THE SALARIES OF NHL DEFENSEMEN MEASURED USING PRODUCTION: AN OFFENSIVE BIAS

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Abstract

Traditionally, defensemen in the National Hockey League (NHL) have been paid unevenly. Statistics measuring offense were applied to defensemen as well. This (along with other factors) resulted in a disparity in salaries between defensemen specializing in offense and defense. In recent years – especially since the lockout and cancellation of the 2004-05 season – defensemen specializing in defensive play became better recognized and paid. However, the salary disparity between offensive and defensive defensemen still exists.

The purpose of this study was to analyze this salary disparity by cross-referencing the production (measured more comprehensively than past studies) of defensemen with their salaries. The defensemen were pooled together and designated either "offensive" or "defensive." Data was collected from all defensemen who participated in the 2007-08 NHL season, paired with their ensuing salaries for the 2008-09 season. In total 209 defensemen were studied, 103 offensive and 106 defensive.

I anticipated that due to a rise in the recognition of the importance of defensive defensemen, the offensive-defensive salary disparity would not be dramatic.

This thesis uses fourteen total independent variables relating to the dependent variable, salary. Three regression models were performed on the 209 defensemen. The regression results showed that there were six significant variables. Age, blocked shots, points-per-game, and shots were found to have a positive impact on salaries. Games played and plus/minus were discovered to negatively affect salaries. The results also show that offensive defensemen are paid almost *double* the salary of defensive defensemen.

KEYWORDS: (Salary, Production, National Hockey League)

ON MY HONOR, I HAVE NEITHER GIVEN NOR RECEIVED
UNAUTHORIZED AID ON THIS THESIS

Signature

To my wonderful family and my beautiful soon-to-be wife, Brittani.

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I would like to thank my advisor, professor Esther Redmount for her assistance with this project.

CHAPTER 1

INTRODUCTION

Philadelphia Flyers defenseman, Norris trophy winner, and Stanley Cup champion Chris Pronger said it best when asked about the importance of defensemen to a hockey team: "Defense wins championships. You're back there trying to stop the puck, and you're also the catalyst for the offense." This not only applies to the National Hockey League (NHL) but to all major sports; a team needs a superior defense to win league championships.

First, a background to the NHL; it has grown from a simple four-team league centered around Montreal, Canada in 1917 into a large moneymaking industry consisting of 30 teams from the United States as well as Canada. It is widely regarded as the world's most premier league with players from over 20 countries. The main sources of income for the NHL are national media coverage (T.V. and radio), the promotion of multi-million dollar players, merchandise, and finally arena contracts. The league had a lockout in the 2004-05 season that shut down operations for 310 days, which is the longest in sports history. The agreement following the lockout changed the NHL significantly. Prior to the lockout, there was no salary cap (for teams or individual contracts) or revenue sharing.

The NHL and the NHL Player's Union (NHLPA) decided on a Collective Bargaining Agreement after the yearlong stoppage. The agreement is best known for establishing a "hard" salary cap, something the NHLPA was dead-set against. The league's success in the CBA occurred primarily because Commissioner Gary Bettman out-waited the NHLPA, which suffered from internal disagreements and fired its leader, Bob Goodenow. The new agreement was given a six-year term set to expire in 2012 with enhanced guidelines. In addition to the cap (which has a minimum and maximum), the players were given a share in the league-wide revenue. Also, the NHL has guaranteed contracts: players will receive their full contracts regardless of injury or poor performance.

These changes have an impact on defensemen in particular. In NHL hockey, defense is perhaps the most physically taxing position. Of the players on a hockey team, defensemen block the most shots, and without the padding goaltenders enjoy. Also, they give and receive hits more often than forwards. With the poor performance, defensemen cannot take a game off because they are more exposed than forwards, and playing inadequately will not go unnoticed. A defensemen's job is to keep the opposing team from scoring, and if a team gets scored on too many times, everybody looks to the defensemen to blame. If the defense plays well, the goalie usually gets most of the credit.

Before the new CBA of 2005, there still were guarantees on a player's contract, and no floor or ceiling on salaries. The NHL was the first of the major North America sports to implement the guaranteed contracts while having a cap. If a player has a one-way contract (a contract that means the player is paid NHL money regardless if he is playing in the NHL or the minors) and gets sent down to the minors or has a long-term

injury the best a club can do is buy-out the players contract. That is, of course, if the team wants to get rid of the player. However, this means the team would still have to pay a fraction of the contract to the individual unless the player is over 35 years of age. If the player is younger than 28 than the individual can be bought out for one-third of his contract, and two-thirds of the remaining contract if the player is 28 or older. Even though a player never wants to get hurt, sent down to the minors, or get dropped from the club, I believe that players appreciate the guaranteed contracts very much because of the fact that they still receive a paycheck.

Table 1.1

List of the price ceiling and price floor of each season from 2003-04 to present.

Year	Salary Cap/Price Ceiling	Price Floor
2005-06	39	21.5
2006-07	44	28
2007-08	50.3	34.3
2008-09	56.7	40.7
2009-10	56.8	40.8

New Rule Changes Following the 2005 Lockout

To understand the way contracts work for NHL defensemen today, it is important to study how the NHL's rules were changed because of the lockout. The lockout not only affected contracts and salaries for the players but the rules were also changed to make the game more fan-friendly. The fans and media wanted more offense and scoring to make games more enjoyable to watch. Most of these rule changes made defense more difficult, especially for the shutdown, stay-at-home, defensive defensemen. Brent Burns (an offensive defenseman for the Minnesota Wild) says, "there's now more emphasis on skating and body positioning for defensemen since the rule changes from the lockout season." The major modification to the NHL was to eliminate holding, hooking and interfering with an opposing player to reduce their speed and scoring opportunities. The sport turned into a more European-style game, which had been less restrictive of speed and skill. Some teams and players couldn't adapt to the new style and were penalized for it. "Teams that built themselves around large, bulky defensemen, like the Philadelphia Flyers, saw some players unable to transition to the new style of play," writes Gregory Miller. The bigger, more defensive defensemen had to learn to play the new style of game or drop out of the league.

Offensive defensemen seemed to benefit from of the rule changes because it created more penalties, leading to more power plays (when a player is penalized, causing his team to play short one skater for a short period of time), giving them an opportunity to score more points (and eventually get better contract offers).

Another major change since the lockout to the rules in the NHL is that the league removed the two-line pass (it used to be that a pass couldn't be made over two lines on the ice surface, i.e. a player in the defensive zone could not pass a puck to a teammate over the center ice red line). This means that defensemen could stay on the offensive blue line longer because a pass could not be made behind them, so it made the game harder for skilled forwards. This led to a strategy called the "neutral zone trap," which became increasingly popular and led to a sharp decline in goals in the NHL. Defensemen simply clogged the neutral zone (the zone between the two blue lines) and fans felt this destroyed hockey's entertainment value. Along the same lines of getting rid of the two-line pass, the NHL also made the neutral zone smaller. This obviously means that both offensive zones get enlarged, which in turn creates more scoring chances and shots. Both these rules (two-line pass taken out and making the neutral zone smaller) totally affected how a defensemen could play their position.

An excellent example how the new rules changed hockey is the 2006-2007 Philadelphia Flyers. The Flyers' best defensive defensemen entering the season were Derian Hatcher and Mike Rathje. Both players had been given large contracts. Hatcher was 6'5, 225 lbs and Rathje was 6'5, 230 lbs. Both were known for using their size to prevent opposing stars (using their physical strength) from scoring. Hatcher and Rathje could not keep up. Hatcher (traditionally known for having a high +/-[1]) was minus 24 on the season and retired the next season. Rathje played only 18 games in what was his last season in the NHL and went minus 7. Because the Flyers were going to rely on Rathje and Hatcher, their skilled defensemen suffered. Usually, an offensive defenseman is

[1] Player gets a plus 1 if he's on the ice for a goal and a minus 1 if he's on the ice for a goal against. This is only for even-strenght play, and it gets counted up during the season.

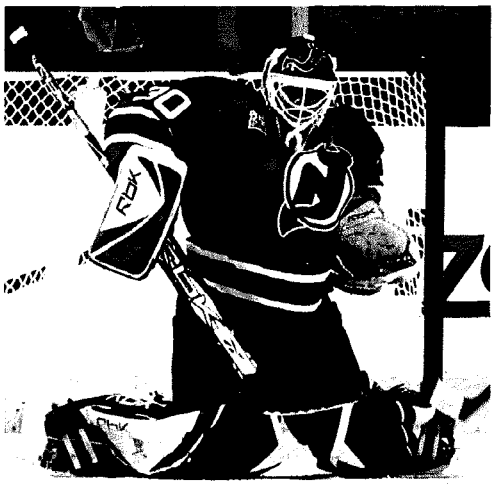
paired with a defensive defenseman (like Hatcher or Rathje) to leave some protection on the ice in the defensive zone. Now, with the offensive defensemen abandoned, the Flyers were exposed. Joni Pitkanen, the Flyers' best offensive defenseman went minus 25 for this reason. Without adequate defensive defenseman, the Flyers were doomed. Head Coach Ken Hitchcock was fired after 8 games. The team finished with a terrible record of 22-48-12.

Finally, the last main rule modification applied to the goaltenders in particular. The goaltenders' leg pads were reduced in size so the fans would see more goals. Pictures of Patrick Lalime (left) and Jean-Sebastien Giguere (right) show the oversized pads used by goaltenders before the equipment restrictions imposed after the lockout.

