruiting arms race between institutions. Athletic Directors are now more managers than they were before (Orlando, 2016). Finding a correlation, or a breakpoint of salary to on-field results could provide valuable information for higher executives in athletic departments.

College Football Success Factors

The determinants of winning a college football game have many factors. Players, coaches, and even pure luck play a role in winning. However, higher investment into programs has been shown to help them win and keep them winning (Cairo, 2012). Investment in a college football's program budget has many options. College football coaches are top managers in their respective athletic departments, and each has the goal that his workers will be productive, i.e., individual players combine their talent and accomplishments on the field to produce a win. Furthermore, the more productive each team is on the field, the greater the benefits and salary are to the coach. When finding the link between performance and pay, it is important to begin with the performance of a head coach (Carol, 2012). A recent study found that there are 5 factors that have positive impacts in the process of determining a head football coaches salary (Byrd et al., 2013). Head coaches previous experience, revenue generated from the football program, bowl appearance, athletic department size (Power Five member institution vs Group of Five member), and if the team reached a bowl in previous seasons (Byrd et al., 2013). These factors create a never-ending cycle, in which coaches who win more get paid more, and coaches who get paid more win more. Regardless of the direction of causation, the relationship between salary and performance is clear for head coaches. Head strength and conditioning coaches have yet to be evaluated in this way.

One big factor of success of college football is of course the level of talent of the team. This is directly related to recruiting success. In order to attract a higher level of talent schools will invest more money into their recruiting budget. More money in the budget allows coaches to travel farther across the country, bring more student athletes on campus, which increases their chance of bringing in better athletes. According to Cairo, who studied the relationship between winning and recruiting, the more money a school spends on recruiting the better chance they have of bringing in superior athletes (2012). Using a regression analysis, he was able to show that conferences with higher average star recruits won more national championships.

The facilities strength coaches are endowed with directly affect the programming and training they are able to do with student athletes as well. Facility space for strength and conditioning is an important factor for programs to maximize their opportunities by attracting better athletes and one of those trends that attracts them is the separate facilities for football. The design/layout, staffing and operation of the department plays almost as vital a role as the facility itself (Judge et al., 2014) A 2014 questionnaire-based study helps provide the landscape of the current status of division 1 facilities. An invitation sent via email for strength departments to participate in an online survey with 84 items was sent out to 285 of the 333 Division 1 institutions on NCAA record. With a response rate of 38.6%, 111 of the institutions responded. The goal of this study was to understand qualitative data surrounding the S & C profession. Further understanding and value of this profession brings to collegiate football

Facilities in Division 1 are most commonly filled with free weight equipment and 100% of coaches surveyed indicated free weight equipment was present. Programs with football programs were found to have a greater focus on free-weight centered training and traditional Olympic lifting (Judge et al., 2014). After that, the equipment used to build strength in athletes

great varies. This is due to the fact that “equipment budgets have historically been difficult to develop and defend and are often cannibalized to fund the emergencies and shortfalls in other budgets within athletic departments” (Judge et al., 2014). Therefore looking at the layout of these facilities and finding the design with staffing that provides the most efficient player development could prove to be beneficial for administrators. A new trend gaining traction is football exclusive weight rooms and performance areas. Now the facilities are laid out it is time to look at how important proper supervision is to increasing strength and muscle mass in athletes.

Strength Coaches Supervision and Effects on Strength.

While the subjects participated in rugby, which is not the exact same sport as American Football, there has been some study on the effects the presence a strength coach has on sport players (Coutts et al., 2004, p. 316). In addition to physical improvements of the athletes, there was another study done over the likeability of strength coaches and what factors played a role in them. One of the contributing factors of rugby players increase in strength. It is commonly understood that there is a higher yield of results when the athlete-coach relationship is strong. One study identified the attributes of a strength coach that led to the best results.

“Coach–athlete relationships are built over time, with prolonged engagement being advantageous for positive relations. Success in a coach–athlete relationship was possible where they work together toward one goal i.e., a “shared purpose”, with athletes in the present study highly valuing the mutual goal setting process” (Cho et al., 2013, p. 64).

As long as the goals align between the coaches and players increased success can be seen. But how will payment of coaches lead to their motivation to succeed?

College Budgeting

The top expense sources for Division 1 FBS member institutions are as followed; Facilities and Equipment 22%, Coaches Compensation 18%, Support and Administration

Compensation w/Severance 18%, Athletic Student Aid 13%, Game Expenses and Travel 11%, Other Expenses 11%, Game Expenses and Travel 11%, Competition Guarantees 2% (College Athletic Financial Information Database, 2020). The revenue of the FBS institutions are as follows; NCAA Conference Distribution for Media Rights 29%, Donor Contributions 20%, Ticket Sales 17%, Institutional Governmental Support 10%, Corporate Sponsorship/Licensing/Advertising 9% (College Athletic Financial Information Database, n.d.).

