COST OF WINNING IN THE NHL

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Michael Boivin

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Michael Boivin

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Abstract

This thesis investigates the factors and cost of a winning NHL franchise. The objective is to learn areas of the team statistics which to improve upon to have a successful team which makes playoffs. The study found that shots on goal and payroll were two variables that a general manager could increase and would results in more wins per season and in some cases taking a team who misses playoffs to a playoff team.

KEYWORDS: (NHL, Cost, Winning)

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Hockey is one of the major sports in North America. With millions of dollars in revenue from ticket sales, advertising, and television deals it goes without saying that putting the best product you can on the ice is a major business. General Managers are the CEO's of the hockey world. They control trades, signings, and all other business related matters for the franchise. Producing wins both for the success of the franchise and business as well as for fans either at the games or watching on television is the number one indicator of success for a General Manager. Maximizing wins is a combination of many factors, including facilities, locations, and the focus of this paper, personnel. Different players bring different aspects and elements to a team. Optimizing the combination of players and skills is a very difficult job with no exact formula for success. Different teams need different skills and there are many different ways to win a hockey game, better defense, better offense, more or less toughness in the style of game, all of these are under consideration when a GM is contemplating a move for his business (franchise). Looking at where players came from before entering the league and their performance once in the league are major aspects considered by a GM. Obviously it goes without saying that any franchise is a business, and like any business financial gains are also an important part of the business. This enters the equation for a GM because he has

to find the right players for the right jobs for the right price, all to improve the success of the franchise and increase the number of wins in a season.

There are many entry points into the NHL. Initially looking into if a player was drafted in the NHL entry draft and which round they were drafted in and then looking into player's performance before entering the NHL. There are several different roads to take to get to the NHL including NCAA, Canadian Major Junior, and European leagues so looking into understanding which leagues prepare the best for the NHL is the next step. Performance in those leagues based off point production and penalty minutes. The NCAA, Canadian Major Junior that consists of three leagues (WHL, OHL, and QMJHL), American Junior (USHL), and grouping all the European leagues together are the dummy variables for league in the model.

The objective is to gain insights and an understanding of how the different routes and performances prior to entering the NHL affect the four major dependant variables, goals, assists, and penalty minutes ultimately affect a teams wins. This two-step approach breaks down the individual's data and then applies those individual findings into a team's performance.

CHAPTER II

LITERATURE REVIEW

The cost of winning in the NHL is a topic anyone interested in hockey would be excited to read about, but this model and this theory provides insight into the economics of business not just the sport of hockey. A hockey team is like any other business, it needs to be profitable to stay alive. And to stay profitable any company needs to be successful at what they do, whether that is selling a product or filling up the seats in a stadium. In every market there are successful businesses and unsuccessful businesses fighting to stay alive, and these companies are always looking for a way to fix their problems and turn their company around. When a company is unsuccessful there are a few options, fold the company, move the company, or make changes to their current situation. This model will look at all those options specifically for a hockey franchise but will have direct relevance to any business in any market. This topic is important to general economics because the theory behind it can be translated to any business in the market being analyzed. The hockey team is just one example of a business in the market but the theory applies to any struggling business, being able to analyze the areas of the business which are weak and need improvements and more funding or looking into moving a struggling company and finding a new market, which will help promote success for the business.

For a hockey franchise or any sporting entertainment enterprise, the higher the competition level the higher attendance will be (Forrest, David 2006). For a hockey team being able to put the best team on the ice who will optimize wins will lead to a more successful business. Putting the best team on the ice is a difficult component to analyze, what is the model or combination for the best team? In this study I will attempt to categorize players by a number of aspects such as point production, time on ice statistics, years in the league to measure a veteran presence, goal tender performance, and salaries. I will try to find the combination of these different types of players with different attributes to optimize wins and lead to a successful season. For the purposes of this study a successful season will be defined initially as making it into the post season for playoffs.

For the perfect combination of players, starting at the goal tender positions seems like as good a place as any to begin. When reading into the existing literature on analyzing goalie performance and their contribution to teams winning it was shown that goalies previous years statistics have less than a 25% correlation to the next years statistics (Berri, David J. 2010). This studies main focus is to see the contribution the goal tender has on wins and to analyze how much a goalies past performance predicts future performance. This tells us that for goal tenders the "star" factor really seems irrelevant, because just because a goalie had an amazing season one year that gives little indication as to how they will perform the following year.

