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

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I. INTRODUCTION

A pre-Super Bowl article published in the *Wall Street Journal* labels the personnel spending and business model of the Seattle Seahawks, the National Football Conference representative to Super Bowl XL, as "extraordinary." Much to the surprise of the author, "they plucked their entire defense from the discount bins" and still made it to the Super Bowl (Walker 2006). Seattle spent far less on its defense in comparison not only to their Super Bowl opponents, the Pittsburgh Steelers, but compared to every single other NFL team. They valued "underpriced or underappreciated players who were as long on character and potential as they were short on intimidating size and athleticism" (Walker 2006). The success of this previously underemployed and ineffective method confounded many familiar with the game. The consensus among scholars of the game *was* the old adage that "defense wins championships" but Seattle had intentionally bought its defense at the Dollar General. This paper analyzes the heart of this issue: can a team really influence its success based on how it allocates its salary to its players? Is there a "natural" allocation strategy inherent to the NFL and its teams that yields a successful team? In short, does spending more money to upgrade the talent of certain positions yield more team success?

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 and is available to the team, he will be offered a contract. 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 in each individual season.

A major aspect of a team manager's duties is to figure how much his team should spend on *types* of players in order to build the best combination of players most conducive to success. I posit that there are one or more types of players that are more conducive to a team's success; I explain "type" and "success" in Section III. 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 pattern among recent NFL teams that would indicate the marginal effect of additional dollars allocated to a specific type of player.

I employ economic theory in evaluating the allocation of skilled human capital in the NFL. 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 in an attempt to find a pattern and potentially increase wins, I have found no economic literature

that has researched this topic in the manner in which this paper is conducted. The next sections include a survey of related literature and my theoretical structure, the IsoWin model. 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.

II. REVIEW OF LITERATURE

Lewis (2003) provides an excellent framework for this study, approaching 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 Major League Baseball (MLB), his maxim—that spending fewer dollars and allocating them wisely can be more advantageous to a team's success—may also apply 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. Oakland provides a refreshing contrast to the New York Yankees, another perennially successful team that spends roughly four to five times more on player personnel than Oakland. The clear reason Oakland is as successful: they wisely allocate their payroll. In other words, they are getting more for their money.

NFL teams spend nearly the same amount as each other on their player personnel, so any parallel between Lewis's work and the NFL must be changed to fit this difference. 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 yields success in the same way as a large payroll; solid

performance in either category brings 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.

Einolf (2004) writes an excellent survey of the inherent differences between a relatively free 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 in that league. Larger markets bring higher revenue potential to the ownership, allowing for more liberal and extensive spending on player personnel. In the NFL, under its convention of profit sharing and its 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. As a result, teams in the NFL cannot compete like the powerhouse baseball teams such as Yankees. Einolf presents a compelling case for the use of a salary cap and establishes that the financial capability 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.

Karl Einolf (2004) analyzes these two markets—MLB and the NFL—citing the different financial structure in each of these leagues. He finds significant difference in the level of franchise efficiency—characterized by profit and revenue—between the two leagues. The NFL operates under a revenue sharing system which distributes the ticket sales revenues among all of

the teams in the NFL, causing small market teams to have revenue comparable to their large-market counterparts. This allows more teams to hire for the top players, bringing more competition into the entire 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, p. 128).

On a more individual level, Hendricks et al. (2003) analyze the impact of uncertainty on the hiring process in the NFL, generating hypotheses about the relationship between hiring patterns and productivity. There are various estimates of individual success used by the managers, but the authors suggest that statistical discrimination—determining a player's potential output by his previous statistics—influences choice in this market. Teams sign talent based on perceived potential value to the team, which is primarily based on a player's statistical past. Players who perform the best are paid the most; the more a player is paid, the more conducive to team success he should be. Spending an extra million dollars on a specific position leads to an upgrade in personnel; a player's ability is represented by his contract size.

