Do Salaries Match Results?

An Analysis of National Hockey League General Managers' Efficiency in the Unrestricted Free Agent Market

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Abstract

Prior to the 2004-2005 National Hockey League season, the owners of the league locked out the players preventing the season from being played. A large percentage of organizations throughout the league were losing substaintial amounts of money, and the owners insisted on a new collective bargaining agreement to create a larger stream of revenues. The new collective bargaining agreement created many salary restrictions that the leagues general managers did not have to adhere to in previous collective bargaining agreements, such as a salary cap. This paper analyzes the efficiency level of general managers throughout the league after the lockout of the 2004-2005 season to see if organizations pay players for the statistics and attributes that most positively influence a team's overall regular season winning percentage. The results will show that general managers are not allocating their team's respective payroll efficiency during the 2005-2006 and 2006-2007 seasons.

I. Introduction

History was made in the National Hockey League during the 2004-2005 season. For the first time in the league's history, a captain from one of the franchises within the league did not hoist the Stanley Cup above his head to kiss the precious trophy, a revered traditional act celebrated for reaching the ultimate hockey player's dream of knowing their name would be carved into the Cup. Only once before in the history of the NHL had the Stanley Cup not been rewarded to the League's champion, that being the 1919 Stanley Cup finals between the Montreal Canadians and the Seattle Metropolitans due to a flu epidemic that crippled the two teams and prevented the series from being completed (Cosentino 5). But, the 2004-2005 season was the first time a labor stoppage prevented a champion from being crowned. Prior to the start of training camps in 2004, owners instituted a lockout of the players in an attempt to force the NHL Players' Association to agree to a new collective bargaining agreement that would increase league revenues. According to *Forbes Magazine,* NHL organizations lost an estimated 123 million dollars in the 2002-2003 season (Staudohar 24-25). The result of the owner's decision to lockout the players was the elimination of the entire 2004-2005 season since the players were willing to forgo their individual season salaries to ensure that their own respective demands were met in the negotiations, and similarly, owners were willing to yield the gate and concession revenues from not operating 41 regular season home games. The lockout dragged on until the summer of 2005, when both the Players' Association and the NHL's Board of Directors agreed to a compromise that would resume NHL games in the 2005-2006 season.

The new collective bargaining agreement implemented a hard salary cap and various adaptations in the rules of the game itself forcing general managers to change how to allocate their franchises' payrolls, as compared to the freedom they had enjoyed prior to the lockout in

terms of how much money they could spend in unrestricted free agency. Even if a franchise's market size would allow for a payroll higher than the hard cap of the new collective bargaining agreement, all 32 NHL teams would now be restricted to the upper ceiling of the salary cap. For example, the two New York franchises, the New York Rangers and the New York Islanders, are forced to remain under the same upper limit as a smaller market franchise such as the Columbus Blue Jackets of Columbus, Ohio. In addition to the salary cap ceiling, the new collective bargaining agreement instigated a salary floor to prevent teams from attempting to earn a profit through keeping the franchise's costs low by assembling a team of low salary players with inferior skills. For the 2007-2008 season, the cap ceiling and floor were approximately 44 million dollars and 28 million dollars respectfully (NHL.com). Additionally, to revitalize the market for hockey through the United States and Canada and to win back a portion of the fans that were lost due to the lockout, the NHL implemented a series of rule changes attempting to widen the appeal of the game. These rule changes centered on increasing the offensive production of the game including: larger offensive zones, the removal of the restriction on the two line pass, limitations on where goalies are allowed to play the puck, the implementation of a shootout after sudden death overtime, and increased power play time by cracking down on interference, holding, and hooking.