[2]

[3]

[2] http://imagecache2.allposters.com/images/pic/PHOTOFILE/AADU009~Patrick-Lalime-Photofile-Posters.jpg
[3] http://i.cnn.net/si/hockey/2003/playoffs/goalie_analysis/images/goalie_jean_giguere.jpg



[4]

This picture of Martin Brodeur shows the equipment changes stipulated by the new rules. Both gloves as well as the leg pads are substantially smaller.

These rule changes to goalies also affected defensemen as well because as stated earlier, when a goalie gets scored upon too many times, the media usually won't blame only the goalie. The defensemen will usually be at fault for giving up too many shots. Certain shots are rewarded as "Grade A" shots against (an area from the goal line out to the dots and up to the top of the circles) and with the new size in goalie's pads, defensemen must limit these shots to a minimum during the game. The goalie equipment changes directly affected how defensemen defend the ice sheet: when NHL-speed shots are taken from the "Grade-A" zone, goalies do not have time to fully react (imagine a pitch thrown to a batter in the MLB from halfway between the mound and the plate). Previously, the large equipment had been very helpful just by giving the goalie better odds. Now that the equipment had been restricted, goalies had a much harder time, and defensemen had to concentrate more on blocking the shots.

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[4] http://5ivehole.files.wordpress.com/2009/03/brodeur.jpg

The Difference Between Offensive and Defensive Defensemen

To understand this thesis topic, one must learn how to tell the difference between an offensive defensemen and defensive defensemen. An offensive defensemen is one who gets involved in the offensive rushes and plays on the power play. They are also very gifted skaters and have smooth strides that take them up and down the ice surface. These specific defensemen also control the pace of the game with no sense of urgency when an opposing player pressures them. They normally have bigger statistics in the areas of points and shots. Offensive defensemen, for the most part, are smaller in stature and do not hit as often. Finally, in their defensive zone they are vulnerable and can get pushed around in the corners and in front of their goalie. The statistics used to evaluate offensive defensemen are goals, assists, points, shots, and time on ice during the power play.

Defensive defensemen are the ones in charge of shutting down the opposing teams best forwards; they always play on the penalty-kill and normally don't get involved in the offensive zone. They are usually bigger in size (height and weight) than offensive defensemen. For the most part do not handle the puck for longer than a second or two because in the NHL you want to maximize the amount of time that skilled players handle the puck. These defensemen typically do not have a smooth skating stride, mainly because they are bigger and takes their body more energy to get around the ice surface. On the other hand, these players do not get pushed around in the corners or around their own net in their defensive zone and will fight if needed.

The big statistical categories for these defensemen are hits, blocked shots, and penalty minutes. It is important to note that blocked shots were not tracked (according to NHL.com) until 2002-2003, one season before the lockout. Recently, blocked shots have become an important statistic for measuring the performance of NHL defensemen. This may be one reason that defensive defensemen traditionally have been paid less than offensive defensemen. But, the lockout changed everything. For example, after 2005-06 (first season after the lockout), Jay McKee, a defenseman for the Buffalo Sabres, led the NHL in blocked shots with 241 (averaging 3.2 per game). The second closest player had only 207. McKee scored only 16 points, and his +/- was even (0) for that season. How does one explain that he was rewarded a 4 year, $4.2 million dollar (per year) free agent contract? With the new rules, and shot-blocking suddenly more important, general managers had a bidding war for McKee even though he didn't have good numbers in the traditionally appealing categories (for offensive defensemen). The reason his +/- (or that of any good defensive defenseman) can be accepted is that these types of defensemen always play against the best forward lines of the opposing team and a certain number of goals are inevitable. Also, defensive defensemen are often paired with defensive-minded forwards who do not often score, further lowering their +/-.

There is usually around seven to eight defensemen on an NHL roster, and a team must decide whether they want to be more offensive or defensive by how many of each defensemen they want on their club. This is the million-dollar question because versatile defensemen (both offensive *and* defensive) are tough to come by, and a team has to stay below their salary cap. (A good example of this is the 2008 NHL draft when ten out of the first twenty picks were defensemen thought to be able to play both roles). This

versatile-type defenseman is a rarity now with the new NHL, and more valuable specifically because of the rule changes. Since there are so few, general managers must do their best to find one or two versatile defensemen and fill out the rest of their roster with defensemen who specialize in one or the other.

However, when it comes to recruiting, NHL general managers and scouts pay far closer attention to finding defensemen with offensive skills. According to Burns, NHL management believes that "you can't train a player to have good offensive skills, but you can train defensive skills." This explains why the recruitment of offensive defensemen is heavier. Of course, many prospects do not turn out the way general managers expect. Even though, management may look more for offensive-minded defensemen, when it comes to the NHL, they are equally important. With the new rule changes, defensive defensemen like Jay McKee are receiving larger contracts than before. However, offensive defensemen still usually make more money.

Table 1.2

Top 20 offensive, Top 20 Defensive Salaries from 2008-09 (in millions)

	Offensive Defensemen	Defensive Defensemen
1	Zdeno Chara- 7.5	Scott Hannan- 4.5
2	Nicklas Lidstrom- 7.45	Eric Brewer- 4.25
3	Brian Campbell- 7.14	Robyn Regehr- 4.02
4	Scott Niedermayer- 6.75	Jay McKee- 4
5	Dan Boyle- 6.667	Mike Commodore- 3.75

6	Dion Phaneuf- 6.5	Brooks Orpik- 3.75
7	Ed Jovanovski- 6.5	Barret Jackman- 3.6
8	Wade Redden- 6.5	Cory Sarich- 3.6
9	Kimmo Timonen- 6.333	Tom Poti- 3.5
10	Chris Pronger- 6.25	Jeff Finger- 3.5
11	Brian Rafalski- 6	Chris Phillips-3.5
12	Andrei Markov- 5.75	Willie Mitchell- 3.5
13	Bryan McCabe- 5.75	Derian Hatcher- 3.5
14	Lubomir Visnovsky- 5.6	Filip Kuba- 3
15	Roman Hamrlik- 5.5	Adam Foote- 3
16	Sheldon Souray- 5.4	Colin White- 3
17	Sergei Zubov- 5.35	Andy Sutton- 3
18	Mike Green- 5.25	Bryan Allen- 2.9
19	Sergei Gonchar- 5	Bryce Salvador- 2.9
20	Pavel Kubina- 5	Toni Lydman- 2.875

Nobody disputes that the performance of offensive and defensive defenseman affects the plight of a team equally. Especially because in recent years, the prominence and popularity of defensive defensemen has increased through the creation of new statistical categories (measuring defensive production) and in other ways, it follows that they should be paid equally to offensive defensemen. Despite this, offensive defensemen are still paid far more, a phenomenon requiring an explanation, which is what this paper attempts.

This chapter lays the groundwork for understanding the changes in NHL defense salaries, as well as examining how NHL management decides how to spend its money and target players. Chapter II examines previous studies on this topic, which will help one gain perspective on how the questions addressed by this thesis have changed over time. Past research will be evaluated to improve the way the topic is addressed. Chapter III will show the sample that I will use for this thesis. Dependent and independent variables that I chose and there predicted signs will also be in this chapter. Chapter IV will take a look into my results and the models that I used to discover the results. Finally, chapter V is the conclusion to this thesis. It will give the practical applications to what I have found, as well as ways to perform future research.

CHAPTER II

LITERATURE REVIEW

The purpose of this chapter is to find previous research that is relevant to studying defensemen's salaries in the NHL, trying to answer certain questions: are offensive or defensive defensemen paid more? And, does their productivity affect their contracts? Also, the effects of the rule changes, the team location and player's birthplace, and salary cap adjustments will be examined.

There has been much debate about the determinants for NHL salaries since the lockout occurred in 2005. To address the question of who gets paid more and why, many different factors are relevant. This includes the salary cap, rule changes, location (of the team) and birthplace of the player, and productivity. The salary cap is obviously important because it puts limits on how much a team can spend on a player. The rule changes are significant because they made effective defensive defensemen (unhurt by the rule changes) harder to find. The location of a team and birthplace of a player are both important. Before the lockout, big-market teams were able to pay higher salaries, but sometimes, players agreed to contracts for less money because the location of the team appealed to them. Following the lockout, this is still true, except the big market teams now must adhere to the cap. Finally, productivity (measured in statistics) is significant because it creates a method to measure players scientifically.

Because the lockout changed the NHL so much, by just looking at the changes (in all these areas) between pre and post lockout hockey, much can be learned. There have been many examinations of these topics from before the lockout, but none of the studies specifically focuses on defensemen. These past studies focused on forwards because they were easy to measure. As early as six years ago, the NHL did not have proper statistics to measure the performance of defensemen (unlike forwards, because goals and assists were all that was necessary). So, past analysis of defensemen was mostly subjective because their output could not be measured statistically. Now, on NHL.com, not a blocked shot or a hit goes unaccounted for. It is finally possible to properly measure the performance of defensive defensemen.

Salary Cap

There has been much research in the field of the NHL and the salary cap has changed it. The salary cap is important for many reasons. In the case of individual contracts, salaries depend entirely on how much revenue the league makes. Depending on league revenues, the NHL adjusts its salary cap up or down before each season (or may leave it the same). All the salary analysis used here was before the lockout of 2004, which means that these studies are using the old CBA. Even though the studies are pre lockout, they will be useful because either way the salaries of defensemen are mostly based on how their owners view them in relation to the league norms.

