6-2014

Money Puck: The Effectiveness of Statistical Analysis in Building an NHL Team

Troy Grosenick
Union College - Schenectady, NY

Money Puck: The Effectiveness of Statistical Analysis in Building an NHL Team

By

Troy Grosenick

****

Submitted in partial fulfillment
of the requirements for
Honors in the Department of Economics
UNION COLLEGE
June, 2014

Abstract

The 2013 Collective Bargaining Agreement in the National Hockey League limits contracts offered to free agents in terms of length and variance in yearly salary. These changes have made finding undervalued free agents even more important to teams' general managers. The purpose of this study is to evaluate players and teams with both traditional and advanced metrics to determine how players are valued in comparison to their impact on their team's performance.

A team's winning percentage is hypothesized to be a function of shooting percentage and save percentage, as well as proxies for puck possession time, such as shots on goal per game, shots against per game, blocked shots, missed shots, and face-off percentage. It is also hypothesized that players with higher puck possession attributes will impact a team's winning percentage to a greater extent than those with lower metrics, and so should be a key factor in determining how general managers use available salary money to improve their team.

Based on data from NHL.com and stats.hockeyanalysis.com, we estimate team performance of all 30 NHL teams for each of the six previous seasons of play (2007-2013) as a function of puck possession proxies. We find that puck possession proxies significantly impact a team's winning percentage and that free agents with higher performance metrics have a significantly greater impact on team performance.

performance as much as several less expensive players in cases that a team lacks depth.

Glossary

Shots on Goal (SoG): Number of Shots per game that reach the opponents net, including all goals and shots that would have resulted in goals had the opposing goaltender not made a save

Shots Against (SAoG): Number of Shots per game taken by an opponent that reach a team's net, including all goals and shots that would have resulted in goals had the goaltender not made a save

Shot Percentage (SP): (Goals)/(Shots on Goal)

Save Percentage (SVP): (Saves)/(Shots on Goal)

Blocked Shots (BSG): Any shot attempted by an opponent and blocked by a player other than the goaltender

Missed Shots (MSG): Any attempted shot that does not reach the net and is not blocked

Corsi (Cor): Total shots per game (Shots on Goal, Missed Shots, Blocked Shots) by a team or player

Corsi Percentage (CP): (Total Shots)/(Total Shots + Total Shots Against)

Fenwick (Fen): Shots on Goal plus Missed Shots (Corsi minus Blocked Shots) by a team or player

Fenwick Percentage (FP): (Fenwick)/(Fenwick + Opponents' Fenwick)

Face-Off Percentage (FOP): (Team Face-Offs won)/(Total Face-Offs)

Table of Contents

List of Exhibits v

Chapter One: Introduction 1
Purpose of Study
Hypothesis
Outline of Study

Chapter Two: Institutional Framework of Professional Hockey 4
The 2013 NHL Collective Bargaining Agreement
Player Development and Organizational Depth

Chapter Three: Measures and Determinants of Team Performance 10
Point Percentage: A Measure of Team Performance
Determinants of Performance
Sabermetrics: Fenwick and Corsi
Traditional Statistics
Roles within a Hockey Team
Team Chemistry and Variance
Regression Model

Chapter Four: Evaluation of Statistics as Determinants of Team Performance 16
Sources and Measurement of Data
Regression Results for Determinants of Team Performance
Case Study 1: The Pittsburgh Penguins acquisition of James Neal
Case Study 2: The Chicago Blackhawks, Multiple Stanley Cups in Study Period
Case Study 3: Columbus Blue Jackets Improvement in the 2012 Off-Season
Case Study 4: Stanley Cup Finalists from Past Six Seasons

Chapter Five: Conclusion 32
Interpretation of Findings
Policy Remarks
Suggestions for Further Research

Bibliography 36

Appendix A 39
Appendix B 40

List of Exhibits

Exhibit 1: NHL CBA Hockey Related Revenue 5

Exhibit 2: Calculation of Point Percentage 10

Exhibit 3: Simplified Roles of Players 13

Exhibit 4: Descriptive Statistics 17

Exhibit 5: Performance Indicator Regressions 18

Exhibit 6: 2009-10 Chicago Blackhawks Roster 21

Exhibit 7: 2012-13 Chicago Blackhawks Roster 22

Exhibit 8: Chicago Blackhawks Core Players 23

Exhibit 9: Blue Jackets Trade Nash to Rangers Detailed 25

Exhibit 10: Columbus Blue Jackets Goaltending Statistics 26

Exhibit 11: Estimated Point Percentage Change Attributable to Sergei Bobrovsky 27

Exhibit 12: Past Six Stanley Cup Finals 28

Exhibit 13: Descriptive Statistics of Stanley Cup Finalists 29

Chapter 1
Introduction

Purpose of the Study

The ultimate goal of every professional sports franchise is to win the league championship. Every general manager is tasked with assembling a team that will ultimately contend for a playoff title. Obviously, the task can be long or short term. This is the reason many teams will trade a star player for prospects as it increases the probability for success in the future while the team's immediate success may be hindered. The signing of players by any general manager has many factors; however, insight into how specific players help a team win is certainly paramount. Sabermetrics attempt to quantify how a player or players impact a team's performance. The field of sabermetrics has grown in recent years with the success of the Oakland Athletics and Boston Red Sox and has increasingly proliferated into sports other than baseball.[1] Because advanced statistical analysis can help general managers make decisions on how to allocate dollars when being confined by a salary cap, it is of critical importance when determining how to build a team. It is most critical in leagues that institute a 'hard' salary cap, as the National Hockey League (NHL) implemented in the 2005 Collective Bargaining Agreement (CBA). In the National Hockey League, the ultimate goal of every team is to win the Stanley Cup.

The purpose of this study is to determine correlations of performance statistics to point percentage as well as how NHL general managers can use this information to make decisions on acquiring players in free agency and through trades. The study shifts focus away from the obvious drivers of players' salaries such as goals and assists, and on to puck

[1] Hakes, John K., and Raymond D. Sauer. 2007

possession statistics in order to find value where other general managers may not be looking.

The research is critical, as NHL general managers have had contract limits imposed with the 2013 Collective Bargaining Agreement. This has eliminated loopholes used by general managers when signing free agents. Understanding the nature of free agency and what types of signings have had significant impacts on team performance will better inform general managers about the value that can be added to their team in the free agent market. For this reason, a detailed study of Stanley Cup Finalists over the past six years will be analyzed to better understand how the teams were put together. In addition, specific case studies will be analyzed to determine how free agent signings and/or trades may have impacted the team's performance.

Outline of the Study

In the second chapter we present the institutional and historical context of managing a professional hockey organization. We first discuss critical changes in the last two NHL Collective Bargaining Agreements, including an introduction to the rules and regulations of how hockey players are acquired by clubs, as well as organizational salary caps and player contract limits. We then explain of how the minor league system impacts the NHL club.

In the third chapter we examine team performance statistics that may positively or negatively impact point percentage. This includes finding an adequate proxy for puck possession. Other statistics that we analyze include face-offs, turnovers, shots for and against, save percentage, and shooting percentage. This analytical framework provides the

context for a model in which future team performance can be analyzed, as well as a framework for what types of players may have a higher impact on team performance.

In the fourth chapter we introduce the sources for the sample data. We estimate team performance statistics through the model to determine magnitudes of impact on point percentage. Next, we analyze the regression results. Finally, we analyze the impact of puck possession for Stanley Cup finalists and teams that experienced drastic improvement in winning percentage from one year to the next.

In the fifth chapter we conclude that advanced statistics can be used in order to inform general about player acquisitions. We determine that the best teams have built their core in the draft while acquiring role players in free agency.

Chapter 2
The NHL Collective Bargaining Agreement and Framework of Professional Hockey

The 2013 NHL Collective Bargaining Agreement

The NHL established a 'hard' salary cap after a lockout cancelled the 2004-05 season. Previously, the NHL did not institute any salary cap, and was the last of the major North American sports to institute a salary cap or luxury tax in order to control players' salaries. The hard salary cap prevents any club from exceeding a payroll limit for any reason, and differs from a 'soft' salary cap, which allows teams to exceed the limit but with a penalty such as a luxury tax. When the 2005 CBA expired in September of 2012 owners wanted to make it easier to fill rosters without inflating salaries further. This caused the league to create a new calculation of the salary cap based on league revenue, cutting the salary cap from $64.3 million in 2011-12 to $60 million in 2012-13. The salary cap will move back up to $64.3 million for the 2013-14 season, in essence creating a two-year freeze on salary inflation.[2] The new formula estimates league revenue for the upcoming season. The league separates its revenue streams into "hockey-related revenue" and "non-hockey-related revenue".