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 analyze data for specific positions to demonstrate how free agency and the salary cap increased competition among the labor supply of players within each position. Essentially, they confirm that players who perform better receive higher salaries. Leeds et al. demonstrate that players are mainly competitive with other players in their position; they are concerned with how much their immediate peers are making, not necessarily how much is being paid to their teammates. This further indicates that players,

because they are evaluated and compensated based on position-specific statistics, are in fierce competition with each other.

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. Spending more money relative to other teams under the salary cap will not necessarily yield more wins. Second, 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. Because spending is controlled, teams have a tighter grasp on the player pool in determining contract length and amount. Third, better players get paid more; players receive their salaries based on statistics measuring past performance. Spending extra on a certain position should increase the quality of that input. Simply increasing the size of one player's contract will not increase talent, but upgrading through higher pay should increase the overall contribution of that position to team success. These ideas indicate a high level of managerial control and highlight the vitality of finding the right combination of players.

III. 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 and the definition of other player "types" are outlined in Table 1.

Table 1 - Player Types as Spending Inputs

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
Other	
Unused	The amount teams do not spend (salary cap minus payroll)
Top3	The three highest-paid players on the team: the superstars
Top5	The five highest-paid players on the team: the stars

Within each position there are various sub-types and qualities of players. For example, there are middle, strong-side, and weak-side linebackers within the Linebacker 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 starting Linebackers typically are paid more than the reserves, but since the reserves play a key role in preparation and special teams (and their style of

play is consistent with the other Linebackers), they 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 unit of players. Higher spending on a type of player should indicate a stronger set of players at that position. There are varying levels of skill among players and therefore it is possible to increase team skill in a certain area if spending in that area is increased to purchase more valuable and higher-performing players. If that stronger group of players helps yield team success, spending a higher amount is beneficial. Managerial skill enters the situation when determining who is worth a higher salary; all players will tell you that they are worth a huge contract, so it is the manager's prerogative to find who is actually a superior player and worth the extra money.

Another type of player I study is the "superstar," or the player that demands a high salary, receives a high degree of public notoriety, and supposedly, produces game-winning play. If these superstars actually produce winning plays, a team's spending on the superstar players should be rewarded with more success. Each team has a handful of players who are paid much more than the rest of their teammates; are they worth the money?

I measure levels of team success in three different ways: by the final number of wins a team achieves in the regular season, whether it is eligible for the playoffs, and its yardage both attained on offense and yielded on defense. First, the number of wins a team achieves is a fair barometer for fan happiness, the quality of the team, and its success against other teams. It is typically what many fans, media, and team personnel analyze to gauge a team's capability. However, there are several drawbacks to its use as a dependent variable. It does not take into account success in the playoffs, which is the ultimate goal of many teams and fans. While only

the best teams make the playoffs, it does not measure, for instance, the playoff failure of a team with 15 of 16 regular-season wins. Econometrically speaking, using wins as a dependent variable indicates that a team with 15 regular season wins is much more successful than a team with only 11, while the team with 11 wins may end up winning the Super Bowl and the team with 15 wins could lose in the first round.

Wins also do not consider the closeness of games; two teams with 10 wins each may not be just as good as each other. One team may have most of its wins in close games with large margins in its losses. A different team with 10 wins might have a large winning margin and small losing margin. While this last argument may sway one to consider using winning margin instead of wins, I choose wins because more people care about wins than winning margin. If winning margin were used, it would have a similar drawback: it would not tell you the actual success of a team in quantifiable terms. After all, the game is about winning, not coming close!