Rick Westhead and Paul Jay, authors for the *Canadian Business*, evaluated Gary Bettman's (the NHL commissioner) job performance since coming over to the NHL from the NBA in 1993, Westhead and Jay write:

> He shies away from the term "salary cap," but has been relentless in pursuing a direct connection between the league's revenue and player salaries, similar to the cap that has stabilized NBA salaries and made its players North America's highest paid.[5]

Westhead also explains how Bob Goodenow, executive director of the NHLPA (and his counterpart Bettman) have often disagreed on the NHL financial structure. Goodenow believes that the players themselves are the product, but Bettman (and the owners) argue that the strength and popularity of individual organizations is what keeps the fans returning and holds the NHL together. Goodenow (in 2004, right before the lockout) had seen NHL salaries steadily increase throughout his time at the NHLPA and said that he "will never accept a salary cap."[6] So, when the NHL had a bad financial season in 2004, a lockout occurred, and the 2004-05 season was lost. Westhead and Jay's main suggestion is that Bettman bring more teams North, into Canada, because the market was stronger.

Like Westhead and Jay, Gerald Scully analyzes NHL player salaries and the distribution of revenue from the league to its players. Scully addresses all four major sports, MLB, NBA, NFL, and NHL. Bettman believed that a main issue before the lockout was that the players were making an unreasonably high percentage of the NHL's revenue. Scully shows in one of his graphs that in 1998 (of the four major sports), the

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[5] Westhead, Rick and Jay, Paul, "Cost Certainty: No *Salary* Cap" *Canadian Business*, Vol. 77, Issue 4 (February 2004): p.2

[6] Ibid, p. 2

NHL was paying its players the highest percentage of league revenue, 58.4%. He suggests that such an arrangement is going to be unsustainable. Why was this the case? If 58% of league revenues (a high percentage) was going to the players, and there were no restrictions on team payrolls, it follows that some teams would have far higher payrolls than others. By capping the team payrolls and having revenue sharing, the NHL was stabilized, and small-market teams could again compete (financially) for the best players and the Stanley Cup. In 2003-2004, 10 teams won under 30 games. In 2005-06, only 5 teams won under 30 games, and two won 29. Clearly, the lockout helped the competitive balance of the NHL. A new CBA was imposed, and a new system of relations between league revenues and player salaries was put into effect: the league targeted a specific percentage of revenue for the players, and shrank all existing player contracts accordingly.

Scully also analyzes the distributions of player's salaries. In the NHL, the inequality of earnings was the lowest of the four major sports in the 1990's. He mainly evaluated the MLB, which has a very different system in comparison to the NHL today. "Interclub salary differentials are wide (e.g., in baseball, from $34 million in Tampa to $124 million for the Yankees," observes Scully.[7] This could not happen in the NHL because of the salary cap that applies to all 30 teams in the league, some teams may have a higher payroll but all must stay below the cap, which makes the NHL the most competitive league.

Another pair of researchers that did pre-lockout analysis of the NHL were Todd Idson and Leo Kahane. These economists studied how the team itself can affect a

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[7] Scully, Gerald, "Player Salary Share and the Distribution of Player Earnings" *Managerial and Decision Economics*, Vol. 25, No.2 (March 2004): p.8

player's performance and ultimately their salaries. At the time of the study, salaries for the players in the NHL were low compared to those of the other major sports leagues, which remains the case today. However, because of the NHL salary cap, the big market teams can no longer overpay players, which prevents even the best NHL players from making salaries equivalent to their equals in other leagues. Idson and Kahane also examined whether coaches had any affect on individual salaries. They ran regressions to test their hypothesis and found that higher coaching quality (tested using the amount of years they've coached and winning percentage while coaching in the NHL) results in higher player salaries. They also tested the average playing quality of an individual player's teammates to see if whom the player works with has any affect on the players salary. (Idson and Kahane used the average height of the players on the team, penalties, plus/minus, weight, and "star" with which they considered with the stock of talent on a team). Using these functions, they found that a player's salary *is* partially determined by the attributes of the other players on his team. "The interactions for points and plus/minus are positive, implying that individual productivity is rewarded at a higher rate on teams with better players, that is, these labor inputs appear to be complements," write Idson and Kahane.[8]

Finally, Joseph Marchand, Timothy Smeeding, and Barbara Torrey examined NHL player salaries from the 2000-01 to the 2003-04 season using over 1,000 players in their study. "More equal pay distributions have been found to be positively related to

[8] Idson, Todd and Kahane, Leo, "Team Effects on Compensation: An Application to Salary Determination in the National Hockey League" *Economic Inquiry*, Vol. 38, No.2, (April 2000): p.9

multiple measures of individual and organizational performance,"[9] state these researchers, meaning that if a team pays its players similar amounts, the team (and individual players) will have more success. Marchand, Smeeding, and Torrey agree that salaries in the NHL are highly unequal, however, the salaries of defensemen are more equally distributed (than the forwards), with most paid between $2 and $5 million.[10] These analysts name two "effects" resulting from unequal payroll distribution, "star" and "journeyman." The "star effect" occurs when one player is paid much more than his teammates, yet because his impact is higher, the disparity in pay is accepted, and the team does well. The "journeyman effect" occurs when several players feel that they are underpaid and don't play to their maximum ability, hurting the team's performance. Players in this situation will also attempt to increase their own production selfishly, causing teamwork to decline.[11] Finally, in their conclusion, these three authors suggest that "in general, a $1 million dollar increase in salary was equivalent to 2.4 more goals during the season and 3.5 more assists."[12] Note that these statistics completely neglect the contributions of defensive defensemen. However, the ignorance of these authors just shows how for a long time, the contributions of defensive defensemen were ignored not only by the public, but also demonstrated by their salaries.

So, prior to the lockout, NHL salary cap analysis often ignored the contributions of defensive defensemen. Also, with the post-lockout changes and the salary cap, teams had to be more cognizant of how they used their resources. It was no longer possible to

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[9] Marchard, Joseph, Smeeding, Timothy, and Torrey, Barbara, "Salary Distribution and Performance: Evidence from the National Hockey League," *Dept. of Economics and Center for Policy Research, Syracuse University and Population Reference Bureau*, March 2006, p.3
[10] Ibid, p.7
[11] Ibid, p.9
[12] Ibid, p.14

give out contracts which anticipated spikes in production because potentially, mistakes could ruin a team's financial structure for years. This relates directly to Marchard, Smeeding and Torrey: spending in the NHL is usually slanted towards forwards and goalies. Defensemen had the lowest average salary of the three major types of positions. After the implementation of the salary cap, teams were more careful about handing out large contracts. So, more money could be spent on those not considered to be stars, including most effective defensive defensemen. So, the creation of the salary cap itself was a contributing factor to the increase in salary for defensive defensemen.

Location and Birthplace

Many researchers have studied the impact of geography on NHL player salaries in two ways: first, to see what influence the location of teams in the NHL has on individual salaries, and second, to see if where players were born has an impact on their salary. In deciding where one might play in the NHL, players consider both these questions. Drafted players have less choice since their signing rights are already determined. However, undrafted players have to decide on a location, and often have several choices. If making money is most important, one would pick a team in a big market because these teams usually are willing to spend more money on players. Also, in the NHL, some players choose to take a pay cut to play in their hometowns. On the other hand, many French Canadians choose to play in French Canada because they feel they will be paid better (because they are sometimes negatively stereotyped in English-speaking areas).

Researchers Robert McLean and Michael Veall examined birthplace in the NHL by focusing on the differences between Anglophone Canadians (English speaking), Francophone Canadians (French speaking), Americans, and Europeans to analyze possible trends in their salaries. They tested to see if there was discrimination against Francophone in comparison to the other groups. They divided players by position, output (the player's career points per game), draft number, and geographic origin.

In 1983-84 a similar study (to that of McLean and Veall), and found that there *was* discrimination of the Francophone Canadian players with regard to pay and draft status.[13] The gap shrunk in between 1984 and 1992 (the year of the McLean-Veal study): "... No evidence has been found of discrimination against Francophone Canadians when it comes to compensation for performance,"[14] note McLean and Veall. They feel this is because the NHL's market pressures teams to win and it does not matter where the players come from. Also, there has been an increase in the number of Francophone coaches and general managers. McLean and Veall found that it should not matter where one is born when it comes to the NHL; teams just want to win, plain and simple.

Another study of French Canadians in the NHL is conducted by Neil Longley, and he specifically looks at this topic along with the team location. Longley cites McLean and Veall, but asserts that players in markets where they face language and culture barriers are likely to be valued less by the team (and paid less by implication).[15] This affects non-French Canadians in Quebec and vice versa for French-Canadians in British Canada or the United States. Since defensive statistics did not exist when this

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[13] McLean, Robert and Veall, Michael, "Performance and Salary Differentials in the National Hockey League," *Canadian Public Policy*, vol. 18, no. 4 (December 1992), p.3
[14] Ibid, p.5
[15] Longley, Neil, "Salary Discrimination in the National Hockey League: The Effects of Team Location," *Canadian Public Policy*, vol. 21, no. 4 (December 1995), p.2

study was done, Longley only uses forwards (who can be generally measured by their offensive production.) He designated the 21 NHL teams (in 1989-90) into three groups: Quebec-based teams, English Canada-based teams, and US-based teams.

Longley notes:

> The coefficients indicate that, when compared to the base case of English Canadians playing for English Canada-based teams, French Canadians playing for English Canada-based teams earn 37 per cent less, while English Canadians playing for Quebec-based teams earn 14 per cent less.[16]

So, Longley finds that there is discrimination against French Canadians on teams based in English Canada, something overlooked by McLean and Veall in their study.