This model used the OLS regression to test for the dependant variable, log of salary, and ran tests for heteroskedasticity, consistent standard errors and covariance. This paper takes the position that the ultimate goal for a team is to win the Stanley cup, a pretty understandable suggestion, it then states that for a team to do that it must have a

"hot" goalie going into playoffs, or a star goalie performance in playoffs. The paper makes this distinction because when looking at the regular season data it revealed an R-squared of .06 which tells us that 94% of the goalies performance cannot be determined by his performance in the previous season. So what is actually important is to look at the post season data, and this revealed an R-squared of .07 which tells us that 93% of what a goalies performance is in the post season can not be explained by what he did in the regular season. What this paper found was the difference between a star goalie and your average goalie statistically is not that much different. When comparing the "star" goalie using Brodeuer arguably the best goalie of all time and the average goalie this paper found that the difference in save percentage throughout a season was about 1%. Something so minor and expanding this to look over the length of a career the paper found an average goalie would only have about two less wins per season than the star goalie.

The next position to analyze would be defensemen. This position requires more insight into categorizing defensemen. For our purposes we will categorize defensemen in two ways, offensive defensemen whose analysis of their value will be determined by their point production, and character veteran defensemen who provide an intangible benefit to a team with their experience and defensive abilities which cannot simply be analyzed through points.

For this veteran aspect of the defensemen using the model by (Vincent, Claude 2009) that looks at salaries and games played in the league we can see that the more games played the higher salaries are generally earned. This shows the value that is put on the veteran aspect of a player. However, the relationship curve between games played

and salary does have a peak and then start to flatten out then decrease slightly showing that eventually the older player's value does start to decline.

We can find the value in dollars for that veteran presence as well as looking at their plus minus statistic. For the analysis of the offensive defensemen we will look at their point production and their plus minus statistic recorded for how well they perform defensively and offensively throughout a season. This paper uses a Quantile regression approach using the OLS model and found that the Plus/Minus stat was significant when looking at earnings for defensemen and the Penalty minutes variable is significant when looking at earnings of forwards. This quantile regression also found that the earnings equation explains more of the variation in the earnings of high-paid defensemen compared to the lower paid players. The R-squared was approximately 30% at the 10^{th} quantile and the explanatory power increases as you move along the earning distribution to 53% at the 75^{th} and 90^{th} quantiles. The paper also found that experience (games played), points per game, and whether a player was drafted or not all have significant effects on the earnings of both forwards and defensemen. This is useful for my own research because these are all variables I will be using in my own model and now know that they do have significant effects on the results in this model.

For the forwards we will be using a very similar approach as the defensemen but will also add to statistic of penalty minutes to add another category of forwards who are the fourth line tough guys and fighters. These are an important aspect to any hockey team because keeping opposing players accountable is necessary for their own team's safety as well as giving the goal scoring forwards more time and space on the ice. We will also be using the same model of veteran forwards as well as the point production and plus minus

statistics for goal scoring forwards (Vincent, Claude 2009). There are different variables that have positive effects for forwards and not defensemen so altering the equation slightly with different variables will give us a more accurate insight while using the same framework as mentioned above for the defensemen. For the forward's games played, points per game, penalty minutes all have a positive sign and are significant at the 5% level. Plus minus for forwards showed to have insignificant coefficients which is surprising because that suggests that only he forwards offensive output is being recognized and valued no matter how risky or incompetent they are in the defensive zone. Similarly to the defensemen the R-squared explains less variation in lower earning forwards, the R-squared explains 32% of variation at the 10^{th} quantile and increases steadily to 62% at the 75^{th} and 90^{th} quantiles.

This player or personnel analysis can be converted to look at any company as well. If a company is not performing the way it should and not producing the output it needs to be successful, looking at the components in that company and their employees is a good place to start. Looking at who to add and what positions they need to make changes to could help provide a better output. In hockey it is changing players and acquiring new players for positions they are weak in, but for a company that can be adding a new president or adding new members to the sales force or whatever changes that company specifically needs.