In my research, I will analyze how efficiently and effectively the general managers of the NHL have adjusted to the changes of the payroll system and to the game itself in their acquisitions of unrestricted free agents. The analysis will be split into two separate multiple regression models to capture the efficiency levels of the NHL's general managers. The first model will focus on the determinants of a franchise's overall regular season winning percentage. Then, to observe the NHL general managers' efficiency level in acquiring unrestricted free

agents, a multiple regression will be run to establish to what extent the independent variables of the model influence an unrestricted free agent's yearly salary after signing an NHL contract. To illustrate the exact levels of efficiency, the absolute value of the ratios of each independent variable's coefficient will be calculated to allow for a comparison of the ratios of the two models. This allows for the isolation of specific statistics and attributes to analyze the efficiency levels of the general managers after the 2004-2005 lockout. For example, if points scored per game gained positively influences a team's overall winning percentage twice as much as a team's average weight, but general managers are paying unrestricted free agents five times more for points gained per game than for the respective player's weight, an inefficiency exists in the unrestricted free agent market because general managers are not properly allocating their payrolls since they are paying unrestricted free agents larger salaries based on statistics and attributes that do not increase a team's overall regular season winning percentage to the same extent. In a perfectly efficient market, the absolute value of the ratios of each model's coefficients would be identical, implying that general managers are signing unrestricted free agents for the ideal salary based on a respective player's individual statistics and attributes.

Section 2 of the paper will discuss previous literature in Major League Baseball that influenced this research. After a description of the data utilized in the models in Section 3, Sections 4 and 5 will demonstrate explain the theory of the two multiple regression models and the results of these respective models. The paper will conclude in Section 6 with an analysis of the efficiency levels of general managers throughout the league after the introduction of the new collective bargaining agreement and the implementation of the rule changes followed by possible future research on the topic of the NHL's labor market.

II. Literature Review

MLB relies on statistical analysis to a much a greater extent than the NHL, thus producing a substantial amount of player performance literature that aided in the development of this paper. Michael Lewis' 2003 best selling novel, *Moneyball,* investigates how the general manager of MLB's Oakland Athletics, Billy Beane, most effectively ran the franchise, in terms of the team's number of wins, while utilizing one of the lowest team payrolls in the league. The model used by Beane demonstrates an increased dependence on the utilization of statistical analysis in evaluating potential players instead of a simple reliance on a professional scout's opinion and possibly biased report. Following the work of the legendary statistician Bill James, Lewis explains how Beane theorized that other general managers throughout the league were not efficiently paying for talent on the free agent market. Through a complex analysis of certain statistics that significantly impacted a team's wins in one season, the Oakland general manager was able to exploit the amateur entry draft, unrestricted free agency, and undrafted college free agents to obtain players who would increase the number of wins of the Athletics but who would receive salary levels well below league averages.

More influential in the development of this NHL free agent market efficiency model was the research performed by University of Clemson economists, Jahn Hakes and Raymond Sauer. Hakes and Sauer explored how Billy Beane was able to implement a "Moneyball" system of acquiring talent to develop a successful professional baseball franchise in the article, *An Economic Evaluation of the Moneyball Hypothesis.* Their research demonstrates how Beane's model shows how general managers throughout MLB valued certain statistics more than they should, based on what extent these respective statistics had on a franchise's number of wins in a season. For example, the two economists highlight how a statistic such as batting average can be

misleading since singles and home runs are given the same value in calculating the batting average statistic. In the words of Hakes and Sauer, "The batting average is a crude index. By weighting singles and home runs the same, it ignores the added productivity from hits of more than a single base. Much better is the *slugging percentage* (total bases divided by at-bats) in which doubles count twice as much as singles, and home runs twice as much as doubles" (Hakes 5). Hakes and Sauer also demonstrate that Billy Beane recognized a certain inconsistency in the statistical evaluation of professional and amateur baseball players and jumped on the opportunity to increase the performance of the Athletics by acting on other general managers' misguided evaluations of players. However, the two Clemson economists go on to show that the inefficiency that existed when Beane first developed the "Moneyball" system was eventually corrected as disciples of Beane were hired as general managers for other franchises around MLB. As a result, the spread of the "Moneyball" principle, brought about by the hiring of former aids to Beane, caused for the MLB free agent market to stop displaying prominent examples of organizations inefficiently overpaying for certain statistics, resulting in the correction of a large proportion of the efficiency problems in the labor market of MLB.