Of importance to the salary cap calculation is hockey-related revenue. Exhibit 1 is a list of what is deemed hockey-related revenue under the 2013 NHL CBA.

[2] NHL Collective Bargaining Agreement. 2013

Exhibit 1: NHL CBA Hockey Related Revenue
1) NHL Regular Season & Playoff Gate Receipts
2) Pre-Season Games
3) Special Games (International Exhibition Games, etc)
4) NHL National, International and National Digital Broadcasts
5) NHL Networks
6) Local Cable Television Broadcasts
7) Local Pay-Per-View, Satellite and Other Broadcasts
8) Local Over-the-Air Television Broadcasts
9) Local Radio Broadcasts
10) Club Internet
11) Publications
12) In-Arena Novelty Sales
13) Non-Arena Novelty Sales
14) Concessions
15) Luxury Boxes/Suites
16) Club/Premium Seats
17) Fixed Signage/Arena Sponsorships
18) Temporary Signage/Club Sponsorships
19) Dasherboards
20) Parking
21) Other Revenues (sale of game-worn jerseys, skills competitions, open practices, etc)

Fifty percent of hockey related revenue is allowed for player salaries, down from 57 percent in the previous CBA. From there a "midpoint" for the projected salary range is estimated. The salary cap is set at 15 percent above the midpoint, while the floor is set at 15 percent below the midpoint. The range between the salary cap and salary floor for NHL teams is not to be under $16 million and is not to exceed $28 million. With a tighter budget in terms of player salaries, NHL general managers must be able to make more informed decisions than ever on what signings will help their organization the most as they have fewer dollars to build their teams.

The smaller cap is compounded by the elimination of contract length loopholes that allowed general managers to lure attractive free agents more easily. Previously, the NHL allowed general managers to sign players to extremely long contracts in order to circumvent the salary cap. For example, Lou Lamoriello of the New Jersey Devils signed

forward Ilya Kovalchuk to a 15-year, $100 million contract in 2010.[3] About $80 million was to be paid within the first 8 years of the contract, but because the cap hit of a player takes into account the average salary made by the player over the length of the contract, Kovalchuk's "cap hit" was $6,666,667.[4] In response, the 2013 CBA limits contract lengths to seven years (eight years if the team is re-signing its own player). In addition, the NHL also included a contract variance rule. Player salaries cannot vary by more than 35% from one year to the next, while the lowest annual salary earned by a player cannot be less than 50% of the highest annual salary earned by the player under the same contract.

General managers must also deal with several forms of free agency. Based on a player's age and NHL games played, a player may be considered restricted or unrestricted. Any player that is 27 years old or older or has 7 years of NHL experience is considered an unrestricted free agent. Unrestricted free agents are able to sign with any NHL club for any salary, so long as the team's payroll does not exceed the salary cap and does not exceed the limit of 50 contracted players. Restricted free agents can obtain qualifying offers from other teams—it is then the choice of the player's previous team to match the qualifying offer and keep the player or to let him sign the offering.[5]

In addition, the NHL CBA limits the contracts of entry-level players. Any player signing their first contract and under the age of 25 is subject to these limits. Length of the contract is determined by age. If the player is 21 or under, the length must be 3 years; if the player is 22 or 23, the contract length is 2 years while 24-year-olds receive a one-year contract. The maximum salary for an entry-level player is $925,000 while the minimum is

[3] Mazzeo, Mike. 2013
[4] Capgeek.com. 2013
[5] NHL Collective Bargaining Agreement. 2013

the same as the league minimum of $525,000.[6] Entry-level contracts must be two-way. This means the player makes substantially less money if he is placed in the minor leagues; however, he cannot be claimed off waivers when the NHL team assigns him to the minor leagues.

All NHL contracts are guaranteed. This means that waiving or cutting a player does not free a team from financial obligations to the player's salary. NHL teams are allowed to buyout the remainder of a player's contract. A player can be bought out of his contract for one-third of his remaining salary due if he is under the age of 26. If the player is over 26, he must be paid two-thirds of his remaining salary. The team has two times the length of the remaining contract to make these payments. The buyout amount is calculated in the teams salary cap limit evenly across the length of the buyout payments.[7]

Teams acquiring a player through a trade must assume at least half of the player's remaining salary. A previous team can only retain a player's salary twice over the course of the contract and the retained salary cannot exceed 15 percent of the upper salary cap limit. Finally, a team is only allowed three retained contracts to be on its books at a particular time and is not allowed to renegotiate player contracts if the player was acquired in a trade. These rules were put in place in order to prevent wealthier teams from acquiring players and evading salary cap rules.[8]

The restrictions introduced in the 2005 NHL CBA and enhanced in the 2013 NHL CBA has made every dollar a general manager spends more important. In addition, the closing of many loopholes has made the idea of finding a 'diamond in the rough' much more

[6] NHL Collective Bargaining Agreement. 2013
[7] NHL Collective Bargaining Agreement. 2013
[8] NHL Collective Bargaining Agreement. 2013

fruitful as the new CBA has made it more difficult to acquire a large number of players valued highly in the market. With a defined amount of money, general managers must be able to decide firstly what areas of the team need to be improved and the value of players available in free agency to fill the team's needs. The depth of the organization's prospect pool compounds these decisions further.

Player Development and Organizational Depth

Every NHL team has an affiliate team in the American Hockey League (AHL). The AHL is considered the premier minor hockey league, only being topped in skill level by the NHL. The AHL is used as a "farm system" for the NHL. On opening day of the 2013 season, 630 players on NHL rosters had played in the AHL, accounting for 84 percent of all NHL players.[9] NHL rosters are not to exceed 23 healthy players; however, teams are allowed up to 50 players under contract. Most players under contract, but not on the NHL roster, are on the AHL roster. This allows the organization to easily fill roster spots vacated by injury or poor performance.

The AHL allows organizations to develop prospects, acquired in the draft or through trades and free agency. For smaller market teams it is imperative to develop players as many of their high-end players will sign with another team when they become free agents. Although all teams are bound by the salary cap and the 50-contract limit, large market teams hold in advantage in attracting high-priced free agents as they often have greater revenues from ticket and merchandise sales. This allows large market teams to pay more for the services of a star player. However, star players are often overpriced. Although goals

[9] http://theahl.com/630-ahl-grads-open-season-in-nhl-p187541

and assists are valued the most in the free agent market, it is entirely possible a player who is a 30-goal scorer with one team scores only 10 goals with another team the next year. Other metrics must be studied to determine how a general manager can spend money most efficiently. Ultimately, every NHL team's goal is to win the Stanley Cup. The goal of this study is to determine how a general manager can build a potential Stanley Cup-winning team with limited resources.

Chapter 3
Measures and Determinants of Team Performance

Point Percentage: A Measure of Team Performance

Point percentage in the NHL is defined differently from winning percentage in other leagues. The NHL awards 2 points for a win, 1 point for an overtime or shootout loss, and 0 points for a regulation loss. Exhibit 2 shows how point percentage is calculated.

Exhibit 2: Calculation of Point Percentage

$$\text{Point Percentage} = \frac{\text{Total Points}}{\text{Total Possible Points}}$$

$$\text{Total Possible Points} = 2 * \text{Games Played}$$

$$\text{Point Percentage} = \frac{\text{Total Points}}{2 * \text{Games Played}}$$

Point percentage is used in the NHL because losing a game may still gain a team a point in the standings. This is due to the NHL no longer allowing ties, yet still awarding points to a team that did not lose in regulation. This is the most effective measure of team performance over an entire season as a team's point total determines whether or not it makes the playoffs and has a chance to compete for the Stanley Cup.