The next component to look at would be the franchise or business as a whole. This analysis for hockey would include a broad market view. Where is the team located and how is that affecting the team's revenue. The factors that go into this analysis are very extensive. Looking at average game attendance, average ticket price population,

median household income, capacity of arena, cost to build arena, number of other major sports teams, 9 and 10 year old participation in the sport (capturing the younger interest in the sport), number of superstars on the team, season winning percentage, last seasons winning percentage, and operating income gives an extensive view into the capability of where the team is currently located to be successful (Poplawski, Wade 2012). The research found that median income of the MSA has little effect on the attendance of games but does have a positive effect on the price that can be charged for tickets. The venue has a positive effect on attendance with a greater capacity building predictably increasing attendance. The Winning percentages from both the current and previous seasons play a significant role in the attendance. For existing teams the model had an accuracy of 74% and predicted better out of sample at 83%. This model follows the Jones and Ferguson (1998) model, which is a two-equation model with attendance and price as the dependant variables and the above list as independent variables. The assumption that a cities demand to attend games is a linear function of the price, where the slope and position of the demand curve depends on the certain location and team characteristics (Poplawski, Wade 2012).

This paper found interesting results for the time it was written. Just before this paper came out the Atlanta Thrashers moved to Winnipeg, a smaller Canadian market. The papers general findings were that with the new CBA smaller market teams became more viable and likely to succeed. This hypothesis and finding was backed up when looking at the specific case of Atlanta and Winnipeg, the paper found that this move was rational and likely to succeed. The model also found two other cities in Hamilton and Portland that are smaller markets that are likely able to succeed and hold a new franchise.

This analysis can be done for a current teams location but also is very useful when looking into relocating or creating a new franchise, or in the business world of economics, where is the best place to start a new business or where to move a current business that is struggling. This paper is very useful for my research when looking into the new or existing markets for team location but is limited in their analysis of the teams success and contribution to the market, which my paper will address.

With all the individual components analyzed looking at the broader view of analyzing the entire model is the next step. The analysis will be based upon a cost function. Looking into previous research on cost functions will help shape my model. A previous study looking at the negative effect that travel has on NBA team production (Nutting, Andrew W. 2010) has a useful single output analysis that can be translated and modified to fit my own model. The model does use the same independent variables while running separate regressions for each of its selected dependant variables. For my own model I could incorporate the required winning percentage to make playoffs and the cost as my dependant variables. The framework of this paper could be very similar to my own when looking at the different factors affecting win production in this case and looking at a production output high enough to make playoffs.

The paper runs a production function, which finds that game frequency affects win production as well as time zone changes being significantly correlated with winning percentage. This is useful for my paper because deciding where to locate a team may now also have to take into consideration which time zone it is in and what relationship to its opponent's time zones it has. This paper also suggests that for future research one should look into the in-game statistics and see what impact they have on the team's production

function. This is very similar to what I plan on doing with my research but for the hockey teams production and cost functions.

Sports teams are complex businesses and franchises because so many variables have an effect on the team's performance. Having narrowed down win production and an output minimum which gets a team into playoffs, the next piece of literature looked at baseball and found that two-output models were a better type of analysis than the single-output producers (Stewart, Kenneth G. 2010). The study found that the two-output model was better when looking at wins, road attendance, and home attendance, which is important information because looking at wins, more specifically the minimum wins required to make playoffs is my main dependant variable. The study also confirmed my original hypothesis of looking at wins instead of any other variable to analyze successful outputs (Stewart, Kenneth G. 2010).

CHAPTER III

THEORY

This chapter explains the theory and importance of understanding the cost of winning in the NHL and the cost of manipulating a franchise to become more successful. There are studies done examining and understanding the importance of each position in the sport but nothing that looks at the cost of creating or having that winning NHL franchise.

The most easily controlled for variables in an NHL franchise and many businesses would be the employees or players. The goal of finding and creating the ideal combination of strength and speed, skill and toughness, expensive and cheap players is the job of the general manager to make a team out of individuals who is going to make his business and his team a successful winning club.

