# The Financial Effect of Influential Events and Statistics for NFL Teams

by

Troy Dreistadt

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Project Advisor: Professor Hoa Nguyen

Second Reader: Professor John Golden

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I hereby recognize and pledge to fulfill my responsibilities as defined in the Honor Code and to maintain the integrity of both myself and the College as a whole.

Troy Dreistadt



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## Abstract

It is true that the most successful sports conglomerate in history is the National Football League. Its 32 separate teams all make considerable operating income, ranging from 25 million, to 300 million dollars per year. Concerning this study is to what extent "significant" or influential team events and certain statistics play a role in contributing to team operating income. The objective of this study is to quantify the financial impact that ACL injuries have on team operating income, tested against other variables that could potentially have an effect on operating income. I compile data via numerous online sources and perform a multiple regression in order to analyze the model chosen. The output results indicate no statistically significant results in relation to team operating income. Despite this, there are still implications on the lack of effect that the chosen variables have on team operating income and how team owners and football enthusiast alike can interpret them.

## Chapter 1: Introduction

Injuries are commonplace among players in the NFL. A wide variety of injuries occur each and every week in the National Football League, some seemingly minor and some major. It is then true that not all injuries are created equal, and each has its own consequences. This is particularly true with that of the ACL or Anterior Cruciate Ligament tear. Players in the NFL rely on strength, speed, and most of all the ability to change direction, with respect to their physicality. Changing direction requires explosiveness and that may be the most important quality a player has; this quality is harbored in the AC Ligament, found in each knee connecting the shin bone to the knee, which helps them to cut and perform dynamic moves on the field. See the Appendix, Figure 1 for more on the ACL.

Once a player experiences a tear of this ligament, surgery is required in most cases and players often miss the remainder of the NFL season while facing a long and grueling recovery process. Some say that 21-37% (Shah, Andrews, Fleisig, McMichael, & Lemak, 2010) of ACL injuries ends in a player never returning to the game. Although, it is also true that some players have the surgery and after an arduous recovery, actually perform better than in past seasons and out perform their formerly uninjured counterparts. For example, Jamaal Charles, a running back in the NFL, tore his ACL in 2011 and came back the next season to rush for the most yards of his career, 1,509. Adrian Peterson, another running back, tore his left ACL in 2011, after having the most yards rushing in 2008 (1,760), returned in 2012 to win the rushing title again (2,097); he won this title for the third time in 2015 (1,485) showing no signs of slowing down. Quarterbacks can also suffer from this

injury, for example Carson Palmer underwent ACL surgery in 2014 and was an MVP candidate in 2015. Palmer even had his best quarterback rating of his career at 82.15. The documentation of conflicting outcomes after ACL surgery, gives more incentive to conduct this study, so that to figure out clearer implications for such an injury in the NFL. Information and statistics about players was found at pro-football-reference.com.

Previous studies have looked into player's return rates from this injury as well as performance based analysis, but only once before this has a study analyzed the financial Impact of such an injury on players. In this study, I will take this lone idea and focus in a similar direction. The objective of this study is to quantify the financial impact that ACL injuries have on team operating income, tested against other variables that could potentially have an effect on operating income I will analyze the effect that in-season ACL injuries have with respect to each NFL team's total operating income. This study aims to better realize the impact of ACL injuries by comparing their effect to other players deemed seriously injured (players placed on the Injured Reserve or the teams "IR"). This is to better quantify and understand the true financial impact this injury has for teams in the NFL.

Specifically, to analyze the impact of the ACL injury, I will separate it from the Injured Reserve (IR) designation, and then compare it to the likes of those other seriously injured (the rest of the IR) and their impacts on team operating income. In other words, how influential are these devastating knee injuries with respect to the team's operating income? Does it affect team operating income more than total team suspensions do? If there is an effect greater than some of the other independent

variables, then in the future, previously ACL injured players could be financially discriminated against more harshly than other players, assuming teams operate using the theory of risk aversion. If this hypothesis is true, that teams will, financially, bear more by incurring ACL injuries than by certain other influential factors, then one could see contracts for ACL injured players be shortened in terms of length, giving their respective team's better options if a player doesn't perform as hoped.

Existing literature claims that ACL injuries take a significant toll on player's own performance and even salary after such an injury, even though there are certain players who continue to prove this conclusion wrong. If the literature holds true, this would limit the financial options of these players, create for less job security, and could be an indicator to an unpredictable career, and to this study's concern, might even affect the team's operating income by raising costs. If this hypothesis is false, meaning that ACL injuries have little or no compelling effect on team operating income, then it can be said teams won't necessarily bleed financially when faced with such injuries and shouldn't shy away from future prospects previously affected by such an injury. In terms of my goals for this analysis, I plan to see if these claims made hold true when analyzing the NFL team itself, in response to these events. These claims made drive this study, so moving forward, I will analyze the existing literature on information surrounding this topic, to better familiarize the issue.

## Chapter 2: A Literature Review

Particularly, my analysis will be one of the first of its kind, since most of the literature relating to my subject deals with football player's "return to play rates", and their longevity in the league after an ACL injury. In Shah, Andrews, Fleisig, McMichael, and Lemak (2010) they had a sample of 49 NFL football players who underwent ACL reconstruction surgery with or without concomitant procedures during the study inclusion period. At least 2 full seasons elapsed after surgery for all those included in the study and of those 49 NFL athletes in the study group, 63% or 31 of them returned to a regular season NFL game after ACL reconstruction, and 37% or 18 of them did not return. Clearly just by this study alone, one can see that an ACL injury can affect a player's ability to return to the game, since 37% of those affected with the injury couldn't return to the game at all. While this literature helps us understand how it affects return to play rates in the NFL, it misses out on quantifying the injury further, when regarding the financial success of those players or the teams after the ACL injury.

This study, Shah (2010), and studies like it have its severe limitations. For example, imagine a number of players who underwent reconstructive surgery for their ACL issue, and like the study above says, 63% return to play in the NFL again. This statistic fails to measure anything past the fact that they returned. Half of the 63% could have only returned to a couple games and then either re-injured their knee or were cut from the team roster. Analyzing the financial well-being of those affected, would correct for this error because then, one would be able to identify

whether their real value in the NFL was lessened by such an injury. Although, in my study I plan on focusing on the impact of such injuries on specific teams financial well-being in response to these ACL injuries, to better see how teams are affected by the injury.