Marc Lavoie agrees more with McLean and Veall than Longley, alleging that there is little evidence demonstrating that French Canadians experience discrimination. Lavoie addresses Longley:

> The main differences from Longley's article are that (a) I deal with the players of the 1993-1994 season instead of those of 1989-1990; (b) the situation of defensemen, as well as that of forwards, is examined; (c) several more determinants of salaries are added to Longley's three variables (career games played, points per game, team revenues); and (4) the number of interaction terms has been reduced, ironically yielding additional information.[17]

Lavoie suggests that *Americans* could be the ones who suffer from pay discrimination. American players are able to get better off-ice endorsement deals when playing for American teams, so the American teams try to take this into account when negotiating player contracts.[18] (This same problem could technically apply to French Canadians playing for Quebec teams.)

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[16] Ibid, p.5
[17] Lavoie, Marc, "The Location of Pay Discrimination in the National Hockey League," *Journal of Sports Economics,* vol. 1, no.4 (November 2000), p.2
[18] Ibid, pp. 2-3

Lavoie uses offensive statistics for the forwards, and uses weight, minutes of penalties, and defensive play for defensemen (as evaluated by himself). His results show that a team's revenue has nothing to do with player salaries, but the location of the team. He also found that French Canadian forwards are discriminated against in English Canada, and that American and European forwards are also underpaid when playing for teams in Canada excluding Quebec; "Teams located in English Canada systematically underpay forwards who are not English Canadians."[19] Lavoie also suggests that French-Canadian defensemen playing for a team in the United States appear to be underpaid, and that more broadly, players on teams in "foreign" areas are underpaid.

A few years later, Marc Lavoie conducted a study similar to the one in 2000. In this study, he uses the same variables, but looks to see if there is discrimination in the entry draft. His results show that American teams underestimate the talent of French-Canadian players at the draft. Along with the French Canadians, Europeans appear to suffer from the discrimination as well. Lavoie notes that the collective bargaining agreement during the time of this study (2003) forbids discrimination against any individual. He believes that if the French Canadians are in fact discriminated against, it's because of their lack of defensive skills when compared to American and English Canadian players. "Not being an English-speaking player may now be less of an issue in the NHL,"[20] asserts Lavoie, who draws this conclusion because from 1993 to 2002 the number of American players has fallen from 18 to 13 percent, Europeans have increased from 16 to 32 percent, and French Canadians have remained constant at 10 percent.[21]

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[19] Ibid, p.5
[20] Lavoie, Marc, "The Entry Draft and the National Hockey League: Discrimination, Style of Play, and Team Location," *American Journal of Economics and Sociology*, vol. 62, no.2 (April 2003), p.18
[21] Ibid, p.18

A slightly different type of study done by Leo Kahane finds that team location and its overall revenue most affects an individual player's salary. He uses the hierarchical linear model to show his readers his results. Kahane analyzes his equations with data from non-rookies and the player's salaries as his dependent variable. His results show that player salary trends are different for every team, including mean salary and reward for greater performance. Kahane states, "... Players that increase their performance tend to benefit from a greater rate of salary increases on teams with larger revenues, other things being equal."[22] So, a player will receive greater pay when playing for teams with higher revenues (at least, this was the case before the lockout where there wasn't a salary cap). Now, all teams can only assign bonuses that do not violate the salary cap.

The location of a team and the birthplace of a player have a significant effect on player salaries. While team market size no longer allows big-city organizations to drastically over-pay players (because of revenue sharing and the cap), the location of a team is still important because of regional prejudices, endorsements, and other factors.

Production

Another main aspect of my thesis topic is how production affects player salaries. Production is complicated in the case of hockey because no statistic truly tells how a player performs in the game or season. Some nights a player will play poorly but still get a couple points, shots, and hits. Other nights a player will play really well and the

[22] Kahane, Leo, "Team and Player Affects on NHL Player Salaries: Hierarchical Linear Model Approach," *Applied Economics Letters*, vol. 8 (2001), p.3

statistics won't show it. This is even more extreme in the case of defensemen, who rarely flourish in the well-established hockey statistics, such as goals and points.

In a USA Today article from 2003, Sandis Ozolinsh's abilities as an offensive defenseman are discussed. Ozolinsh was known for scoring many more points than most defensemen. However, the article points out what the statistics did not, that he had an important role in the defensive zone as well: "Ozolinsh is picking his spots when to join the rush, making sure not to be a defensive liability, becoming an offensive asset when the time is right."[23] Offensive defensemen get the more recognizable stats but they also know that they must not hurt their team defensively.

The available professional research on player production is pre-lockout, a time when almost only offensive statistics were used to evaluate production. Therefore, most of the research in this field is done testing the skills that the players possess.

First, J.C.H. Jones and William Walsh demonstrate that skills are the principal determinant of salaries at all positions in the NHL. They put the different positions (forwards, defensemen, and goalies) into their different regression models. Also, they broke the ethnic groups (French Canadian and non-French Canadians) into different categories and models. Jones and Walsh found that the skills of all skaters (defensemen and forwards) are most distinguished by their points per game. Also, determined that the coefficient (points per game) would be larger for forwards than defensemen in their equation. Their results show that points per game, experience, star status (number of all-stars on the team), and star potential (drafted in the first round or not- dummy variable)

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[23] "Goals Change for Ozolinsh: Defense a Key," *USA Today*, 4 June, 2003, sec. Sports, p.7C

are all significant for defensemen and forwards.[24] Also, to explain the salaries of both forwards and defensemen, Jones and Walsh used points per game as the main measure for forwards, and weight (strength) for defensemen. They concluded, "To summarize very simply, irrespective of what differences exist among positions, skills are very significant in determining player salaries."[25]

Another study done by Claude Vincent and Byron Eastman claims (like Jones and Walsh), that it is easy to measure the performance of forwards and rather problematic trying to find good measurements for defensemen, especially in the pre-lockout era. Obviously, career points per game is used for offensive statistics, and plus/minus, penalty minutes per game, height, and weight are used to capture defensive skills. Vincent and Eastman used different regressions for both forwards and defensemen (and for my thesis, we will only look at their analysis of defensemen). They studied 218 defensemen from the 2003-04 season, and used experience (number of games in his career), points per game, star (all-star selected or not), draft (in first or second round or not), plus/minus, penalty minutes a game, height, weight, and revenue (total amount of revenue the team he plays for makes). Their results show that experience, points per game, "star," and draft are all significant for the earnings of forwards and defensemen.[26] The plus/minus is also positively correlated with earnings for defensemen. They used the ordinary least squares for their results and conclusions.

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[24] Jones, J.C.H. and Walsh, William, "Salary Determination in the National Hockey League: The Effects of Skills, Franchise Characteristics, and Discrimination," *Industrial and Labor Relations Review*, vol. 41, no.4 (July 1988), p.8

[25] Ibid, p.8

[26] Vincent, Claude and Eastman, Byron, "Determinants of Pay in the NHL: A Quantile Regression Approach," *Journal of Sports Economics* (2009), p.15

Aju Fenn and John Heyne use a slightly different method for studying production. These researchers examined how a team attains success and establishes good attendance to games. Heyne and Fenn use team statistics: "As Team Points will be used as an overall measure of an NHL team's success, Goals Allowed will give deeper insight into defensive contributions to team production."[27] Team points (wins and losses) and goals allowed are their dependent variables in their models. Their independent variables are goals, goaltending, penalties, face-offs, shooting, assists, and plus/minus. Like the other aforementioned studies, Heyne and Fenn also use the ordinary least squares regressions to demonstrate their results. They found that even-strength goals, power-play goals, and short-handed goals were all significant contributors to their team points model for estimating the team's overall performance. (This is obvious, scoring any kind of goals will help a team's chances of winning games.) In their goals allowed model, Heyne and Fenn found (naturally) that goals against have a negative impact. More than just the score, these goals impact team morale, NHL teams are not upbeat and positive after allowing a goal. "This reiterates the importance of momentum in the game of hockey,"[28] note Heyne and Fenn. Penalties were negative in the team points model, and were positive in the goals allowed model, meaning that the more penalties a team takes, the harder it is for the team to win games. In the same breath, major penalties (mainly fighting) has a negative significance level for the goals allowed model, which implies that fighting helps a team win games, and helps to prevent the opposing team from scoring. Lastly, assists and plus/minus will help NHL teams win games because these are teamwork statistics, and the more the team works together, the team is more likely to be

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[27] Heyne, John Jerald and Fenn, Aju, "NHL Team Production," *Department of Economics and Business*, Colorado College, p.8

[28] Ibid, p. 17

successful.[29] Heyne and Fenn's *NHL Team Production* helps to show how a team wins, with the ultimate consequence of financial success since people are more likely to pay to watch a winning team.

In measuring Sandis Ozolinsh (and offensive defensemen), Jones and Walsh would look up his salary and make assumptions about his ability depending on how high it was. Vincent and Eastman would look at a group of statistics and attributes to decide if Ozolinsh was being paid his worth. Heyne and Fenn would focus primarily on Ozolinsh's team's total goals against. Since Ozolinsh was a first-pair defenseman, his personal ability played a key part of his team's total goals allowed.