To look at how all these components correlate with wins and finding the cheapest way to produce these wins the economics comes from production functions. There are two main interpretations of the contribution of labor to the production of a firm or business. The first being average products which is the output per unit of labor input. This equation is simply dividing the total output (q) by the total input of labor L

Average product of labor = Output / labor input = q/L

Generally speaking the average product of labor is given by the slope of the line drawn from the origin to the corresponding point on the total product curve.

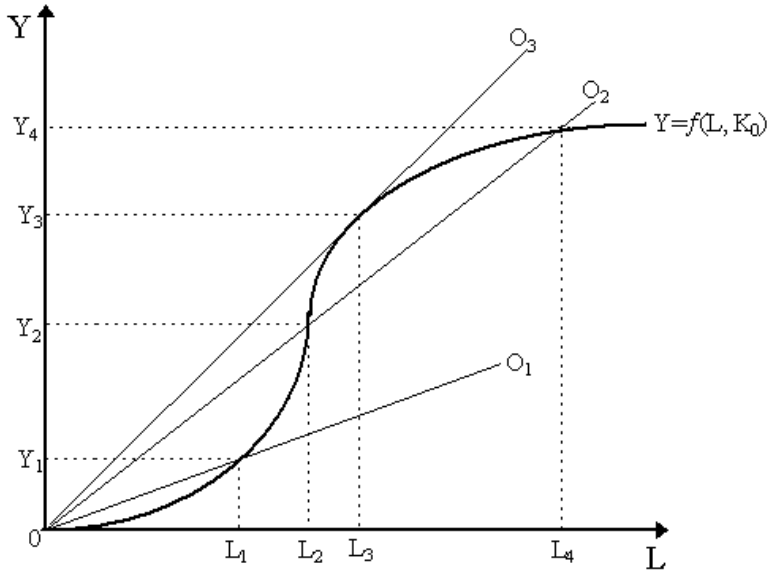
The second analysis of production is similar to the average product but is gives a unique insight into the added benefit of each additional unit of labor. This is the additional output produced as labor input is increased by 1 unit. The marginal product of labor can be written as $\Delta q / \Delta L$ so the change in output Δq resulting from the 1-uni increase in labor input ΔL.

Marginal product of labor = Change in input / change in labor input = $\Delta q / \Delta L$

Generally speaking for Marginal product of labor at any point is given by the slope of the total product at that point, or the tangent of the line at the given point.

FIGURE 3.2

LABOR CURVE MAP



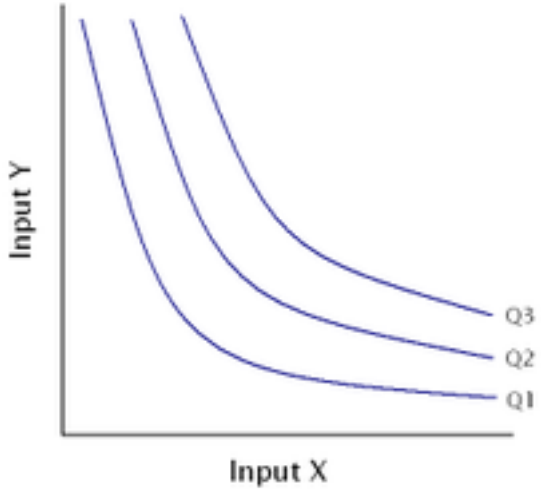
In this diagram of a production function the darkest thick black line is the total production line. The first line labeled O1 that originates at 0 and crosses the line where Y1 meets L1 shows the average product of labor at that point. If you take the slope of the O1 line where it crosses that point you get the average product of labor.

In the same diagram there is the line designated O3. Where the line O3 makes a tangent line with the total production line at the point where Y3 meets L3 we have an example of the Marginal product of labor. The marginal product of labor is given by the slope of the total product at the given point where Y3 meets L3, shown by the tangent line O3 at that point.

These are two ways to analyze single input production functions and the basis of all production functions. However, for our analysis and study understanding and analyzing multiple input production functions is more insightful. When looking at multi-input production functions understanding isoquants is key. The isoquant lines are curved lines that show all possible combinations of the different inputs that produce the same output. Having multiple isoquants showing different outputs and all the possible combinations is called an isoquant map.