III. Statistical Data

The data used in this research will be taken from the 2005 and 2006 seasons for the winning percentage multiple regression model and from the 2001-2006 seasons, excluding the 2004-2005 lockout year, for the player salary multiple regression model. Unlike MLB, winning percentage in the NHL cannot be calculated by dividing the number of wins by the total number of games played. In the NHL, teams are awarded two points for a win and one point for an overtime loss or a loss in the shootout following overtime; two or three points can be awarded in a single game depending on the type of outcome. Therefore, the winning percentage dependent

variable is calculated by dividing the total number of points a team achieves by the total number of games played, 82. The winning percentage model will also take into account statistics that cannot be calculated on the player level since the data will exclude goaltenders from the model due to the fact that a goaltender's statistics significantly differ from the other five hockey positions.

Since player statistics vary from year to year, a three-year average for each unrestricted free agent will be utilized in determining which statistics and attributes most impact a player's unrestricted free agency contract. For the small minority of players who elect to sign in a European league during one or more of the three years prior to their unrestricted free agency contract, a maximum of one additional prior year will be utilized to calculate the player's three-year average. For example, Michal Rozsival signed an unrestricted free agent contract with the New York Rangers prior to the 2005-2006 season. However, the defenseman played the 2003-2004 campaign in the Czech Republic instead of the NHL (NHL.com). Since only NHL statistics are used in the model, Rozsival's three-year average will consist of the 2000-2001, 2001-2002, and 2002-2003 seasons. Yet if Rozsival had played both the 2002-2003 and 2003-2004 seasons in Europe, his three-year average would be compiled of only two years worth of statistics. Utilizing player statistics from more than three years back may bias the results of the model because of varying player improvement and decline over the recent years. Additionally, statistics achieved in any North American league besides the NHL, such as the American Hockey Association or the International Hockey League, will not be included in a player's statistics due to the varying degrees of competition from league to league. The models will only be comprised of NHL statistics to ensure that a competition factor will not play a role in the results and analysis of the model.

Under the new collective bargaining agreement, NHL players fall into seven categories in determining their labor market restrictions. Group I players cannot be offered contracts by any franchise other than the organization that drafted the player. Group II players are restricted free agents and can be offered a contract by opposing franchises, but the original franchise has the right to match any offer or, if not, receive draft pick compensation depending on the yearly salary of the contract. Group IV is the only other group of players who have restricted free agency. These players are classified as "defected" players, such as ones who sign to play in a European league while under a NHL contract. Group III, V, VI and UFA players all are classified as unrestricted free agents. This research will exclude group VI players since these specific players qualified for free agency because they had reached the age of 25 and had not played in more than 80 regular season NHL games. Only Group III, V, and UFA players will be used in the model because of the salary constraints players face before a player reaches unrestricted free agency including the salaries of players with restricted free agency, salary arbitration, and limits on entry-level contracts. Including the salaries of players who are not playing under an unrestricted free agency contract would significantly bias the results.

Player and team data will be weighted by the number of games played, where appropriate, to account for statistics that may be influenced by the amount of games a respective player plays. Height, weight, age, and career playoff games will not be weighted by the number of games played by a respective player. Lists of free agents, salaries and player data is compiled through NHL.com, ESPN.com, HockeyZonePlus.com, and USAToday.com, which provide the necessary yearly statistics for each team and player. The following summary statistics in *Table 1* illustrate the variables of the winning percentage and salary models.

Table 1:

Winning Percentage Model

Variable	Obs	Mean	Std. Dev.	Min	Max
Winning %	60	0.557	0.099	0.341	0.756
Points/GM	60	8.006	1.132	5.659	10.439
PIM/GM	60	14.819	2.266	10.024	18.768
AVGheight	60	73.178	0.502	72	74.39
AVGweight	60	205.076	4.241	196.78	216.13
Avgage	60	26.831	1.206	24.57	29.5
$Avgage^2$	60	721.305	65.005	603.685	870.25
Goals Allowed	60	237.3	29.851	183	304
FO %	60	0.499	0.018	0.459	0.538

Winning % = Team's overall regular season winning percentage
Points/GM = Total player points scored per game
PIM/GM = Total player penalties in minutes per game
AVGheight = Average team height
AVGweight = Average team weight
AVGage = Average team age
$AVGage^2$ = Average team age squared
Goals Allowed = Team's total number of goals allowed
FO % = Team's overall faceoff percentage