Previous studies in college football have examined the relationship between head coaches and on field performance. With the rise of head coaching salaries, assistant coaching salaries have followed, which includes head and assistant strength coaching positions. One unique function of the college football economics is the process that allows for offering increasing salaries. Due to NCAA rules, schools are not allowed to pay the athletes a competitive market wage. Instead, schools focus on spending funds on suitable indirect investments such as coaches and facilities. (Traugutt, et. al., 2020). This non-price competition leads to additional investment in unrestricted factors (e.g., coaching pay), leading to an inefficient allocation of resources (Schwarz & Rascher, 2017).

Strength & Conditioning Coaches Salaries:

According to USA Today, the highest paid strength coach in the nation is Iowa's Chris Doyle at \$800,000, while the lowest publicly available salary is Ohio's head strength coach which is only \$54,500 (Salaries, 2019). The wide range of salaries seem to be reflective of the overall budget of each school rather than success. In 2004 a study on FBS and FCS strength coach demographics and responsibilities had respondent's average salary of \$40,000 (Massey et., al 2004). While this study averaged out two divisions of head strength coaches and is over 15 years old, it provides a peek into the rising salary of this position. A school such as Ohio has a

lot smaller budget than the top paid coach's salary, but Iowa is not in the top 5 of overall spending on football. It is also of note that the overall persona of Iowa's football program is toughness and a team known to have strong tough dudes at traditionally bigger positions. Last year alone they had two tight ends drafted in the first round of the NFL Draft.

Positions Associated with Stronger Bench Press

The NFL combine is the only standardized event where top-level athletes who are draft eligible are invited. During this multi-day event the athletes compete in many tests to provide information to teams who are interested in drafting them. Events include 40 yard dash, 3-Cone drill, Bench Press, Vertical Jump and position specific drills. The bench press max is the only event that includes weights during the event. Completing the most reps of a bench press at a weight of 225 pounds is a big focus during the pre-draft process. Many strength and conditioning specialist takes great pride in preparing athletes for their next move in life. Positions that complete more bench press reps than others on average are Offensive Lineman, Tight Ends, Defensive Lineman, Linebackers and Running backs (Hedlund, 2018). Because of this, the priority of this test is held higher in evaluation of the prospect (Hedlund, 2018). Another role strength coaches play in the athlete draft is the relationship they play with professional football scouts. SCC (Strength & Conditioning Coaches) serve as a liaison between professional scouts and their team. This includes providing feedback on players eligible for the draft and is not limited to skill alone. Often they are tasked with answering questions about the character and attitude of prospective athletes (Massey et al., 2004).

Job Analysis of Strength Coaches

The strength coach profession in college sports is still relatively new and ever changing. A 2004 study found the following information and statistics on the head football Strength &

Conditioning Coach. In a 2004 study over the profession the average years the head strength coaches who responded held their respective position for 8.1 years overall and 6.1 years as their current school. Also, of the surveyed coaches over 80% participated in college football themselves (Massey et., al 2004).

Responsibilities of a Head Strength Coach

Strength and conditioning coaches of college football teams are tasked with a wide array of responsibilities. Coordinating and preparing a training regimen for players in and out of season is often the first that comes to mind, but it reaches far deeper. On game day alone, strength coaching staff as a whole (along with the head SCC) is held responsible for pre-game warm-up and stretching routine along with controlling the sidelines. Each year SCC are also tabbed with planning and running a college ‘Pro Day’. This day consists of testing athletes in a variety of tests to help scouts gauge their interest in a player (Massey et al., 2004). College football coaches are top managers in their respective athletic departments, and each has the goal that his workers will be productive, i.e., individual players combine their talent and accomplishments on the field to produce a win. Furthermore, the more productive each team is on the field, the greater the benefits and salary are to the coach. When finding the link between performance and pay, it is important to begin with the performance of a head coach.

Strength and Conditioning and Academic Performance

Physical activity and fitness level have shown to have an improvement on academic results for individuals (Committee on Physical Activity and Physical Education in the School Environment, 2013). The role of the strength coach could provide valuable service in improving academic success of the student athletes. “Evidence suggest that increasing physical activity and physical fitness may improve academic performance” (Committee on Physical Activity and

Physical Education in the School Environment, 2013). From a young age, children who participate in moderate to vigorous intensity activity have increased executive function and brain health. Those types of physical activity would be under the administration of the strength coach for a majority of the calendar year. Mathematics and reading seem to benefit the most from increased physical activity based on peer review studies (Committee on Physical Activity and Physical Education in the School Environment, 2013). To this point, no apparent research has considered the academic effects of variable investment in strength and conditioning team coaches.

Summary

There is a glaring gap in empirical data to reflect the marginal impact changes salary of a strength coach have on the performance outcomes of college football programs. There has been regression analysis done with head football coaches' salary and on field performance, but behind the head coach, and controlling for player talent, strength coaches may have the next greatest impact on success of the team. Strength coaches likely play a vital role in the success of the program, evidenced by their very existence, but there does not appear to be any peer-reviewed empirical evidence that attempts to estimate their value.