FIGURE 3.2

ISOQUANT MAPS



By understanding the flexibility of the variables and switching one input for another is job of any manager, or in our case general manager of the hockey team. Choosing combinations of inputs that can maximize profits (wins) and minimize costs is information found from the isoquant map.

CHAPTER IV

DATA

The dependant variable wins will be functions of goals, assists, save %, plus/minus, salary, and penalty minutes. To get the value of those independent variables the first step of looking into the individual characteristics like draft rank, experience in the NHL, league played in prior to entering the NHL, and nationality will be determined.

This model will analyze the cost per win and what statistics, either personal prior to NHL or production once in the league, should have the most emphasis and value placed upon them. There is a lot of weight put into looking into a player prior to entering the league. Teams spend lots of money and investment into traveling all over the map scouting and watching young players about to make the jump into the big league. Understanding what information or statistic holds the most weight into judging a player once they have entered the league would give any team an upper hand in the competitive field of getting their hands on the young talent.

Looking at a players draft ranking is important because majority of players who are currently in the NHL were drafted in the NHL entry draft. The draft is important to NHL teams because once a team drafts a player they own that players rights for the next three years and no other team can talk negotiations with that player.

The entry draft each year is for players who are playing junior hockey, college hockey, or hockey in the European leagues. Teams send scouts to watch and assess these

players and their talent to be able to draft and have claim to players they feel will give added value to their franchise. It is a common perception in the hockey world that playing major junior hockey in one of the three Canadian leagues is the best route to being drafted and eventually playing in the NHL. However, many North American players chose to go to college or play juniors in the US over the major junior leagues in Canada and many European players chose to stay in Europe and play until they are ready to make the jump to the NHL. Understanding actual value and benefit of playing in one league over another and how that relates to NHL production would give scouts the opportunity and knowledge of narrowing their scouting areas or at least which leagues to give the most attention. Finding both where a player played before entering the NHL and individuals draft ranking came from the National Hockey Leagues website www.nhl.com.

Breaking players up into positions is a necessary step because they can then be used as dummy variables. Separating defensemen, centers, and wingers is important because there are different statistics that can be used for different positions. For centers we have face off percentage, the individual's percentage of winning faceoffs throughout a season. Positions and faceoff statistics are also found on www.nhl.com. Players of all positions come in all shapes and sizes so understanding what makes for the best player is important. Every sport requires a different set of skill and body type and hockey is no different. Looking into how height and weight affects goals and wins will give insight into this aspect of looking at prospects about to enter the league or current players in the league.

Obviously the objective of a team and player is production. So when looking at production looking at goals, assists, and total points is the most obvious place to start. Looking into a players point production before entering the NHL and production once in the league will give a comparison of what's important to actually contributing to the success and wins of a team. To find individuals point production before and during their NHL career using www.hockeydb.com, which is a great hockey database for statistics we can find all the stats necessary to understand what players are capable of producing and what they have produced in the past.

Another aspect that teams general managers assess when looking into new contracts or new players to acquire is experience in the league. Naturally players who have played in the NHL for longer periods of time have an acquired skill of veteran understanding of the game. This understanding of how to play in the league is a value to be assessed in the model. Finding a players experience of the game from www.hockeydb.com.

Players in the league with all different point production, previous leagues played, veteran statuses come from all different countries. Looking at the different countries of origin players come from is a dummy variable in the model and shows the frequency of each country and what value added to wins comes from a player form each country. This information also came from the hockey database.

CHAPTER V

RESULTS

The first step of the model looks at how the individual statistics before entering the NHL affect Goals, Assists, and Penalty Minutes once in the NHL. Looking at the break down of how each independent variable affects each of the dependant variables it clearly shows the relationship each variable plays. The R-Squared for each of the variables is high enough that it is clear that the relationship between the dependant and independent variable is accurate. Goals has the highest R-Squared of 64% then Assists at 62% and then Penalty Minutes at 34%.