Determinants of Performance

Sabermetrics: Fenwick and Corsi

Sabermetrics is the term used to describe the empirical examination of sports centered on statistical analysis. The scientific analysis of baseball was first put in the national spotlight in 1964 when Earnshaw Cook published *Percentage Baseball*. Although,

originally dismissed by Major League Baseball teams, the field gained traction through the second half of the 20th century with the work of Bill James who coined the term sabermetrics itself. Baseball lent itself to statistical analysis because of the nature of the game—it is a one-on-one game within a team sport. With the success of open sabermetric proponents Billy Beane of the Oakland Athletics and Theo Epstein of the Boston Red Sox in the early 2000's, researchers began attempting to uncover statistical formulas for winning in other sports.[10] This has led to the proliferation of advanced statistics in many sports, including hockey.

Of particular interest to this study are Fenwick percentage and Corsi percentage, both of which are statistics used to measure the number of shots attempted by a team.[11] Fenwick is defined as shots on goal plus missed shots, while Corsi is defined as all attempted shots (Fenwick plus blocked shots). These are of particular interest as proxies for puck possession. In theory, the sport of hockey comes down to puck possession. When one team has the puck, the other cannot score. Therefore, whoever has the puck more should have more attempted shots, more scoring chances, more goals, and therefore more wins. It is important to note that a team does not win because of a high Fenwick or Corsi percentage, but by the process that a high Fenwick or Corsi percentage requires. This means a coach should not necessarily preach to shoot the puck from anywhere on the ice. Yes, this would increase both the team's Fenwick and Corsi percentages; however, it renders them useless as a puck possession proxy. Fenwick and Corsi percentages compare the amount of attempted shots by a team and their opponents.[12] Because the percentages

[10] Fry, Michael J., and Jeffery W. Ohlmann. 2012
[11] Wagner, Daniel. 2013
[12] stats.hockeyanalysis.com. 2013

contain both an offensive and defensive aspect, they will be used in the regression models. However, Fenwick and Corsi percentages are not available specifically for players and therefore players will be compared in terms of Fenwick of Corsi per game. As puck possession proxies their merits should still hold as a player who has higher Fenwick or Corsi values allows his opponents less time with the puck.

Traditional Statistics

Just as Fenwick and Corsi are theorized to be correlated to point percentage, traditional statistics that contribute to puck possession are hypothesized to impact a team's success. Traditional statistics that impact puck possession include face-off percentage, turnovers, and takeaways. The fewer turnovers a team commits, the longer it will have the puck. Similarly the more takeaways and face-offs won by a team will contribute to more puck possession. These statistics are not considered drivers of players' salaries; however, they could have a large impact on the success of a team.

Shots on goal and shots against on goal are both taken into account in Fenwick percentage and Corsi percentage, and for this reason they will not be included in the regression model. However, shooting percentage and save percentage are not intrinsic to Fenwick or Corsi and therefore will be included in the regression model.

Statistics that have a large impact on both salaries and the success of a team are goals and assists. It makes the most sense as the more goals a team scores, the more games that team is likely to win. However, we are concerned about metrics that may relate to more goals for and fewer against, therefore improving point percentage. Because goals and goals against are obviously correlated to wins and because players known as goal scorers

are able to obtain high salaries, both goals and assists will not be included in the regression model. Because goal scorers are often the highest paid players in the NHL a general manager could be better off to acquire multiple players for the same price as a single star player. This is dependant on the types of players already on a roster.

Roles within a Hockey Team

One reason sabermetrics are successful in analyzing baseball is because the basic role of every batter is the same and the basic role of every pitcher is the same. Batters are tasked with getting on base, while pitchers keep them off the bases. It is an individual game within a team game. This is very different from hockey in which five players on a team need to work as a unit to score *and* prevent the other team from doing so. The sixth player, the goaltender, is the only player tasked with only one job—prevent the opponent from scoring. Because of the fluidity and teamwork involved in hockey, players have different roles. They are broken down in Exhibit 3.

Exhibit 3: Simplified Roles of Players

Position	Task	Salary
Skilled Forwards	Score, top two lines most often	High
Two-Way Forwards	Prevent opponenent from scoring, occasionally score	Moderate to Low
Offensive Defensemen	Create scoring opportunities, prevent opp. scoring	High to Moderate
Defensive Defensemen	Prevent opponent from scoring	Moderate to Low
Goaltenders	Prevent opponent from scoring	High to Low

Because teams may have different numbers of different types of players, general managers can easily value the same player differently. For example, a team with only one offensive defenseman would most likely value a second more than a team that already has three offensive defensemen. Because only two defensemen are on the ice at a time, the fourth offensive defensemen offers a lower return than the second.

Team Chemistry and Variance

Along with different roles, players themselves may fit differently in one team compared to another. For example, an offensive player may not perform as well under a coach who stresses defense. Similarly, a player may put up great numbers when playing on the same line as one teammate, yet be less productive when playing with others. These "chemistry factors" and others may create a substantial amount of variance that is extremely difficult to quantify.

Regression Model

Both sabermetrics and traditional statistics will be used in the regression models. The first model will include Fenwick percentage while the second will include Corsi percentage. They will not be included together because they are highly correlated. The regression model is based on the model used by Hakes and Sauer (2007).

Regression Model:

$$PP = \alpha + \beta_1 Proxy + \beta_2 FOP + \beta_3 SP + \beta_4 SVP + \beta_5 TOG + \beta_6 TAG + \varepsilon$$

Where: PP = Point Percentage; Proxy = Puck Possession; FOP = Face-off Percentage; SP = Shooting Percentage; SVP = Save Percentage; TOG = Turnover per Game; TAG = Takeaways per Game

Point percentage is the most viable and readily available measurement of team performance and is therefore used as the dependent variable in both models. The model will estimate the impact of each performance statistic on point percentage and therefore indicate what statistics should be heavily valued in the free agent market. This will allow general managers to make informed decisions on how a certain player may impact the

team's performance. In the models, we expect coefficients on Proxy, CP, FOP, SP, SVP, and TAG to be positive and the coefficient on TOG to be negative.

Chapter 4
Evaluation of Statistics as Determinants of Team Performance

Sources and Measurement of Data

The data comes from the 2007-08 Season through the 2012-13 Season. The 2012-13 Season was shortened by a lockout and therefore measurements are evaluated on a 'per game' basis in order to eliminate any bias. The 2007-08 Season was the first season in which advanced statistics such as Corsi and Fenwick are readily available. All thirty NHL franchises are observed in each season's data set.

Data collected for each team includes: Fenwick percentage, Corsi percentage, faceoff percentage, shooting percentage, save percentage, turnovers per game, takeaways per game, powerplay time and the dependent variable, point percentage. Fenwick percentage and Corsi percentage are collected from stats.hockeyanalysis.com[13] while all other statistics are from the NHL's website.[14] The descriptive statistics are reported in Exhibit 4.

[13] stats.hockeyanalysis.com. 2013
[14] www.nhl.com/ice/teamstats.htm. 2013

Exhibit 4: Descriptive Statistics			
Point Percentage		**Takeaways per Game**	
Mean	55.858	Mean	6.843
Standard Deviation	7.963	Standard Deviation	1.405
Minimum	37.200	Minimum	1.000
Maximum	80.200	Maximum	11.560
Shooting Percentage		**Turnovers per Game**	
Mean	7.766	Mean	8.062
Standard Deviation	0.881	Standard Deviation	1.857
Minimum	5.490	Minimum	4.460
Maximum	10.520	Maximum	12.870
Save Percentage		**Corsi Percentage**	
Mean	92.229	Mean	49.991
Standard Deviation	0.952	Standard Deviation	3.269
Minimum	89.320	Minimum	41.900
Maximum	94.470	Maximum	59.500
Faceoff Percentage		**Fenwick Percentage**	
Mean	49.996	Mean	49.961
Standard Deviation	2.025	Standard Deviation	3.219
Minimum	44.200	Minimum	41.300
Maximum	56.400	Maximum	59.700

Determinants of Team Performance

In order to determine the impact of each performance statistic on a team's winning percentage, two basic regressions are used. The first utilizes Fenwick percentage as the proxy for puck possession, while the second uses Corsi percentage as the proxy for puck possession:

Equation 1:

$$PP = \alpha + \beta_1 FP + \beta_2 FOP + \beta_3 SP + \beta_4 SVP + \beta_5 TOG + \beta_6 TAG + \varepsilon$$

Where: PP = Point Percentage; FP = Fenwick Percentage; FOP = Face-off Percentage; SP = Shooting Percentage; SVP = Save Percentage; TOG = Turnover per Game; TAG = Takeaways per Game

Equation 2:

$$PP = \alpha + \beta_1 CP + \beta_2 FOP + \beta_3 SP + \beta_4 SVP + \beta_5 TOG + \beta_6 TAG + \varepsilon$$

Where: PP = Point Percentage; CP = Corsi Percentage; FOP = Face-off Percentage; SP = Shooting Percentage; SVP = Save Percentage; TOG = Turnover per Game; TAG = Takeaways per Game

The results are shown in Exhibit 5.

