Team Success and Personnel Allocation under the National Football League Salary Cap

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Introduction

The National Football League (NFL) is an especially interesting market in which to study labor economics. The salary cap rule of the NFL — that each team is permitted the same fixed amount of money to spend on its player personnel — allows for controlled comparison between teams and players. Because team success depends on the combined output of its players, knowing on whom to spend these limited dollars is valuable information. Managers and coaches analyze a player's statistics, discuss him with another manager, watch film of his past performance, and hold special workout sessions to determine his potential contribution to the team's success. If a player is deemed beneficial, he will be offered a contract or a trade will be made to obtain his services. This contract awards a fixed salary and may include one or more of several types of bonuses—signing, performance-based, option, etc. Most bonuses are amortized across the length of the contract and added to the salary to obtain a player's "cap value". Cap value refers to the amount a player is paid that counts against the salary cap during a given season. I consider this figure to be the dollar equivalent of the player's expected output and contribution to team success.

From a managerial perspective, the goal is to pay top talent as little as possible to maximize overall team talent. Recognizing rising performers, signing them to a cheap initial contract, and then capitalizing on their rise to stardom a major method of achieving such results. This requires expertise and managerial skill; each NFL team must allocate its salary cap wisely to be competitive. There is no way around the salary cap; all money paid to the players must, at some point, count against the team's cap. Therefore, it is the responsibility of the personnel manager to build a combination of players that will maximize wins during any given season.

A major aspect of a team manager's duties is to figure how much his team should spend on *types* of players. For example, some teams choose to spend more on their defensive backs, some on skill position players, some on kickers, etc. Frequently teams will build around a core of three to five players whom the front office deem exceptional. By looking at the amounts a team spends on types of players, I analyze how these types contribute to team success. Specifically, I search for a trend among recent NFL teams that would indicate the marginal effect of any additional dollars allocated to a specific type of player. I posit that there are one or more types of players that are more conducive to a team's success; how I define "type" and "success" are crucial elements of my study upon which I expound in Section II.

Because the NFL is a multi-billion dollar industry and winning greatly improves a team's overall brand and profitability, this study provides insight to those interested in the game and also to team managers and owners. Though undoubtedly teams have conducted similar studies to attempt to find a trend and potentially increase wins, no economic literature I have found has researched this topic in the manner in which this paper is conducted. In this study, I employ economic theory in evaluating the concept of skilled allocation of labor capital in the NFL market. The next sections include a survey of related literature and my theoretical structure. The explanation of the data set and the empirical model follow that, trailed by the results of, conclusion to, and further avenues for research generated by the model.

I. Review of Literature

Karl Einolf (2004) analyzes two commonly studied markets in sports economics: Major League Baseball (MLB) and the NFL. Citing the different financial structure in each of these leagues, he finds a significant difference in the level of franchise efficiency between the two leagues. The revenue sharing system in the NFL yields a more egalitarian distribution of revenue than in MLB, causing a more competitive market. Since revenue is the major determinant of a team's payroll, teams invariably carry a payroll comparable to their competitors. As a result, "MLB franchises, with little revenue sharing and no salary cap, tend to be less efficient than NFL franchises" (2004).

Einolf writes an excellent survey of the inherent differences between a freer market like MLB and a strictly regulated market like the NFL. Because MLB teams are allowed to limitlessly spend on player personnel, issues such as market size, the owner's financial capacity, and fan attendance have a very strong impact on payroll size and team success. Larger markets bring higher revenue potential to the ownership, allowing for more liberal and extensive spending on player personnel. In the NFL, under its conventions of profit sharing and a strict salary cap, the aforementioned issues do not have as large an impact. Most NFL teams spend roughly the same amount on their players and share revenues to compensate for varying attendance figures. Einolf presents a compelling case for the use of a salary cap and establishes that the financial capabilities of the team does not have a large effect on the success of an NFL franchise. Because each team can afford the same caliber of players, the differences between teams lie in the management of its salary cap and the combination of personnel.

Hendricks et al. (2003) analyze the impact of uncertainty on the hiring process in the NFL. Their models generate hypotheses about the relationship between hiring patterns and productivity. There are various estimates of individual NFL success, which suggest statistical discrimination and option value influence choice in this market. Managers tend to rely on prior knowledge and statistics in choosing what types of contracts to offer. Essentially, this study supports my idea that teams do not necessarily know if a contract offer will benefit the team, but they must sign talent based on perceived potential value to the team. The general manager's skill and foresight in recognizing the most beneficial combination of players eventually determines, to a large extent, the success of the team.

