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The Look of the Line: An Empirical Investigation of the Impacts of Facial Symmetry on Salary Levels of Offensive Linemen in the NFL

Kristen Wampole
Ursinus College

Adviser: Jennifer VanGilder

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Abstract

Evaluation of a professional athlete's performance for the purposes of compensation determination is difficult, especially when decision making may not follow the expected "instrumental rationality." This paper will look to examine the factors, both productive and non-productive, impacting an Offensive Lineman's salary in the NFL. The purpose of this study is to determine whether an offensive lineman's salary is based on productive characteristics adhering to instrumental rationality, or whether the influence of non-productive characteristics influence salary as ultimately determined by team management. Results indicate that players within the tackle position with earning salaries in the seventy-fifth percentile gain additional benefits for having more facial symmetry.

Introduction

Evaluation of a professional athlete's performance for the purposes of compensation determination is difficult, especially when decision making in the professional sports environment may not follow the expected "instrumental rationality." Instrumental rationality is the belief that practical reasoning helps one decide how to do things, such as problem solve, resolve disputes or execute technical tasks, by considering the factors involved in a situation as variables to be controlled (Instrumental Rationality, 2011). In other words, instrumental rationality refers to how effectively one allocates his/her abilities, or in the case of professional athletes, his skills, toward accomplishing a certain goal (Hackfort). Given the severe consequences of failure, including loss of playing time and public humiliation, and the wealth of information on individual performance, economists expect professional athletes' salary determinants to follow instrumental rationality. However, Berri (2007) found that decision-making in professional sports may not always follow this theory.

For example, in *Moneyball*, Lewis (2003) explains how decision makers in Major League Baseball undervalued a player's on-base percentage. Lewis revealed that managers tend to overlook a player's ability to successfully get on base. It would be "practical," and thus follow instrumental rationality, to field a team with a high on base percentage since getting on base is the only way to score runs and thus win games. Yet in practice, managers sought number one recruits and big name hitters, none of which were proven on-base players. In the National Football League, Romer (2006) revealed that coaches were too conservative when choosing to go for it on fourth down. More frequent fourth down conversion attempts would increase a team's probability of winning as it provides one additional chance at reaching the first down marker. In order to win football games, a team must out-score its opponent. The only way to score points is to effectively transition the football down the field and the most common way of doing so is through first down conversions. Thus, this study indicates that the coaches' decision not to go for it on fourth down is counterintuitive to his team's goal of winning football games.

While some research claims that decision-making in professional sports does not always follow instrumental rationality, this opinion has not been fully substantiated. Therefore, this research will attempt to understand management's decision-making inputs related to player compensation in the professional sports setting. More specifically, this paper will look to examine the factors, both productive and non-productive, impacting a professional athlete's salary in the National Football League (NFL), particularly members of the offensive line. The purpose of this study is to determine whether an offensive lineman's salary is based on productive characteristics adhering to instrumental rationality, or whether the influence of non-productive characteristics influence salary as ultimately determined by team management. Furthermore, this paper will attempt to explain how salary is allocated across the offensive line and identify any salary premiums by position.

Background

The offensive line is composed of five men: left tackle, left guard, center, right guard and right tackle. This offensive unit has three essential jobs: First, the center, positioned in the middle of the line, initiates every offensive play by "hiking" the football on the quarterback's count. This is also called a "snap." The second role of the offensive line is to prevent the quarterback from being "sacked." A sack occurs when the other team's defense successfully tackles the quarterback before he has a chance to make a play on the ball. A sack results in a loss of yardage making it more difficult for the offense to reach the first down marker[1]. A sack may also put unnecessary strain or injury to the quarterback that may prove to be detrimental to the entire offense. The majority of sacks originate from the area just outside the offensive line; therefore, it is the job of the left and right tackles, who line up on opposite far sides of the line, to be aware of any defensive movement or "blitzes[2]" that may result in a sack. Finally, the offensive line must refrain from committing penalties as penalties set the offense further back from the original line of scrimmage. A "hold" and a "false start" are two of the most common penalties committed by offensive linemen. A holding penalty, which occurs when a player illegally blocks another player, results in a loss of 10 yards. A false start, or an illegal movement prior to the snap, results in a loss of five yards.

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[1] The offense is allotted four attempts to move the ball 10 yards. If they have failed to do so after their third attempt, the team will typically elect to punt the ball or kick a field goal if within range to avoid turning the ball over on downs.

[2] A blitz occurs when defensive players lined up on or behind the line of scrimmage burst across the line to the offensive side in an attempt to tackle the quarterback or interfere with his pass attempt.

In order to effectively do their job, offensive linemen must be big. In 2009, senior analyst Jeremy Kaufman stated "in the contemporary NFL, it is almost impossible for a lineman under the playing weight of 290 pounds to make it in the league, regardless of talent level" (Bleacher Report). In fact, every offensive lineman included in the 2010 dataset exceeded 300 pounds. Kaufman goes on to claim that the natural weights of these massive human beings range between 200 and 230 pounds. This begs the question: At what point does the size of an offensive linemen become detrimental to his performance and his health? Thus, a second question this paper will address will be whether or not there is a turning point when weight becomes a non-productive characteristic for an offensive lineman.

Weight of offensive linemen has been discussed in popular press as well. In 2006, Scripps Howard determined that heavyset football players were twice as likely to die by the age of 50 compared to their lower weight teammates. Moreover, compared to the standard population, offensive linemen have a 52% increased risk of death from heart disease (Hargrove). Fall 2001 *The Biggest Loser* contestant, Antone Davis, former offensive lineman for the Philadelphia Eagles and Atlanta Falcons, is testimony to the weight struggles of offensive linemen. Before retiring in 1997, Davis weighed 335 pounds. Nearly 15 years later, Davis weighed into this season's *The Biggest Loser* at 447 pounds. When describing his motivations for joining the reality show, Davis laments "All my friends are literally falling dead."[3] After attending the funerals of seven former offensive line teammates from the University of Tennessee, all of whom were younger and weighed less than him, Davis realized that he needed to lose weight or he would be next.