Similarly, a study by Carey (2006) analyzed the return to play rates of NFL players after an ACL injury. Carey's study differed from that of Shah's in the respect that they only gathered data on running back and wide receiver positions. They used a cohort study with a level of evidence, 2. They then collected data spanning five years in the NFL, from 1998 to the 2002 season. The data only included running backs and wide receivers. They used variables that involved player age, experience, position, return time to competition, and the yearly total yards and touchdowns. To better analyze production, they used "Power ratings" which is total yards divided by 10 plus touchdowns, and then multiplied by 6. These numbers were computed for the injury year and the 3 seasons prior to and after injury. Their control group grouped of all running backs and wide receivers without a recognized ACL injury that played in the 2000 season.

The data they comprised was of 31 running backs and wide receivers, and 33 ACL injuries. They reported that of the players who returned, it took them on average 55.8 weeks, plus or minus 5.4 weeks, to return to competition. Additionally, power rating for each game played was said to have decreased from 9.9 (plus or minus 1.1) pre-injury to 6.5 (plus or minus 0.9) post-injury for the 24 players with anterior cruciate ligament injuries with a minimum total power rating, for all seven

seasons, of 200 points. They also mentioned that the decline in power rating per-game played was statistically significant at P = .002 when compared with the change in the control group, made up of 146 players in the league. Their main findings were that roughly 80 percent of NFL running backs and wide receivers that underwent an anterior cruciate ligament injury, returned to play in a game. This intuition here says than a little over 20 percent of players did not return to competition. The first piece of literature examined, where Shah found that 21-37 percent of players never returned to play, is similar to this finding. Also, it was found that when examining "return to competition," player performance of injured players is reduced by about 33 percent.

Carey's 2006 study went into more depth than Shah (2010) and colleagues by focusing their examination on the skilled positions seen on the offensive end of the game, wide receivers and running backs. Their return to play numbers actually found similar conclusions of around 20 percent. There can be a number of reasons a player returns to play in the league including a spot start (when teams are faced with injuries they recall lower level players) and that would contribute to the inflation of such a RTP statistic, while not representing the true impact of the injury. This conflicting information about the RTP rates of ACL injured player's gives more incentive to conduct a study focusing on a different aspect of the ACL injury. Hopefully, my study will help judge how concerned teams should be if one of their better players goes down due to such an injury.

The closest any study has come to analyzing the financial impact of ACL injuries in the NFL came from Secrist, Bhat, and Dodson (2010). They started out finding every player in the NFL suffering an ACL injury from 2010-2013 using a comprehensive online search. They then conducted a matched cohort analysis, using a database of NFL player salaries, comparing ACL injured players with the rest of the NFL. Cohorts in the study were divided based on their initial salary: group A, less than $500,000; group B, $500,000-$2,000,000; and group C, greater than $ $2,000,000. Their results concluded that on average, ACL injured players earned $2,070,521 less than salary-matched controls over the four years following the injury. Also, they found that players initially earning less than $2,000,000 per year have lower mean salaries and are less likely to remain in the league than uninjured controls. An interesting fact they point out is that the careers of players initially making more than $2,000,000 per year, meanwhile, are not negatively affected financially.

This study was the first to analyze how ACL injures affect NFL players not by their return to play percentage, but by grouping three different sets of players all with respectively similar earnings and testing whether or not they stayed in the league and how much they made relative to the other groups and the control group over the following seasons. Although this study is quite helpful to getting an even clearer understanding of the ACL injury and quantifying its impact for players in the NFL, there are still complications that must be further addressed. This study is a good comparison of ACL-injured players to those other ACL-injured players with

different initial salaries, along with the rest of the NFL, but could be further improved.

Seriously injured players in the NFL are usually placed on the Injured Reserve list (IR) by the team they play for and must then be out for at least the remainder of the season in which they were injured. This designation is perfect for quantifying those who were seriously injured In the NFL. In my study, the analysis will be focused comparing the ACL injured players under this IR tag, to all others under the same IR designation. This is an attempt to better relate this specific injury (ACL) to other seemingly serious injuries in the NFL. Then, the main focus will be to compare the statistical impact the ACL injured players have on team operating income to those who were also on the IR for a different injury, determining if the ACL injury actually did significantly affect the teams balance sheet. Hopefully, this method will further delineate the impact of the ACL injury, and make a clearer articulation on the financial impact of such an injury on the team itself. If Secrist, Bhan, and Dodson (2010) found that on average players who tore their ACL earned less than their counterparts, then it gives reason to investigate the effect it has on their respective teams as well.

An important issue regarding the demand for NFL players as either weathered veterans or up and coming rookies is an interesting topic of analysis, something Allen (2012) examined. Allen analyzed the NFL draft process and veteran free agent markets to see how productivity and risk factors played a part in the labor economics of the NFL. He states that teams are inclined to draft rookies earlier and pick up veterans in the market faster when exhibiting greater demand

for such players. In his findings he states, kind of obviously, that with better physical productivity, the labor demand for all players will be improved, but risk such as injuries or off the field issues, exert a more severe labor market consequence for veterans when compared to rookies. In his study he analyzes rookie and veteran players for both their productivity and risk factors. He lists multiple risk factors for each group that were used in his empirical analysis to determine in fact how risky these players are. In his study he actually did incorporate an IR variable that supposedly captured "cross risk" by measuring the mean NFL experience (in seasons played) of players placed on IR. In his study, he examines a much broader concept of labor economics, only having time to quickly control for the IR designation using the mean of seasons played of players placed on the IR. Although, it is helpful to understand how free agents are viewed in the NFL and how teams value players with respect to events that happened that may or may not alter a player's performance. As I've stated before, I will examine more specifically the IR designation and how this certain injury to a player's knee (ACL) affects them compared to other players under the same designation.