Exhibit 5: Performance Indicator Regressions

Dependent Variable: Point Percentage

Sample Size: 180 Mean Dependent Variable: 55.85833

Equat	Constant	Fenwick Pct	Corsi Pct	Face-off Pct	Shooting Pct	Save Pct	Turnovers Per Game	Takeaways Per Game	R^2
1	−398.731 (−11.64)	1.617 (13.75)		0.1423 (0.772)	3.831 (9.727)	3.661 (10.21)	0.1302 (0.685)	-0.2659 (-1.066)	0.701
2	−367.927 (−10.19)		1.505 (12.15)	0.1502 (0.758)	3.721 (8.907)	3.405 (8.965)	0.0593 (0.294)	-0.3539 (-1.338)	0.662

Source: Appendix A

Both regressions show the relationship between performance statistics and point percentage using a linear model. Model 1 has a higher R^2 value than Model 2, suggesting Fenwick percentage is a slightly better predictor of team performance than Corsi percentage. Model 1 shows us that for every one percent increase in Fenwick Percentage, a team's winning percentage increases 1.6 percent, on average, holding all else constant. The results also show that for every one percent increase in shooting percentage, a team's winning percentage increases just under 4 percent on average, while a one percent increase in save percentage increases a team's winning percentage by about 3.6 percent on average, ceteris paribus.

Model 2 shows similar results as Model 1 as for every one percent increase in Corsi percentage, on average, a team's winning percentage is estimated to increase 1.5 percent. A one percent increase in shooting percentage is expected to raise winning percentage by 3.7 percent holding all else constant. Finally a one percent increase in save percentage increases winning percentage by 3.4 percent on average, holding all else constant.

Face-off percentage, turnovers per game, and takeaways per game did not produce significant coefficients in either model. NHL general managers can use these results to

more efficiently fill the needs of their respective teams. For example, a team with a low shooting percentage can greatly benefit from acquiring a player or players with high shooting percentages. This is similar to the situation in our first case study, which shows that the use of advanced statistics is being used by NHL general managers on making personnel decisions.

Case Study 1: The Pittsburgh Penguins' acquisition of James Neal

Before the 2011 trade deadline, the Pittsburgh Penguins were looking to bolster scoring depth heading into the playoffs. The organizations top two players (Sidney Crosby and Evgeni Malkin) were both out of the line-up with injuries. Penguins director of player personnel Dan MacKinnon consulted with The Sports Analytics Institute (SAI), a company that researches and predicts the results of trades before executing the deal. The Penguins primary target was forward James Neal who they acquired along with Matt Niskanen for defenseman Alex Goligoski. Neal was a rising star, however most organizations, including the Stars did not value him the same way the Penguins and the Sports Analytics Institute did. The reason was a metric referred to by MacKinnon as "conversion rate." Neal had an "ability to produce goals at a high rate based on where he was shooting from, something SAI analysts Mike Boyle and Kevin Mongeon felt meant he could score far more often if elite players were getting him the puck in better areas on the ice."[15] This is a more refined metric comparable to shooting percentage. From the start of the 2011-12 season through March of the 2013, James Neal had scored the second most goals in the NHL. The Penguins reached the Eastern Conference finals in the 2013 Stanley Cup Playoffs. MacKinnon claims

[15] Mirtle, James. 2013

the Penguins have not "made an impact decision since then without consulting the analytics."[16] The case shows how analytics can be used in order to find higher value in players who might be playing on worse teams and therefore are not valued fairly in the market. SAI also claims another top-tier NHL team uses their company as a consultant in personnel decisions. The company uses shot-quality data as well as puck-possession metrics based on shots attempted in order to predict the number of goals a team will score over the course of a season.[17] The presence of SAI and the impact James Neal's move to Pittsburgh has had on the Penguins shows NHL general managers are increasingly aware of the value of advanced statistics and analytics in personnel decisions.

Case Study 2: The Chicago Blackhawks, Multiple Stanley Cups in Study Period

While the Detroit Red Wings, Pittsburgh Penguins, and Boston Bruins all made two Stanley Cup Finals appearances (winning once each) in the previous six seasons, only the Chicago Blackhawks won two Stanley Cups in the past six years. To understand their success, the team's roster will be further studied, specifically how players were acquired and the impact the acquisition types have made in terms of the salary cap. Exhibit 6 is the Chicago Blackhawk's roster for the 2009-10 season, with the 25 players in the organization that played the most games in the NHL that year.

[16] Mirtle, James. 2013
[17] Mirtle, James. 2013

Exhibit 6: 2009-10 Chicago Blackhawks Roster					
Player	**Position**	**Acquired**	**Games**	**Cap Hit**	**Entry Level**
Burish	F	Draft - 02	13	$712,500	
Keith	D	Draft - 02	82	$1,475,000	
Seabrook	D	Draft - 03	78	$3,500,000	
Byfuglien	F/D	Draft - 03	82	$3,000,000	
Bickell	F	Draft - 04	16	$500,000	
Bolland	F	Draft - 04	39	$3,375,000	
Barker	D	Draft - 04	51	$3,083,333	
Brouwer	F	Draft - 04	78	$1,025,000	
Hjalmarsson	D	Draft - 05	77	$643,333	
Toews	F	Draft - 06	76	$850,000	EL
Kane	F	Draft - 07	82	$875,000	EL
Hendry	D	FA - 06	43	$625,000	
Sopel	D	FA - 07	73	$2,333,333	
Niemi	G	FA - 08	39	$826,875	
Huet	G	FA - 08	48	$5,625,000	
Campbell	D	FA - 08	68	$7,142,875	
Hossa	F	FA - 09	57	$5,275,000	
Kopecky	F	FA - 09	74	$1,200,000	
Madden	F	FA - 09	79	$2,750,000	
Fraser	F	Trade - 04	70	$700,000	
Sharp	F	Trade - 05	82	$3,900,000	
Eager	F	Trade - 07	60	$965,000	
Versteeg	F	Trade - 07	79	$3,083,333	
Ladd	F	Trade - 08	82	$1,550,000	
Ebbett	F	Waiver - 09	10	$487,500	

Source: http://blackhawks.nhl.com/club/stats.htm?gameType=2&season=20092010
Capgeek.com

The 2010 Stanley Cup Championship Team featured eleven of the organization's own draft picks. Two of those draft picks, Patrick Kane and Jonathan Toews, were still on their entry-level contracts. This is critical considering Kane accumulated 88 points and a shooting percentage of 11.5 percent while Toews scored 68 points with a 12.4 percent shooting percentage. Kane was ranked third on the team with a 13.052 Fenwick rating per game, while Toews ranked 11th with a 9.162 Fenwick rating per game. The fact that the Blackhawks were able to establish such strong offensive output from entry-level players allowed the team to acquire all-star Marian Hossa before the year began, and he led the

team with a 14.319 Fenwick rating per game.[18] The Blackhawks were able to round out the team in free agency with well-established role players such as Tomas Kopecky and John Madden. The value added by Toews and Kane far exceeded their value in terms of their salaries—this allowed the Chicago Blackhawks to fill their roster with the necessary pieces along side the two young stars and ultimately win the Stanley Cup.

The 2013 Stanley Cup Champion Chicago Blackhawks returned nine players from the 2010 Championship Team. Those players are italicized in Exhibit 7, which shows the 25 players who played the most games with the Blackhawks that season.