For Minnesota Vikings' offensive linemen Bryant McKinnie weight cost him his job. Despite being a Pro Bowl player, the Minnesota Vikings released McKinnie in 2011 when he

[3] *The Biggest Loser*, NBC's reality weight loss show (Season 12)

showed up to pre-season weighing 387 pounds, 85 pounds more than he weighed the previous season (O, Mike). This move suggests that Minnesota viewed McKinnie's weight as unfavorable toward his ability to effectively protect the quarterback. However, the Baltimore Ravens disagreed. Baltimore quickly signed the Pro Bowler, now weighing 360 pounds, and gave him Michael Oher's coveted position at left tackle (Corbett). Again we ask how much is too much. At what weight does an offensive lineman's size inhibit him from effectively allocating his skills to contribute to the team's goal of winning football games?

Literature Review

Productive Determinates of Salary

Academic literature on the offensive line is scarce, thus the majority of supportive literature will come from studies conducted in other professional sports arenas including the National Basketball Association (NBA) and the National Hockey League (NHL). Berri, Humphreys and Simmons (2011) examined the determinants of salaries of offensive linemen in the NFL. Their research focused primarily on the position of starting left tackle and the phenomena of the "blind side" as made popular by Michael Lewis' novel *The Blind Side: Evolution of a Game*, in addition to other performance-based salary determinants including penalty yards, size and draft position. The authors observed salary distributions that were highly skewed to the left with few players earning substantially more than others. This study found that on average, offensive linemen (center, tackle or guard) earn $1.7 million. The results of his research also point to a salary hierarchy among the specialized positions on the line with tackles earning the most, followed by guards, centers then general offensive linemen[4].

[4] A general offensive lineman is a player who can play any position on the line.

The researchers observed that starting left tackles earned $3.49 million on average. While this average is above that of the line as a whole, the dummy variable for starting left tackle was found to be insignificant, which would suggest that being a starting left tackle does not consistently impact salary. More specifically, at the 25th quantile, starting left tackles do not earn significantly more than regular tackles. However, at the median and 75th quantile, a significant pay increase is observed for starting left tackles above tackles as a whole. This inconsistency may be attributed to the narrowness of the study. The researchers solely looked at starting *left* tackles; however, if the quarterback is left-handed, protecting his blindside becomes the job of the starting *right* tackle. While there are currently just five active left-handed quarterbacks in the league, the quarterback's handedness remains an important consideration. Regardless, the researchers show a consistent salary premium for starting left tackles in the majority of quantile analyses, as well as a salary distribution with the majority of starting left tackles in the top fifty percent of the distribution. These results suggest that Lewis' story of *The Blind Side* holds true – starting left tackles are valued higher than the rest of the line and their salary reflects this notion *ceteris paribus*.

Berri, Humphreys and Simmons' (2011) research on draft selection uncovered that initial perceptions—typical drivers of draft selection—remain influential on salary even after observations of player performance in the NFL. According to the free agency established by the NFL, following a draft, rookie players are expected to remain with his team for at least three years. After three years, a player becomes a free agent, at which point he is free to sign a new contract with any interested team in the league or renegotiate his current contract based recent performance. Therefore, for the first three years of a player's career, his salary is highly dependent on draft selection. These researchers found that offensive linemen, in particular, with free agent status and more than three years of experience with the same team earn more than other players *ceteris paribus*. Furthermore, offensive linemen who switch teams suffer a salary penalty. A possible explanation for this trend may be the fact that an effective offensive line serves as a cohesive unit, one which compliments each player's strengths and weaknesses. Thus, a lineman who frequently switches teams fails to establish the necessary cohesion with the rest of the line and is therefore less effective, which is reflected in his lower salary.

Berri, Brook and Schmidt (2007) noticed similar trends in draft position and free agency in the NBA. After the first two years of a NBA player's career, his draft position was still influential on the amount of playing time he receives, regardless of prior performance. Therefore, despite disappointing performance, coaches will continue to reward high-draft picks with more playing time than other players simply based on their position in the draft. This suggests that NBA decision makers are slow to adapt to fresh information on player performance. These researchers also analyzed salary determinants in the NBA. In particular, they observed recent free agents to overcome the lag year between player performance and salary determination[5]. It is beneficial to study free agents since their new team salary is based on their most recent performance as one does not need to compensate for multi-year contracts or signing bonuses. By restricting the sample space to free agents, these researchers found points scored to be the most important performance statistic. In fact, when points scored per game is used as the sole measure of player performance; one can explain 59% of a player's average salary. Again, the researchers found that negative performance, including inaccurate shooting and turnovers, does not negatively impact salary.

[5] A free agent is a professional athlete whose current contract has expired and is now eligible to sign a contract with another team.

In addition to draft selection and free agency status, Berri, Humphreys and Simmons (2011) studied the effects of sack prevention on an offensive lineman's salary. Consistent with the aforementioned research conducted by Berri, Brook and Schmidt (2007) on the NBA, these researchers concluded that a lineman's negative performance—his inability to prevent sacks—has no impact on salary. The authors propose two possible explanations for this outcome. First, it is possible that the other explanatory variables in the model, including Pro Bowl status and a player who remains with his team for at least three years, already account for a player's ability to prevent sacks. More specifically, Pro Bowl status indicates a successful career and success on the line is characterized by effective quarterback protection including sack prevention. Furthermore, sack prevention is typically a function of the entire line's ability to hold off the opposition. Therefore, team longevity contributes to offensive line cohesion, ultimately increasing the line's ability to prevent sacks. Second, since the act of preventing a sack may be seen as the job of the whole line, assigning sacks allowed to an individual lineman may not be an appropriate method of assessing salary across the offensive line.