TABLE 5.1

GOALS, ASSISTS, AND PIMS REGRESSION COEFFICIENT RESULTS

Variable	Goals Coef.	Goals p-value	Assists Coef.	Assists p-value	PIMS Coef.	PIMS P-value
Weight	.14	.24	.14	.46	**3.45**	**.00**
Round	.39	.65	1.71	.22	**8.74**	**.02**
Forward	**9.03**	**.03**	-4.81	.47	**64.81**	**.00**
Defense	**-47.23**	**.00**	**-49.38**	.00	-17.52	.41
Canadian	-2.99	.62	**-13.92**	.15	**67.42**	.01
USA	1.02	.88	-10.34	.32	**57.42**	**.04**
Sweden	.52	.94	-.94	.93	.98	.97
Cap Cost	**.000023**	**.00**	**.000036**	.00	**.000049**	.00
TOI/G	**5.79e-07**	**.00**	**4.29e-07**	.05	4.03e-07	.48
Shifts/G	**1.29**	**.02**	**3.78**	.00	**4.83**	.04
MajorJR	-.04	.99	-7.27	.39	-.84	.97
AmericanJR	-5.59	.51	-16.82	.21	-13.39	.71
NCAA	1.41	.86	-16.58	.81	373.03	.31
R-Squared	.64	-	.62	-	.34	-
# Of observations	709	-	709	-	709	-

When looking at the three relationships with regards to weight it is clear that the one most affected is penalty minutes. Adding weight doesn't add much to your goals or assist production but does add a significant amount of penalty minutes. When you think about this in real terms it makes sense because the fighters in the NHL are all the biggest strongest players, the skill guys are usually smaller quicker players, therefore the results make sense that the heavier you are the more penalty minutes you are likely to have.

For the players who have been selected in the NHL Entry Draft the relationship with the dependant variables shows a strong change in penalty minutes as well. Fighters and tough guys in the NHL also explain this increase in penalty minutes that comes with each additional round of the draft. Normally players drafted in the early rounds of the

draft are the highly skilled and point producing players. As the rounds go on players start to be selected based off characteristics other than points. This is where role players like fighters or penalty killers get picked up in the draft and these players generally take many more penalties than the highly skilled offensive players.

Forwards and Defense were one of the dummy variables selected for the model and they are in relationship to centermen, the group of players omitted from the model. Forwards are the wingers on the team, forwards are either wingers or centermen and the relationship to goals indicates that wingers are producing 9 more goals than the centermen. Looking at penalty minutes the results are what you would expect because fighters and major penalty takers in the NHL are often wingers, centermen are rarely tough guys because it is a very difficult and skilled position.

Defensemen generally score far fewer goals and acquire far fewer points throughout a season, that being said the results back up that assumption. Defensemen score almost 50 fewer goals and 50 fewer assists than the forwards and centermen because their main job on the team is to defend the opposition's forwards and prevent goals from being scored on their team. While there are offensively gifted defensemen who score, these are rare and maybe only one per team.

The next three dummy variables are in regards to the country in which the players were born. The countries selected were Canada, USA, and Sweden and these countries are being looked at in terms of the omitted group, which is the rest of the countries from which players came from. The results for Canada show Canadians score about 14 fewer assists than the omitted European group. Canadians also have around 67 more penalty minutes. Thinking about this is practical terms makes sense because European players are

very rarely fighters and are almost always highly skilled point acquiring players. The Americans had around 57 more penalty minutes, which is expected because you would expect the Canadian and American born players to play similar styles and trend similar ways with regards to the selected variables. The Sweden results were as expected for all three dependant variables. With Sweden being one of the many European countries from which players originated you would expect their numbers to be very close to the omitted group, which they are.

Cap Cost, which is a players annual salary is measured in millions because most players in the NHL are earning over a million dollars a year and for the few that aren't they are close to a million which makes the regression numbers work. Penalty minutes seem to be the most affected by Cap Cost but Goals and Assists are also very close behind. This result shows that while you can try and buy more points by going into the market and acquiring a top end player that costs a lot to a teams salary cap, you are also acquiring more penalty minutes than either goals or assists on their own.