Exhibit 7: 2012-13 Chicago Blackhawks Roster

Player	Position	Acquired	Games	Cap Hit	Entry Level
Keith	D	Draft - 02	47	$5,538,462	
Crawford	G	Draft - 03	30	$2,666,667	
Seabrook	D	Draft - 03	47	$5,800,000	
Bolland	F	Draft - 04	35	$3,375,000	
Bickell	F	Draft - 04	48	$541,667	
Hjalmarsson	D	Draft - 05	46	$3,500,000	
Toews	F	Draft - 06	47	$6,300,000	
Kane	F	Draft - 07	47	$6,300,000	
Kruger	F	Draft - 09	47	$735,000	EL
Saad	F	Draft -11	46	$764,167	EL
Shaw	F	Draft -11	48	$577,500	EL
Hossa	F	FA - 09	40	$5,275,000	
Mayers	F	FA - 11	19	$600,000	
Emery	G	FA - 11	21	$1,150,000	
Carcillo	F	FA - 11	23	$825,000	
Rozsival	D	FA - 12	27	$2,000,000	
Bollig	F	FA -10	25	$575,000	
Brookbank	D	FA -12	26	$1,250,000	
Sharp	F	Trade - 05	28	$5,900,000	
Hayes	F	Trade - 10	10	$654,167	EL
Stalberg	F	Trade - 10	47	$875,000	
Leddy	D	Trade - 10	48	$899,999	EL
Frolik	F	Trade - 11	45	$2,333,333	
Oduya	D	Trade - 12	48	$3,383,333	
Handzus	F	Trade -13	11	$2,500,000	

Source: http://blackhawks.nhl.com/club/stats.htm?season=20122013
Capgeek.com

[18] stats.hockeyanalysis.com

Again, eleven players on the roster were Chicago Blackhawks' draft picks. Another similarity to the 2010 Stanley Cup Championship Team is the impact of entry-level players. The 2013 Blackhawks had five entry-level players. Of particular interest are Brandon Saad and Nick Leddy. Saad finished the season seventh on the team with a Fenwick per game of 10.956, a mark that bettered Patrick Kane's 10.731 during the 2012-13 season. Saad finished the year with a 10.2 shooting percentage and 27 points in the lockout-shortened season, a mark good for fifth on the team. Meanwhile, Nick Leddy ranked second among Chicago defenseman in Fenwick per game (5.280) and third in points with 18, only 2 points behind Brent Seabrook. Sheldon Brookbank, acquired as a free agent prior to the start of the season, led the defense with a 6.9 Fenwick per game rating. Like the 2010 Stanley Cup Champion Team, the 2012-13 Blackhawks found a great amount of value in entry-level players while filling other needs through free agency. The impact of the players returning from the 2010 Championship Team must also be considered. Exhibit 8 shows the teams 'core' players (those returning from the 2009-10 team) salary increases from the previous 2009-10 season.

Exhibit 8: Chicago Blackhawks Core Players

Player	Position	12-13 Cap Hit	09-10 Cap Hit	Increase
Keith	D	$5,538,462	$1,475,000	$4,063,462
Seabrook	D	$5,800,000	$3,500,000	$2,300,000
Bolland	F	$3,375,000	$3,375,000	$0
Bickell	F	$541,667	$500,000	$41,667
Hjalmarsson	D	$3,500,000	$643,333	$2,856,667
Toews	F	$6,300,000	$850,000	$5,450,000
Kane	F	$6,300,000	$875,000	$5,425,000
Hossa	F	$5,275,000	$5,275,000	$0
Sharp	F	$5,900,000	$3,900,000	$2,000,000

Source:Capgeek.com

Only two of the Blackhawk's core players were on the same contract for the 2012-2013 season as for the 2009-10 season, Marian Hossa and Dave Bolland. Even with no increase in either Hossa's or Bolland's average salary, the Blackhawks paid these nine returning players an average of $2,459, 644 more per year each in 2012-13. However, the Blackhawks had not resigned the two highest paid players from the 2010 Stanley Cup Champhionship Team, defenseman Brian Campbell ($7,142,875 per year) and goaltender Cristobal Huet ($5,625,000 per year). Jonathan Toews finished fourth in the NHL with 35 points while Kane finished eleventh with 30 points. Both players achieved a shooting percentage of over 16 percent while Marian Hossa shot at 14 percent. Toews led the core with a Fenwick per game of 12.75 while Sharp, Hossa, and Kane were all above 10. The ultimate result was Chicago ranking second in Fenwick Percentage and fifth in shot percentage among all 30 NHL teams. Goaltenders Corey Crawford, Ray Emery and a strong defensive corps achieved the eighth ranked save percentage in the NHL.[19]

Chicago's success has stemmed from drafting well, and developing these players along with those acquired early in their careers through trades such as Nick Leddy and Patrick Sharp in the AHL. This is evident as on average, NHL teams only have 8.5 players on the active roster drafted by the team—in both Stanley Cup years the Blackhawks have had 11.[20] In addition, the performance statistics of entry-level players for the Blackhawks in both Stanley Cup years have been comparable to veteran players with multi-million dollar contracts. Harnessing this value added by young players has also allowed the Blackhawks to gain an edge in performance statistics while remaining under the salary cap.

[19] stats.hockeyanalysis.com
[20] Kurt, R. 2013

Case Study 3: Columbus Blue Jackets Improvement in the 2012 Off-Season

The 2011-12 Columbus Blue Jackets finished last place in the entire NHL with a total of 65 points in an 82 game season, a point percentage of 0.396. Of particular interest is the fact that the Blue Jackets' roster included All-Star Rick Nash, who scored 30 goals and added 29 assists for a total of 59 points. In fact, although Nash had been with the team since being drafted in 2002, the Blue Jackets only made the playoffs once, losing to the Detroit Red Wings in the first round of the 2009 Stanley Cup Playoffs.[21] Nash was widely sought after leading up to the 2012 trade deadline, but General Manager Scott Howson did not move the star player until the off-season. On July 23, 2012, Nash was traded to the New York Rangers for forwards Brandon Dubinsky and Artem Anisimov, and defenseman Tim Erixon.[22] The players performance statistics for the 2011-12 year and salary cap hit for the 2012-13 season are detailed in Exhibit 9.

Exhibit 9: Blue Jackets Trade Nash to Rangers Detailed

Player	11-12 Points	11-12 Fenwick per Game	11-12 Shot Pct	12-13 Cap Hit
Rick Nash	59	14.75	8.7	$7,800,000
Brandon Dubinsky	34	10.327	7.3	$4,200,000
Artem Anisimov	36	8.981	9.8	$1,875,000
Forward Totals	70	19.308	8.55	$6,075,000
Tim Erixon	2	3.141	0	$900,000
New CBJ Total	72	22.449	5.7	$6,975,000

Source: Capgeek.com; stats.hockeyanalysis.com

If points are projected solely based on the previous year, the Blue Jackets gained 13 points while increasing the team Fenwick rating by just under 8. It is also important to consider 2011-12 was Erixon's rookie season in which he only appeared in 18 games. When this is coupled with the fact Erixon is a defenseman it is not surprising he did not

[21] www.hockey-reference.com/teams/CBJ. 2013
[22] Allen, Kevin. 2012

score a goal. If we exclude Erixon in the analysis and focus solely on forwards, the number of points scored increases 11, Fenwick per game increases by just over 4.5, shot percentage decreases by .15% on average, while the Blue Jackets open just under $1 million in cap space even with the Salary of Erixon included. The extra salary cap space is critical when considering the Blue Jackets' other major 2012 off-season roster move.

About a month before the Blue Jackets traded Rick Nash, General Manager Scott Howson traded three future draft picks to the Philadelphia Flyers for goaltender Sergei Bobrovsky who had been splitting time with the highest paid goaltender in the NHL during the 2011-12 season, fellow Russian Ilya Bryzgalov. Bobrovsky came to the Blue Jackets on the final year of his entry-level contract, with a cap hit of only $900,000.[23] His impact on the Columbus defensive corps was enormous. Exhibit 10 shows the performance statistics and salaries for Columbus Blue Jackets Goaltenders during the 2011-12 and 2012-13 seasons.

Exhibit 10: Columbus Blue Jackets Goaltending Statistics

2011-12	Games	Save Pct	GAA	Cap Hit
Steve Mason	46	0.894	3.39	$2,900,000
Curtis Sanford	36	0.911	2.60	$600,000
2012-13				
Steve Mason	13	0.899	2.95	$2,900,000
Sergei Bobrovsky	38	0.932	2.00	$900,000

Source: Capgeek.com; NHL.com

During the 2012-13 season, Bobrovsky's save percentage was .932 while his goals against average was a mere 2.00. His save percentage was 3.3 percent higher than Steve Mason's in 2012-13 and 3.8 percent higher compared to Mason's 2011-12. When these stats are utilized in the regression findings, we would expect the Blue Jackets winning percentage to increase drastically when Bobrovsky became the starting goalie. Exhibit 11 shows the

[23] Wyshynski, Greg. 2012

estimations of Bobrovsky's impact on the team's winning percentage compared to Steve Mason. For ease of calculation we will treat the calculations as if each goaltender played every game of the season for the team.