Given the overall findings of Berri, Humphreys and Simmons' (2011) study, the authors conclude that the salary model used is similar to the neoclassical model of worker compensation since the variation in NFL salaries can be explained by the same factors that explain the variation in factory workers', teachers' and doctors' salaries. Moreover, since the number of sack yards allowed was found to be insignificant in explaining salary, this model may specifically explain worker compensation in a group setting. Since the linemen must work together to achieve the desired output (i.e. hold off the defense allowing the offense to obtain a first down), this model would similarly demonstrate the collaboration necessary of factory workers on an assembly line or a surgical team to achieve their desired outcome.

As previously mentioned, the success of the offensive line depends on their ability to work as a unit. Idson and Kahane's (2000) research on the team effects of compensation will be utilized as a basis to theoretically determine whether individual characteristics are valued differently across different work environments. The researchers found that individual productivity can vary in different settings since the level of coworker assistance varies by setting. For an individual in an environment where there exists some level of complimentarity in human capital efforts, it is possible that productivity is a function of both team and individual inputs; as a result, his compensation may also be a function of both inputs.

Unlike any other position in the NFL, including the defensive linemen, the offensive linemen are most often evaluated as a unit. One only has to watch a football game to hear references about the performance of "the offensive line" rather than "an offensive lineman." As such, it is very difficult to find individual statistics for these players. Because of this, it is important to analyze whether or not the salary determinants of the offensive linemen are more closely affected by one another's performance opposed to strictly their own. Using the NHL as the basis for their study, Idson and Kahane (2000) found that when team productive statistics were included in the salary model, it had a higher adjusted R^2; therefore, these variables did a better job explaining the variation in individual player compensation. Adding prolific scorers, intense two-way plays, swift skaters and star players into the model increased salary, suggests that a player's salary is affected by the attributes of the rest of the players on the team. Furthermore, the authors established positive correlation between a player's career points and his presence on the ice during a full-strength goal[6]. Therefore, members of teams with high

[6] A full-strength goal occurs when a team scores with all 6 players on the ice. In other words, there are no members of the scoring team sitting in the penalty box at the time of the goal. Therefore, presence on the ice during a full-strength goal may be a way to measure team cohesiveness, as a full-strength goal requires the combined effort of all six men on the ice.

productivity, as characterized by factors such as high scorers, star players and skilled skaters, receive greater compensation. These results further support the claim that individual productivity, and therefore individual salaries, are valued higher on teams with better players. Thus, their labor inputs are viewed as complements. Moreover, the authors state that some positions are expected to be more compatible than others, which may lead to more significantly positive interactions. The offensive line positions—tackle, guard and center—may be considered highly compatible. As such, this paper will seek to establish the statistical significance of their interactions and the corresponding effects on individual salaries.

Based on these results, Idson and Kahane (2000) concluded that team attributes have both direct and indirect effects on individual player compensation as seen by the varied salaries rewarded for individual productivity. While inclusion of team attributes in the model increased the overall explanatory power of the model, certain individual productive variables declined, including games-squared, points scored, penalties against, height, star status, forward position and free agent status. Wherefore, the researchers concluded that the explanatory power of individual attributes may be overvalued when team effects are excluded from the model.

Non-productive Determinates of Salary

In addition to the productive statistics influencing salary, it is beneficial to consider any non-productive forces that may explain player compensation. In 2011, Simmons, Berri, VanGilder and O'Neill (2011) looked at the non-productive determinants, namely physical attractiveness, affecting salaries in the NFL. The researchers defined attractiveness as a physical characteristic representing greater facial symmetry. Facial symmetry is distinguished by balanced lateral proportions. In general, superior attractiveness is correlated with observed outcomes. The researchers restricted their study to NFL quarterbacks as players in this role are often team leaders and the "face of the franchise." Therefore, one would perceive quarterbacks as more physically attractive than positions with less media exposure. This perception is consistent with the mere exposure effect, which is a psychological phenomenon where people naturally prefer people or objects simply based on familiarity (Fournier). Given this research and the mere exposure effect, this paper will attempt to explain how the physical appearance of offensive linemen, typically characterized by their obese frames and mean facades, impacts their salaries.

Revisiting Simmons, Berri, VanGilder and O'Neill's (2011) research on quarterbacks, the researchers found, using an online program, Symmeter, to measure attractiveness, that facial symmetry of quarterbacks ranged from 90.36 to 99.77. This range is consistently above the attractive measure of the average person which falls at the top of the 80th percentile. Moreover, symmetry was found to have a positive impact on salary with a coefficient of 0.089 at the 95% confidence level. Therefore, a unit increase in facial symmetry increases salary by 8.9%. Furthermore, moving from one standard deviation below the mean to one standard deviation above the mean, or an increase of 3.16 points on the Symmeter reading, increases expected salary by 11.8%. Given these results, attractiveness, as a non-productive characteristic, increases a quarterback's salary regardless of performance.

Additional research by Hamermesh and Biddle (1994) showed that more attractive people earn greater salaries than their average looking counterparts, thus creating a 5% wage premium. Mobius and Rosenblatt (2006) also found that attractive people earn higher salaries, mainly due to their better communication skills. In their research, Mocan and Tekin (2010) cite a variety of reasons why attractive people may be perceived as more productive or competent in the labor market as is suggested by their consistently higher wages. First, these researchers claimed that attractive people naturally have more self-confidence, in addition to possessing better leadership and social skills. Second, more attractive individuals may have higher self-esteem and motivation. Greater levels of motivation in school, as well as during human capital attainment throughout the development of one's career may also contribute to his higher compensation.

Salary Model

The model of linemen salaries used herein is based on the basic Mincer "human capital earnings function" often utilized to model earnings regressions. Mincer originally designed the model to have the log of earnings dependent on the sum of years of education and a quadratic of years of potential experience following:

$$(1)\ \log(y_i) = \beta_0 + \beta_1 S_i + \beta_2 X_i + \beta_3 X_i^2 + \varepsilon_i$$

where y is earnings, β_0 is the earnings of an individual with no education and no experience, S_i is the years of schooling and X_i is years of experience in the labor market (Lemieux 2006). When applied to sports literature, this form often depends on experience, player performance and team characteristics (see Berri, Humphreys and Simmons (2011) for references to evidence across various sports settings). Applying the idea of instrumental rationality introduced at the onset of this paper, experience, player performance and team characteristics are all factors that contribute to the practical reasoning coaches use to determine players' salaries.