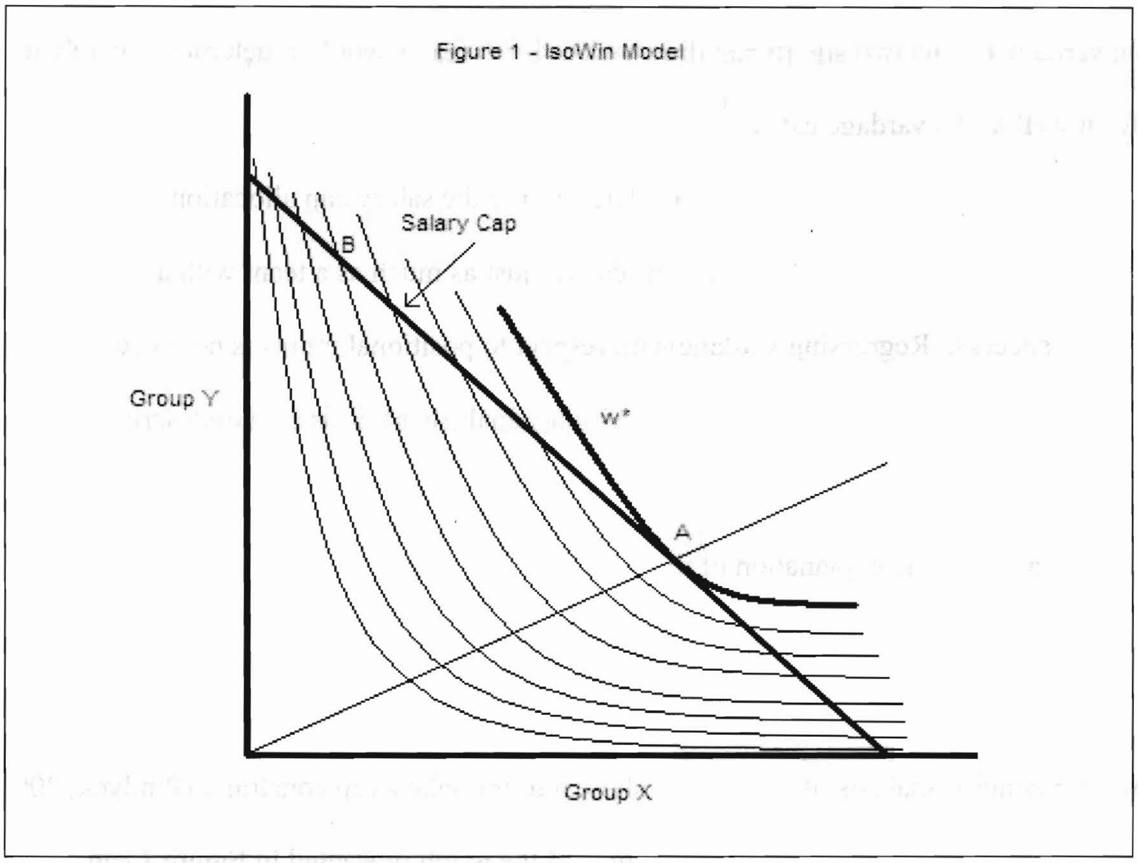
The second dependent variable I use is playoff appearance. Many teams consider playoff success more important than regular-season success, and I would agree: the playoffs are more important to teams and fans and must be considered. However, it is hard to mathematically quantify success in the playoffs without arbitrarily assigning numbers to the different playoff rounds. To choose the econometrically sound method, I assign a dummy variable to an appearance in the playoffs. This is less than ideal because a team that barely makes it into the playoffs is considered the same as the Super Bowl champion. However, it is much easier to understand than an arbitrary quantification of the playoff rounds.

The final dependent variable I use is yardage. This is perhaps the most econometrically and numerically reliable variable because it is the most accurate representation of a team's strengths and weaknesses. Yardage is incremental in a more micro-oriented way than wins;

instead of assigning one win randomly to increase a team's "success" by a specific percent, why not use yardage to gauge the exact quality of different aspects of a team's success? After all, yardage measures exactly how well a team performed on offense and defense. Nonetheless, using yardage entails two significant drawbacks. First, teams would much rather win than perform well in the yardage category. In other words, it does not necessarily confront the goal of a team's manager—to win games—when determining the salary cap allocation. Second, a team with a high degree of offensive success might win just as much as a team with a high degree of defensive success. Regressing yardage with respect to positional inputs is not necessarily a good measure of overall team success but rather a micro-analysis of different nondescript facets of success.

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.