Burgess (1998) focused on the hiring of risky workers, a main theme seen in my paper. They use and test the hypothesis questioning whether high worker turnover is related to Lazear's measure of a firm's expected horizon, and to another measure available in their data, said to be the mean age of firms currently alive in the industry. They go on to use an establishment-level dataset in which they said they analyzed extensively in a series of other papers. The database that they used is the University of Maryland quarterly wage reports. They found that there were

approximately 1.5 million employees each quarter, and more than 100,000 reporting units. Their database consisted of these records spanning from March of 1983 to March of 1994.

With that said, they used this establishment level data to define churning flows (or worker turnover) as the difference between worker flows (hires and separations in a given quarter) and job reallocation, or the absolute value of employment change, as they describe it. The churning flow rate they use is calculated by taking total churning, divided by total employment. The industry growth rate is calculated by taking the employment change, divided by average employment. They measure mean age by using the mean current elapsed life span of establishments.

In conclusion, they found that employers in expanding industries do indeed display higher churning flows or worker turnover, and to the contrary, a high average age of employers decreases churning rather than increasing it. This examination of Lazear's model and determining whether or not expanding industries experience higher labor turnover helps illustrate important points about the labor demand for NFL players. Although in this paper they talk about growing industries and how they exhibit different turnover, one can observe these same happenings within the NFL by basis of teams as well. Teams that are better than average are inclined to keep their safer players and thus be mostly attracted to free agents who are considered safer players exhibiting steady performance. Similarly, teams that aren't considered top league contenders are more likely to hire and fire workers (players), a lot of which can be considered more risky. This is in hopes of a

better profit, or return from those players. This study doesn't directly aid my examination but does provide a good basis on how free agency and team decisions work in the NFL regarding the hiring of risky and safer workers.

Stair, Neral, Mizak, and Day (2008) performed a study that examined statistical analysis of the factors that influence team wins, or as they put "success," in the NFL. Although this study may differ slightly with regards to the definition of success (mine is terms of operating income), they also provide insight into a theory I will use. The variables examined were sectioned into offensive, defensive, and special team's classifications. They use variables such as net turnovers, and penalties to determine factors of success. More interestingly, they use another variable called "off-field conduct," as measured by team arrests. This inclusion of a variable that isn't considered a performance based statistic, is something I am doing with my study. Including number of suspensions along with another non-performance related statistic (ACL injury dummy variable) would show the basis for my risk aversion theory and how teams react to risk.

The results show surprisingly that team arrests were not found to have a statistically significant impact on team performance. They stated that the quarterback rating has the biggest impact on team wins followed by field goal percentage, opponent's passing yards per game, and opponent's rushing yards per game; which are all performance based statistics. To further emphasize the use of this study, one must realize how alternate factors affect free agents and the labor demand for such players. Using variables that are thought to affect players in a certain way (good or bad) can help identify how important they are when compared

with performance based statistics, in finding out the true impact of such an event. I will include a variable for suspensions so that I can eliminate any bias of an unrepresented variable, so that to better the impact of an ACL injury.

Interestingly enough, one of the few analyses of risk aversion theory and salaries given to free agents thereafter, was done by Krautmann (2014) by examining the free agent market in the MLB. Even though this paper doesn't deal with the NFL player market directly, a lot of the implications made are one's that could carry over. Krautmann (2014) shows that risk-averse owners will pay a premium for reliability on the field. The results he finds are consistent with his hypothesis that the higher degree of variability in a player's performance will have likewise negative consequences for that player's contract term. In his empirical models, his goal was to observe whether the dependent variable falls as his 'variance variable' rises. The first contract term he used is the player's annual real salary or REALSAL (corresponds to the salary of the first year of a contract term). He went on to give the empirical wage equation as: $\ln(REALSAL_i) = b0 + \text{þ}\ b1PERFi + b2VARi + b3Xi + b4TREND\ \text{þ}\ b5POP + Ei$. He had two more regressions in which he substituted the dependent variable REALSAL for $SIZE_i$ (which is the real size of the contract signed) and also $LENGTH_i$. This regression signified how long the team was willing to commit to a certain player.

He found that meaningful statements about the economic impact of an increase in variability on LENGTH are tough because most contracts are only 1 year long. Krautmann (2014) found that when variability is measured by the recent extremes in the player's performance, it is found that a free agent's salary is

negatively affected in relation to his performance variability. Later, in the economic theory section, I explain the risk aversion theory in relation to my paper but Krautmann's (2014) analysis gives good preliminary information on how player's variability with respect to performance can affect their contract terms. This would then also be true for players who were injured and missed time during the season, causing variability in their performance. This is where Krautmann's (2014) study connects to my paper, since he accounts for variability in performance related to contract terms. Variability can be caused by numerous factors; one in particular I am concerned with is serious injury like that of an ACL tear, and how salary in affected by it.

Massey and Thaler (2012) conducted a study about the complexities of the NFL draft and how it, along with much of the business world, uses faulty logic when making decisions for the betterment of the company. They used archival data on draft-day trades, player performance and compensation, they went and compared the market value of draft picks to the surplus value those drafted players provided to their respective teams. In doing this, they make a point central to one of my independent variables, "Number of First Round Draft Picks," in that they claim they find evidence showing how teams overvalue or become overconfident of the first round in the NFL draft and that expectations are less than exceeded when drafting in the first round.

In their results, they find that those high draft picks are significantly overvalued in a manner that is inconsistent with rational expectations and efficient markets and consistent with psychological research. I examine, as a variable, the

number of first round draft picks a team had (implying, the more the better) and whether or not it has a significant effect on team operating income. Massey and Thaler's study would harshly disagree of my use of this variable, since I use it as an indicator of success. Although my goal is to either further prove their point, that the first found in the NFL draft makes little difference for a team, or counter it with statistical significance relating to team operating income.