Human capital is often defined as an investment in education, training, health, or mobility (Becker, 2008). According to Becker, an individual's accumulation of knowledge and training affects his or her ability to perform specific tasks. Furthermore, his human capital theory asserts that the more knowledgeable an individual is, the more valuable he becomes in the workforce thus warranting his higher salary. A lineman’s knowledge base is primarily made up of his on the job training, which emphasizes physical health and fitness, studying the playbook, etc. More generally, this model will depend on experience, health and individual player performance.

The dependent variable is the natural log of salary. NFL players generally receive a base salary, a signing bonus, and other bonuses both performance and non-performance related. Signing bonuses are paid within the first year of the player signing the contract. In the NFL, pay scales are experience driven, salaries are not typically guaranteed and players can be released from their contracts at any moment. The dependent variable will be a summation of the following three salary inputs: *Base Salary*, *Signing Bonus*, *Other Bonus*. Table 1 outlines descriptions of each variable that will be used in the study.

Table 1: Variable Descriptions

Variable	**Definition**
Weight	Lineman's weight in pounds
NFL Experience	Total number of seasons played in the NFL
First Round Pick	Dummy variable indicating that the lineman was drafted in the first round
Second Round Pick	Dummy variable indicating that the lineman was drafted in the second round
Third Round Pick	Dummy variable indicating that the lineman was drafted in the third round
Undrafted	Dummy variable indicating that the lineman was undrafted
Games Played	Number of games played per season
Games Started	Number of games started per season
Total Penalties	Number of total penalties per season
Penalty Yards	Number of total penalty yards per season
False Start	Number of false starts per season
Hold	Number of holding penalties per season
Sacks Allowed	Number of sacks allowed per season
Yards Lost by Sack	Total yards lost by sack per season
Base Salary	Lineman's base salary per season
Signing Bonus	Lineman's signing bonus per season
Other Bonus	Lineman's other bonuses awarded per season
Total Salary	Lineman's total salary per season
Symmetry	Measure of facial symmetry used to represent physical attractiveness

The first explanatory variable is NFL Experience. As the human capital model suggests, experience is expected to have a positive impact on lineman salary. With each additional year in the NFL, a player becomes more comfortable and knowledgeable about the game thus making him a more valuable asset to the team justifying his salary increase. However, at a certain point, one expects to see diminishing returns to an additional year of experience due to the physical demands of the sport. After years of extensive wear and tear on the body, one's speed and strength begin to decline ultimately decreasing his productivity. The quadratic variable, NFL Experience squared, captures the diminishing returns to experience.

College performance paves the way for experience in the NFL. Successful collegiate football players are in high demand, a demand which is highlighted each year in the NFL draft selection process. There are seven rounds to the NFL draft. Players drafted in the first round are considered to be of the highest quality. Therefore, early draft picks are expected to have the highest salaries. Using the lower draft rounds as a benchmark, *First Round Pick* is expected to have a positive impact on salary. The dataset also includes the dummy variable, *Undrafted*, to represent players who were undrafted. These players are expected to have the lowest salaries and a negative impact on salary compared to the benchmark of a drafted player.

A player's size, a key variable of interest in this study, is measured by *Weight*. As weight increases, salary is expected to increase since massive linemen are more effective blockers; however, at a certain point a one pound increase in weight is expected to decrease salary as linemen who are too massive lose agility, quickness and consequently their ability to successfully protect the quarterback. The diminishing returns to weight are captured by the quadratic variable $Weight^2$.

The non-productive variable, *Symmetry*, will also be used to explain linemen salaries. Based on Simmons, Berri, VanGilder and O'Neill's (2011) research on NFL quarterbacks, players with high levels of facial symmetry, a measure of physical attractiveness, are expected to earn a salary premium over their less attractive teammates. Therefore, it is expected that facial symmetry will positively impact salary.

The productive statistics for offensive linemen make up the rest of the explanatory variables in the model. These variables represent the player's individual performance in the NFL. It is expected that linemen salaries will be highly influenced by their success on the field. For example, success in sports is often rewarded with increased playing time. Therefore, the variables *Games Played* and *Games Started* are expected to be positively correlated with salary. One's salary is also affected by his ability to perform his job duties. For offensive linemen such duties include preventing the other team's defense from sacking the quarterback and helping the offense gain a first down. Effective blocking is the most useful way to achieve this goal. Ineffective blocking is represented by the number of sacks allowed by the offensive linemen. If the defense successfully penetrates the offensive line and reaches the quarterback, the play typically results in a loss of yards. Consequently, the offense now has one less play and farther to go to obtain the ten yards required for a first down. A lineman's ability to prevent sacks in a given season is represented by the variables *Sacks Allowed* and *Yards Lost by Sack*. Penalties also result in a loss of yards. A holding penalty or illegal use of the hands, arms or body results in a loss of ten yards. A false start is penalized with a loss of five yards. The following variables capture a lineman's penalty history: *Total Penalties, Penalty Yards, False Start* and *Hold*. Given the consequences of sacks and penalties, all six of these performance variables are expected to negatively impact salary.

Data Description

This data set consists of performance data, player characteristics and salary figures for starting offensive linemen in the NFL spanning the 2000 to 2010 regular seasons. A starting offensive lineman was determined by any player whose games played equaled the number of games started. Player characteristics and performance statistics came from various online sources including the official NFL website, ajc.stats.com, and Pro-Football-Reference.com. The majority of salary information came from USAToday.com. Due to the absence of a salary cap during the 2010 season, salary data for this timeframe is difficult to obtain and will come from different sources on a team-by-team basis if available[7]. There are a total of 1,233 observations in this dataset containing detailed information on 360 unique offensive linemen. Each observation contains data on an individual offensive lineman in a given season. Table 2 contains summary statistics for each explanatory variable in the dataset.