Rule Changes

Since the lockout, the NHL has changed, and now places more emphasis on skill and speed. "It's becoming more of a skill game," said Doug MacLean, a former NHL coach and general manager. "Typically we used to see only the Red Wings making these great plays, now we are seeing the Sharks making them, the Rangers, the Sabres."[30] The lockout led to these rule changes, which are designed to increase offense, making hockey more enticing for the fans. This was not always the case. In the mid-1990's teams that did not want to pay for superstars (there was no revenue sharing or salary cap at the time) had to find a way to win without high-scoring players.

The "neutral zone trap" or "left-wing lock" was used most notably by the New Jersey Devils under coach Jacques Lemaire to win the 1995 Stanley Cup. In the finals,

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[29] Ibid, p. 22
[30] *NHL back on offensive*, USA Today, p.1

the Red Wings had an overwhelming talent advantage, with 5 certain Hall-of-Fame players (Paul Coffey, Dino Ciccarelli, Steve Yzerman, Nick Lidstrom, Sergei Fedorov). The Devils had far less talent. They had two Hall-of-Famers. Scott Stevens was known for hitting rather than offensive talent, and Martin Brodeur was only in his second season. Despite this, the Devils swept, and completely shutting down the Red Wings offense. The legacy of 1994-95 Devils run was their popular "crash line" comprised of Randy McKay, Mike Peluso, Bobby Holik. This line was sent out against the best opposing players, and had far less talent, yet they managed to "crash" the opponents and prevent them from scoring by obstructing them in every way thinkable.

These tactics became worse in the late 1990's and became so effective that after the lockout, rule changes were necessary to correct them. Specifically, the league cracked down on clutching, grabbing, and hooking. From the final season before the lockout (2003-04) to now, scoring is up 23 percent. Jordan Leopold, a defensemen for the Calgary Flames says, "Most of the rules are oriented toward the defensemen. I lead the team in minor penalties."[31] These new rule changes have totally affected how a defensemen can play the game, and many had to change their style just to keep up with the changes.

Rodney J. Paul analyzes the impact of pre-lockout attempts to fix the problems. These changes had specifically intended to put a halt to violence and increase scoring. Before the lockout, the NHL has tried to increase the goals-per-game through rule changes like increasing the offensive zones' sizes, increase the penalties on obstruction, and shrink the size of the goaltender's pads. He also studied fighting. Paul's variables were the total number of goals scored by the team in the previous season (1999-2000)

[31] "NHL Giving Obstruction the Hook," *USA Today*, 6 Nov. 2008, sec. Sports, p.11C

and the average amount of goals scored per game in the next season (2000-2001). For the violence aspect of his study, he used the amount of fights per game. His regressions showed interesting results. Higher scoring teams tended to draw smaller attendance, which applied to all the teams in the league during this time. "This could arise from fans preferring to see a more physical style of game... rather than a more wide-open contest,"[32] states Paul. On the other hand, Paul's results have also shown that fighting for the home team is highly significant and positive for teams in the U.S. and Canada. Basically, Paul asserts that teams who fight more often tend to have higher attendance numbers.[33] Even though the league has tried to crack down on violence because of incidents (like when enforcer Marty McSorley struck an opposing player in the head with his stick without provocation), violence still motivates attendance. "It appears that fans prefer teams that win and have tendencies toward fighting and violence, as opposed to high-scoring, low-violence teams,"[34] Paul said. So maybe the rule changes that brought more scoring and offense was a bad idea for the NHL, and keeping the more defensive, tough-nosed hockey would have been a better option.

A study conducted *after* the lockout was conducted by Gregory Miller, *Does Player Size Affect Productivity In the 'New NHL'?* He specifically examined to see whether a players production was affected by his size once the new rule changes were in affect. The rule changes were widely criticized for being an aid for smaller players, hurting the performance of larger players. This is what interested Miller: "The purpose of this study is to determine if larger players experienced a drop in productivity following

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[32] Paul, Rodney, "Variations in NHL Attendance: The Impact of Violence, Scoring, and Regional Rivalries," *American Journal of Economics and Sociology*, vol. 62, no.2 (April 2003), p.13
[33] Ibid, p.13
[34] Ibid, p.15

the rule changes, as measured by points-per-[game]."[35] The new rules were mainly intended to prevent certain aspects of physical play, not hitting, but obstruction. This required larger players to adjust their style and sometimes hurt their ability to perform at their best. This is important because if large players' productivity did decrease, then their teams needed to reevaluate how they recruit and put their lineups together (particularly trapping teams). Miller's dependent variable is the amount of points a player scores per hour. His independent variables are height, age, and position. Miller also uses data from the year previous from the lockout (2003-04) and the year following the lockout (2005-06) in his linear regression. The coefficients of the two height variables did not change from his two years of studies. Miller notes: "These results imply that the rule changes did not decrease the productivity of larger players and contradict popular belief among fans, franchises, and players."[36] The study shows that taller players are just as likely to produce (get points) as they were before the rule changes. Apparently, the rule changes did *not* hinder taller players, which affects my topic because most defensive defensemen fall into Miller's category of "larger players."

Rodney Paul and Gregory Miller's studies help to shed light on how the rule changes affected the game and the way it is played, specifically addressing the role of larger players and their role in the "new NHL." Paul conducted his study in the pre-lockout era, and if someone did his same exact study today, the results might be different. Currently, it seems that fans and the media love to see both physical play *and* scoring. Miller's study will be especially helpful in studying defensemen in the NHL, especially his assertion that larger players were not hindered by the changes of the lockout.

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[35] Miller, Gregory, "Does Player Size Affect Productivity in the 'New NHL?,'" *Issues in Political Economy*, vol. 17, (August 2008), p.1
[36] Ibid, p.7

Defensive defensemen are normally bigger in stature and it will be interesting to see if his conclusion (that bigger players were unaffected by the rule changes) matches mine.

Conclusion

After analyzing previous studies of NHL player salaries, the effects (on salaries) of team locations and player birthplace origins, player production, and the rule changes, solid groundwork has been laid for proceeding with original analysis. None of these studies focused specifically on defensemen, and worked mostly with forwards specifically because they are easier to study using the popular statistics. For defensemen, production is harder to track using numbers and statistics. There are just some traits which one can only see from watching a hockey game. Defensive defensemen have a job that goes uncounted by the score sheet. To be fair, many of these researchers did not use defensemen in their study because defensive statistics (such as blocked shots) were not tracked until the early-2000's.

This past research uses differing types of variables, most of which could be used in my study, and selecting the correct ones will be critical. Defensemen, as stated earlier, are tough to analyze using statistics. Choosing the right statistical categories to use for my season of study will be of great importance. Many of the researchers used common variables, like points, height, weight, plus/minus, and penalty minutes. The previous research has also used many different determinants for player salaries, and the salary cap is now a consideration (not taken into account by past research since it was not yet

implemented). These selections of salary determinants and factors are all fine, but they could have gone into greater depth using other statistics, which I intend to do.

CHAPTER III

DATA METHODOLOGY

The purpose of this chapter is to discuss the variables (used in the empirical model) that describe determinants of salary for defensemen in the NHL. The data sources, samples, and time frames will also be explained. A quantitative approach (rather than a qualitative) and a regression model will be used to examine the salaries of offensive defensemen compared to those of defensive defensemen. The reason for choosing a quantitative approach is that the data required is easily accessible. To use qualitative, one must have access to players, coaches, and general managers of the NHL teams, which I do not. Also, many people should easily be able to relate to a quantitative approach because I will explain everything.

Sample and Time Frame

This thesis will examine statistics for every NHL defensemen from the 2007-2008 season and their salaries from the 2008-2009 season. The players, statistics, and salaries were taken from NHL.com, nhlnumbers.com, and hockeydb.com. Each of these websites will give me the necessary means to construct each part of my regression model. Every

defensemen that played at least 7 games in the 2007-08 season will be examined. There are 30 NHL teams with roughly 7 defensemen per club. In total, 209 defensemen were included. Of these, 103 were offensive defensemen and 106 were defensive defensemen.

Defensemen were divided into these two categories because while both types contribute equally to a team's winning percentage, their salaries are vastly different. Forwards are far easier to examine in this type of study (as noted by most of the articles in the Literature Review) because their primary job (by far) is to help increase their team's offensive production, and offensive production statistics would be an accurate measure for all forwards. Forwards rarely make an impact on defense during even-strength play, but this is not true both ways; defensemen often have a heavy impact on offense. Because defensemen have major impact in both *areas*, it is more difficult to measure their production. (There is no single statistic that measures the overall production of a defenseman, but for forwards, "points" can be used for this purpose.)

Distinguishing between defensive and offensive defensemen was problematic because there was no "objective" way to do it. I split up the players into two categories using my own, subjective intuition derived from the in-game tendencies of the players. I believe that I am a sufficient judge in this area because I have played hockey (at high levels) all my life and have watched most (if not all) the defensemen in the NHL. I also had the assistance of a few teammates to help me with my assessments. The majority of serious hockey players could distinguish between the two types of defensemen by watching a single game. Some easy ways to tell the difference between the two is whether the defensemen is used on the power play or penalty kill, what opposing forward

line they usually play against, how much they handle the puck, and if they are fast and smooth skaters or not.

Variables

Dependent Variable

In this thesis, offensive defensemen, defensive defensemen, and all the defensemen combined each have their own equation and regression model. The dependent variables are their salaries. Salaries are used because the main question of this thesis is whether financial compensation reflects output. Salaries from the 2008-09 season were used because in most cases (excluding long-term contracts), these directly reflect the value placed on players based on their production. (Note: regardless of how many games the player skated in, his contract is guaranteed, so the number of games played does not affect payment of contracts. The statistics for the dependent variables will be gathered from nhlnumbers.com.)