Suppose success in this situation is measured by the number of wins. 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 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 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 B 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 4 more games with the same amount of spending. This 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 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.

A limitation to the IsoWin model is that, unlike in most industries where firms can choose to produce at a higher output, firms in the NFL are limited to 16 wins per season. The number of wins constitutes a zero-sum game; that is, there are only a finite number of wins that a team can achieve in a season. For every win there must be a loss, and therefore teams can only differentiate between each other up to a certain point. Even though 16 wins is nearly impossible to achieve—only one team has ever accomplished such a feat—the standard isoquant and budget constraint model cannot be universally applied to a zero-sum situation such as this.

A second limitation of this model is that it assumes that there *are* still unexploited opportunities in the market. Assuming that there is room for improvement and that some teams simply use the "correct" or "optimal" method to allocate salary, the tests should show significant coefficients. However, no significant coefficients might indicate that the market is, in fact, efficient and that teams are not neglecting some universal law of salary cap allocation. Simply put, insignificant results may indicate an exploitable and relatively obvious strategy employable by team managers.

IV. DATA

A. Dependent Variables – Measures of Team Success

I use three measures of team success: regular season wins, playoff appearances, and yardage. I use the number of wins a team achieves in the regular season. Each team plays 16 games per season; the "Wins" variable is simply the numerical value of wins attained in a season for each team. The next dependent variable considers a team's participation in the playoffs. I set up a dummy variable that records "0" if a team does not qualify for one of the 12 playoff spots per season, with "1" counting a playoff appearance.

Finally, yardage most completely measures a team's specific output over the course of a season, insofar as it aids in understanding the consistency of a team's output in a given facet of production. I use four types of yardage: Offensive Passing, Offensive Rushing, Defensive Passing, and Defensive Rushing. Offensive Rushing is the number of yards in a season that a team obtains by running the ball on offense. Defensive Passing is the number of yards yielded by the defense to the opposing team's offensive passing game. So, the more offensive yards and fewer defensive yards, the better a team performs. The yardage data are summarized in Table 2.

Table 2 - Yardage (per NFL season)

Type of Yards	Average	Maximum	Minimum	Std. Deviation
Offensive Rushing	1,841	2,774	1,062	336
Offensive Passing	3,305	5,232	1,946	560
Defensive Rushing	1,837	2,637	970	310
Defensive Passing	3,312	4,295	2,423	379

B. Independent Variable – Salary Cap Allocation by Player Type

I use salary data for each of the 32 NFL teams over the 2000-2004 seasons published by USAToday.com. This amounts to 158 individual team seasons due to the expansion in 2002 from 31 to 32 teams. They list the full salary cap information for each team and for each season with every player that received a salary or bonus included. For each player they list 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. As is evident by looking at the data found in Table 3, there is wide variation between teams in what they spend on each group of players.

Table 3 - 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
Top3	$7.546	$15.707	$29.279	$3.459
Top5	$10.790	$22.320	$37.467	$4.321

*Total team expenditure by position or group

I also measure "superstar" output by taking the figures from two groups for each team: the group of the three highest paid players and the group of the five highest paid players. Adding together their salaries, the groups "Top3" and Top5" are created. As is apparent, there is again a great range involved with these two variables, indicating no clear pattern in the NFL allocation to superstars. Because these data suggest that teams are not following a specific pattern in team spending, my hypothesis—that there are groups of players on whom spending money proves more beneficial—is tested.

C. Empirical Method

I employ an OLS regression to test the effect of salary cap allocation to player type on team success. 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. While this may not necessarily be the

case—that a team's previous season may impact its current season—for the purposes of this study, I consider them independent to simplify the analysis. My independent variables are the dollar figures each team spends on the different types of players, specifically designated in this regression by position (as outlined in Table 1) and by size of salary (star power). 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. I use regular season wins, playoff appearance, and yardage as dependent variables yielding three sets of regressions. I report four regressions for each set.