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[7] The old collective bargaining agreement (CBA) did not require teams to report salaries to the National Football League Players Association (NFLPA) in the same way it does today; therefore, the primary data source has dried up in some cases (Kevin Quinn).

Table 2: Summary Statistics

Variable	Mean	Standard Deviation	Minimum	Maximum
Weight	313.371	15.856	234	375
NFL Experience	6.655	3.059	1.000	19.000
First Round Pick	0.25	0.43	0	1
Second Round Pick	0.20	0.40	0	1
Third Round Pick	0.13	0.33	0	1
Undrafted	0.15	0.35	0	1
Games Played	14.49	3.15	1	16
Games Started	14.49	3.15	1	16
Total Penalties	4.38	2.95	0	17
Penalty Yards	31.85	21.93	0	169
False Starts	2.32	2.17	0	13
Holds	1.46	1.42	0	8
Sacks Allowed	3.85	2.82	0	17
Sack Yards Allowed	24.44	19.30	0	114
Base Salary	1,444,888	1,381,025	0.00	12,690,000
Signing Bonus	1,412,875	2,591,551	0.00	16,000,000
Other Bonuses	382,421	1,035,596	0.00	12,217,280
Total Salary	2,819,742	2,686,887	277,778	20,200,000
Symmetry	97.858	2.312	74.568	99.765

The average starting offensive lineman in the NFL earns $2.8 million dollars. Orlando Pace, starting left tackle for the St. Louis Rams, earns the highest salary. In 2008, this number one, first round draft pick earned $20.2 million dollars. Note that the salary distribution is not normal. Graph 1 illustrates that it is highly skewed to the left. In reference to draft selection, it is important to note that 25% of the offensive linemen in this dataset were drafted in the first round, 20% in the second round and 13% in the third round. Fifteen percent of the offensive linemen were undrafted.

Graph 1: Salary Distribution of Starting Offensive Linemen in the NFL

Of the 16 regular season games, the average offensive lineman played in and started 14.5 games. To qualify for inclusion in the dataset, an offensive lineman had to have at least started in one regular season game, establishing an acceptable range for *Games Played* and *Games Started* from one to 16. The decision to include only starters in this model was made in an effort to decrease the variance in salary and productive statistics, including total penalties and sacks. In order to have all the necessary performance statistics, an offensive lineman needed at least one year of experience in the NFL to quality for the study. Ray Brown of the Washington Redskins and Bruce Matthews of the Tennessee Titans were the most experienced linemen with 19 years in the league. The average offensive lineman had approximately six and a half years of experience, which is consistent with the expected length of an NFL player's career according to Bloomberg Businessweek (2011).

A characteristic of particular interest in this study is the size of the offensive linemen. Given their job description—protecting the quarterback or ball carrier from massive defensive players—the offensive linemen must be equally enormous. Due to high levels of muscle mass in professional athletes, researchers, including Berri, Humphreys and Simmons, typically use Body Mass Index (BMI) as a measure of an athlete's size. Body Mass Index combines a player's size and strength in the following ratio: weight divided by height-squared, the sum multiplied by 703 (What Health?). The average BMI of an adult male ranges between 20 and 25. A BMI between 25 and 30 classifies as overweight and a BMI above 30 labels a person obese. The average offensive lineman in this dataset had a BMI of 37.669, falling into the obese category. Mike Schneck, center for the Pittsburgh Steelers, was the smallest offensive lineman with a BMI of 30.9 (234 lbs.), and Chris Dishman, offensive lineman for the Arizona Cardinals, was the largest offensive lineman with a BMI of 46.9 (375 lbs.). While increased muscle mass in male athletes naturally increases their BMI, given the recent health concerns for overweight offensive linemen, BMIs of this magnitude may be a cause for some concern. On the other hand, researchers from Michigan State University suggest that it may be necessary to recalculate the normal, overweight and obese thresholds based on athlete and non-athlete populations. Ode, Pivarnik, Reeves and Knous (2007) proposed setting the upper limit for a normal BMI at 27.9. Furthermore, the team of researchers specifically identified football linemen as extra large individuals and concluded that their appropriate BMI is around 34.1, which is still below the average linemen's BMI in this dataset. Given the uncertainty surrounding male athletes and BMI, this research will use weight as a proxy for size. The average offensive lineman weighs 313 pounds.

The explanatory power of a player's physical attractiveness on salary is another area of concentration in this research. Using facial symmetry as a measure of physical attractiveness, the average lineman has a symmetry reading of 97.858, approximately 10% above the national average, classifying offensive linemen as very attractive individuals. With a symmetry reading of 99.86, Brett Romberg, an undrafted center who received $649,680 in 2008, was determined to be the most attractive lineman. These numbers appear inconsistent with expectations since Simmons, Berri, VanGilder and O'Neill (2011) and Hamermesh and Biddle (1994) showed that more attractive individuals receive salary premiums over their less attractive peers. Moreover, Polumbus' symmetry reading makes him technically more attractive than any of the quarterbacks in the aforementioned research, including Tom Brady.

Also included in the dataset are six measures of negative performance for offensive linemen. For each player, there are statistics on the total number of penalties, false starts and holds, the number of penalty yards, the number of sacks allowed and the total number of yards lost due to a sack. On average, an offensive lineman was penalized four times for an average of 32 lost yards. The offensive linemen averaged 2.3 false starts and just 1.5 holding penalties per season. In an average season, the offensive linemen gave up almost four sacks for a loss of 24.4 yards. However, the ranges for each of these variables are large, indicating that their means may be heavily influenced by the players with little playing time and consequently fewer penalties. For example, one player committed 169 yards in total penalties, while another allowed 17 sacks in a single season.