## Chapter 3: Economic Theory

The economic theory of risk aversion is the main framework from which this study is based on. To illustrate risk aversion would describe an investor who, when faced with two separate investments with similar expected returns, but differing risks, would usually prefer the option associated with less risk. To help familiarize one with this theory, a good way to look at this economic phenomenon, is through the lens of the stock market. Being risk averse or risk avoidant when buying stocks, when seeking long term gains, would be to choose investments that have proven yearly gains, thriving in a safer more stable market. This would be an example of a lower risk, low reward scenario, resembling what's called a blue chip stock. An example of a blue chip stock would be Disney Company (in the U.S.) in which the stock price has risen steadily for the past 40 years. In this study, we realize this risk aversion tactic when considering the signing of free agents and when making draft picks. Teams might pick up a free agent (a player who is not bound by any contract and is eligible to join any team) who hasn't sustained an injury such as an ACL tear, over a player who has. This would be considered a risk averse decision. Another

way of thinking about this would be if a team might be willing to pay a previously uninjured player more money (a.k.a. a premium) for a longer period of time than they would be willing to pay a player with a previously torn ACL. This would be anticipating that the player who tore his ACL might not return to full health and thus full performance. With this being said, a team would then likely pay a premium for a more reliable player than a player prone to more risk. This is central when examining the findings of the results because if the results of these variables (ACL, IR, and susp, etc....) happen to have a strong negative relationship to the teams operative income, due to increasing salary and medical costs, players who are considered risky (as described above) might pose a larger threat to future teams, and could see even more financial discrimination in the future.

Remembering the stock market analogy, the other option in this scenario is seen as a high risk, high reward investment. Which would be the equivalent of investing in a damaged or new business, which might or might not return to full expectations, but if so, has the chance to exceed such expectations, thus increasing the reward that was coupled with the higher risk. In my study, an example of a high risk, high reward free agent pickup would be a player, as described above, who has torn his ACL. In this example, the riskier player's previous performance or other performance indicators would have to be as good or better than the less risky player in order to warrant a team's interest. The option exercised in this example is the riskier player who might be cheaper, in hope to get returns from the player that either meet or surpass that of the safer player.

Teams aren't always going to be risk averse at all times, and some teams might actually prefer the riskier option in hope to gain a larger reward. Also, the decision to pick up a riskier player would be based on the team's current projections and if they need someone who can possibly provide the returns necessary to achieve the team's goal. With respect to NFL team owners and how they might be able to glean substance from this study, I further examine the risk aversion theory. If the results in this regression conclude that ACL injured players have a drastic negative effect on their respective teams operating income, when compared with the other independent variables, then teams might consider paying less for previously ACL-injured players. If it can be concluded that ACL injuries don't significantly affect team's operating income, these players might be perceived as safer financial options when signing free agents. They could also be given higher salaries and even more chances to recover and play in the future, ending the stern stigma associated with such an injury. Again, if I reject the null hypothesis, and say that ACL injured players have little or no effect when compared with the other chosen independent variables, then teams might consider these group of players as less of a liability, which brings about the next theory involved. The contingency expense pool model which helps explain how teams are affected by negative experiences like severe injuries and unpredictable player suspensions.

. In its standard format, the overall cost incurred by an entity is based on the Total Fixed Cost (TFC) and the Total Variable Cost (TVC). $P_K K + P_L L = TC$, Capital (K) is fixed and usually the price of each capital and labor would be fixed as well. When regarding the dynamic of a football player and the costs associated with that player,

I am particularly concerned with a non-performance based statistic (the ACL injuries a team incurs, and how it affects team operating income). In other words, the costs incurred, Medical and salary expenses, aren't changing with output, like a variable cost does, nor is it a fixed cost, which is constant.

When players are seriously injured like with that of an ACL injury, there are costs imposed on that team, including the cost of surgery and the cost of adding a new player and providing a salary for the replacement player. This can be categorized as a contingency expense. The idea of a contingency expense can be thought of as expenses that are likely to happen again, but the unknown information pertains to when the cost will occur and how much it will be. Contingency expenses, like surgery required for an ACL tear and new player salary, will thus increase the a teams total cost. That is why most companies have what they call "Contingency Expense Pool's," in which they have funds strictly in case of an expense for which they have incurred before, but is outside of the standard expense function mentioned earlier.

The reason, for example, that the costs mentioned above would be considered a contingency expense and not an unexpected expense is because a NFL team realizes that their players are prone to injury and they wouldn't consider it a freak happening or emergency expense because its part of the game. As a team, they plan for medical expenses. With that said, all that would occur, would be an increase in cost due to the new contingency expense in which they expected to occur. That is not to say teams expect their star running back to tear his ACL, but

they realize that it can happen, and therefor they would plan for such future events by creating an Expense pool for the likes of future medical expenses.

When measuring a company's total operating income, the formula is Total Revenue – (Operating Expenses + Any depreciation). So, by incurring more contingency costs from these injuries, in theory, it should reduce the total operating income because, to find the operating income, one must subtract the expenses (surgery's and new salaries) from total revenue. So, in theory, the ACL injury should show a negative impact on total operating income. This theory is proven true in the case for the Green Bay packers; due to large contracts negotiated, the teams operating income sunk by nearly 53 percent. This affirms that contracts signed impact teams operating income (Rovell, 2014). This is a phenomenon one wouldn't generally see if total revenue was used as the dependent variable, instead of Operating Income. In other words, the expense information isn't accounted for in team's revenue, and to further see the financial impact that injuries can have, one must use the total team operating income.

## Chapter 4: Data and Methodology

### *I. Data Sources and Compilation:*

To determine the effect that ACL injuries, and the other variables chosen, have on teams operating income, data was utilized from a multitude of different sources. All injury information regarding ACL injuries and Injured Reserve listings was found at pro-football-reference.com. To account for the number of player-suspensions each NFL team had, I used spotrac.com. Each teams super bowl and

regular season wins, and also all draft information, regarding the number of 1st round draft picks for each team, were gathered at NFL.com. For the variable "AVGQBR" or average quarterback rating, I received data on QBR from teamrankings.com. Home game attendance for each respective team was found at ESPN.com. Finally, for the dependent variable, I found information regarding team's individual operating income on Statista.com for the 2015 season and on Forbes for the 2014 season

All information gathered was for the NFL seasons 2014 and 2015. The data was limited to the years 2014 and 2015 due to the lack of availability for ACL injury and operating income information. The NFL is noted for being less than transparent in regards to releasing its injury and financial information, which is truly the sole reason this study was limited to only two years of observation. Although this study is limited in regard to its sample size, it narrows down the lens in which I will observe the results, which allows this study to be a contemporary guide for factors affecting teams operating income. As information becomes more publically available, this study would be interesting to run with more than two years of observation data, creating for more generalizable results.