Lewis (2003) provides a excellent framework and approach to the idea that *the more a team spends on its players the more success it will have.* While he analyzes a different market in that of MLB, his maxim—that spending fewer dollars and allocating them wisely can be more advantageous to a team's success—also applies to the NFL. He studies the Oakland Athletics, which, as of late, have enjoyed a great deal of success in the form of regular-season wins and playoff appearances. The Athletics' payroll is substantially smaller than the payrolls of most of its competitors due to the small revenue stream in Oakland and the ownership's strict obedience to their objective of spending less money wisely to get more.

However, because NFL teams spend nearly the same amount on their player personnel, any parallel between Lewis's work and my study must be altered. In MLB, if a team can spend less and still consistently compete with the teams that spend three to four times as much as do they, it must be due to their increased efficiency in the allocation of their money. Efficient allocation of resources works yields success just as a large payroll; solid performance in either category can spell success in MLB. However in the NFL, teams are bound to operate within the salary cap. Their ability to succeed as a team—namely their ability to win more games than the others—can only be achieved through efficient allocation. In spite of these differences, Lewis's concept remains the same: it is not necessarily *how much* money a team spends but *on whom* it is spent that can yield more wins.

Leeds et al. (2001) show that free agency and the salary cap brought profound changes to the level and nature of players' salaries in the NFL. They also outline that football players are evaluated by position-specific statistics, supporting the grouping of players by position for comparison purposes. They analyze data for specific positions to demonstrate how free agency and the salary cap affect compensation, positing that it has increased competition among the labor supply, the players. This article gets to the heart of the performance-by-position stance that I take; because there is a limited amount of money to be paid to the players, they have become more competitive. The salary cap has made an efficient market out of NFL by solving many of the issues inherent to a market such as MLB: spending is limited and allocation and performance are now integral.

This selection of research yields three main ideas. First, each team's success is dictated by its management, not necessarily by the size of its payroll. The major disparity between teams that win and teams that lose is the difference in the efficiency of salary cap allocation. Second, in the NFL, spending more money — relative to other teams under the salary cap — will not itself yield more wins. Third, the efficiency of the NFL and its labor market has caused a more competitive labor supply and has increased the leverage that management possesses over the players. These ideas indicate a high level of managerial control over their teams and highlights the vitality of finding the right combination of players.

II. Theoretical Structure

The human capital theory states that laborers will receive a wage that corresponds to their projected output. This projected output is based on past performance and potential for success. Theoretically, teams should be spending the most on the players that help them the most. I analyze which *types* of players yield the most success. Because the variety of positions in football contribute differently to a team's ability to win, I group the specific positions into categories or "types". This analysis flows directly from the defined nature of each position as it relates to the team's ability to win (the positional duties are outlined in Table 1).

Table 1 - Player Types as Spending Inputs

Position	Positional Duties
Offense	
Lineman	Block defensive players from tackling the Quarterback, open gaps in the defense through which the Runningback can run
Quarterback	Manage and control on-field performance of the team, throw ball to offensive players, hand off to offensive players
Runningback	Run the ball toward the endzone, usually from a handoff
Tight End	Perform duties as a Lineman and a Wide Receiver, usually quite versaitle, athletic, and big
Wide Receiver	Run the ball toward the endzone, usually on the receiving end of a pass from the Quarterback
Defense	
Cornerback	Prevent the Wide Receivers from catching the ball, pursue and tackle the ball carrier on long-range plays
End	Break past the Offensive Line and reach the Quarterback or Runningback before he passes the line of scrimmage
Linebacker	Pursue and tackle the ball carrier on short- to mid-range plays
Safety	Last line of defense, also used to cover Wide Receivers and Tight Ends out on deep passing plays
Tackle	Break up the Offensive Line to disrupt the ability of the Quarterback and Runningback to make a successful play
Special	
Kicker	Kick field goals and extra points; one of the primary scorers on the team
Punter	After an unsuccessful offensive stint, punt the ball to put the other team as far away from the endzone as possible