Exhibit 11: Estimated Point Percentage Change Attributable to Sergei Bobrovsky						
	Regression Equation 1			Regression Equation 2		
	Sv Pct Diff	Sv Pct Coef	Exp. Point Pct Change	Sv Pct Diff	Sv Pct Coef	Exp. Point Pct Change
Estimate 1	3.3%	3.661	12.1	3.3%	3.405	11.2
Estimate 2	3.8%	3.661	13.9	3.8%	3.405	12.9

Source: Appendix A & Exhibit 10

In Exhibit 11, estimate 1 uses the difference between Bobrovsky's 2012-13 save percentage and Mason's 2012-13 save percentage while estimate 2 uses the difference between Bobrovsky's 2012-13 save percentage and Steve Mason's 2011-12 save percentage. Estimate 1 is a better indicator of the value in terms of point percentage Bobrovsky added because it directly compares the goaltenders playing behind the same team. The estimates show Bobrovsky increased the team's expected point percentage by between 11.2 and 13.9 percent. With the team earning 39.6% of the possible points in 2011-12 the team's point percentage would be expected to increase to between 50.8% and 53.5% had Bobrovsky played every game of the 2012-13 season. In fact, the team earned 55 of a possible 96 points during the 2012-13 season, or 57.3% of the teams possible points. This means that although Bobrovsky added significant value to the Blue Jackets in terms of winning percentage, the increased production provided by the acquisition of Dubinsky and Anisimov (2 good players) for Rick Nash (1 great player) likely affected the team's success positively. The trade provided the Blue Jackets with greater depth and may be a model for other small market teams with one or two all-star caliber players but not much team depth beyond their top player or line.

Even though the Blue Jackets saw their point percentage increase by 17.7% from the 2011-12 season to the 2012-13 season, they missed the playoffs. The Blue Jackets tied with the Minnesota Wild for the eighth and final playoff spot in the Western Conference at 55 points apiece. The Wild won the tiebreaker, wins excluding shootout wins, eliminating the Blue Jackets from a chance to win the Stanley Cup. Although, the Blue Jackets failed to reach the playoffs the strong and sudden improvement of team performance is worth studying for NHL general managers.

Case Study 4: Stanley Cup Finalists from Past Six Seasons

Ultimate success in the NHL is winning the Stanley Cup, therefore the Stanley Cup finalists will be analyzed to determine their performance in the statistics studied compared to the performance of all teams. The teams studied are listed in Exhibit 12.

Exhibit 12: Past Six Stanley Cup Finals

Year	Champion	Runner-Up
2012-13	Chicago Blackhawks	Boston Bruins
2011-12	Los Angeles Kings	New Jersey Devils
2010-11	Boston Bruins	Vancouver Canucks
2009-10	Chicago Blackhawks	Philadelphia Flyers
2008-09	Pittsburgh Penguins	Detroit Red Wings
2007-08	Detroit Red Wings	Pittsburgh Penguins

The data from these twelve teams was compiled (See Appendix B). Descriptive statistics of this data set are shown in Exhibit 13.

Exhibit 13: Descriptive Statistics of Stanley Cup Finalists			
Point Percentage		**Takeaways per Game**	
Mean	65.167	Mean	6.508
Standard Deviation	6.994	Standard Deviation	1.356
Minimum	53.700	Minimum	5.170
Maximum	80.200	Maximum	9.730
Shooting Percentage		**Turnovers per Game**	
Mean	7.962	Mean	7.633
Standard Deviation	0.830	Standard Deviation	0.830
Minimum	6.350	Minimum	6.610
Maximum	9.490	Maximum	9.390
Save Percentage		**Corsi Percentage**	
Mean	92.446	Mean	53.400
Standard Deviation	0.876	Standard Deviation	4.131
Minimum	90.720	Minimum	45.200
Maximum	93.420	Maximum	59.500
Faceoff Percentage		**Fenwick Percentage**	
Mean	51.558	Mean	53.567
Standard Deviation	3.154	Standard Deviation	3.852
Minimum	46.100	Minimum	46.400
Maximum	56.400	Maximum	59.700

Source: Appendix B

When compared to the descriptive statistics of the original data set (Exhibit 4), some interesting patterns emerge. We would expect the mean of every statistic to increase with the exception of turnovers per game. The mean point percentage of Stanley Cup Finalists is over 9 percent higher than the average NHL team. This is important, as over half the teams in the NHL make the playoffs, meaning teams near the average point percentage can in theory win the Stanley Cup. The idea that a general manager's goal is to create a playoff caliber team and that once they reach the playoffs anything can happen is central to Billy Beane's management style in baseball.[24] The 2009-10 Philadelphia Flyers seem to support Beane's idea of the playoffs, as their 53.7 percent point percentage was lower than average, but earned them the eighth spot in the Eastern Conference that year. The team reached the Stanley Cup Final despite their below-average regular season before losing to the Chicago

[24] Lewis, Michael. 2003

Blackhawks. However, closer examination shows teams that win the Stanley Cup have done far more than merely perform good enough to reach the playoffs. The lowest winning percentage for a Stanley Cup winning team in the past six years belonged to the 2011-12 Los Angeles Kings at 57.9 percent. While the Flyers and Kings were around the average in their Stanley Cup Final years, the remainder of the Stanley Cup Finalists from the 2007-08 to 2012-13 seasons all achieved point percentages above 60 percent, 4 percent higher than the overall average point percentage. When evaluated as a group the Stanley Cup Finalists averaged a 65.2% point percentage, much higher than the overall point percentage average of 55.9%, which would in theory make the playoffs. Therefore, Beane's attitude that analytics should be used only to get a playoff team at which point randomness prevails does not seem to transfer from baseball to hockey.

Also of interest are the Fenwick and Corsi percentages of Stanley Cup Finalist Teams compared to the overall average. Other than point percentage, these are the statistics that the mean value of Stanley Cup Finalists differs the most from the overall average. The mean Corsi percentage for Stanley Cup Finalists is 53.4 percent while the overall average is just under 50 percent. Similarly, Stanley Cup Finalists achieve a Fenwick percentage of 53.6 percent while the overall average is again just under 50 percent. Using these percentages as puck possession proxies once again, we can assume Stanley Cup Finalists posses the puck about 3.5% more than the average NHL team. The only teams to achieve Fenwick and/or Corsi percentages under 50 percent and still reach the Stanley Cup Finals were the 2007-08 and 2008-09 Pittsburgh Penguins. The 2007-08 team lost to Detroit in the finals after achieving a Corsi percentage of 45.2 and a Fenwick percentage of 46.4 during the regular season. Their subpar puck possession proxies were likely offset by a high shooting

percentage of 8.5, the third highest among all Stanley Cup Finalists studied. Similarly, the 2008-09 Penguins achieved a Corsi percentage of only 49.2, while the team's Fenwick percentage was above the overall average at 50.1 percent. The Penguins avenged their finals loss from the previous year by defeating the Detroit Red Wings. The 2008-09 Penguins achieved the best shooting percentage of any Stanley Cup Finalist studied at just under 9.5 percent, which likely offset the team's relatively average puck possession.

As a whole, Stanley Cup Finalists perform better in the regular season than the NHL average, which generally is considered as a playoff team. However, this is not to say a team with a point percentage that far exceeds the NHL average will also be above average in each performance statistic studied. The study of Stanley Cup Finalists seems to suggest that the most successful teams are able to offset areas of the team that are average with other areas that are extremely strong. In addition, the 2009-10 Flyers show there is an element of randomness, momentum, and chemistry, all intrinsic to hockey that carry over from regular season play to the playoffs.