Results and Discussion

Table 3 shows the log-linear regression results based on 1,233 observations of starting offensive linemen in the NFL. This regression took into consideration season, individual performance statistics, experience and non-productive variables such as facial symmetry and weight. The Adjusted R^2 for this regression was 0.2243 signifying that 22.43% of the variation in salary is explained by the variables in the model. The Durbin Watson hypothesis test and graph of the model's residuals indicate that there is no serial correlation in the model. The DW statistic was 1.983, which is statistically close to 2 and there was no pattern identified in the graph of the residuals. The Variance Inflation Factors (VIF) show that there is a high degree of multicollinearity between the season dummy variables, as well as weight and weight-squared. However, these variables will be left in the model because they make theoretical sense. Omitting them may cause bias in the model. Finally, the significance of the Chi Square hypothesis test shows that the model suffers from heteroskedasticity, which suggests that there may be omitted variable bias. This result is not surprising given the large dispersion in salary along the line. To correct for this, ACOV was added to the regression. See Table 6 and 7 in Appendix A.

Table 3: Log-Linear Regression – Parameter Estimates and t-Statistics

Variable	Parameter Estimate	t-Statistic
2001 Season	0.861	1.35
2002 Season	0.726	1.14
2003 Season	0.794	1.24
2004 Season	0.851	1.33
2005 Season	0.792	1.23
2006 Season	1.027	1.60
2007 Season	0.964	1.50
2008 Season	1.175 *	1.83
2009 Season	1.014	1.58
Games Played	0.048 ***	5.71
NFL Experience	0.109 ***	11.82
Symmetry	0.021 *	1.91
Total Penalty Yards	-0.002 *	-1.69
Sack Yards Allowed	-0.003 *	-1.90
First Round Draft Pick	0.442 ***	7.29
Weight	-0.022	-0.55
Weight^2	3.47×10^{-5}	0.54
Center	0.034	0.36
Guard	0.120	1.36
Tackle	0.408 ***	4.79

*Significant at 10% level; **Significant at 5% level; ***Significant at 1% level

The results indicate that the more games an offensive lineman starts, the higher salary he earns holding everything else constant. More specifically, for every additional game played in the previous season, an offensive lineman will see a 4.8% increase to his current salary. This result follows the expectation that coaches want their best players in every game, and therefore;

the number of games played is indicative of a player's perceived skill level, which is ultimately represented in his salary as supported by the human capital theory.

The human capital theory also supports the fact that offensive linemen drafted in the first round receive a salary premium over their fellow linemen either drafted in a lower round or undrafted. A player drafted in the first round is perceived to be one of the most skilled and knowledgeable new players on the market. As expected from theory and prior research on the NBA, these players are duly compensated for their talents. In this regression, a first round draft pick receives a 44.2% salary premium.

However, in contrast to Berri, Brook and Schmidt's NBA research and Berri, Humphreys and Simmons' (2011) research on the offensive line, which concluded that negative performance had no impact on salary, these new results suggest that negative performance actually hurts a lineman's salary. The results indicate that the summation of total penalty yards and sack yards allowed against one's quarterback negatively impact salary. For every additional penalty yard committed by an offensive lineman, his salary is decreased by 0.2%. Similarly, for every additional sack yard allowed against the quarterback, an offensive lineman sees a 0.3% decrease to his salary.

Experience also matters. With every additional year of experience, an offensive lineman's salary increases by 10.9%. There was no significant turning point for experience identified in this model. In previous offensive linemen research, Berri, Humphreys and Simmons (2011) found that the turning points for offensive linemen ranged from 9-12 at various quantiles. The average experience level of an offensive lineman in this dataset was 6.7 years with a standard deviation of 3.05, which puts the average turning point just out of reach of one standard deviation.

Consistent with other NFL research, the results indicate that tackles receive salary premiums, specifically 40.8%, over other positions on the line. There are a couple theories supporting this conclusion. First, depending on the handedness of the quarterback, one job of a tackle is to protect the quarterback's blind side. Given the importance of the quarterback in leading the entire offense, ensuring his safety may be perceived as the most important job of the entire line, a duty falling primarily to the tackle who is responsible for sealing off the outsides. Second, given the significance of the tackle's job, this position often receives the most attention. NBA researchers observed that player evaluation relies heavily on visual observation, i.e. scoring, rather than analysis of performance statistics. Scoring in the NBA may be equated to shutting down the massive defensive end on the opposing team who is attempting to rush the outside and attack the quarterback[8].This highly visible play may contribute to a tackle's salary premium.

As for the impact of facial symmetry on the salary of an offensive lineman, the results indicate that symmetry is significant at the 10% level. Therefore, offensive linemen are rewarded for their physical attractiveness regardless of their performance on the field. More specifically, for every additional degree of facial symmetry, as measured by Symmeter, an offensive lineman sees a 2.1% increase to his salary. This result violates both instrumental rationality and common perceptions of offensive linemen. First, the significance of symmetry suggests that team management considers more than just one's observed performance when making salary decisions. The consideration of physical attractiveness may be regarded as an impractical determinant of salary as it has no impact on a lineman's ability to do his job (i.e. protect the quarterback). Second, as previously mentioned, offensive linemen are known for their obese

[8] The defensive end is typically the fastest, most athletic player on the defense. As a result, he usually has the most sacks, making him a quarterback's worst nightmare.

frames and mean facades. However, this result suggests that not only is the average offensive lineman 10% more attractive than the average male, but he earns a 2% salary premium over his less attractive teammates on the line. While this result is less than the salary premium of quarterbacks at 11.8%, it does suggest that offensive linemen may hold some sort of leadership role on the team and they do receive a certain amount of media exposure, for which they are duly compensated. Additionally, while an offensive lineman's size was of particular interest in this study weight was found to be insignificant suggesting that the size of an offensive lineman as no impact on his salary.

Given the wide salary dispersion in the model, a quantile regression technique was implemented. A quantile regression compensates for any outliers and allows comparisons and conclusions to be drawn about players who are more similar to one another on the salary scale. Quantile regressions can be used to compliment and or improve on Ordinary Least Squares regressions, like the first one presented in this paper. The results of this regression are found in Table 4.