Salary Model

Variable	Obs	Mean	Std. Dev.	Min	Max
Salary	279	1,781,137	1,576,587	250,000	7,600,000
Points/GM	279	0.426	0.251	0	1.412
PIM/GM	279	0.843	0.606	0	4.718
Height	279	73.172	1.949	68	81
Weight	279	206.979	15.158	174	263
Age	279	31.660	3.432	24	44
Age^2	279	1,014.061	224.502	576	1936
Playoff Games	279	53.624	48.740	0	246

Salary = Player's yearly salary
Points/GM = Total points scored per game

PIM/GM = Total penalties in minutes per game
Height = Player's height
Weight = Player's weight
Age = Player's age
Age^2 = Player's age squared
Playoff Games = Number of career playoffs games played in

IV. Theory of the Models

The goal of this research is to demonstrate the efficiency levels of general managers in the NHL after the lockout-cancelled season of 2004-2005. A single regression model cannot illustrate how efficient general managers were following the drastic alterations to the game, both on and off the ice, in concordance with the new collective bargaining agreement. Therefore, I have developed a model that includes two separate multiple regressions, one for a team's overall regular season winning percentage and the other for a player's unrestricted free agent contract. Calculating the absolute value of the ratios of the two models' coefficients reveals to what extent one individual independent variable influences the dependent variable compared to the other independent variable in the coefficient ratio. In the winning percentage model, for example, the team's total points gained per game coefficient divided by the team's average height coefficient yields a ratio of 4.803, showing that points gained per game relatively influences a team's overall regular season winning percentage 4.803 times greater than does the respective team's average height. However, this does not illustrate that a team's total points gained per game is more influential on a team's overall regular season winning percentage than the team's average height. Points and height are measured in different units, which prevents a definitive conclusion from being stating on which independent variable influences winning percentage to a greater extent. The 24.639 coefficient ratio of a player's points per game played to a player's height demonstrates that after the lockout NHL general managers value a player's points statistic 24.639

times more than a player's height, as will be explained with other results in greater detail in the following section. The two multiple regression models constructed for the analysis of the efficiency levels of NHL general managers in the unrestricted free agent market are listed below.

$$\textit{Winning Percentage} = \alpha + \beta_1(\text{Points/GM}) + \beta_2(\text{PIM/GM}) + \beta_3(\text{AVGheight}) + \beta_4(\text{AVGweight}) + \beta_5(\text{AVGage}) + \beta_6(\text{AVGage2}) + \beta_7(\text{Goals Allowed}) + \beta_8(\text{FO \%})$$

$$\textit{Salary} = \alpha + \beta_1(\text{Points/GM}) + \beta_2(\text{PIM/GM}) + \beta_3(\text{Height}) + \beta_4(\text{Weight}) + \beta_5(\text{Age}) + \beta_6(\text{Age}^2) + \beta_7(\text{Number of Playoff Games Played In})$$

The first drafts of this model included many statistics that a common fan would not include in measuring the success of a player, such as the number of short-handed goals per game of the number of shots per game of a respective player. However, the large range of statistics caused for the structure of the first models to exhibit strong multicollinearity. For example, the overall regular winning percentage model included separate independent variables for even strength goals per game, power play goals per game, and short-handed goals per game. The issue of multicollinearity arises due to the nature of goal scorers in the NHL. A player the scores a large amount of even strength goals will most likely earn additional time on the power play allowing for more opportunities to score power play goals. This demonstrates the high correlation between the different types of goals scored. To remove the high correlation between independent variables, the model is now comprised of a much more basic set of statistics and attributes, such as utilizing the number of points per game a player gained, which includes all goals and assists no matter the situation of when the point was gained, instead of separate variables for each statistic. As the results and analysis in the next two sections will show, even though the NHL general managers are supposed to possess the best hockey minds in the world, the changes implemented after the 2004-2005 lockout show that these "hockey brains" do not

efficiently value players in the unrestricted free agency market as illustrated by the unequal absolute values of the ratios of coefficients from the two models.

V. Results

Tables 2, 3, 4, and *5* illustrate the results of the multiple regression analysis for both the team's overall regular season winning percentage and a player's unrestricted free agent contract and the absolute values of the coefficient ratios for the two models. *Table 2* displays the OLS linear regressions for both the salary and winning percentage models. The key element in analyzing the results of the regression models is that the points per game and PIM per game are weighted by games played. Therefore, the coefficients do not reflect a change in salary or winning percentage to one additional point but rather one additional point per game played.