V. Results

The regressions, as a whole, provide modest support for the idea first established in the MLB market by Lewis (2003) that there are certain types of players on whom spending more money is more conducive to team success than spending on other types. The results of the study also support the position of Hendricks et al. who point to a high level of managerial control over the success of an NFL team. This model does not test the research of Leeds (2001) or Einolf (2004), but does rely heavily on the theory each establishes. Overall, however, the results are indicative of relative efficiency and balancing of spending. Because most of the positions did not have significant or large coefficients, it indicates that teams generally are doing everything they should be doing—there is no obvious pattern that indicates disparity among teams strictly based on spending philosophy.

A. Wins

Starting with all of the positional variables in the first regression, I eliminated the most insignificant variables in the subsequent regressions and added "Unused" and the Star Power

variables. The regression results are shown in Table 4. I report four regressions to represent the improvements on the original model of player position versus the dependent variable. By eliminating certain variables and adding others, the regression changes enough to allow for a different interpretation and analysis. Each time, the adjusted R-square improved; however, the values are quite small. This indicates that wins are not explained very well by the player-type I

Table 4: Positional Spending, Star Power, and Wins

	DEPENDENT VARIABLE: Wins							
	Regression 1		**Regression 2**		**Regression 3**		**Regression 4**	
	B	Sig.	B	Sig.	B	Sig.	B	Sig.
Constant	4.207	0.046	4.377	0.010	7.135	0.005	9.915	0.000
Offense								
Line	0.091	0.206	0.093	0.185	0.036	0.653	0.075	0.354
Quarterback	0.048	0.580	0.044	0.598	-0.011	0.900	0.014	0.889
Runningback	0.136	0.218	0.136	0.210	0.093	0.403	0.117	0.300
Tight End	**0.400**	**0.080**	**0.399**	**0.076**	**0.378**	**0.091**	**0.372**	**0.093**
Wide Receiver	-0.010	0.929	-	-	-	-	-	-
Defense								
Cornerback	-0.025	0.785	-	-	-	-	-	-
End	0.129	0.174	0.121	0.189	0.080	0.403	0.095	0.336
Linebacker	0.032	0.692	-	-	-	-	-	-
Safety	0.021	0.894	-	-	-	-	-	-
Tackle	-0.085	0.443	-0.089	0.414	-0.141	0.216	-0.131	0.244
Special								
Kicker	**1.345**	**0.012**	**1.320**	**0.008**	**1.213**	**0.015**	**1.146**	**0.026**
Punter	**-1.282**	**0.031**	**-1.247**	**0.024**	**-1.312**	**0.018**	**-1.111**	**0.046**
Other								
Unused	-	-	-	-	-0.070	0.137	**-0.123**	**0.020**
Top3	-	-	-	-	-	-	**0.647**	**0.046**
Top5	-	-	-	-	-	-	**-0.593**	**0.030**
Adjusted R Square	0.058		0.082		0.090		0.108	

define and/or by the method I use. Each "B" value is the coefficient. Looking at the Regression 1, spending an extra $1 million—assuming there is $1 million to spend—to upgrade the quality of the Runningback leads a team to expect 0.136 more wins. With almost the same degree of increase, spending that same $1 million on the Defensive Ends leads to 0.129 more wins.

Applying this to the other regressions, increasing spending by $1 million on a team's Tight Ends will create 0.400, 0.399, 0.378, and 0.372 more wins, respectively, according to each of the four regressions. In the first regression this means that a team that has $1 million to spend

to upgrade the quality of its Tight Ends can expect to win 0.40 more games as a result. This interpretation changes slightly in the other regressions with the addition and omission of certain variables. For example, in the third regression, because I control for teams that had various amounts unspent under the cap, spending a million on Tight Ends as opposed to Safeties can expect to win 0.378 minus 0.021 or 0.357 more games. Spending an extra $1 million on one input requires it be taken from another input.

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. Teams that spent more on their Kickers and Tight Ends and less on their Punters won more regular season games from 2000-2004. In spite of this, the average team spent during those seasons only $854,000 on its Kickers. Spending just $1 million more on the Kicker would yield between 1.345 in the first regression and up to 1.213 minus a negative 1.312 or 2.525 more wins (if allocated away from the Punter in the third regression).