Chapter 5
Conclusion

Interpretation of Findings

Four different performance statistics showed a positive and significant correlation to team success, measured in terms of point percentage. The first regression tested showed Fenwick percentage, shot percentage, and save percentage as reliable indicators of team performance. The second regression replaced Fenwick percentage with Corsi percentage with the results showing Corsi percentage, shot percentage, and save percentage as relevant indicators of a team's success. From these two regressions we can draw some meaningful conclusions for NHL general managers attempting to put together the most competitive team possible. First, both puck possession proxies (Fenwick and Corsi) are positively correlated with team success. This shows these metrics are valuable tools to evaluating players, although some NHL general managers disagree.[25]

Similarly, capitalization percentages such as shot percentage and save percentage have a major impact on the success of a team as evidenced by the results of both regressions. Anecdotal evidence from *Case Study 1* supports these findings as the Pittsburgh Penguins and the Sports Analytics Institute used "conversion rate" to determine James Neal was worth more in reality than his market value would have led others to believe. *Case Study 2* shows the importance of drafting well, the use of the AHL, and capitalizing on players still on their entry-level contracts while making significant contributions in terms of puck possession proxies, shooting percentage, and ultimately points. Although the Blackhawks were unable to retain the services of some crucial players from their 2010 Stanley Cup Championship Team, the organization replaced them in a span

[25] Hawerchuk, 2012.

of three years with entry-level players such as Nick Leddy and Brandon Saad to win another Stanley Cup in 2013.

Case Study 3 shows how star players might be over valued in the trade or free agent market. Although Rick Nash led the Columbus Blue Jackets in points, the team did not have the depth to realistically compete for a playoff spot in 2011-12. By trading Nash to acquire more depth, the Blue Jackets were able to improve puck possession and ultimately performance. In addition, the acquisition of goaltender Sergei Bobrovsky and the difference he made on the team's save percentage made a large impact on the team's performance, ultimately contributing to the Blue Jackets improving their point percentage by over 17 percent.

Conclusion

In conclusion, both sabermetrics and traditional statistics are useful for evaluating team performance. Fenwick, Corsi, shot percentage, and save percentage are all statistics NHL general managers should consider when making personnel decisions. These statistics have the potential to highlight players that will impact the team's point percentage greatly, even though the market does not value a player as highly. The introduction of entry-level contract limits in the 2005 Collective Bargaining Agreement has provided general managers a great tool to increase a team's success with a minimal cap hit. This is evident in the success of the Chicago Blackhawks over the past 4 NHL seasons as well as by the improvement of the Columbus Blue Jackets, arguably due to the acquisition of entry-level goaltender Sergei Bobrovsky. The quality of players signed in free agency or acquired in trades has been shown to work in both ways. In *Case Study 2* the depth of the Chicago

Blackhawks and contributions of entry-level players Jonathan Toews and Patrick Kane in the 2009-10 season allowed high priced and high quality free agent signings Brian Campbell and Marian Hossa to increase team success. However, *Case Study 3* shows how a team with one great player can achieve more success by trading him for several good players and increasing team depth. Although the Blue Jackets lost Rick Nash, they added Brandon Dubinsky, Artem Anisimov, and Sergei Bobrovsky for roughly the same price as Nash would have cost them. This shows how in some situations it is to the team's benefit to acquire several players for the price of one all-star caliber player. The general manager must be able to determine the amount of depth on his team and determine what areas need to be improved.

The findings of this study help to show how a general manager can determine what trade-offs are necessary to improve his team's success. *Case Study 4* shows that as a whole, teams who make the Stanley Cup Finals are far better than teams who merely make the playoffs even during the regular season. This means Billy Beane's theory for baseball, that once the playoffs start all teams have an equal chance to win the title, does not hold true in hockey. In addition, the study shows the most successful NHL teams are able to offset their average or below average areas with at least one exceptionally strong area.

There are limitations to this study. First of all, it is hard to determine exactly how the rule changes in the NHL CBA agreed to in January of 2013 will impact the market. This is because the season was limited to 48 games and the statistics from the recently opened 2013-14 season were not included in the study. In addition, the impact of the 2005 NHL CBA on general managers decision-making was limited because the sabermetric statistics of Fenwick and Corsi could not be collected prior to the start of the 2007-08 season. The

true impacts of a single free agent signing or trade is very hard to calculate due to the fact that hockey is largely based on teamwork and chemistry, these variable are difficult to measure, which may account for variance in a player's or team's performance from year to year.

Suggestions for Further Research

In conclusion, the analytical approach to studying hockey is effective and many NHL general managers are using sabermetric principles in their decision-making. However, the scientific study of hockey is in its infancy and needs to be further studied. Notable areas that should be studied further include shot quality and scoring chances. Further study in these areas will allow for a better understanding of goal scoring potential for forwards and defensemen as well as a better measurement for goal prevention for defensemen and especially goaltenders. Possession time studies for each zone (offensive, defensive, and neutral) can also give more insight into exactly how puck possession plays a role in winning hockey games. For example, how does the zone in which a team has the puck impact success and how does it compare to the fact their opponent does not have it? In order to help evaluate players for the draft and those in the minors, further study should be completed on how performance statistics of players in junior leagues, the college ranks, and the AHL translate to success in the NHL.

Bibliography

Allen, Kevin. "Blue Jackets Trade Rick Nash to Rangers." *USATODAY.COM*. Gannett Company, 24 July 2012. Web. 10 Nov. 2013. <http://usatoday30.usatoday.com/sports/hockey/nhl/story/2012-07-23/rick-nash-trade/56441030/1>.

Berri, David J., and Stacey L. Brook. 2010. “On the Evaluation of the “Most Important” Position in Professional Sports.” *Journal of Sports Economics* 11: 157-171. April 2010. Web. 1 July 2013.

"CapGeek.com - The Definitive Source for NHL Salaries, Salary Cap Data and Player Contracts." *CapGeek.com - The Definitive Source for NHL Salaries, Salary Cap Data and Player Contracts*. N.p., n.d. Web. July 2013. <http://www.capgeek.com/>.

"Columbus Blue Jackets Franchise Index." *Hockey-Reference.com*. Sports Reference LLC, 2013. Web. 12 Nov. 2013. <http://www.hockey-reference.com/teams/CBJ/>.

Desjardins, Gabriel. "About Advanced Statistics." *Behind the Net*. Web. 28 June 2013.

Fry, Michael J., and Jeffery W. Ohlmann. "Introduction to the Special Issue on Analytics in Sports, Part I: General Sports Applications." *Interfaces* 42.2 (2012): 105-08. *Google Scholar*. Web. 1 July 2013.

Hakes, John K., and Raymond D. Sauer. "The *Moneyball* Anomaly and Payroll Efficiency: A Further Investigation." *International Journal of Sport Finance* 2.4 (2007): 177-89. *Fitness Information Technology*. West Virginia University. Web. 1 July 2013.

Hawerchuk. "Brian Burke (and Mike Milbury) on Advanced Stats in the NHL." *Arctic Ice Hockey*. Sbnation.com, 3 Mar. 2012. Web. 28 June 2013. <http://www.arcticicehockey.com/2012/3/3/2841995/brian-burke-and-mike-milbury-on-advanced-stats-in-the-nhl>.

Johnson, David. "How Are Hockey Analysis Ratings Calculated." *Hockeyanalysis.com*. Yard Barker, 11 Apr. 2013. Web. 28 June 2013.

Jones, J.C. H., and William D. Walsh. "Salary Determination in the National Hockey League: The Effects of Skills, Franchise Characteristics, and Discrimination." *Industrial and Labor Relations Review* 41.4 (1988): 592-604. *JSTOR*. Web. 2 July 2013.

Kahn, Lawrence M. "The Sports Business as a Labor Market Laboratory." *The Journal of Economic Perspectives* 14.3 (2000): 75-94. *JSTOR*. Web. 8 July 2013.

Kesenne, Stefan. "The Impact of Salary Caps in Professional Team Sports." *Scottish Journal of Political Economy* 47.4 (2000): 422-30. *Google Scholar*. Web. 8 July 2013.

Kurt, R. "How Do NHL Teams Put Together Their Rosters? - Broad Street Hockey." *Broad Street Hockey*. SB Nation, 27 May. 2013. Web. 10 Nov. 2013. <http://www.broadstreethockey.com/2013/5/27/4352668/nhl-rosters-drafting-trades-free-agents-flyers-defense>.

Lewis, Michael. *Moneyball: The Art of Winning an Unfair Game*. New York: W.W. Norton, 2003. Print.