Shifts per game showed additional production for all three-dependant variables. Penalty minutes were affected the most with almost 5 additional penalty minutes followed by assists at 3.78 and goals at 1.29. These results are expected because with more ice times comes more opportunities to gather points in either goals or assists as well as acquire penalty minutes by being involved in more play.

The next three independent variables were included to look at the different affects that come from going down three different paths prior to entering the NHL. Young players have decisions to make at as young of an age as 16 when considering what path will give them the greatest chance of fulfilling their life long dream of playing in the

NHL. For North American born players there are three main routes to the NHL that I selected to look at. The NCAA, the USHL, and CHL (Canadian Major Junior). The results showed that even though there are many different paths to the NHL, in my model not one route seemed to show a significant difference on any of the dependant variables over any other route.

After looking at how all these statistics and variables prior to entering the NHL play a roll in Goals, Assists, and Penalty Minutes we start to look at how some of the same variables and a few additional ones affect the new dependant variable of wins. When looking at wins we chose a players Plus/Minus, Penalty Minutes, Shots per game, Team Payroll, Country born (either Canada, USA, or Sweden), and league played in prior to entering the NHL (either Canadian Major Junior, American Junior, or NCAA). Looking at how all these variables affect wins will give insight into which categories are most correlated and important to improving a franchises wins.

Table 5.2

WINS REGRESSION RESULTS

Variable	**Wins Coefficient**	**P-value**
Plus/Minus	.08	.00
Penalty Minutes	.00069	.16
Shots per game	1.33	.00
Team Payroll in Millions	.39	.00
Canada	-.01	.99
USA	1.12	.03
Sweden	1.32	.04
Major Junior	-.43	.29
American Junior	-1.34	.06
NCAA	.03	.96
R-Squared	.39	-
# Of observations	1453	-

The Plus/Minus variable was chosen because a players Plus/Minus stat is calculated by giving a +1 stat for every time the player is on the ice for a 5 on 5 goal for his team and a -1 stat for every time the player is on the ice for a 5 on 5 goal against his team. Therefore a player with a higher plus/minus stat is producing more offense and scoring than he is giving up. This stat showed a .08 coefficient on wins which may not seem like a lot but adding almost a tenth of a win for every additional plus a player produces would add up throughout the length of a season.

Penalty Minutes showed very little affect on the wins coefficient with .00069, which was surprising because one would think that the more penalty minutes being killed off in the game the less opportunity for scoring and more opportunity to be scored against costing you more wins in the long run.

Shots per game had a 1.33 coefficient one of the strongest in the model. This follows the general thinking that the more shots on goal results in more scoring chances and goals, and the more scoring chances and goals a team has the better their chances of winning a game are.

Team Payroll is significant in wins with a coefficient of .39 and follows traditional thinking because players are paid on performance and the better performers and point producers make more money. The more high paid players on a team would result in more wins because you would assume they have more highly skilled players. This model suggests that for the a sample team like the Atlanta Thrashers if they were to increase their payroll by 6.4 Million dollars by picking up a high end forward for example, they could potentially increase their wins per season by just over 3 wins.

The next three variables were looking how players born from different countries affect wins similarly to how in the previous model the different countries were looked at their affect on Goals, Assists, and penalty minutes. USA and Sweden both had positive coefficients, 1.12 for USA, and 1.32 for Sweden. These dummy variables are in terms of the omitted group of European born players and indicate that the more USA and Sweden born players the higher a teams wins will be.

Like in the previous model after looking at a player's birthplace the model looks at the league played prior to entering the NHL. The same three leagues were used in this model the Canadian Major Junior (CHL), the American Junior (USHL), and NCAA. The results showed that only the American Junior variable was significant with a coefficient of -1.34, which suggests that all other leagues are better at contributing to wins than the USHL.

After running both of the regressions and understanding the variables that effectively impacted a teams wins I looked at how the predicted wins compares to the teams mean wins over the two chosen seasons. Comparing the predicted wins to the actual mean wins shows which teams are over performing or under performing.