I used an excel sheet to compile all the information I found via online sources. It should be noted that I collected information on total team revenue as well as operating income, although I didn't use total revenue in the model or regression. Once all the variables were merged into one data set, I transcribed the excel sheet and its data into Stata, where I performed my regression and other outputs.

## *II. Regression Model:*

Given the information gathered, next, I've illustrated the main model used for regressing such data. Keep in mind that the variables of interest are the dependent variable Team, Operating Income, and the independent variable, Number I have used one dependent variable, regressed against eight independent variables. The first three independent variables are expected to have an inverse relationship with the dependent variable and the last five variables chosen are anticipated to have a direct positive relationship with team operating income. Further discussion of the variables and the reason each were selected will be explained, succeeding the regression model, which is represented below:

Team Operating Income (opinc) $_{it}$= **β0**+ **β1** Number of ACL Injuries per Team (ACL) $_{it}$ + **β2** Number of Players Listed on IR per Team (IR) $_{it}$ + **β3** Team Suspensions (susp) $_{it}$ + **β4** Average Team Quarterback Rating (AVGQBR) $_{it}$ + **β5** Number of 1st Round Draft Picks (#FSTRNDDRFTPKS) $_{it}$ + **β6** Team Wins (wins) $_{it}$ + **β7** Home Game Attendance (HGATTEND) $_{it}$ + **β8** Super Bowl Wins (sbwins) $_{it}$ + **ε**

## *III. Explanation of Dependent and Independent Variables:*

The dependent variable, Team Operating Income, will be logged to get the percentage value in my regression. Its purpose is to measure each independent variables impact on the total team operating income. The reasoning behind using

team operating income instead of the total team revenue is because revenue is shared throughout the league since the NFL operates under revenue sharing sediment. This fudges the actual income the team receives or creates itself, because it is the shared, redistributed revenue between all 32 teams. Instead, I chose to use operating income as the dependent variable because it incorporates actual the costs teams incur which includes medical and salary expenses, which are pertinent, to this study. It is significant to note that the Green Bay Packers are the only publically traded team in the NFL; therefore their financial information is available to the public. Through this information, I was able to find that because of large contracts negotiated, the teams operating income dropped by nearly 53 percent, meaning that contracts signed indeed impact teams operating costs and therefor operating income (Rovell, 2014). This information gives further validation for using operating income as the dependent variable.

The Independent variable of the most interest for this study is the number of ACL injuries accumulated by each NFL team for the years 2014 and 2015, known as "ACL." This variable is chosen because I am attempting for quantify one of the more serious injuries in the NFL and determine its effect on team operating income. In theory, I expect "ACL" to have negative or inverse relationship to the dependent variable. So, as the number of ACL injuries a team incurs increases, I should see the magnitude increase negatively in relationship to team operating income. The next independent variable deals with the number of players on a team that were placed under the Injured Reserve designation. This designation is given to players who are not likely to return in a given year due to serious injury, and this should control for

other serious injuries that teams are affected by other than just the ACL injury. "IR" is also predicted to have an inverse relationship to the dependent variable, in other words, negatively impact team operating income. The third independent variable is the number of player suspensions that a team is afflicted by throughout 2014 and 2015. These first three variables are predicted to have an inverse relationship to the independent variable team operating income in that they represent negative experiences. The overall statistical significance that "ACL" and "IR" have, are a main point of emphasis, since I want to determine how impactful ACL injuries are for each team. Also the variable team suspensions was found in earlier studies (named team arrests) to have no significant impact on team success but I introduce it into the regression as team suspensions because it gives a broader definition than that of "team arrests," which can be less likely to occur than suspensions.

I introduce a variable previously found in research to be the best indicator of team success (wins), which in QBR (quarterback rating, which evaluates a quarterback's performance, arguably the most important position in football). This variable is predicted to have a direct positive relationship to the dependent variable. So, the higher the quarterback rating for a team, the more success and thus more team income that would be recorded. I expect the secondary variables to do their job in controlling for other factors indicative of teams' success in the NFL and use them in juxtaposition to the other variables in order to evaluate the overall financial impact of ACL injuries and their impact on team's operating income. The next independent variable is the number of first round draft picks by each team for the years 2014 and 2015, which is supposed to represent a control variable for team

success. The intuition here is that the number of first round draft picks should directly and positively correlate to team success, therefor team revenue. Next is the variable number of team wins, which is expected to observe a direct positive relationship to the dependent variable. Meaning, the more wins a team achieves, the higher income that team should receive.

The following variable, "HGATTEND," is the total number of fans that attended home games for the 2014 and 2015 seasons respectively. This variable was chosen In order to try and determine the share of teams operating income that fans contribute to. Also, this variable was chosen in response to the unavailable information on team's actual home ticket sales. Either way, I expect this variable to have a direct positive relationship with team operating income.

Lastly, I chose the variable, overall super bowl wins. I intend on accounting for any changes in team operating income depending the number of super bowls won. Of course there were only two teams to win the super bowl in 2014 and 2015, So, I can only observe the change in income for the 2014 winner, looking at their 2015 income. Although, overall super bowl wins tend to impact the fan base and therefor income due to ticket sales and merchandise. So along with the other independent variables, the goal is that this will control for income received by each team, having a direct positive relationship with team operating income.

Each variable chosen is expected to either directly or inversely correlate to the dependent variable but what is of this study's main concern, is to what degree each independent variable is related to operating income and how significant they are. In this model, before I run the regression, I went ahead and created dummy

variables (seen in Figure 1) for all 32 teams, t1-t32, to easily see how each team reacts to the chosen independent variables. After I run the regression, each of the dummy variable coefficients should give a clear indication, if significant, of how well the independent variables cover each teams operating income. Before these tests, I must mention that not all information is accounted for regarding team's operating income. This is due to information about team advertising contracts not being accessible. So there are limitations to this study, regarding pin-pointing the exact percentage of income that comes from each facet of the teams operations. Despite this, this study still intends to quantify the impact of the events chosen, so that to better understand if or in fact by how much, a team's total ACL's injuries, along with suspensions, QBR, etc.... contribute to the team's financial status.