While there are a couple studies done on the demographics of strength staff, it is not very recent. One very good resource was the 2014 survey about the facilities and staffing at division 1 schools. Some of the evidence suggests that the salaries of the overall coaching staff is growing year to year as well, which follows the trends of head and assistant coaches in Division 1 Football. This current study aims to fill the knowledge gap with respect to the programmatic value of strength coaches.

Chapter 3: Methodology

Research Problems/Research Questions

This chapter outlines the proposed methods of this study. The study will rely largely on secondary descriptive and correlational data analysis. Some new data collection will be included in the form of “web scraping” data from college football databases.

Sample

The study includes all Division 1 institutions with available data. Each school will be organized by conference affiliation and if they fall into the category of Power Five vs. Group of Five. Some private schools are not required to release financial data, and those schools were excluded from the study. Schools from all Division 1 Football member conferences, along with FBS independents were included. The Five Power Conferences are SEC, BIG Ten, Big 12, ACC and PAC 12. All other conferences will be referred to and treated as Group of Five Teams.

Each school chooses to structure strength coach salaries differently. Consequently, total pay will be used as arguably the better indicator of the overall sample. The above criteria yielded N=89 schools available for this study across the period from 2016-2018.

Data Collection Procedures

Widely known as the leader for up-to-date databases for College coach salaries, USA Today also reports financial data across several categories, including strength and conditioning coaches. In their published table they report every single strength coach’s salary if it was available via open records requests. The same process was followed for head coaching salaries and athletic budgets of schools. The request from USA Today Sports goes directly to the school and asks for all forms of public employee compensation. Private schools and one public school’s coach salary was not available due to not being released to the public. USA Today updates this

database every year. Multiple previous correlational studies use this same database for their analyses, albeit acknowledging some limitations in reporting. The data are formatted in a manner that is conducive to web scraping techniques. Using R to download the table, the financial data are collected as a CSV file to clean and analyze. Private schools along with a with a small number of public schools who structure their budget in a way that is not subject to open records requests were not included. The wins and losses that were used in the regression model were collected from CollegeFootballData.com which has frequently updated statistics from the whole realm of college football. They allow for csv files to be downloaded, which allows for easy merging.

Following the same procedures, a Talent variable was collected from CollegeFootballData.com. This metric is derived 247Sports.com, one of the leading scouting services for college football recruits. To mitigate bias, 247sports uses a conglomerate of other recruiting rankings of players along with their own to produce the metric. “Each recruit is weighted in the rankings according to a Gaussian Distribution Formula (a bell curve), where a team's best recruit is worth the most points. You can think of a team's point score as being the sum of ratings of all the team's commits where the best recruit is worth 100% of his rating value, the second best recruit is worth nearly 100% of his rating value, down to the last recruit who is worth a small fraction of his rating value. This formula ensures that all commits contribute at least some value to the team's score without heavily rewarding teams that have several more commitments than others.” (2020 College Football Team Talent , 2021). This produces a number that is indicative for the current state of each team’s talent level.

The academic performance metrics of Academic Performance Rate (APR) and APR ranking were collected from CollegeFootballNews.com and validated through the NCAA database. The SCC and Head coaches' salaries were collected from the USA today database and then cleaned in R. After cleaning and compilation of tables data will began to be analyzed. R is a free software that allows for large amounts of data to be ran at one time. Microsoft Excel will also be used in management of the variables in the form of CSV files.

Data Analysis

Before running a regression analysis, descriptive statistics will be examined to understand strength coach salaries along with outcomes of Division 1 football teams from the same season. Descriptive statistics will help understand any pre-existing patterns and generalization about the population of Division 1 programs. Specifically, the two dependent variables will be analyzed for trends.

An initial correlation analyses will be conducted among the continuous variables, which will initially identify the significant relationships of basic control variables, primarily the relationship between strength coaches' salaries and budget of schools. The significance level of $\alpha=0.05$ will be used for relationships to be considered statistically significant. A Pearson's correlation between WinPct-SCC.Salary and APRO - SCC.Salary will also be conducted to look for correlation. Pearson's is shown by an R-value that can run from -1 to 1. A positive value would indicate a positive relationship, a negative value would indicate a negative relationship and a value of 0 would indicate no relationship. After initial correlational analysis is ran, an ordinary least squares (OLS) regression was ran with variables indicated below.

Variable	Description
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<i>WinPct</i>	Dependent variable for equation one. Winning percentage for each team and seasons. 2016-2018
<i>Academic Performance Rate Outcome (APRO)</i>	Dependent variable for equation two. Predicted performance on Academic Performance Rate (APR) for a team.
<i>SCC.Salary</i>	Independent variable for all equations. Average Salary of coach for years 2016-2018. (10,000s)
<i>PFive</i>	Independent variable for both equations. Categorical dummy variable for whether a team is in a power five conference (1 if true, 0 if no).
<i>State</i>	Independent Abbreviation for State. This was used to match state population in. Not used in model.
<i>StatePOP</i>	Independent variable for both equations. Continuous measure for a state's population. (10,000s)
<i>TALENT</i>	Independent variable for both equations. Continuous measure for talent level of each team. Composite Talent for team using recruiting rankings
<i>Total. Revenue</i>	Independent variable. Continuous measure for total revenue brought in by athletic department of school in said year. (10,000s)
<i>Expenses</i>	Independent variable for expenses of school minus strength coach and Head Football Coach Salary. Continuous measure for total expenses of athletic department in said year. (10,000s)
<i>HC.Total.Pay</i>	Independent variable for all equations. Continuous measure for head footballs coaching salary for year and school. (10,000s)
<i>PSAL</i>	Interaction term for Power Five Conference affiliation and Strength and Conditioning Coach Salary.