Regression three yields an important finding: there appears to be little connection between how much a team spends and its overall ability to win. The very small and slightly significant coefficient for "Unused" indicates that for each $1 million a team does not spend, it loses .07 games. Or, more simply, a team has to spend over $14 million under the cap to lose one game. This finding is mitigated somewhat in regression four. Its coefficient is -0.123 which would indicate that teams would have to spend only $8 million under the cap to lose a game because of their shortfall in spending.

Perhaps the most unexpected and, consequently, interesting finding of this set of regressions is that of the effect of high-priced players on wins. Spending an extra million dollars on a team's three highest-paid players yields .647 more wins. This is a relatively high coefficient

(and high level of statistical significance) and indicates the importance of having three team leaders to whom many dollars are devoted. Equally as surprising is the coefficient for the five highest-paid players; at -0.593, it indicates that those players who are fourth and fifth in the ranking must not be as important as their salary would indicate.

B. Playoff Appearance

Parallel to the use of regular-season wins to measure success, playoff appearance is a tangible measure of team success and an issue with which many teams and fans are concerned. Analyzing playoff appearance as a dummy—or 0,1—variable allows for a simple and mathematically sound regression. The results indicate that, once again, the Kicker is the most underpaid player on any team (Table 5). Looking at Regression 5, spending an extra $1 million to upgrade the quality of a team's kicker leads to an increase of the marginal probability of making the playoffs by 0.253. In contrast, spending that same $1 million on the Punter leads to a decrease of -0.146 in the marginal probability of making the playoffs. In every regression,

Table 5: Positional Spending, Star Power, and Playoffs

DEPENDENT VARIABLE: Playoff Appearance (dummy variable)	Regression 5		Regression 6		Regression 7		Regression 8	
	B	Sig.	B	Sig.	B	Sig.	B	Sig.
Constant	-0.197	0.559	-0.300	0.232	0.215	0.622	0.432	0.347
Offense								
Line	0.016	0.178	0.015	0.176	0.006	0.648	0.011	0.402
Quarterback	0.015	0.297	0.013	0.323	0.002	0.892	0.006	0.716
Runningback	**0.038**	**0.034**	**0.039**	**0.026**	0.031	**0.090**	0.035	**0.065**
Tight End	0.012	0.740	-	-	-	-	-	-
Wide Receiver	-0.005	0.764	-	-	-	-	-	-
Defense								
Cornerback	-0.011	0.475	-0.008	0.558	-0.016	0.289	-0.010	0.511
End	**0.037**	**0.016**	**0.037**	**0.013**	**0.031**	**0.049**	**0.033**	**0.047**
Linebacker	-0.010	0.437	-0.009	0.467	-0.017	0.210	-0.015	0.305
Safety	-0.014	0.588	-	-	-	-	-	-
Tackle	-0.006	0.748	-	-	-	-	-	-
Special								
Kicker	**0.253**	**0.003**	**0.249**	**0.003**	**0.255**	**0.002**	**0.235**	**0.007**
Punter	-0.146	0.122	-0.153	**0.082**	-0.164	**0.063**	-0.140	0.116
Other								
Unused	-	-	-	-	-0.012	0.152	**-0.017**	**0.068**
Top3	-	-	-	-	-	-	0.077	0.152
Top5	-	-	-	-	-	-	-0.069	0.128
Adjusted R Square	0.076		0.097		0.104		0.106	

higher spending on the Kicker is shown to contribute more than spending on any other type of player. The Defensive End and Running Back both prove to be significant and positive in this scenario, indicating that they influence an appearance in the playoffs. This is not all too surprising when compared with the "Wins" regressions as both positions have positive coefficients and relatively low significance-values in the first set of regressions.