Table 2

	Salary		*Winning Percentage*
Points/GM	3,608,777	Points/GM	.0498845
	(9.53)		(11.20)
PIM/GM	221,342.8	PIM/GM	-0.0005296
	(1.97)		(-0.27)
Height	146,463.9	AVGheight	0.0103854
	(2.53)		(0.81)
Weight	-4,719.854	AVGweight	-0.0026117
	(-0.64)		(-1.97)
Age	949,983.6	AVGage	-0.1447471
	(4.28)		(-1.23)
Age Sq	-17,005.73	$AVGage^2$	0.0027341
	(-4.81)		(1.25)
Playoff Games	13,991.74	Goals Allowed	-0.0018436
	(5.53)		(-11.94)
Constant	-2.33e+07	FO %	0.3108969

	(-4.73)
Observations	279
R-squared	0.5118
Robust t statistics in parentheses	

	(1.24)
Constant	2.134814
	(1.14)
Observations	60
R-squared	0.9134
Robust t statistics in parentheses	

The coefficients of the two respective models vary to such a large extent due to the structure of the dependent variable of each model. A player's unrestricted free agency contract can vary from the league minimum to multi-millions of dollars per year while a team's overall regular season winning percentage can only rest between a value of zero and one. Both models have statistically significant coefficients at the 5 percent level, but not for the entire set of independent variables. The coefficients also match signs between the two models, except the variables including PIM.

PIM illustrates a unique scenario where what is good for the team in terms of winning percentage will not always reflect well for a player in negotiating an unrestricted free agency contract. The more PIM a team takes, the more time they will have to play one or two man down. Even if a team's penalty kill unit ranks near the top of the league, committing more penalties will negatively impact a respective team's overall winning percentage. However, the PIM per game a player commits will reflect the style of play that this respective player plays. The 2006-2007 Stanley Cup Champion Anaheim Mighty Ducks demonstrated that players with a more aggressive and physical style of play would positively influence a team's winning percentage, as illustrated by their march to the Stanley Cup Finals. Naturally, the more aggressively and physically a team plays night in and night out will lead to more PIM. Therefore

in evaluating unrestricted free agents, NHL organizations will look positively upon a player with a large amount of PIM since the statistic shows how "hard" and "intense" a player plays the game.

As explained in the previous section, the coefficient ratios for each model show how significantly one variable influences the respective variable compared to another independent variable. *Tables 3* and *4* illustrate these coefficients. To assess the relative effectiveness of general managers in the unrestricted free agent market since the 2004-2005 lockout, a simple comparison of the ratios will demonstrate the levels of efficiency. The absolute values of the coefficient ratios are used since the ratios are calculated to determine the magnitude of influence on the respective independent variable. Therefore, in analyzing these coefficient ratios the direction of the sign of a coefficient will not impact this specific analysis. *Table 5* is a simple chart demonstrating the differences of the coefficient ratios. The coefficient ratio of the regular season winning percentage model is subtracted from the respective coefficient from the unrestricted free agent salary model. The differences between the coefficients are used to analyze the efficiency levels of the variable because the difference between comparable ratios will show the difference in relative influence the independent variables have on the dependent variable. The larger the difference, the greater the inefficiency.

Table 3

Regular Season Winning Percentage's Coefficient Ratios

	Points/GM	PIM/GM	AVGheight	AVGweight	AVGage	$AVGage^2$
Points/GM	1	0.011	0.208	0.052	2.902	0.055
PIM/GM	94.193	1	19.610	4.931	273.314	5.163
AVGheight	4.803	0.051	1	0.251	13.938	0.263
AVGweight	19.100	0.203	3.976	1	55.423	1.047

AVGage	0.345	0.004	0.072	0.018	1	0.019
$AVGage^2$	18.245	0.194	3.798	0.955	52.941	1