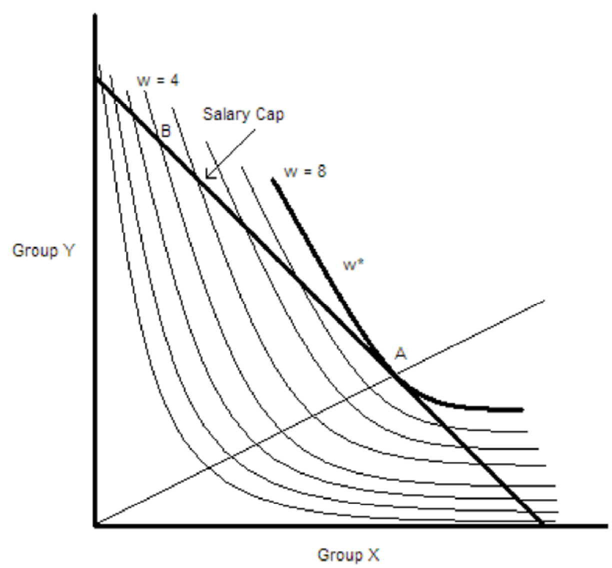
Within each position there are various sub-types of players. For example, there are middle, strong-side, and weak-side linebackers within the LB position. I do not differentiate between these types; their jobs are roughly the same and for the purpose of this study are considered one group. The same is done when grouping the other positions. I consider the expenditure in dollars of each team on each type of player (as defined in Table 1) to be representative of the skill and ability of that group of players. Higher spending on a type of player should indicate a stronger set of players at that position. If that stronger group of players helps yield team success, sending a higher amount on them will prove beneficial.

I measure levels of team success by the final number of wins a team achieves in a particular season. To assist in the explanation of the theory of this paper, I employ a theoretical model that is related to the standard isoquant and budget constraint model in microeconomics. Because the isoquant model "shows all the possible combinations of inputs that yield the same output", it allows for concise analysis of the theory inherent to the salary cap constraint (Pindyck, 2001, 179). It is best understood in graphical form, and the graph presented in Figure 1 can be related to any team in the NFL in any given season. For the sake of this theoretical explanation, assume there are two groups of players: "Group X" and "Group Y".

The x-axis is the dollar figure that the team spends on its Group X players; the y-axis represents the same for Group Y players. The line stretching from the y-axis to the x-axis is the salary cap, naturally considered the budget constraint in this model. Since every position falls under either the Group X or Group Y classification, the salary cap constrains all team spending on personnel and forces the money to go to one of the groups. Every team in the NFL is allowed to spend up to that point without going a dollar over. Each isoquant—specifically, the downward sloping, convex curves—represents a number of wins that a team can attain in a season.

The isoquants are convex because the nature of the two groups: Group X and Y players are imperfect substitutes. As the amount spent on Group X increases, the amount spent on Group Y decreases. A team entirely composed of either group would fail to win because each group is necessary. Each isoquant that is further from the origin represents one more win than the last. The isoquants approach *w**, the highest number of wins achievable by that team during that season. The points at which the isoquants intersect the salary cap limit are individual spending amounts that a team could choose. For example, point B indicates a possible spending level for the example team. It corresponds to a small expenditure on Group

Figure 1 - IsoWin Model



X and a large expenditure on Group Y. Because this is not a very efficient spending system, it intersects the isoquant that corresponds to only 4 wins. NFL teams play 16 games in a season, and 4 wins is not very successful. If they spent at point A, however, they will win 8 games. The team in this graphical example, while winning a mediocre 8 games, represents exactly how allocating away from Group Y and toward Group X will yield an increase in wins. The points where the isoquants intersect the salary cap line (with the exception of the tangency point of *w**) are inefficient and therefore correspond to fewer wins. As the wins increase, the optimal spending point is reached where isoquant *w** is tangent to the salary cap line. The next isoquant, *w**+1 (or w=9) is not pictured as it would be beyond the salary cap limit and therefore unattainable for that team.

However, in this case, starting at point B we see that Group X players are more conducive to winning games, due to specific vital skills needed to play their positions. These skills relate directly to a team's ability to win. A dollar spent on a wide receiver may be more valuable to the team than the same dollar if it were spent on an offensive lineman because the wide receiver can directly advance the ball down the field. In Figure 1, this is indicated by the slight slant of the line from the origin down toward the x-axis. Spending a slightly higher amount on Group X will yield more wins. I hypothesize that spending more on specific types of players will directly affect a team's ability to win.