Table 1 Variables and Description of Regression Model

Equation One:

$$\begin{aligned} \text{Win Percentage} = & B_0 + B_1\text{SCC.Salary} + B_2\text{Talent} + B_4\text{STATEPOP} + B_5\text{Expenses} \\ & + B_6\text{PFIVE} + B_7\text{HC.TOTAL.PAY} + B_8\text{PSAL} + \varepsilon \end{aligned}$$

Equation Two:

$$\begin{aligned} \text{APRO} = & B_0 + B_1\text{SCC.Salary} + B_4\text{STATEPOP} + B_5\text{Expenses} + B_6\text{PFIVE} + B_7\text{TALENT} \\ & + B_8\text{HC.TOTAL.PAY} + B_9\text{PSAL} + \varepsilon \end{aligned}$$

To accurately predict season wins based off Strength coach salary, as many other variables must be controlled as possible. The same is true for Equation two when predicting the academic progress rate for the school. In our equation, School and state population, budget, and a dummy variable whether the school was a Power Five member or not was taken into consideration. Although prior studies have included football stadium age as a control, after researching the time frame of this study there was less than 10 schools with stadiums built in the last year and this factor was assumed to be acceptably invariant. Coaching salaries of each institution for Head Football Coach was also used as a variable. To avoid direct correlation the salaries of both coaches included in the model were subtracted from average expenses for each school. To further asses the relationship between Salary and PFive variables an interaction effect will play a deeper role in analysis of maximizing winning percentage.

Chapter 4: Results

The aim of this study was to find whether a relationship existed between the head strength and conditioning coach's salary with winning percentage and academic progress rate. APR is an academic measure for schools that is specific for each sport at the institution. It is a combination of progress towards a degree per student athlete and GPA.

Table 3: Descriptive Statistics of Variables of Averages

Variable	Mean	Median	Min	Max	Passes Normality
Salary*	21.175	19	5.16	67.5	Yes
Win.Pct	.5293	.5210	.1940	.9320	Yes
Talent	559.6	556.6	250.2	986.3	No
HC.Sal*	245.6	216.67	39.06	879.28	No
StatePop*	1067.09	727.87	57.88	3951.22	No
Expenses*	8414	9024	2416	21333	No
ARPO	966.4	966.7	936.7	992	Yes

***10,000s**

Descriptive statistics were first calculated for the variables present in the data. Running descriptive statistics help summarize the data and can help show patterns in the data before running additional analyses. In this instance the first area to look at was the dispersion of strength coach salaries in two different distinct groups, Power Five Conferences and Group of Five. In the table and analysis there is a variable labeled PFIVE which a value of 1 states the school is a member of a Power Five conference. A value of 0 indicates that the institution is a member of a conference considered in the 'Group of Five'. The dependent variable in equation 1,

winning percentage (Win.Pct) mean was 52.9%, and a standard deviation of 21.6% of the schools in this three year study. In Equation 2 the dependent variable is Academic Progress Rate Outcome (ARPO), which had a mean of 966.38 with a standard deviation of 13.77. Descriptive for an ARPO variable because the min and max of this variable are only 68 points difference. Descriptive statistics are important, but the conclusions will be drawn from an OLS regression model.