Independent Variables

For the offensive and defensive defensemen models, 13 independent variables are used from the 2007-08 season. The first variable is assists (A), the total number of assists that the player had for the entire year (not counting the playoffs). Assists are a good statistic for measuring offensive teamwork. This is also a statistic that both offensive and

defensive defensemen can achieve routinely. The source consulted for this data will be hockeydb.com.

The second independent variable is age. This is simply the age of the player during the 2007-08 season. This data was taken from NHL.com.

The third independent variable is the origin of the player's birthplace (BIRTH). This is simply a dummy variable to take note of whether a player is American-born or not. A value of one is given to the player if he is American, zero if he is born anywhere else in the world. The data source consulted to find the birthplaces was NHL.com.

The total number of blocked shots (BS) over the course of the season (not counting the playoffs) was the fourth independent variable. This statistic, as mentioned in my Literature Review, was not recorded until the early-2000's. It is very important for a defenseman to block shots to be noticed in the "new NHL." This number can vary tremendously. NHL.com again provides this statistic.

The fifth independent variable is goals (G). Like assists, goals are measured by the total number recorded in a season (not counting the playoffs). Defensemen rarely score goals, even on the power play because even then, they're usually stationed out at the blue line in the offensive zone. Goals are not often (directly) scored from such distances. The most goals scored by a defenseman in the 2007-08 season was 18 (by Mike Green). Many did not score even once. The statistics for goals were found on hockeydb.com.

Games played (GP) were the sixth independent variable. As previously stated, the minimum here was 7 games. This statistic demonstrates the ability to play through injury and sickness, which impacts most players in the league. The NHL season is an 82-game

grind. Even playing 38-40 games at the college level is difficult. The GP data was gathered from hockeydb.com.

The seventh independent variable is the total amount of hits the player recorded during the season (not counting the playoffs). Like blocked shots, this statistic is especially important for measuring the production of defensemen. Defensemen must do everything possible to slow the forwards of the opposing team. The more times the forwards get hit, the more their bodies wear down and the less likely they are to score. The statistics for hits were located on NHL.com.

Height (HT) is the eighth independent variable. Size is an attribute that defensemen normally need to produce and succeed in the NHL. Height is recorded with decimals. If a player is 6 foot, 1 inch, it is recorded as 6.01. The data consulted for height was located on NHL.com.

The ninth independent variable is total amount of penalty minutes (PIMS) received in the 2007-08 season (not counting the playoffs). With the new rules, penalties occur regularly during a game. Defensemen usually take more penalties than forwards. Defensemen also fight more often, which is worth 5 penalty minutes in the penalty box (as opposed to the usual two). The data on penalty minutes data was collected from hockeydb.com.

Plus/minus (PLSMIN) is my tenth independent variable. This statistic is defined on page 5 of my Introduction. Plus/minus is often (improperly) thought to be an accurate measurement of the general performance of defensemen. This is because the top defensive defensemen will have to go against the opposing team's top forward line, and more times than not, they will not be prevented from scoring for an entire game. So, the

plus/minus of the defensemen charged with confronting the best opposing forwards is often *not* a true indicator of their performance. On the other hand, offensive defensemen will be matched up with the less dangerous forwards of the opposing teams, so their plus/minus may be inflated relative to defensive defensemen. The plus/minus data was recorded from hockeydb.com.

The eleventh independent variable is points-per-game (PPG). PPG is measured by dividing the total number of points by the number of games played (both being totals from the regular season only). This statistic will affect offensive defensemen more than defensive defensemen because offensive defensemen need to produce offensively to have value. Defensive defensemen are obviously a different case. PPG was recorded from NHL.com.

Shots are the twelfth independent variable. This is simply the total number of shots on goal recorded by defensemen during the 2007-08 regular season. Again this statistic applies primarily to offensive defensemen, but defensive defensemen also must record shots every once in awhile, if anything to cause a rebound for the forwards to play. Shots were recorded from NHL.com.

The thirteenth and final independent variable is weight (WT). Weight is measured in the total amount of pounds that each player weighs. This should be very closely related to height. Height and weight both determine a player's size and we will see if this has anything to do with the salary that he inherits. Also, like height, weight data was found on NHL.com.

In the complete regression model, one more independent variable was added, whether the player is right-handed or left-handed (RL). When stating a forward's

position, the *exact* position is usually accounted for: centers are in the middle, left wings and right wings take their sides. On the other hand, defenseman usually just listed as "D" and play both sides of the ice. It's considered highly preferable for defensemen to be on their forehand relative to the boards (facing up-ice) as often as possible because when trying to stop a puck along the boards, it's drastically easier to be on the forehand (to shoot the puck away from an opposing player or make a pass). This is called the "strong side," and the opposite is the "weak side." For defensemen, playing the strong side (and thus right or left handedness) is a major consideration in the evaluations of general managers and scouts. This attribute (RL) is also a dummy variable, with left-handers numbered with a 0 and right-handers are presented with a 1. The data was recorded from NHL.com.

The table below is a list of the independent variables to be used in the empirical model, as well as their abbreviations, the expected outcomes for defensive defensemen and offensive defensemen, as well as the data source used for each variable. For the expected outcomes, the top entry applies to defensive defensemen and the bottom to offensive defensemen.

Table 3.1

Variable, abbreviation, expected outcome, and data source table

Variable	Abbreviation	Expected Outcome	Data Source
Assists	A	Def: Negative Off: Positive	Hockeydb.com
Age	AGE	Def: Negative Off: Negative	NHL.com
Birthplace	BIRTH	N/A	NHL.com
Blocked Shots	BS	Def: Positive Off: Negative	NHL.com
Goals	G	Def: Negative Off: Positive	Hockeydb.com
Games Played	GP	Def: Positive Off: Positive	Hockeydb.com
Hits	HITS	Def: Positive Off: Negative	NHL.com
Height	HT	Def: Positive Off: Negative	NHL.com
Penalty Minutes	PIMS	Def: Positive Off: Negative	Hockeydb.com
Plus/minus	PLSMIN	Def: Positive Off: Positive	Hockeydb.com

Points-per-game	PPG	Def: Positive Off: Positive	NHL.com
Shots	SHOTS	Def: Positive Off: Positive	NHL.com
Weight	WT	Def: Positive Off: Negative	NHL.com
Right-handed or Left-handed	RL	N/A	NHL.com

Conclusion

This chapter has examined the variables to be used in the empirical model. It also showed the statistics that best measure production, and *should* determine salaries. All of the variables were defined, expected outcomes were given, and data sources were specified. The following chapter will present the regression models and the results that they give.

CHAPTER IV

RESULTS

This chapter will examine my empirical and regression models featuring the 209 defensemen that played in the 2007-08 season. Listed below are summary statistics, specifically, the mean, standard deviation, minimum, and maximum are displayed.

Table 4.1

Table of the variables, mean, standard deviation, minimum, and maximum

Variable	Mean	Standard Deviation	Minimum	Maximum
Salary	2.308354	1.779943	.071	7.5
A	14.98	11.1	0	60
AGE	27.167	4.5737	19	45
BIRTH	.22	.415	0	1
BS	82.64593	42.20348	8	227
G	4.292	4.034	0	18

GP	63.62	18.49	7	83
HITS	76.785	49.987	4	266
HT	5.90809	.3049	5.08	6.09
PIMS	50.335	30.356	0	182
PLSMIN	1.39234	10.0105	-29	40
PPG	.286536	.178248	0	.921
RL	.29	.45	0	1
SHOTS	80.8278	48.8971	5	263
WT	210.258	14.7025	175	255

On the following page is the correlation matrix. This table shows the relationships between the various independent variables in this thesis.

Table 4.2

Correlation Matrix

WT	SHOTS	RL	PPG	PLSMIN	PIMS	HT	HITS	GP	G	BS	BIRTH	AGE	A	
-0.1586	0.8251	0.0030	0.9198	0.2322	0.2253	-0.0833	0.0993	0.5583	0.7304	0.2834	-0.0564	0.1973	1.0000	A
0.0162	0.0933	0.0879	0.1885	0.1214	0.1358	0.0233	0.0481	0.1251	0.0265	0.2354	-0.0397	1.0000	0.1973	AGE
-0.0896	-0.0502	-0.0202	-0.0471	-0.1456	-0.1366	-0.1196	-0.0769	-0.0215	-0.0012	-0.0207	1.0000	-0.0397	-0.0564	BIRTH
-0.1228	0.3063	-0.0557	0.1050	0.0351	0.3534	-0.0391	0.5141	0.6407	0.1580	1.0000	-0.0207	0.2354	0.2834	BS
-0.0447	0.8402	0.1247	0.8016	0.2188	0.2665	-0.0321	0.1691	0.4482	1.0000	0.1580	-0.0012	0.0265	0.7304	G
-0.0082	0.6214	0.0730	0.3181	0.1752	0.4531	-0.0559	0.4918	1.0000	0.4482	0.6407	-0.0215	0.1251	0.5583	GP
-0.3964	0.3038	-0.0048	-0.0139	-0.0988	0.5773	-0.0592	1.0000	0.4918	0.1691	0.5141	-0.0769	0.0481	0.0993	HITS
-0.5040	-0.0877	-0.0213	-0.0824	-0.0886	-0.1076	1.0000	-0.0592	-0.0559	-0.0321	-0.0391	-0.1196	-0.0233	-0.0833	HT
-0.3724	0.3631	-0.0366	0.1365	0.0656	1.0000	-0.1076	0.5773	0.4531	0.2665	0.3534	-0.1366	0.1358	0.2253	PIMS
-0.0385	0.1396	-0.0101	0.2021	1.0000	-0.0656	-0.0886	-0.0988	-0.1752	-0.2188	-0.0351	-0.1456	-0.1214	-0.2322	PLSMIN
-0.1697	0.7828	0.0798	1.0000	-0.2021	-0.1365	-0.0824	-0.0139	-0.3181	-0.8016	-0.1050	-0.0471	-0.1885	-0.9198	PPG
-0.0472	0.0805	1.0000	-0.0798	-0.0101	-0.0366	-0.0213	-0.0048	-0.0730	-0.1247	-0.0557	-0.0202	-0.0879	-0.0030	RL
-0.0556	1.0000	-0.0805	-0.7828	-0.1396	-0.3631	-0.0877	-0.3038	-0.6214	-0.8402	-0.3063	-0.0502	-0.0933	-0.8251	SHOTS
1.0000	-0.0556	-0.0472	-0.1697	-0.0385	-0.3724	-0.5040	-0.3964	-0.0082	-0.0447	-0.1228	-0.0896	-0.0162	-0.1586	WT