## *IV. Summary Statistics:*

To observe the data and its summary statistics, visit the Appendix, and find Table 1. To briefly overview, the data set comprises of observations on 32 different NFL teams for two separate years, resulting in 64 total observations. Examining the chief independent variable, ACL injuries per team, I notice that minimum value recorded for a team was zero and the maximum was four ACL inflictions (per season). Analyzing the dependent variable, team operating income, it is important to note that the Dallas Cowboys who recorded the maximum amount of operating income at 300 million and also 270 million, heavily skewed the mean (83.82 million), where realistically, without the outliers, the mean would be much smaller.

Also, when looking at the variable, number of first round draft picks, it reports the mean at 1. This is because each team usually receives one first round pick in each draft, but in this case, for both the years 2014 and 2015, one team didn't get a first round pick and one team received two picks (this was true for each of the two drafts examined). The Washington Redskins didn't make a first round pick in 2014 and the Buffalo Bills in 2015. Also, the same team received the two picks for each of the two drafts, this was the Cleveland Browns. This is likely due to the phenomenon of trading draft picks for future money or other investments with other teams. It is then likely that the variable, First Round Draft Picks, will only be slightly useful when examining these teams above, who either lacked a pick completely or had one more than everyone else. This is definitely a slight limitation in the study but nonetheless, the results will be examined.

## Chapter 5: Empirical Analysis

### *I. Regression Results*

Number of Observations = 64; F(39, 24) = 4.35; Adjusted R-squared = 0.6747

| Team Operating Income | Coef. | Std. Error | T-Stat | P>\|t\| |
|---|---|---|---|---|
| **Total ACL injuries per Team** | -0.0651162 | 0.0579846 | -1.12 | 0.273 |
| **Total Listed on IR per Team** | -0.0094518 | 0.0244468 | -0.39 | 0.702 |
| **Team Suspensions** | 0.0046488 | 0.0437167 | -0.11 | 0.916 |
| **Average Quarterback Rating per Team** | -0.0008948 | 0.0075341 | -0.12 | 0.906 |
| **Number of 1st Round Draft Picks** | -0.1487889 | 0.1704667 | -0.87 | 0.391 |
| **Team Wins** | -0.0114899 | 0.0274393 | -0.42 | 0.679 |
| **Home Game Attendance** | 3.65e-07 | 3.04e-06 | 0.12 | 0.905 |
| **Super Bowl Wins** | 0.1410362 | 0.4316975 | 0.33 | 0.747 |

## *II. Variable Interpretation*

The following information about the regression will come from what is seen in Table 2. First, I take notice of the model and its readings. There are 64 observations in the model, along with an R-squared term at **.8761**. The R-squared indicates that the percent of variance explained by the explanatory variables is high in other words the overall fit of the model is respectable. Then, the Adjusted R-squared term was observed, which is considered a better test for the overall fit of the model when there are low numbers of observations. The Adjusted R-squared term was **.6747**, which is still relatively high. The log of team operating income (in millions of dollars) was taken and used as the dependent variable. That is to see how teams operating income is affected by the independent variables chosen. The main independent variable in question is the ACL variable. The goal with respect to the variable, "ACL," is to see, by how much or if at all, the number of ACL injuries on a team impacted operating income. The coefficient for ACL has a slightly inverse relationship with operating income, as expected, at **-.0651162**. The meaning of this coefficient is that with one more ACL injury incurred, a team's operating income decreases by 6.51%. It is important to note that "ACL" held no statistical significance. Naturally, the next variable examined is "IR" or the number of players placed under the Injured Reserve designation (usually due to a serious injury). Its coefficient reads **-.0094518,** meaning that a one unit increase in the number of players on Injured Reserve, is associated with a .95% decrease in team operating income. Despite this, I found that it is not statistically significant, like the ACL

variable. The next step was test for any joint significance between these two variables given that they both could be multicollinear, or in other words highly correlated to each other. Using the "test" command in Stata (as seen in Figure 3), I tested for any joint significance between ACL and IR, only to get a small F statistic of **.68** and a large p-value of **.5145.** So, I accepted the null hypothesis that "ACL" and "IR" aren't jointly significant.

I used the "estat vif" command can check for any multicollinearity within my model. With this test, any values greater than 10, for a variable, would warrant further investigation. In the results, seen in Figure 4, all of the independent variables are below 10, except for the dummy variables created, and two of the chosen independent variables. This is expected since the dummy variables are related to each other, so no red flags were raised regarding that. The two variables that had number above 10 were "home game attendance" and "super bowl wins." Although two of the control variables came up higher than 10, since they nor any other variables were significant, I can conclude this test by saying that multicollinearity isn't prevalent in the results, except for the expected dummy variables.

Looking at the variable "susp," which is the number of suspended players for each team, it's coefficient read **-.0046488**, implying a very slight inverse relationship with the dependent variable, in other words, each additional suspension a team incurs, is associated with a .46% decrease in operating income. This relationship is observed to have a low T-stat and high p-value, making it easy to conclude that this variable is not statistically significant. Regarding the output from

the predicted inverse relationship variables, "ACL, IR, and susp," each did have an inverse relationship but each was also found to be statistically insignificant.

Regarding the other independent variables used, I examine "AVGQBR" or the average quarterback rating a team had for the 2014 and 2015 season. This variable was found a study, (Day 2008), to be the best indicator of a team's success. Although this study is slightly different in the fact that I wanted to see its effect on revenue, which is believed to be an extension of how successful a team is. Average QBR had a coefficient of **.0008948**, so a one unit increase in QBR results in a .09% decrease in team operating income. Also, it had a high p-value and a low T-stat of .12. What this means is that the productivity, of arguably the most important position in football, has little to no effect on team operating income. It was reasonable for the first three variables to carry no significance or influence on the team income, but the average QBR variable was already tested, and tested positively for impacting team success, so it furthers the hypothesis that other outside factors not included in the study dilute the effect of our variables chosen on team operating income

Next, I assess at the variables named "wins," "First Round Draft Picks" and "home game attendance." Number of wins in a season was chosen to control for success the team had which I assumed might result in revenue created. Its coefficient was actually slightly negative at **-.0114899,** meaning that one more win, is associated with a 1.15% decrease in operating income. This variable was also statistically insignificant pronounced by it's a large p-value. This was odd considering the assumption that teams, who win more, would be more successful in

creating income, but this isn't the case. Next one can see that "First Round Draft Picks" had a beta of **-.1487889**, indicating that with one more first round draft pick, a team would see a 14.9% decrease in team operating income. The variable was not statistically significant either. As mentioned earlier, only two teams (WAS and BUF) didn't get a pick and one team had two picks each year (CLE). This created for a small range within this variables composition, which may have skewed the results. This variable was used as well to control for factors influencing team success, using the idea that the better prospects a team acquires, the better its results may be, and in turn affecting income. This notion was not supported by the results.