TABLE 5.3

TEAMS PERFORMANCE OFF PREDICTED VS. ACTUAL WINS

Team	**Predicted Wins**	**Mean Wins**	**Performance**
CBJ	40.8	31.3	-9.5
DAL	36.2	42.0	5.8
EDM	35.0	28.5	-6.5
FLA	38.3	33.9	-4.4
MTL	42.9	37.2	-5.7
NSH	36.8	46.0	9.2
NYR	41.2	47.4	6.2
VAN	47.0	52.6	5.6

There were many cases of teams either under or over performing but this chart shows the most extreme cases. From this chart we can see that Columbus, Edmonton, Florida, and Montreal were all under performing by at least 4 wins. Columbus was the worst team of underperforming by getting around 9 wins less than the model predicted they should. These teams underperforming could be due to a number of different reasons such as location, team chemistry, coaching or a number of other factors that could affect a player and teams performance.

The results also show a number of teams who are over performing or doing better than expected. Dallas, Nashville, New York, and Vancouver are the most extreme cases. It goes without saying that a team over performing is a good thing and something any general manager would be pleased with. Nashville is leading this category by getting just over 9 wins more than predicted but the other three teams are also getting 5 or more wins which is a significant amount in an NHL season.

These results are something to take into account because making the playoffs is such an important part of the success of a hockey franchise and often teams will miss the cut of making playoffs by only one win. Making the playoffs not only gives a team the chance to win the Stanley cup but also brings in huge amounts of extra revenue that teams missing the playoffs and missing out on those extra games miss out on.

The next table shows how adding 1 standard deviation to select variables can increase the number of predicted wins. The calculations were done for each team and for each team it was the variables shots on goal and payroll in millions that improved predicted wins the most. For most teams increasing either of those two variables by one standard deviation shows an increase of around 2 predicted wins. As mentioned earlier

even increasing a teams wins by 1 is often enough to move a team who just missed playoffs into the playoffs. Below is an example of the effect that shots on goal and payroll play in increasing predicted wins for the Atlanta Thrashers.

TABLE 5.4

INCREASED VARIABLE RESULTS EFFECT ON WINS

Pred. Wins	Pred. Wins +1 Std Dev.	Variable
38.8	41.5	Shots on Goal
38.8	41.3	Payroll in Millions

Clearly being able to increase your teams winning percentage is something that every franchise is looking to do and if a general manager can do that with the existing players on his roster by increasing shots on goal then that is even better. This is not always the case sometimes the job of the general manager is to go into the market and acquire players that are going to make his club better, and if the team is under the salary cap finding a high profile player and increasing the teams payroll in millions can accomplish that and increase wins.

CHAPTER VI

CONCLUSION

After looking at the results and understanding the value each of the different components of the team add to the franchises winning potential it appears shots on goal and payroll held the most value. There are many aspects to the job of the general manager but most importantly it is creating a team that is a winning team who makes playoffs and is successful. There are many different ways to create a winning team because there are so many different components that go into a team and the success of that team. This thesis focused on the player statistics but there are many other areas that could be analyzed such as coaching, goalies, location, along with others.

Many times when looking at whether a team is going to make playoffs or not it comes down to only a few wins so optimizing and maximizing a teams wins is the most important. The ability to add only a few wins is often enough to take a team from missing playoffs to a team who makes the first round. In the last five years the points needed to make the cut for the NHL post season has been between 90-95 points. With the point system in the NHL teams can get one point for an overtime loss so even a loss can help a team acquire points but over the past five seasons the number of wins to make the post season has been 40 or more. Every year the race for the last playoff spot comes down to the wire, even the last game of the season many times. Each year there are one or two teams from each of the two divisions who miss out by only a win or a few points and

being able to capitalize on the playoff opportunity is something every General Manager takes seriously.

Unfortunately for general managers one of the two variables this model found that showed the strongest ability to improve wins was increasing payroll, with the new NHL collective bargaining agreement between the players and the owners there is a salary cap so there is a limit to the general managers ability to increase this variable. What this means for general managers is they can increase their payroll by trying to sign high end players who's stats will give their team a better chance of winning more games and getting into playoffs but only to a certain level. Once general managers hit the salary cap with the players signed to their team they have to try and look at the next best avenue to improving wins. Shots on goal is a stat which every player on every team can try and help to increase it is just about buying into the teams philosophy and system of shooting the puck on net more often.

CHAPTER VII

RESOURCES

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