Table 4

Unrestricted Free Agency Contract's Coefficient Ratios

	Points/GM	PIM/GM	Height	Weight	Age	Age^2
Points/GM	1	0.061	0.0406	0.001	0.263	0.005
PIM/GM	16.304	1	0.662	0.021	4.292	0.077
Height	24.639	1.511	1	0.032	6.486	0.116
Weight	764.595	46.896	31.031	1	201.274	3.603
Age	3.799	0.233	0.154	0.005	1	0.018
Age^2	212.209	13.016	8.613	0.278	55.863	1

Table 5

Differences of the Coefficient Ratios

	Points/GM	PIM/GM	Height Var	Weight Var	Age Var	Age^2 Var
Points/GM	0	-0.051	0.168	0.051	2.638	0.050
PIM/GM	77.889	0	18.948	4.910	269.022	5.086
Height Var	-19.836	-1.460	0	0.219	7.451	0.147
Weight Var	-745.495	-46.693	-27.055	0	-145.851	-2.556
Age Var	-3.454	-0.229	-0.082	0.013	0	0.001
Age^2 Var	-193.964	-12.822	-4.814	0.678	-2.921	0

VI. Analysis and Future Research

An NHL general manager's job is to assemble a team that will produce a high enough overall regular season winning percentage to make the Stanley Cup playoffs for a chance at winning Lord Stanley's Cup. The rule changes and payroll structure alterations following the

2004-2005 season presented general managers throughout the league with the problem on how to distribute the limited funds of their respective payrolls in accordance with the "new" NHL.

When building a successful team, a general manager must acquire players that can fit into specific roles. This fact needs to be taken into account in the efficiency analysis through the comparison of the coefficient ratios in the tables of the previous section. General managers must make decisions regarding unrestricted free agents based on how this player will aid in improving his team's overall regular season winning percentage. This paper does not show what statistics are most influential on a team's overall regular season winning percentage and unrestricted free agent salary; it only illustrates the magnitudes that specific statistics and attribute impact the respective dependent variable. One cannot conclude from these models that one independent variable is more influential than another one in an equation due to the fact that each variable is measured in different units. For example, an additional inch for a team's average height cannot be compared to an additional point scored per game for a respective team.

Table 5 in the previous section demonstrates the significant conclusions of this paper. If general mangers valued specific statistics and attributes efficiently in terms of paying unrestricted free agents for certain statistics and attributes for the statistics and attributes that influence a team's overall regular season winning percentage, the coefficient ratios of the two equations would be equal leaving a difference of zero. However, *Table 5* shows that in reality general managers do not sign unrestricted free agents to contracts that value the statistics and attributes in a relative way that influences their individual team's overall regular season winning percentage. There are certain statistics and attributes where the relative impact on the dependent variable, as illustrated by the coefficient ratios, has a difference close to zero.

For example the differences involving the weight variable has four of the five coefficient ratio differences that are less than one showing that general managers have valued weight to an extent approximately equal to the relative impact of a team's weight to winning percentage. Yet, the majority of the differences of the coefficient ratios exhibit large magnitudes of differences. This demonstrates the inefficiency of NHL general managers in signing unrestricted free agents to contracts since they pay for statistics and attributes that do not relatively impact their team's overall regular season winning percentage to an equivalent extent. One of the more surprising results was the difference in ratios involving the height variable. The large difference, 18.948, between the height variable to PIM/GM ratios implies general managers do not evaluate height correctly when signing unrestricted free agents. On the other hand, I expected the large differences of the ratios involving Points/GM. These large differences ranged from the -3.454 to -745.495. Flashy players score more goals and make spectacular passes. This highlights their individual performance to the fans and the media creating a greater demand for players in the unrestricted free agent market who can "entertain" the fans in the arena and on television with their skills. This explains why the Points/GM variables are all substantially greater than zero. In reality though, a hard-working penalty killer is just as valuable to the team. General Managers will need to correct a large proportion of these market inefficiencies if they want to properly allocate their respective organizations funds to ensure that the club is paying players for statistics and attributes that will win the Stanley Cup.

On a whole the differences between coefficient ratios illustrate a major inefficiency in NHL general managers signing unrestricted free agents. In the future, I would like to include a set of variables that could explain the marketing power of an individual player. This could play a

major role in a player's unrestricted free agency salary since the NHL is a business and would not continue to operate if the product was not viewed and purchased by the public.

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