The correlation matrix shows that there are some relationships between independent variables that require analysis. Many of these relationships are obvious. Some independent variables that are closely correlated are shots to goals (.8402), shots to assists (.8251), and shots to points-per-game (.7828). This should not come as a surprise because the more shots a player gets to the net, the more goals he is likely to score. The "Great One," Wayne Gretzky put it best when he said, "One hundred percent of the shots you don't take don't go in." Also, when a player shoots the puck more frequently, the better his chances for assists because of rebounds and deflections that occur around the net.

Another expected correlation is points-per-game to goals (.8016) and points-per-game to assists (.9198). These relationships should be high because the more goals a player generates and the more assists he records, the higher his points-per-game will be. These high correlation values mean that there is multicollinearity between several of the independent variables.

One correlation that is somewhat surprising is goals to assists (.7304). This means that the more goals a defenseman scores, the more assists he will generate as well. This correlation directly relates to offensive defensemen. Their specific job is to produce points, either by scoring or helping a teammate score. Defensemen generally will not produce many goals, but according to this matrix the more goals they score, the more assists they will get and ultimately points they will achieve. To address the issue of multicollinearity, three regression models were run, one for offensive defensemen,

another for defensive defensemen, and a third for all the defensemen combined. The three models are listed below in their empirical form.

Model Equations

Model 1

Offensive Defensemen Salaries= β0 + β1 Assists (A) + β2 Age + β3 Player's Birthplace (BIRTH) + β4 Blocked Shots (BS) + β5 Goals (G) + β6 Games Played (GP) + β7 Hits + β8 Height (HT) + β9 Penalty Minutes (PIMS) + β10 Plus/minus (PLSMIN) + β11 Points-per-game (PPG) + β12 Shots + β13 Weight (WT)

Model 2

Defensive Defensemen Salaries= β0 + β1 Assists (A) + β2 Age + β3 Player's Birthplace (BIRTH) + β4 Blocked Shots (BS) + β5 Goals (G) + β6 Games Played (GP) + β7 Hits + β8 Height (HT) + β9 Penalty Minutes (PIMS) + β10 Plus/minus (PLSMIN) + β11 Points-per-game (PPG) + β12 Shots + β13 Weight (WT)

Model 3

All Defensemen Together Salaries= β0 + β1 Assists (A) + β2 Age + β3 Player's Birthplace (BIRTH) + β4 Blocked Shots (BS) + β5 Goals (G) + β6 Games Played (GP) +

β7 Hits + β8 Height (HT) + β9 Penalty Minutes (PIMS) + β10 Plus/minus (PLSMIN) + β11 Points-per-game (PPG) + β12 Shots + β13 Weight (WT) + β14 Right/Left Handed (RL)

The table below displays the regression results for offensive defensemen. T-Statistics are considered significant if they are greater than 1.96. There are no problems with heteroskedasticity, serial correlation, or normality. Heteroskedasticity was checked using the White correction test, and the result for R-squared was lower than the chi-table number given for thirteen variables at the 5% level. Serial correlation was tested when applying the Durbin Watson test where the number needs to be near two (which they all are). Normality was confirmed using the Jarque-Bera test, where the number has to be below six, which the results are.

Table 4.3

Regression results for offensive defensemen

Dependent Variable: SALARY
Method: Least Squares
Date: 12/15/09 Time: 21:55
Sample: 2 104
Included observations: 103

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-8.927982	2.593127	-3.442941	0.0009
A	0.012703	0.040049	0.317184	0.7518
AGE	0.082464	0.031930	2.582629	0.0114
BIRTH	0.018679	0.310314	0.060194	0.9521
BS	0.013076	0.004761	2.746554	0.0073
G	-0.089917	0.063486	-1.416315	0.1602
GP	-0.023327	0.015653	-1.490296	0.1397
HITS	-0.000803	0.004042	-0.198689	0.8430

HT	0.721174	0.403832	1.785824	0.0775
PIMS	0.002310	0.005334	0.433041	0.6660
PLSMIN	-0.026805	0.012285	-2.181931	0.0317
PPG	5.577964	2.755906	2.024004	0.0460
SHOTS	0.014371	0.005785	2.484358	0.0148
WT	0.012616	0.012843	0.982269	0.3286
R-squared	0.710349	Mean dependent var		2.963825
Adjusted R-squared	0.668040	S.D. dependent var		2.067572
S.E. of regression	1.191251	Akaike info criterion		3.313638
Sum squared resid	126.2981	Schwarz criterion		3.671756
Log likelihood	-156.6524	F-statistic		16.78968
Durbin-Watson stat	1.771634	Prob(F-statistic)		0.000000

Table 4.4

The table below shows the regression results for defensive defensemen.

Dependent Variable: SALARY
Method: Least Squares
Date: 12/15/09 Time: 21:58
Sample: 105 210
Included observations: 106

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.287258	3.824731	-0.336562	0.7372
A	0.056482	0.058442	0.966467	0.3363
AGE	0.039550	0.023008	1.718924	0.0890
BIRTH	-0.153716	0.238307	-0.645033	0.5205
BS	0.007237	0.003175	2.279160	0.0250
G	-0.023919	0.084058	-0.284549	0.7766
GP	-0.007962	0.012419	-0.641166	0.5230
HITS	0.004274	0.002834	1.508163	0.1349
HT	0.058884	0.658510	0.089419	0.9289
PIMS	0.002597	0.004364	0.595145	0.5532
PLSMIN	-0.009565	0.011505	-0.831374	0.4079
PPG	-0.216350	3.209269	-0.067414	0.9464
SHOTS	0.001281	0.006792	0.188619	0.8508
WT	0.001952	0.008093	0.241228	0.8099
R-squared	0.372922	Mean dependent var		1.671434
Adjusted R-squared	0.284314	S.D. dependent var		1.136812
S.E. of regression	0.961723	Akaike info criterion		2.882320
Sum squared resid	85.09186	Schwarz criterion		3.234095
Log likelihood	-138.7630	F-statistic		4.208639
Durbin-Watson stat	2.071292	Prob(F-statistic)		0.000018

Table 4.5

The table below illustrates the regression results for all the defensemen together.

Dependent Variable: SALARY
Method: Least Squares
Date: 12/15/09 Time: 22:00
Sample: 2 210
Included observations: 209

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-5.846077	1.823767	-3.205496	0.0016
A	0.032380	0.029486	1.098134	0.2735
AGE	0.074865	0.018683	4.007149	0.0001
BIRTH	-0.060677	0.194062	-0.312667	0.7549
BS	0.007791	0.002640	2.951558	0.0036
G	-0.026115	0.046333	-0.563641	0.5736
GP	-0.019783	0.009110	-2.171586	0.0311
HITS	0.002530	0.002349	1.077229	0.2827
HT	0.590112	0.302420	1.951298	0.0525
PIMS	0.003758	0.003423	1.097895	0.2736
PLSMIN	-0.023132	0.008478	-2.728462	0.0069
PPG	3.721176	1.894962	1.963721	0.0510
RL	-0.240081	0.176749	-1.358315	0.1759
SHOTS	0.010210	0.004115	2.481225	0.0139
WT	0.003402	0.007203	0.472334	0.6372

R-squared	0.637115	Mean dependent var	2.308354
Adjusted R-squared	0.610927	S.D. dependent var	1.779943
S.E. of regression	1.110252	Akaike info criterion	3.116116
Sum squared resid	239.1359	Schwarz criterion	3.355996
Log likelihood	-310.6341	F-statistic	24.32886
Durbin-Watson stat	1.731186	Prob(F-statistic)	0.000000

Regression Models Discussion

Offensive Defensemen

In the first regression model run, there were five variables that were statistically significant at the 5% level: AGE, BS, PLSMIN, PPG, and SHOTS. For this model, the data implies that age, blocked shots, points-per-game, and shots all have a positive impact on the offensive defensemen's salaries. The variable plus/minus, however, has a negative impact on the offensive defensemen's salaries. Surprisingly, all the positive impact variables seemed to have the same amount of influence on the salaries. This model's results imply that older defensemen, those with more blocked shots, high points-per-game, and the more shots will all contribute positively to the salary of an offensive defenseman. Also, the results suggest that the better plus/minus an offensive defensemen has, the less his salary will be. For this model, when looking at the R-squared total, the variables account for 71 percent of the variation of offensive defensemen's salaries.