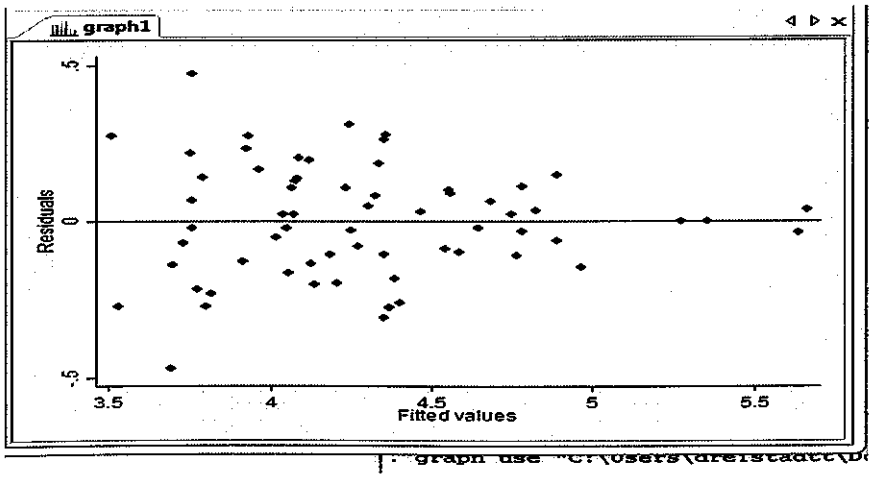
Home game attendance was one variable that was predicted to have a larger impact on revenue being that the amount of fans that come to games would theoretically directly impact ticket sales, merchandise bought, and concession profits. This variable was found to be insignificant after analyzing both the t-test and p-value. Its coefficient was very small at **3.65e-07**, implying that with a one unit increase in attendance, it is associated with a .0000365% increase in operating income. This implies that team income is much more than just the operations of facilities and a much larger slice of the revenue pie is due to TV commercials and endorsements.

The following variable titled "Super Bowl Wins" which is the overall Super Bowl wins a team has. This was used to control for any revenue gains as well as the other control variables I used. Its coefficient was small at **.1410362**, meaning that with a one unit increase in super bowl wins, there is a 14.11% increase in operating income. This variable was statistically insignificant relative to team income. This

was puzzling because obviously teams gain more revenue due to a Super Bowl win, but in this study that might have been skewed because I only looked at two years and then added cumulative super bowl wins as an independent variable. So, later studies might want to look at more specific examples of teams who win the super bowl and then examine the change in revenue from years past against their post-super bowl income, to clarify this subject.

After analyzing the main regression results, the next procedure performed was to run a "hettest" and plot the residuals against the fitted values in order to determine any signs of heteroscedasticity. For the hettest, I must first assume the null hypothesis is that the variance of the residuals is homogenous. So in this case, the evidence suggests that the variance isn't homogeneous, due to a small p-value of .0018, so I rejected the null hypothesis. In order to verify this claim, I plotted the residuals against the fitted values to visually observe any heteroscedasticity.

*Command: Rvfplot*



In the figure above, one can see that a few of the plot points stretch to the right of the graph plotted, indicating as the hettest did, that there is some slight heteroscedasticity.

Through running these tests, I determined to re-run the same regression using the "robust" measure to correct for any heteroskedasticity. The new, robust regression displayed that the coefficients didn't change with any significance in sign change (-or +) or magnitude, nor did the robust test create any variables, which happen to be statistically significant. I can conclude that heteroskedasticity or any extreme outliers observed didn't seem to affect this model and its results in a substantial way.

To test for specification errors, I performed a link test. After running the test, and examining the p-value for "_hatsq," it can be said that I failed to reject the assumption that the model is stated properly. From this information, it seems that there are no specification errors. The last test I ran is the "ovtest," which is very similar to the "linktest," testing for omitted variables. The results came up with a p-value of .1269 and an F-stat of 2.13, meaning that there could be omitted variables, which I predicted at the start of this study. With the very middle of the road results I got, it also implies that there aren't overwhelming signs indicating many omitted variables. So, overall, the results from this test weren't out of the ordinary.

The overall results of the regression output are largely insignificant, statistically speaking. Even after controlling for possible biases and broken norms, the results were surprisingly similar to the original output. I will attempt to garner any further explanation of the variables of interest, and what they represent in

respect to this study's findings. In addition, I will discuss any possible implications of such findings.

## Chapter 6: Conclusion

### *I. Analysis of Variable Explanation*

This study's main ambition was to quantify the impact of the events chosen, so that to better understand if or in fact how much a team's total ACL's injuries, susp, QBR, ect... contributes to its financial well-being. Through the tests ran, to determine the exact influence ACL injuries have on teams operating income, it is safe to say that there is no significant influence of total team ACL injuries on the respective teams operating income. This is true for the variable IR as well, in that they both had negative coefficients, which were expected, each held no statistical significance. This was further proved through a joint significance test. So the implications of these results can be understood by saying that severe injuries like the ACL tear and other serious injuries categorized by the IR variable, don't hinder the team through increasing expenses in a significant way, ultimately not having a significant effect on the team operating income.

Another variable that was expected to have an inverse relationship with the dependent variable, team's suspensions, came up with insignificant results relating to team operating income, aiding the claim made in the study by Stair, Neral, Mizak, and Day (2008), that team arrests don't affect wins. I can go a step further and say that not only do arrests not affect wins, but also an even broader category, suspensions, don't affect teams operating income. So it seems that suspensions

aren't monetarily hazardous, even though they may be morally hazardous events. Examining the "x" variables predicted to have a negative effect on the "y" variable, the independent variable of interest, ACL, had the largest magnitude at roughly -.06 and was the most significant. So, even though no significance was observed, ACL was the most impactful negative event variable.