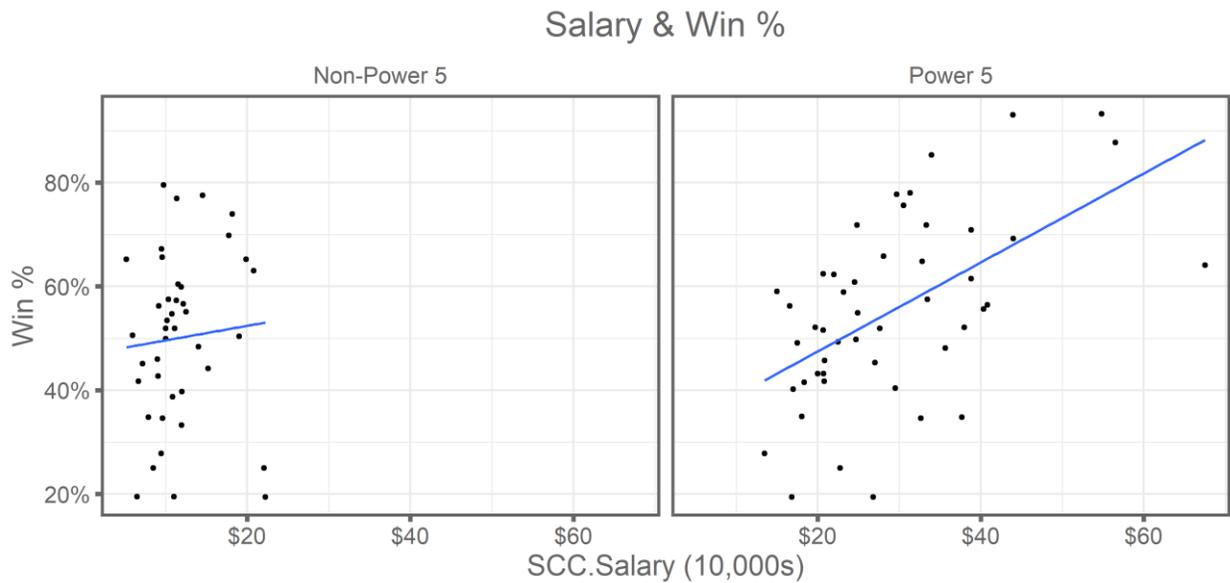


Figure 1: Salary & Win Percentage

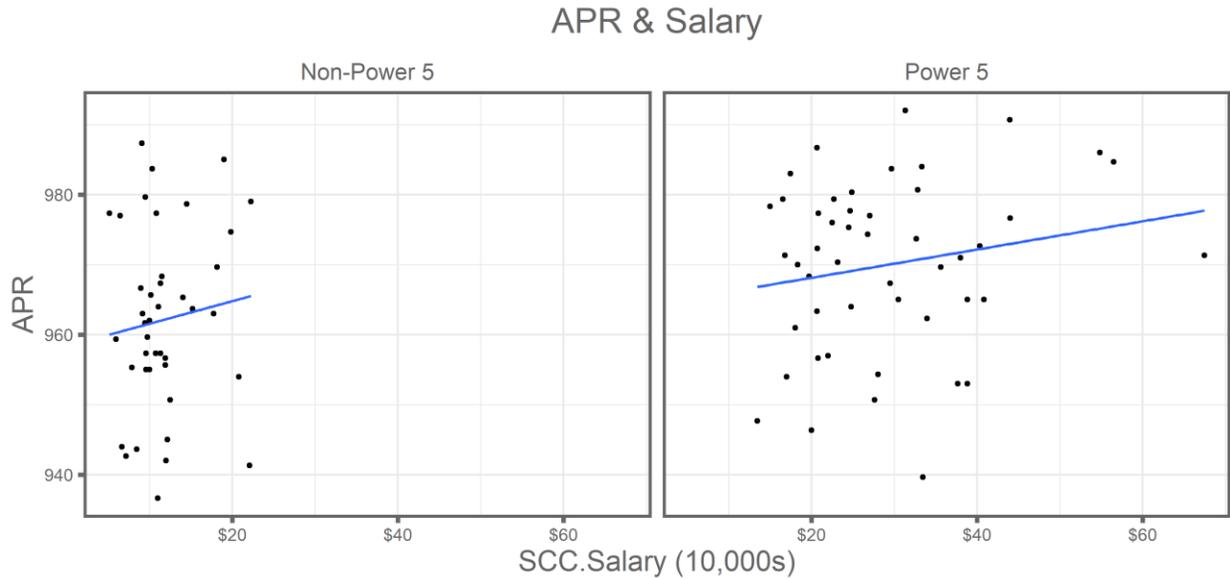


Figure 2: APR & SCC Salary

Regression Analysis

Before running OLS a Pearson's correlational analysis was run between the dependent and main independent variable. In terms of a simple bivariate relationship SCC Salary had a significant positive relationship with Win.Pct with a correlation of 0.2916878 ($t = 4.9642$, $df = 265$, $p\text{-value} < 0.001$). With a 95% confidence interval, the alternative hypothesis was accepted.

Equation One OLS:

Table 4: Equation One

	<i>Dependent variable:</i>
	Win.Pct.avg
SCCSalary.avg	-0.00000 (0.00000)
TALENT.avg	0.0004** (0.0002)
PFIVE.avg	-0.252** (0.096)
StatePOP.avg	-0.00001 (0.00002)

Expenses.avg	-0.00001 (0.00001)
HC.TOTAL.PAY.avg	0.001*** (0.0002)
PSAL	0.00000 (0.00000)
Constant	0.372*** (0.086)
<hr/>	
Observations	89
R ²	0.380
Adjusted R ²	0.327
Residual Std. Error	0.141 (df = 81)
F Statistic	7.098*** (df = 7; 81)
<i>Note:</i>	* p < 0.05 ** p < 0.01 *** p < 0.001

The first part of this research question is to look for a relationship between strength and conditioning coach salary and winning percentage while controlling for other variables. Three years and 89 teams were used for this with variables added to create a more robust equation. To control for effects, expenses minus coaching salaries for the school, population of the state, if they were power five or not, and the talent level of each team and year. These values were averaged and an OLS regression was completed. The dependent variable was winning percentage expressed as a decimal place to two spaces. Two variables demonstrated positive relationships and were significant. For each unit of talent increase the winning percentage for schools went up .004. Power Five variable was shown to have a negative effect of -.252. The r^2 of .380 indicates that the model chosen is not a good indicator of winning percentage. The model itself had independent variables that were not good indicators of winning percentage. The F-statistics being large indicates the correct decision was to accept the null hypothesis.