III. Data

I use data for each of the 32 NFL teams over the 2000-2004 seasons published at USAToday.com. This amounts to 158 individual team seasons due to the expansion in 2002 from 31 to 32 teams. I have the full salary cap information for each team; for each team and for each season, every player that received a salary or bonus is included. For each player I have data detailing position, salary, the amount of signing and other bonuses, the amortization of these bonuses across different seasons, the type of these bonuses, and the "cap value" of every player. I standardize the dollar amount into 2004 dollars to control for the effects of inflation, also scaling the dollar figures to be in millions of dollars to create more understandable variables. As is evident by looking at the data (found in Table 2 – Positional Data), there is wide variation between teams and what they spend on each group of player. Because these data suggest that there is no rubric by which all teams are comprised, my hypothesis—that there are groups of players on whom spending money proves more beneficial—can be tested.

IV. Empirical Model

I employ an OLS regression with my dependent variable as the number of regular season wins for each team in each season. I treat the same franchise's different seasons as independent of each other; i.e. the data for the 2002 Minnesota Vikings have no impact on that of the 2003 Minnesota Vikings, amounting to 158 individual and unique observations. My independent variables are the dollar figures each team spends on types of players, specifically designated in this regression by position (as outlined in Table 1). Another variable, "Unused", measures the dollar amount that was not spent by the team but *could* have been spent—i.e. seasonal salary cap minus total team payroll. My equation for the first regression is as follows:

$$Wins = \alpha + \beta(\$CB) + \gamma(\$DE) + \delta(\$DT) + \varepsilon(\$K) + \zeta(\$LB) + \eta(\$OL) + \theta(\$P) + \iota(\$QB) + \kappa(\$RB) + \lambda(\$S) + \mu(\$TE) + \nu(\$WR)$$

To control for multicollinearity, I follow the first regression with two similar regressions, each time excluding variables that were shown to be the most insignificant in the first regression.

Table 2 - Independent Variables (in Millions of Dollars)

Postion	Minimum	Average	Maximum	Standard Deviation
Offense				
Line	$5.080	$11.625	$22.094	$3.361
Quarterback	$1.223	$5.503	$16.590	$2.767
Runningback	$0.970	$5.306	$12.619	$2.165
Tight End	$0.734	$2.464	$7.088	$1.050
Wide Receiver	$2.853	$6.790	$15.163	$2.275
Defense				
Cornerback	$1.369	$6.203	$18.798	$2.795
End	$1.189	$6.086	$14.626	$2.618
Linebacker	$2.502	$7.536	$19.175	$3.039
Safety	$1.705	$4.066	$9.902	$1.599
Tackle	$0.634	$5.161	$12.516	$2.199
Special				
Kicker	$0.056	$0.855	$2.383	$0.478
Punter	$0.069	$0.700	$4.115	$0.435
Other				
Unused	$0.055	$12.142	$32.590	$6.388

V. Results

The regression supports the idea first established by Lewis (2003) that there are certain positions which are consistently more conducive than others to winning. These benefit a team insofar that increasing spending on those players is statistically shown to increase the ability of a team to win. Significant results are obtained by this study, also indicating that there is a level of managerial control over the success of a NFL team as posited by Hendricks et al. This model does not test the research of Leeds (2001) or Einolf (2004) research, but does rely heavily on the theory each establishes. The regression results are found in Table 3.

Table 3: Positional Spending, Star Power, and Wins

	Regression 1		Regression 2		Regression 3	
	B	Sig.	B	Sig.	B	Sig.
Constant	4.207	0.046	4.377	0.010	3.969	0.005
Offense						
Line	0.091	0.206	0.093	0.185	0.096	0.165
Quarterback	0.048	0.580	0.044	0.598	-	-
Runningback	0.136	0.218	0.136	0.210	0.144	0.180
Tight End	0.400	**0.080**	0.399	**0.076**	0.419	**0.060**
Wide Receiver	-0.010	0.929	-	-	-	-
Defense						
Cornerback	-0.025	0.785	-	-	-	-
End	0.129	0.174	0.121	0.189	0.127	0.163
Linebacker	0.032	0.692	-	-	-	-
Safety	0.021	0.894	-	-	-	-
Tackle	-0.085	0.443	-0.089	0.414	-	-
Special						
Kicker	1.345	**0.012**	1.320	**0.008**	-1.313	**0.017**
Punter	-1.282	**0.031**	-1.247	**0.024**	1.397	**0.004**
Adjusted R-Square	0.058		0.082		0.074	