C. Offensive and Defensive Yardage

The dependent variable set that differs significantly from the other two is Yardage. The results are quite insignificant, and indicate that there is a high degree of ambiguity as to how exactly a player's salary can be used to measure his output and contribution to team success. Yardage is the most precise representation of team success in a facet of the game—e.g. high Offensive Passing yardage over the course of a season indicates a very good passing game. However, the results show that, while offensively a team's inputs and spending is reasonably correlated with its output, defensively, it is relatively impossible to predict yardage based on defensive player spending. The results are shown in Table 6.

Table 6: Positional Spending and Yardage

	B	Sig.	B	Sig.
DEPENDENT VARIABLE:	Passing Yardage Gained		Rushing Yardage Gained	
Offense				
Constant	2609.711	0.000	1532.968	0.000
Line	-5.850	0.652	8.757	0.273
Quarterback	**48.804**	**0.003**	-7.036	0.473
Runningback	27.591	0.170	14.117	0.253
Tight End	48.068	0.247	**67.981**	**0.008**
Wide Receiver	**33.837**	**0.083**	0.336	0.978
Adjusted R Square	0.081		0.037	
DEPENDENT VARIABLE:	Passing Yardage Allowed		Rushing Yardage Allowed	
Defense				
Constant	3,558.131	0.000	1,744.929	0.000
Cornerback	7.390	0.517	14.906	0.109
End	-15.662	0.188	0.008	0.999
Tackle	-2.305	0.870	11.441	0.319
Linebacker	-10.078	0.332	**-14.669**	**0.084**
Safety	-26.655	0.172	12.677	0.424
Adjusted R Square	-0.002		0.009	

These results indicate that, most predictably, spending on a team's Wide Receivers and Quarterbacks correlates positively to a team's passing yardage. Spending an extra $1 million on each yields 48 and 33 more passing yards per season, respectively. So, reallocating $5 million to $10 million to the passing game is most efficiently spent on those two positions and can be expected to lead to up to 480 more passing yards in a season. A team's spending on Tight End—presumably as a blocking force to clear a path for the Running Backs—increases its running game significantly. Spending an extra $1 million on the Tight Ends increases the running game by 67 yards per season per million.

The only significant variable on the defensive side is the positive effect (negative yardage) the Linebackers have on the defensive rushing game. Because yardage is not desirable on the defensive side, the Linebackers prevent 14 yards per million per season. The generally weak results on the defensive side are due to the fact that there are many defensive spending strategies that are either all successful or equally unsuccessful when considering all the teams in the league. Because there is no clear pattern in defensive spending that leads to higher defensive output in terms of yardage, teams such as the Seattle Seahawks have enjoyed much success with their "bargain bin" defense as teams that spend most of their free money on defense paying for top-notch players.

These results indicate that my assessment of team spending based on Yardage is weak and that the yardage data are not explained well by salary cap inputs. Instead of pointing to a problem surrounding the efficiency of the NFL—that spending on Running Backs is not immediately the most significant aspect of a high number of rushing yards in a season—it is more sensible to see that teams already are spending efficiently. There is no clear pattern of unintelligent teams versus intelligent teams when considering the regressions based on yardage.

D. Summary

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 teams may overspend or pay bargain prices on their talent at these positions and that balances itself out. 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 the Quarterbacks, Wide Receivers, and Linebackers and other more physical positions. What is most likely the case, however, is that teams are already spending what they should be spending and that there is efficiency in the market. If teams win just as much as they lose and that fact does not depend on spending on these major positions, then it is reasonable to conclude that they are already spending what they should be spending. However, the Kicker, Punter, and to a large extent the Tight End are positions that do not experience as many injuries and are considered sort of necessary nuisances by some teams. In other words, they may not have experienced scrutiny in spending patterns, and therefore, teams essentially have not determined the efficient means of compensation for these positions.

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 manager of the team to allocate the owner's money wisely. This position is taken by Hendricks (2003) and Leeds (2001) and is supported by this study.

Avenues for further work should include a more comprehensive analysis of the timing of signing bonuses and other types of bonuses. Because teams can choose to offer many different types of bonuses, this 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.

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