Like equation one we saw similar results in equation two. Pearson’s correlational analysis was conducted and understood to accept the alternative hypothesis of strength coach salary as an independent correlation with academic performance outcome. The p-value was less than the significance alpha of 0.05 indicating that there is a significant correlation. This was due to a significant bivariate relationship between Academic Performance Outcome (ARPO) and SCCSalary, where the correlation was 0.2901623 ($t = 4.9359$, $df = 265$, $p\text{-value} < 0.001$).

Equation Two OLS:

Table 5: Equation Two

	<i>Dependent variable:</i>
	APRO.avg
SCCSalary.avg	0.00001 (0.00005)
TALENT.avg	0.007 (0.017)
PFIVE.avg	-2.242 (8.250)
StatePOP.avg	-0.004** (0.001)
Expenses.avg	0.001 (0.001)
HC.TOTAL.PAY.avg	0.013 (0.019)
PSAL	-0.00002 (0.00005)
Constant	956.880*** (7.362)

Observations	89
R ²	0.225
Adjusted R ²	0.158
Residual Std. Error	12.083 (df = 81)
F Statistic	3.361*** (df = 7; 81)
<hr/>	
<i>Note:</i>	* ** *** p<0.01

Equation two tackles the effect of strength coach salary on academic outcomes. This equation includes a dependent variable which is an academic progress rate outcome (APRO) for each school included in the dataset. Independent variables were talent, salary, state population, total allocated money from school, PSAL and total revenue. ARPO only had one control variable that proved to have a significant relationship. The StatePop variable had a negative effect on the trend of Academic Progress rates of these schools. No other variables were shown to have a relationship positive or negative for APRO.

Chapter 5: Discussion and Conclusion

As stated in the literature review the differences in motives and resources are vast. So understanding these differences before the regression analysis is critical. In this study we used Academic Progress Rate, an academic metric to try to find if there was a different outcome variable we could look at in addition to sport performance. This was with the understanding that different institutions have different motives for their funds. While all look to excel on the field some may place a higher emphasis on academic achievement compared to other institutions.

The initial Pearson's correlation test using R provided encouraging evidence that suggested a significant relationship between the two outcome variables, winning percentage and APR, and our dependent variable SCC Salary. This allowed for further investigation into the two outcomes and our Salary variable using multiple regression for the control of other confounding variables, specifically other factors that would be correlated to both the salary levels and the outcomes. Equation one saw an interesting result of three significant variables, PFive, Talent and HC.Total.Pay. Talent and HC.Total.Pay had a positive effect on winning percentage. Talent proves to be a strong indicator of team performance, due to the way teams recruit and attract talent. For each increase in unit of talent there was .04% increase in the average three year winning percentage. Another non-surprising positively correlated variable was Head Coaching Pay. This may be since coaches who perform well are typically awarded monetarily in relation to an increasing "market value". The negatively correlated variable of PFive could be due to a few causes. Teams who are members of Power Five conferences are facing a stronger level of competition and increased strength of schedule. While Non-PFIVE schools may play one or two games against PFive opponents but not enough to significantly effect a three year trend of winning percentage.

In equation two only one variable demonstrated significance and that was state population. This was interesting since none of the control variables were good indicators for academic performance. This further supports acceptance of the null hypothesis that strength coach salary is correlated with on field or academic performance. In equation one, a positive correlation came at no surprise, since the literature typically shows that schools with bigger budgets, on average, perform better. A similar but opposite trend exists for schools who are only able to pay lower than the national average. Using win percentage as an outcome variable demonstrated both strengths and weaknesses. One strength to this approach was that it provided for analysis of records of teams who played in different games. However, a weakness was that when running the analysis there is a lot less specificity allowed for the study due to all WinPct being between 0 and 1. Ultimately results showed that accepting the null hypothesis for both equations was the correct decision.

Areas for Future Research

Missing from not only the current research investigation but any of the available literature are recent statistics on strength coach demographics. Going forward there are many ways this study could be expanded to cover more ground and find more correlation in this department. Creating a survey that is sent out to each FBS Strength Coach filled with questions that could fill the holes of demographics and current situation of the job would prove to be beneficial. The job analysis study that is referenced in the paper is from 2004 and only has six participants (Judge et. al, 2014). Another consideration not included in this study was spending on strength and conditioning on a yearly basis. Every year universities are adding improvements, which often include additional equipment and staff to strengthen that department, but that information is not readily available to the public. It is noted that coaches alter the path of the

actual training for student athletes, the decisions regarding budgets for the strength and conditioning department play a vital role. The financial decisions to purchase, maintain and use equipment may change the direction a specific athlete takes (Lawrence et al., 2014). Strength coaches are looking for ways to prove their worth and providing them with the opportunity to provide information to show that should be an incentive to participate. This study does lend some support to the fact that



coaches have a positive marginal impact on team performance.