Table 4: Quantile Regression Model – Parameter Estimates and t-Statistics

Variable	25th Quantile	50th Quantile	75th Quantile
NFL Experience	0.161 *** 17.02	0.150 *** 11.11	0.077 *** 5.64
Games Played	0.0442 *** 4.72	0.064 *** 5.52	0.034 *** 3.03
Symmetry	0.019 1.41	0.039 *** 2.34	0.024 * 1.75
Center	0.281 *** 2.82	0.114 1.15	0.034 0.41
Guard	0.204 *** 2.65	0.246 *** 2.75	0.283 ** 3.27
Tackle	0.526 *** 4.92	0.565 *** 5.91	0.543 *** 7.13
Total Penalty Yards	-0.003 *** 02.18	-0.001 -0.66	-0.001 -0.33
Sack Yards Allowed	-0.002 -1.13	-0.004 -1.47	-0.002 -1.20
First Round Draft	0.512 *** 5.70	0.420 *** 5.14	0.369 *** 5.25
Weight	0.023 0.49	0.019 0.30	-0.067 -1.25
Weight^2	-0.000 -0.46	-0.000 -0.28	0.000 1.29

*Significant at 10% level; **Significant at 5% level; ***Significant at 1% level

The results indicate that like the log-linear regression, experience, the number of games played, and being a first round draft pick remain significant variables in the determination of salary at the 25th, 50th and 75th quantiles at the 1% level. While tackles consistently earn the highest salary premium across all quantiles, the results of this regression also suggest that guards receive a salary premium over the generic offensive lineman at the 25^{th}, 50^{th} and 75^{th} quantiles. Only at the 25^{th} quantile do centers see a significant salary premium above generic offensive linemen. Interestingly, the 25^{th} quantile results indicate an earnings hierarchy that conflicts with Berri, Humphreys and Simmons' research which found the following hierarchy: tackles, guards, centers, offensive linemen. On the other hand, this result suggests that tackles earn the highest salary premium (52.6%), followed by centers (28.1%), then guards (20.4%), and finally the generic offensive linemen *ceteris paribus*. Despite this result, the average salaries by position support the earnings hierarchy previously presented by Berri, Humphreys and Simmons. It is possible that the result is being skewed by the high percentage of centers in the 25^{th} percentile. The average salary of a center in this dataset was $3 million and the predicted value of the mean at the 25^{th} percentile was $992,418.

Regarding the performance statistics, only total penalty yards was significant at the 1% level in the 25^{th} quantile. This suggests that observed individual performance has no impact on salary determination for players in the upper half of the earnings scale. On the other hand, the results indicate that symmetry matters most for the top 50% of offensive linemen. This result may be explained by the fact that the "best" offensive linemen earn the highest salaries, get the most playing time and consequently more face time. As previous research suggests, management awards players for being more physically attractive when they have a higher probability of being in the limelight.

Conclusion

The results of this research find that both productive and non-productive factors explain the variation in an offensive lineman's salary. At the lower ends of the salary spectrum, observed performance, as measured by negative productivity, is significant to the determination of a player's salary from year to year. At the upper end of the spectrum, non-performance related factors, such as facial symmetry, become significant. Weight, however, was found to be insignificant across all quantiles. This suggests that team management is not concerned with an offensive lineman's weight, but rather his performance on the field and how he presents himself in the media spotlight.

Table 5: Salary Dispersion of Offensive Line Positions

	Mean	Minimum	Maximum
Center	2,355,624	101,606	15,007,150
Guard	2,542,798	172,000	17,006,240
Tackle	2,543,130	284,000	18,000,000

Given the salary dispersion across the line (see Table 5), it is possible that the offensive line is not the cohesive unit it was initially perceived to be. In fact, conflict amongst linemen is possible as certain players on the lower end of the salary scale rely heavily on their individual performance and the ability of the line to work together, while their higher paid teammates have less pressure to perform. Furthermore, the observed earnings hierarchy may contribute added conflict amongst teammates. In 2010, Michael Oher and Marshal Yanda of the Baltimore Ravens lined up on the right end of the Ravens offensive line. At tackle, Oher earned $15.7 million. To his right, Yanda, at guard, earned $1.7 million. The $14 million gap separating these two players could understandably be a high point of contention and lead to decreased cooperation between teammates. In order to increase camaraderie across the line, team management may need to look into closing the gap between the linemen's salaries.