The adjusted R-Square values for each of the regressions indicate that I do not explain the entire picture. I plan to improve the values in further research. Each "B" value is the coefficient. For example, increasing spending by $1 million on a team's Tight Ends will create 0.400, 0.399, and 0.419 more wins, respectively, according to regressions 1, 2, and 3. The other coefficients can be interpreted similarly. The results indicate that the Kicker, and to a lesser extent, the Tight End, have a large degree of influence on a team's ability to win and that a Punter does not. Because the Kicker is responsible for scoring more points than any other player, he is valuable. In spite of this, the average team spent, over the last five seasons, only $854,000 on its kickers.

Surprisingly the players whom many believe to be integral and on whom much attention is focused—the Quarterback, Wide Receivers, and even Linebackers—did not produce significant results. This could be because spending on these players is not necessarily completely correlated with talent; that is, teams may overspend or pay bargain prices on their talent at these positions. Also to be considered in explaining the model is the potential for injury. Players always receive a paycheck, injury or not. If a star player receives a $10 million cap value and then gets injured, my model does not test for that. Injuries are common among WR, QB, LB, and other more physical positions. The K, P, and to a large extent the TE are positions that do not experience as many injuries, and therefore, teams can essentially get what they pay for when they buy their athletes.

VI. Conclusion

This study supports the hypothesis that there are types of players that are beneficial to a team's ability to win and types of players who do not contribute as much. Lewis's *Moneyball* (2003) is aligned with this study. It also finds that there is no one "recipe for success" in the NFL and each team could combine any number of different ways and can still succeed. The study indicates that there is a high constraint placed on managerial latitude by the salary cap and it is up to the executor of the team to allocate his money wisely. This position is taken by Hendricks (2003) and Leeds (2001) and is supported by this study.

I must acknowledge that my model may be incomplete for two reasons. First, the timing of signing bonuses and other types of bonuses may influence the size of a team's salary cap in a given year. This is to say that a team can pay a player $10 million in one year, only attributing $1 million to salary and $9 million to a performance-bonus. If the player signs a contract for two years, he will make $10 million against the cap in the first year and only $1 million in the second year. This averages out to $5.5 million per season, but does not count in the salary cap as such. As such, teams may not be "starting from scratch" each year because team expenditure for each season depends largely on the expenditure during other seasons.

Second, wins may be a suspect dependent variable. As the number of wins in a season is finite, the average amount of wins is always going to be 8. I am not sure if this causes any real problem, but it could confound my results. For this reason, in my continued research, I will attempt to implement a playoff variable to the equation. Possible other methods include forming different groups not based on position to see how they affect wins. For example, I can analyze how spending a high amount on three to five "superstars" and less on the rest of your team influences wins.

REFERENCES

Boulier, Bryan L; Stekler, H O. "Predicting the Outcomes of National Football League Games." *International Journal of Forecasting*, 2003, *19*(2), pp. 257-70.

Einolf, Karl W. "Is Winning Everything? A Data Envelopment Analysis of MLB and the NFL." *Journal of Sports Economics*, 2004, *5*(2), pp. 127-51.

Hadley, Lawrence; et al. "Performance Evaluation of National Football League Teams." *Managerial and Decision Economics*, 2000, *21*(2), pp. 63-70.

Hendricks, Wallace; DeBrock, Lawrence; Koenker, Roger. "Uncertainty, Hiring, and Subsequent Performance: The NFL Draft." *Journal of Labor Economics,* 2003, *21*(4), pp. 857-86.

Leeds, Michael A; Kowalewski, Sandra. "Winner Take All in the NFL: The Effect of the Salary Cap and Free Agency on the Compensation of Skill Position Players." *Journal of Sports Economics*, 2001, *2*(3), pp. 244-56.

Lewis, Michael. *Moneyball.* New York: W. W. Norton & Company, 2003.

Pindyck, Robert S., and Rubinfeld, Daniel L. *Microeconomics*. Upper Saddle River: Prentice Hall, 2001.

USAToday.com. "NFL Football Salaries Database." 2000-2004, as of 11/11/05. http://asp.usatoday.com/sports/football/nfl/salaries/default.aspx