One important finding that was uncovered during the analysis were the differences in PFIVE v. Non-PFIVE SCC Salary impacts. The simple bivariate correlations were apparently quite different in magnitude, suggesting that there may be different marginal payoffs in terms of SCC Salary investments based on the program type. This was confirmed as a moderator relationship (interaction of predictors) in the overall regression analysis. This is an area that should be investigated further and/or accounted for in analysis of college sports team performance.

Understanding the motives of the organization and having specific outcome variables for the individual institutions instead of grouping them by Power Five vs Group of Five could prove to show further insight to the understanding of true intended outcomes of Division 1 FBS Football. “The majority of sport wage distribution has utilized team performance (i.e., winning) as the outcome variable. However, this is not the main concern for all sports organization” (Watson, 2014). Nevertheless, using wins as an outcome variable could prove to be beneficial as well. The choice of win percentage was based on the fact teams do not play in equal games, due to conference championship games in addition to bowl games which create an unbalanced number of games for teams in Division 1.

One of the roles the SCC can fulfill which is not accounted for in this study, is injury prevention in coordination with the athletic training staff. Creating value through mobility, stretching and other techniques can be useful tools for a strength program (Judge et. al, 2014). Often a single injury to a team's star player can derail a season. In the off-season the strength staff tries to build up the players body to withstand injury during seasonal play. Anterior Cruciate Ligament (ACL) is a very common injury that if torn can lead to nothing shorter than a 6 month recovery. Strength and conditioning coaches play an important role in developing and implementing professional programs for their athletes, with primary responsibilities including achieving optimal performance and reducing the risk of injury (Liang, 2019). Due to the nature of HIPPA laws there would be a need of a surveyed analysis of injuries. Despite the lack of specific data about injuries, this activity would be indirectly reflected in the overall team performance metric since better or worse performance in injury prevention would inevitably feed through to team performance.

Conclusion

While there was reason to believe based off initial Pearson's correlational models that there would be a strong enough relationship to find a relationship between the independent variable of Salary and academic progress rate outcome. Recruiting talented players had the greatest effect of all variables on winning percentage of teams playing Division 1 Football from years 2016-2018. In a time with constrained resources due to external forces such as a global pandemic, teams will look to maximize on field performance and performance in the classroom. Based off the data on hand it is best spent in ways to increase your level of talent to increase wins. Currently, APRO demonstrated no direct relationship with any of the variables present in this study other than state populations.

Appendix

Example of Power Five Conference Pay for S&C Coaches – Southeastern Conference 2019

University of Alabama - Scott Cochran - \$595,000

University of Arkansas - Trumain Carroll - \$290,000

Auburn University - Ryan Russell - \$400,000

University of Florida - Nick Savage - \$375,000

University of Georgia - Scott Sinclair - \$450,000

University of Kentucky - Corey Edmund - \$254,684

Louisiana State University - Tommy Moffitt - \$520,000

University of Mississippi - Paul Jackson - \$375,000

Mississippi State University - Corey Bichey - \$150,000

University of Missouri - Rohrk Cutchlow - \$390,000

University of South Carolina - Jeff Dillman - \$425,000

University of Tennessee - Craig Fitzgerald - \$625,000

Texas A&M University - Jerry Schmidt - \$583,000

Vanderbilt University - James Dobson - N/A

Code

```
library(modelsummary)
library(readr)
library(plm)
library(ggplot2)
library("ggpubr")
library(correlation)
library(stargazer)
#Descriptive Statistics
Nonnum <- Finaltable %>% mutate(Salary = parse_number(Finaltable$Salary),
                               StatePOP = parse_number(Finaltable$StatePOP),
```

```

    Total.Revenue = parse_number(Finaltable$Total.Revenue),
    Total.Allocated = parse_number(Finaltable$Total.Allocated),
    Total.Expenses = parse_number(Finaltable$Total.Expenses),
    School = as.factor(School))
Nonnum <- Nonnum %>% filter(Year == 2016 | Year == 2017 | Year == 2018)
Nonnum <- Nonnum %>% arrange(School, Year) %>% group_by(School) %>% mutate(
  yeardata = row_number())
Nonnum <- Nonnum %>% group_by(School) %>% mutate(totalyears = max(yeardata))
Nonnum <- Nonnum %>% filter(totalyears == 3)
View(Nonnum)
#Pearson's Correlation
pearWins <- cor.test(Nonnum$Salary, Nonnum$Win.Pct,
  method = "pearson")
pearWins

pearAPRO <- cor.test(Nonnum$Salary, Nonnum$APRO,
  method = "pearson")
pearAPRO
#Panel Regression WINPCT
winPRdata <- pdata.frame(Nonnum, index = c("School", "Year"))
winpr <- plm(Win.Pct ~ Salary + TALENT + PFIVE + StatePOP + Total.Expenses, data =
winPRdata,model="within",index = "School")
summary(winpr)

winprp <- plm(Win.Pct ~ Salary + TALENT + PFIVE + StatePOP, data =
winPRdata,model="pooling")
summary(winprp)
stargazer(winpr,type = 'html', out = "winprstargazer.doc")

#Panel Regression APRO
APROdata <-pdata.frame(Nonnum, index = c("School", "Year"))
APROs <- plm(APRO ~ Salary + StatePOP + Total.Expenses + TALENT + PFIVE +
Total.Allocated + Total.Revenue, data = APROdata, model = "within", index = "School")
stargazer(APROs,type = 'html', out = "APROs.doc")
#Vizualizations
ggscatter(Nonnum, x = "Nonnum$Win.Pct", y = "Nonnum$Salary",
  add = "reg.line", conf.int = TRUE,
  cor.coef = TRUE, cor.method = "pearson",
  xlab = "Winning Percentage for years 2016-2018", ylab = "SCC Salary in USD")
plot(Nonnum$Salary,Nonnum$Win.Pct)
#OLS Regression of Averages
#Joseph Castiglione
library(readr)
library(DT)
library(tidyverse)
library(stargazer)