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APPENDIX A

Table 6: Statistical Tests for Serial Correlation

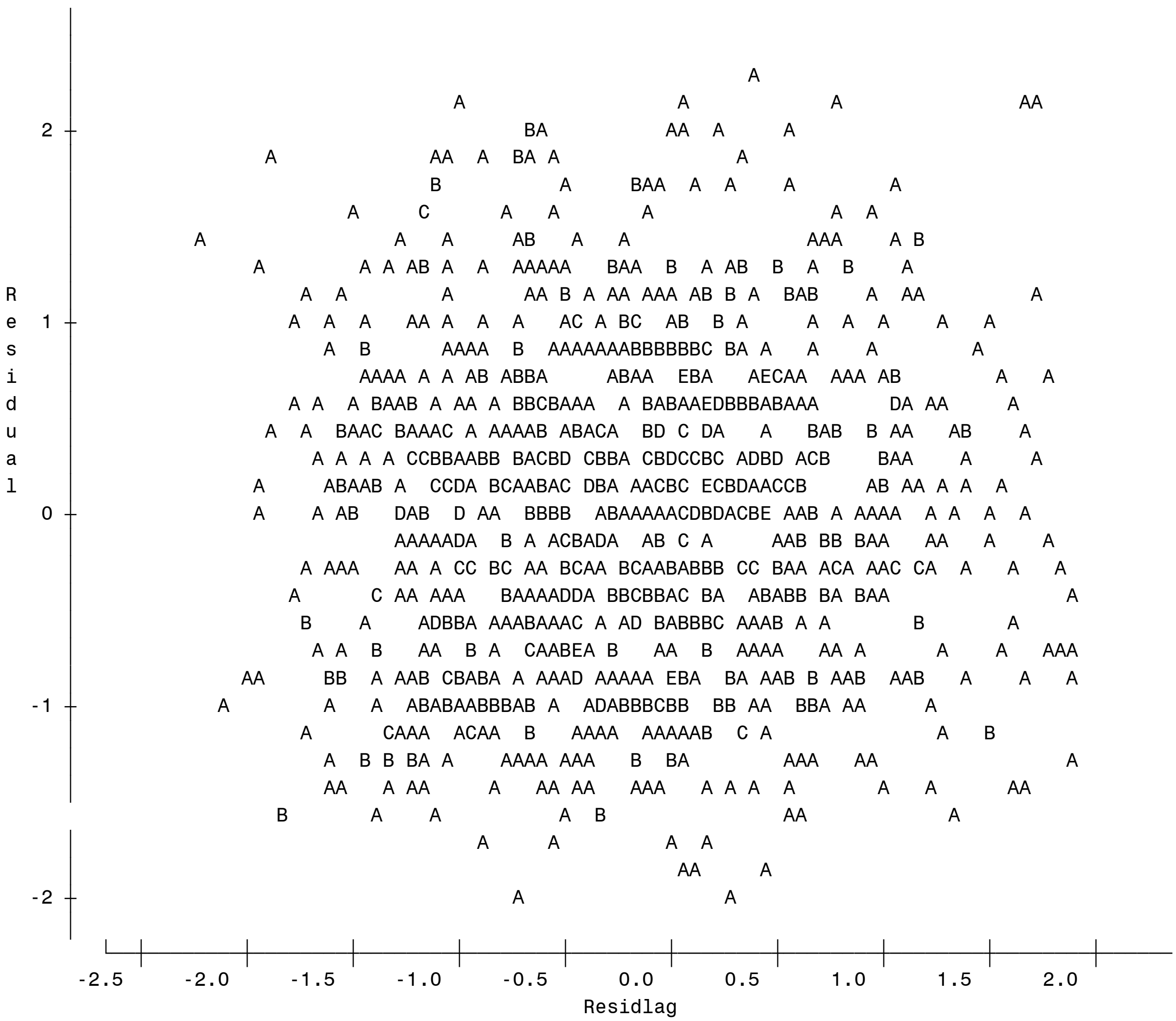
The REG Procedure
Model: MODEL1

Dependent Variable: lnsalary

Durbin-Watson D	1.983
Number of Observations	1124
1st Order Autocorrelation	0.009

The SAS System 12:44 Friday, April 6, 2012 9

Plot of resid*Residlag. Legend: A = 1 obs, B = 2 obs, etc.



DW ~ 2
No pattern in the graph of the residuals

Thus, no serial correlation

Table 7: Statistical Tests for Heteroskedasticity

The REG Procedure

Model: MODEL1
Dependent Variable: lnsalary

Test of First and Second

Moment Specification

DF	Chi-Square	Pr > ChiSq
168	**217.32**	**0.0062**

The Chi Square was significant at the 1% level, so there is heteroskedasticity in the model.

To fix: Added ACOV to the Proc Reg

The REG Procedure
Model: MODEL1
Dependent Variable: lnsalary

Number of Observations Read	1233
Number of Observations Used	1124
Number of Observations with Missing Values	109

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	20	236.08768	11.80438	17.23	<.0001
Error	1103	755.58659	0.68503		
Corrected Total	1123	991.67427			

Root MSE	0.82766	R-Square	0.2381
Dependent Mean	14.43606	Adj R-Sq	0.2243
Coeff Var	5.73331		

Parameter Estimate

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	--Heteroscedasticity Consistent- Standard Error	t Value	Pr > |t|
Intercept	1	13.48157	6.42101	2.10	0.0360	6.48967	2.08	0.0380
year01	1	0.86058	0.63748	1.35	0.1773	0.34560	2.49	0.0129
year02	1	0.72554	0.63838	1.14	0.2560	0.34362	2.11	0.0350
year03	1	0.79388	0.63825	1.24	0.2138	0.34538	2.30	0.0217
year04	1	0.85057	0.63912	1.33	0.1835	0.34628	2.46	0.0142
year05	1	0.79248	0.64300	1.23	0.2180	0.35512	2.23	0.0258
year06	1	1.02728	0.64110	1.60	0.1094	0.35406	2.90	0.0038
year07	1	0.96387	0.64242	1.50	0.1338	0.35502	2.72	0.0067
year08	1	1.17497	0.64346	1.83	0.0681	0.35600	3.30	0.0010
year09	1	1.01411	0.64359	1.58	0.1154	0.35804	2.83	0.0047
gplag	1	0.04795	0.00840	5.71	<.0001	0.00812	5.90	<.0001

yearinleagu	1	0.10853	0.00918	11.82	<.0001	0.01047	10.37	<.0001
Symmetry	1	0.02126	0.01112	1.91	0.0561	0.01166	1.82	0.0684
penydslag	1	-0.00208	0.00123	-1.69	0.0915	0.00124	-1.68	0.0930
sackydslag	1	-0.00277	0.00146	-1.90	0.0578	0.00159	-1.74	0.0814
draft1	1	0.44221	0.06068	7.29	<.0001	0.06221	7.11	<.0001
weight	1	-0.02230	0.04076	-0.55	0.5845	0.04073	-0.55	0.5842
weight2	1	0.0000347	0.00006387	0.54	0.5870	0.00006421	0.54	0.5890
center	1	0.03413	0.09588	0.36	0.7219	0.09168	0.37	0.7097
guard	1	0.12002	0.08836	1.36	0.1747	0.08892	1.35	0.1774
tackle	**1**	**0.40786**	**0.08518**	**4.79**	**<.0001**	**0.08429**	**4.84**	**<.0001**