Defensive Defensemen

In this regression there was just one variable that was significant, which was BS. The blocked shots variable has a positive effect on a defensive defensemen's salary. Age and hits are close to being positively significant, but fell just short of the 1.96 mark. There are a few variables that impacted the salaries of defensive defensemen, but none

were of high significance. This model accounted for 37 percent (the R-squared) of the regression equation.

All Defensemen Together

The final regression model showed that there were six significant variables: AGE, BS, GP, PLSMIN, PPG, and SHOTS. In this model, the R-squared result is approximately 64 percent of the variation of all the defensemen's salaries. As with the regression for offensive defensemen, age, blocked shots, points-per-game, and shots all positively impacted salaries. Also, like the offensive defensemen model, plus/minus impacted all the defensemen negatively. Games played also affected the dependent variable negatively. In summary, the model suggests that the better plus/minus and the more games a defenseman has skated in, the less his salary will be.

Expected Vs. Actual

The four independent variables that were significant for determining salaries positively were somewhat surprising. Points-per-game and shots were both predicted to positively affect salaries, but age and blocked shots for offensive defensemen were predicted to be negative (and were actually positive). For defensive defensemen, blocked shots were predicted to be a positive variable for salaries and they were. Plus/minus –

while expected to influence salaries positively for all -- negatively impacted offensive defensemen, as well as the salaries of all defensemen combined. Another category that was predicted to be positive but turned out negatively was games played. The one variable that was consistent in all three models was blocked shots, which impacted all three positively.

Chow Test

The Chow test was additionally run to determine if the regression models were tested correctly and also helped in determining whether to reject the null hypothesis. One must find the F-statistics (for the regression models) and make sure that the number is larger than their critical value in order to verify the potential rejection of the hypothesis. Below is the equation for my F-Statistic. All the numbers were found in the regression model of all the defensemen combined.

F Stat = (239.1359 – 126.2981- 85.09186/ 13) / (126.2981+ 85.09186) / (103+ 106 – 2*13) = 2.1343 / 211.38996 / 183 = 5.51722

Critical Value = F (11, 183) = 3.60

The F-Statistic is larger than my critical value. Thus, I reject the null hypothesis, which was that offensive defensemen and defensive defensemen would be paid evenly. As seen in the regression results, as well as the Chow test, the salaries of the two types of defensemen were not equal whatsoever.

Conclusion

This chapter discussed the three empirical and regression models that were used as well as their findings. After examining the results given by the regression models, interpretation must follow. The next chapter will explain the conclusions and impact of the regression results as well as discussing limitations and potential follow up.

CONCLUSION

In this chapter, there will be a research summary, as well as discussion of the goals and results of this thesis. Limitations and possible areas for future study and will also be presented.

Summary

The focus of this study was the salary determinants for offensive defensemen and defensive defensemen using data from 2007-08 and salaries from 2008-09. This thesis aimed to analyze what statistics and production numbers determined the salaries. As seen in the regression models, on average, offensive defensemen were paid almost twice the salary of defensive defensemen (see regression models: $2.96 million -$1.67 million). This was somewhat expected, since traditionally, offense has been a more admired trait (even for defensemen), but the disparity was substantially larger than one would anticipate. The degree of difference is particularly surprising because of the recent increase in the recognition of defensive defensemen, both in statistical categories (blocked shots) and salaries (the example of Jay McKee).

Many sports economists have studied NHL contracts and their determinants, but no one has specifically looked at the breakdown of offensive and defensive defensemen. The previous studies mainly examined forwards, and occasionally examined defensemen with variables normally used for forwards. Defensive statistics did not become popular until the early-2000's, which hindered the economists who attempted to study defensemen in previous years. Some researchers found that a defenseman's salary is determined by his skill, experience, and size. However, other economists assert that it is impossible to measure defensemen through conventional statistics.

To attempt an answer to the question of which statistics help a defenseman earn a higher salary, the statistical data for every defensemen from the 2007-08 season was gathered to perform a comprehensive analysis. In total, 209 defensemen were evaluated. There were fourteen independent variables used for all the defensemen pooled together, and thirteen independent variables used for measuring both the offensive defensemen and defensive defensemen separately. All of these variables were expected to affect the dependent variable, salary. The correlation matrix showed that shots to goals, shots to assists, and shots to points-per-game were highly correlated, as well as points-per-game to goals and points-per-game to assists.

Of the fourteen total independent variables tested, six were discovered to be statistically significant to salaries. Age was found to be the most positively significant for a defensemen. A potential reason for this is that experience for defensemen is highly valued. Perhaps NHL General Managers believe that when defensemen are older, they generally play with more confidence. I have learned this first hand: Being an older

player in a league (first the USHL, then the WCHA) has helped me play with more confidence, which has improved my overall play.

Blocked shots and shots were also highly significant for determining the salaries of defensemen. The more shots a defensemen gets in a season, the more he is getting involved in the offense. Getting shots on goal through traffic (opposing players) from the offensive blue line is an important skill that often plays a major role in helping a team win games. Thus, when defensemen gets their shots through they get paid more. Another positive correlation was blocked shots: in the new NHL, it has become increasingly important (and noticed) for defensemen to have the proper shot-blocking technique and the willingness to block shots. The new rules have increased the amount of time the puck stays in the offensive zones (and not the neutral zone) as well as shrinking the size of goaltender's pads. Hence, the more shots a defenseman block, the higher his salary.

Points-per-game was also found to be statistically significant. This should be obvious because ultimately this statistic (which is the most popular) shows if the player contributes to scoring. In the case of defensemen, it also shows whether the player is skilled enough to appear on their team's power play. When a defensemen does well in points-per-game, it shows that they are offensively talented. These types of defensemen are a valuable (and somewhat rare) commodity, so they are usually paid a higher salary than a defensive defenseman.

On the other hand, there were two negative independent variables that strongly impacted salaries. Plus/minus is a statistic that *can* be used to determine the performance of a defenseman, but this sort of evaluation has flaws, especially in the case of defensive defensemen. Because a defensive defenseman's job is to shut down the opposing team's

top lines, his plus/minus is often lower than it would normally be. Ordinarily, he would also spend time matched up against unskilled opposing forwards, substantially lessening the chances of goals being scored against his team. In the opposite case, offensive defensemen are primarily matched against the opposing team's bottom lines, forwards who normally will not score nearly as often as the first line. Personally, I dislike measuring defensemen using plus/minus for these reasons. My study shows that the higher a defenseman's plus/minus, the less he is paid.

The other negative independent variable is games played. This result seems odd because usually, a defenseman who manages to play most games demonstrates stability. However, the job of a defenseman is more bruising and physically taxing than that of forwards. To play a full season without missing a game (of which there are 82), a defenseman either demonstrates incredible resilience and durability, or it means he isn't playing very much. In a few cases, the top defenseman on a team (playing more minutes than the others) will manage to stay healthy for the entire season. However, this is a rare occurrence, and only a few elite players manage it. This is how one might explain why the more games a defenseman plays, the less he is paid: the defensemen who miss the fewest games stay healthy because they see *less* game time (because they are less skilled, which explains why they have lower salaries).

Practical Applications

My results help to explain the critical decisions made by NHL General Managers and scouts. They must recruit and assemble a winning lineup constrained by a hard

salary cap. Because of the restriction, they must carefully coordinate their strategy and select defensemen whose capabilities fit their mold (balanced between defense and offense). GM's must try to anticipate the future as to what kind of defensemen they will need, not just depending on their current roster, but anticipating possible NHL rule and style changes. With an expected salary cap of about $56 million and a minimum roster of 20 players, the payroll must be managed carefully.

This thesis uncovers many important practical trends. Age and points-per-game proved to be significant determinates for salary. This is valuable information for GM's because it shows that the more points a defensemen gets and the older he is, the more GM's (as a group) pay him. Another result that GM's might find interesting is that the plus/minus variable negatively impacts salary. This shows that GM's (in contrast with the public) likely to do not rely too heavily on plus/minus, which makes sense.

Future Study

This thesis contains a few results that would make for great future study. For one thing, to make the results more secure, the study could be extended for a longer time period, perhaps five years.

One future change that could possibly be used would be to use different dependent variables for the defensemen. Instead of using just salary, it would be interesting to try points-per-game, blocked shots, and age as *dependent* variables.

Another area for future study would be to differentiate between offensive and defensive forwards. One would use points-per-game, goals, assists, hits, penalty minutes or age as dependent variables, but also incorporate defensive statistics such as blocked shots as well.

A final area for possible future research would be to apply a similar study (to this one) to the NBA or Soccer. One could do this by separating the more offensive players from the defensive players to see what determines a salary in each sport. For both, one could use points-per-game, assists, fouls and variations of plus/minus. Basketball would include blocks.

Limitations

There is one especially significant limitation for this thesis, and it is that only one year was analyzed. A few more years (maybe the two years before and after the lockout) would have cemented results and increased accuracy. Time was an issue however, so looking at the 2007-08 season alone was used.

Using *all* the defensemen (209) in the NHL for one season, yielded plenty of data, but if additional years had been used a more accurate pool (of only regulars, rather than all defensemen who played seven or more games) could have been used. Also, with more years studied, the size of the pool would have been increased considerably. The defensemen who played and earned the most would have probably given me more accurate results.

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