```

```

NonnumHC <- read.csv('NonnumHC.csv')
names(NonnumHC)[1] <- "School"
View(NonnumHC)
#:::
Strength_of_win <- lm(Win.Pct.avg ~ Salary.avg + TALENT.avg + PFIVE.avg + StatePOP.avg
+ Total.Expenses.avg + HC.TOTAL.PAY.avg, data = NonnumHC)
summary(Strength_of_win)
stargazer(Strength_of_win, type = 'html', out = "Strengthofwin.doc")
Academics <- lm(APRO.avg ~ Salary.avg + TALENT.avg + PFIVE.avg + StatePOP.avg +
Total.Revenue.avg + HC.TOTAL.PAY.avg, data = NonnumHC)
summary(Academics)
stargazer(Academics, type = 'html', out = "Academics.doc")

```

```

NonnumHC <- read.csv('NonnumHC.csv')
names(NonnumHC)[1] <- "School"
View(NonnumHC)

```

```

#:::

```

```

Strength_of_win <- lm(Win.Pct.avg ~ Salary.avg + TALENT.avg + PFIVE.avg + StatePOP.avg
+ Expenses.avg + HC.TOTAL.PAY.avg + PFIVE.avg*Salary.avg, data = NonnumHC)
summary(Strength_of_win)
stargazer(Strength_of_win, type = 'html', out = "Strengthofwin.doc")

```

```

Academics <- lm(APRO.avg ~ Salary.avg + TALENT.avg + PFIVE.avg + StatePOP.avg +
Expenses.avg + HC.TOTAL.PAY.avg + PSAL, data = NonnumHC)
summary(Academics)
stargazer(Academics, type = 'html', out = "Academics.doc")

```

```

#Visualizations

```

```

# Scatter Plot For APR & Salary

```

```

NonnumHC %>% mutate(
  PFIVE = ifelse(PFIVE.avg==0,"Non-Power 5","Power 5")
) %>% ggplot(aes(x=Salary.avg, y=APRO.avg)) + geom_point() + theme_bw(16) +
  theme(plot.title = element_text(hjust = 0.5),
        plot.subtitle = element_text(hjust = 0.5),
        panel.border = element_rect(colour = "#656565", size = 2),
        axis.text = element_text(colour="#656565", size = 12), axis.ticks = element_line(colour =
"#656565", size = 1.5),
        text = element_text(colour="#656565", family = "Euphemia UCAS", size = 20),
        strip.text = element_text(color = "#656565"), strip.background = element_blank()) +

```

```

labs(title = "APR & Salary",x = "SCC.Salary (10,000s)", y = "APR") +
scale_x_continuous(labels=scales::dollar) + geom_smooth(method="lm", se = FALSE) +
facet_wrap(~PFIVE)
ggsave(filename = "APR&Salary_Joe.png", width = 12)

```

```

# Scatter Plot for WinPCT & Salary

```

```

NonnumHC %>% mutate(
  PFIVE = ifelse(PFIVE.avg==0,"Non-Power 5","Power 5")
) %>% ggplot(aes(x=Salary.avg, y=Win.Pct.avg)) + geom_point() + theme_bw(16) +
  theme(plot.title = element_text(hjust = 0.5),
        plot.subtitle = element_text(hjust = 0.5),
        panel.border = element_rect(colour = "#656565", size = 2),
        axis.text = element_text(colour="#656565"), axis.ticks = element_line(colour = "#656565",
size = 1.5),
        text = element_text(colour="#656565", family = "Euphemia UCAS", size = 20),
        strip.text = element_text(color = "#656565"), strip.background = element_blank()) +
  labs(title = "Salary & Win %",x = "SCC.Salary (10,000s)", y = "Win %") +
  scale_x_continuous(labels=scales::dollar) +
  scale_y_continuous(labels=scales::percent) + geom_smooth(method="lm", se = FALSE) +
facet_wrap(~PFIVE)
ggsave(filename = "WinPct&Salary_split.png", width = 12)

```

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