Analyzing the variables chosen to represent positive influences on team success and therefor, financial gains, one must first examine the variable "wins." Wins was found to be statistical insignificant, and with a negative coefficient. Without even looking at the impact of QBR, and First round draft picks, if one applies the logic recently learned, that team wins don't significantly affect operating income, then a QBR measure that influences wins, wouldn't either, and the number of first round draft picks would follow suit because it was predicted to affect team's success in terms of record as well. The results concluded this, but there are other explanations too. It could be that even with a good quarterback, resulting in a good QBR (above 85) the team still didn't win. Take the San Diego Chargers, abbreviated LAC because they moved to Los Angeles, who recorded am average QBR of 93.4 and 94.5 for both years had had only a total of 13 wins for two years (not good). So different factors could have affected QBR but nonetheless, it doesn't affect the dependent variable. In regards to the effect of the number of first round draft picks, one can point back to the literature remembering what Massey and Thaler as concluded, that these picks are overvalued. This is true in the sense that it doesn't immediately affect operating income. A future study would more closely track this

complex issue using more years of observation to generate more generalizable results, instead of only two years for the sample data.

The last two variables used were total home game attendance and super bowl wins, the former was used to control for team ticket sales, merchandise, etc.... and the ladder was to control for financial success incurred by a pastime of success and even the present super bowl wins in 2014 and 2015. Attendance didn't significantly affect operating income, but super bowl wins was noted to having the highest positive correlation to the dependent variable. To, clarify, the result was not statistically significant, so its coefficient can be basically disregarded, but it is interesting to point out.

## *II. Implications and Closing Remarks*

Overall, this study didn't provide results that were significant, but one must not confuse this with being a sign of a failure of tests. The implications for this study are still germane to the research question. What impact do these variables truly have on the respective teams operating income? Generally in this study I see no clear negative effect that ACL injuries, injured reserved players, suspensions, have on operating income. It is also true that the other direct relationship variables, like QBR, wins, total number of first round draft picks, etc.... have no true positive effect on operating income. One must understand that after reaching this conclusion, it is more of a failure of the model for not including more necessary variables, than anything else. This study also reveals that minor events within the team like the variables chosen (ACL, IR, susp, etc...), don't have the power to financially affect the

enormous franchise that encompasses them. Of course then, it would be easier to quantify these pieces of information under operating income if I had all sources of income that teams received.

Hopefully in forthcoming studies, more financial information about the most lucrative sports industry in history will become available. As well as this, an additional variable that I could have used in this study, would be the city population for each team, which would likely be a contributing factor to operating income. If these limitations were overcome, this would be golden opportunity for any economist. To comprehensively analyze revenue streams in the NFL and determine which factors truly affected income, would be a great step in understanding how NFL teams operate. With that being said, in an attempt to quantify what physicians call serious injuries, and what analysts call influential factors for team success, I found that the majority of the independent variables, which may affect team wins or losses, don't affect the team's financial status in a significant way.

For NFL owners, this information can be interpreted as helpful, in the sense that ACL injured players may face hardships in recovery, but overall they don't impact a team's true operating income. It is tough to determine the actual effect ACL injuries have with respect to the other independent variables, because of the overarching insignificance witnessed in the study. So the cause for concern about risky players should be slightly mitigated and thus more opportunities with regard to these risky players could be taken In the future. This speaks specifically when examining a high-risk, high reward situation like a previously ACL injured player. I

hope this study can act as a building block for new and future studies as more information can flow to the public on NFL injury and financial records.

## Appendix

*Figure 1: Anterior Cruciate Ligament (ACL) Tear*

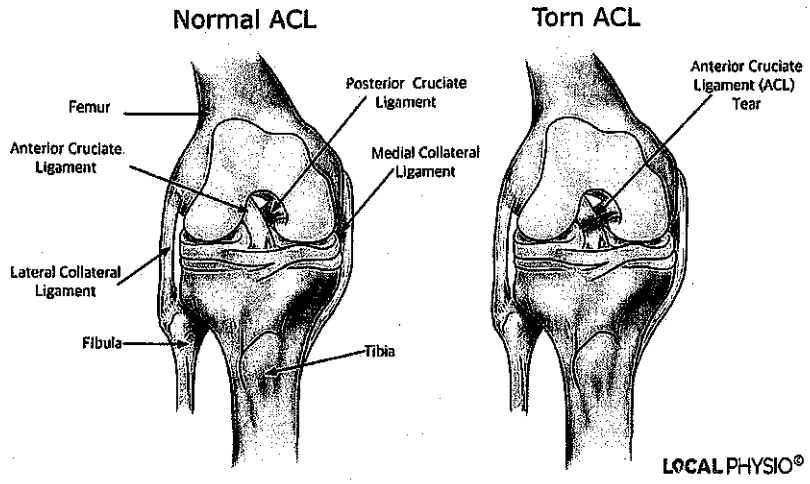



*Table 1: Summary Statistics*

| Variables | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|
| **Team Operating Income** | 83.82813 | 51.66484 | 25 | 300 |
| **Total ACL injuries per Team** | .84275 | .8585471 | 0 | 4 |
| **Total Listed on IR per Team** | 6.9375 | 3.02306 | 1 | 14 |
| **Team Suspensions** | 1.609375 | 1.40991 | 0 | 6 |
| **Average Quarterback Rating per Team** | 88.925 | 8.900187 | 72 | 112.3 |
| **Number of 1st Round Draft Picks** | 1.00 | .3984095 | 0 | 2 |
| **Team Wins** | 7.984375 | 3.083454 | 2 | 15 |
| **Home Game Attendance** | 542167.8 | 68891.73 | 375897 | 731672 |
| **Super Bowl Wins** | 1.578125 | 1.824043 | 0 | 6 |

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*About the Author:*

Troy is an Economics Major and is also minoring in the field of Religious Studies. He is a second year transfer student from the Pennsylvania State University, who found Allegheny through family and reputation. As an Allegheny Graduate, he plans on possibly continuing further education in order to pursue a career in the field of Finance and/or accounting.