Mason, Daniel S., and William M. Foster. "Putting *Moneyball* on Ice?" *International Journal of Sport Finance* 2.4 (2007): 206-13. *Fitness Information Technology*. West Virginia University. Web. 1 July 2013.

Mazzeo, Mike. "Ilya Kovalchuk Leaves $77M On table." *ESPN*. ESPN Internet Ventures, 12 July 2013. Web. 5 Nov. 2013. <http://espn.go.com/new-york/nhl/story/_/id/9470677/ilya-kovalchuk-new-jersey-devils-announces-retire>.

Mirtle, James. "Moneyball-ization of Hockey Pays off for Penguins" *The Globe and Mail*. Phillip Crawley, 21 Mar. 2013. Web. 23 Oct. 2013. <http://www.theglobeandmail.com/sports/hockey/moneyball-ization-of-hockey-pays-off-for-penguins/article10122427/>.

Mondello, Mike, and Joel Maxcy. "The Impact of Salary Dispersion and Performance Bonuses in NFL Organizations." *Management Decision* 47.1 (2009): 110-23. *Google Scholar*. Web. 8 July 2013.

National Hockey League, and National Hockey League Player's Association. *NHL Collective Bargaining Agreement*. 16 Sept. 2012. Professional Contract. New York City.

"NHL Team Statistics." *NHL.com*. Nation Hockey League, n.d. Web. July 2013. <http://www.nhl.com/>.

"NHL Team Stats." *Hockey Stats*. Hockeyanalysis.com, 28 Apr. 2013. Web. July 2013. <http://stats.hockeyanalysis.com/teamstats.php?disp=1&db=201213&sit=5v5close&sort=PDO&sortdir=DESC>.

Richardson, David H. "Pay, Performance, And Competitive Balance In The National Hockey League." *Eastern Economic Journal* 26.4 (2000): 393-417. *Google Scholar*. Web. 2 July 2013.

Rosen, Sherwin, and Allen Sanderson. "Labour Markets in Professional Sports." *The Economic Journal* 111.469 (2001): 47-68. *Google Scholar*. Web. 8 July 2013.

"Sabermetrics and Hockey." Web blog post. *The Puck Stops Here*. Blogspot, 26 May 2013. Web. 27 June 2013. <http://puckstopshere.blogspot.com/2005/05/sabermetrics-and-hockey.html>.

Scott, Frank A., James E. Long, and Ken Somppi. "Relationships between Cohesion, Collective Efficacy and Performance in Professional Basketball Teams: An Examination of Mediating Effects." *Atlantic Economic Journal* 13.3 (1985): 50-59. *Google Scholar*. Web. 8 July 2013.

Scully, Gerald W. "Pay and Performance in Major League Baseball." *The American Economic Review* 64.6 (1974): 915-30. *JSTOR*. Web. 6 July 2013.

Spann, Martin, and Bernd Skiera. "Sports Forecasting: A Comparison of the Forecast Accuracy of Prediction Markets, Betting Odds and Tipsters." *Journal of Forecasting* 28.1 (2009): 55-72. *Google Scholar*. Web. 25 June 2013.

Wagner, Daniel. "How Corsi and Fenwick Encourage a Completely Backwards View of Hockey (and Are Still Useful)." Web blog post. *Backhand Shelf*. The Score, 12 Mar. 2013. Web. 28 June 2013. <http://blogs.thescore.com/nhl/2013/03/12/why-advanced-statistics-approaches-hockey-completely-wrong-but-still-gets-things-right/>.

Wyshynski, Greg. "Flyers Trade Sergei Bobrovsky to Blue Jackets for Picks; Has Columbus Helped Goalie Woes?" *Puck Daddy*. Yahoo Sports, 22 June 2012. Web. 10 Nov. 2013. <http://sports.yahoo.com/blogs/nhl-puck-daddy/flyers-trade-sergei-bobrovsky-blue-jackets-picks-columbus-164027453--nhl.html>.

"630 AHL Grads Open Season in NHL." *The American Hockey League*. The AHL, 1 Oct. 2013. Web. 18 Oct. 2013. <http://theahl.com/630-ahl-grads-open-season-in-nhl-p187541>.

Appendix A

Model 1: OLS, using observations 1-180
Dependent variable: PP

	coefficient	std. error	t-ratio	p-value	
const	−398.731	34.2680	−11.64	1.75e-23	***
FP	1.61741	0.117663	13.75	1.54e-29	***
FOP	0.142324	0.184451	0.7716	0.4414	
SP	3.83129	0.393865	9.727	4.11e-18	***
SVP	3.66129	0.358575	10.21	1.87e-19	***
TOG	0.130247	0.190264	0.6846	0.4945	
TAG	−0.265880	0.249424	−1.066	0.2879	

Mean dependent var 55.85833 S.D. dependent var 7.963084
Sum squared resid 3392.943 S.E. of regression 4.428588
R-squared 0.701076 Adjusted R-squared 0.690709
F(6, 173) 67.62370 P-value(F) 8.31e-43
Log-likelihood −519.6936 Akaike criterion 1053.387
Schwarz criterion 1075.738 Hannan-Quinn 1062.449

Excluding the constant, p-value was highest for variable 19 (TOpG)

Model 2: OLS, using observations 1-180
Dependent variable:
PP

	coefficient	std. error	t-ratio	p-value	
const	−367.927	36.1240	−10.19	2.21e-19	***
CP	1.50505	0.123913	12.15	6.05e-25	***
FOP	0.150215	0.198178	0.7580	0.4495	
SP	3.72135	0.417818	8.907	7.07e-16	***
SVP	3.40541	0.379837	8.965	4.91e-16	***
TOG	0.0593116	0.201874	0.2938	0.7693	
TAG	−0.353920	0.264558	−1.338	0.1827	

Mean dependent var 55.85833 S.D. dependent var 7.963084
Sum squared resid 3831.509 S.E. of regression 4.706108
R-squared 0.662438 Adjusted R-squared 0.650730
F(6, 173) 56.58295 P-value(F) 2.74e-38
Log-likelihood −530.6341 Akaike criterion 1075.268
Schwarz criterion 1097.619 Hannan-Quinn 1084.330

Excluding the constant, p-value was highest for variable 19 (TOpG)

Appendix B

Stanley Cup Finalists from Past Six Seasons												
Team	Point Pct	Goals per Game	GA per Game	Shots per Game	SA per G	FO Pct	Fenwick Pct	Corsi Pct	Shot Pct	Save Pct	TO Game	TA Game
2012-13 BOSTON	64.6	2.65	2.21	32.4	28.6	56.4	54.5	55	8.18	93.31	8.38	5.79
2012-13 CHICAGO	80.2	3.1	2.02	31.1	26.2	50.8	56.1	55.4	8.29	92.41	7.19	9.73
2011-12 LOS ANGELES	57.9	2.29	2.07	30.6	27.4	51.5	53.7	54.9	6.35	93.38	9.39	5.51
2011-12 NEW JERSEY	62.2	2.63	2.5	27.5	26.8	47.1	51.1	51	6.93	92.14	7.71	5.93
2010-11 BOSTON	62.8	2.98	2.3	32.9	32.7	51.9	50.8	51.1	8.41	93.42	6.61	5.17
2010-11 VANCOUVER	71.3	3.15	2.2	32	30.1	54.9	53.5	53.7	7.86	93.38	6.77	7.27
2009-10 CHICAGO	68.3	3.2	2.48	34.1	25.1	52.4	58.1	56.9	8.69	90.72	6.71	8.33
2009-10 PHILADELPHIA	53.7	2.83	2.71	31.6	28.6	50.1	51.3	50.5	7.48	92.23	8.1	6.82
2008-09 DETROIT	68.3	3.52	2.93	36.2	27.7	55.1	57.5	58.4	7.61	91.45	7.43	5.43
2008-09 PITTSBURGH	60.4	3.15	2.84	29	30.3	49.1	50.1	49.2	9.49	92.86	7.96	5.71
2007-08 DETROIT	70.1	3.07	2.18	34.4	23.5	53.3	59.7	59.5	7.75	91.6	8.27	6.54
2007-08 PITTSBURGH	62.2	2.93	2.58	27.7	30.8	46.1	46.4	45.2	8.5	92.45	7.07	5.87

Source: NHL.com; stats.hockeyanalysis.com