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ABSTRACT

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Abstract

In the rapidly growing field of sports economics labor issues are one of the major focuses, yet ice hockey has been left with little attention. This thesis sets out to study one aspect of labor economics in professional ice hockey: the player trade. In the National Hockey League the players are traded between the clubs as an exchange in players. The decision making in these player trades is of interest, as the trade lacks monetary compensation. The measures of player quality and the critical variables as per clubs' preferences are explored.

This research uses the bargaining models of game theory to study the different aspects and criteria for player trade. The models by Nash and Rubinstein are used to introduce the influences different limitations for player trade have on the resulting trade. The player trades from 2000–2008 seasons are examined to find the common characteristics of trades and players traded. The motives for trades are discussed and the effects of trades on team performance are investigated based on the team performances in seasons 2000–2008. The changes brought on by the new Collective Bargaining Agreement of 2005 between the League and the Players' Association are discussed.

This research serves as a starting point to further study on player trade in professional ice hockey. It explores the structure of the trade and the critical variables in player trade decision making. The different values of players for the teams involved in bargaining give rise to mutual gains from trade. The key determinants of trade are found to be possible outside options available for teams, the inside gain from delay of trade and the relative patience of clubs to complete the trade. This research raises several questions for further study in the field of sports economics in general and in professional ice hockey in particular. Most important of those are the questions of player valuation measures as well as the comparison of *ex ante* and *ex post* player evaluations in a trade situation.

Key words	game theory, bargaining, sports economics, ice hockey, player trade
Further information	

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Tiivistelmä

Urheilun taloustieteessä työhön ja työvoimaan liittyvät kysymykset ovat keskeisiä. Lajeista jääkiekko on jäänyt vähälle huomiolle. Tämän tutkielman tarkoitus on tutustua yhteen työn taloustieteen puolista ammattilaisjääkiekossa: pelaajakauppaan. Pohjois-Amerikan ammattilaisliigassa NHL:ssä pelaajakaupat ovat seurojen välisiä pelaajavaihtoja. Päätöksenteko näissä pelaajakaupoissa on mielenkiintoista taloustieteellisessä mielessä, sillä rahakorvaukset puuttuvat. Siksi pelaajien arvon mittaamista ja seurojen preferenssien kriittisiä muuttujia tutkitaan.

Tässä tutkielmassa käytetään peliteorian neuvottelupelejä tutkittaessa pelaajakaupan eri piirteitä ja kriteereitä. Erilaisten rajoituksien vaikutuksia pelaajakauppaan tutkitaan Nashin ja Rubinsteinin neuvottelumallien avulla. Kausien 2000–2008 pelaajakauppoja tutkimalla selvitetään kauppojen ja siirrettyjen pelaajien yhteneväisiä piirteitä. Pelaajasiirtojen motiiveja ja niiden vaikutuksia joukkueiden menestykseen selvitetään tutkimalla seurojen menestystä kausilla 2000–2008. Lisäksi käsitellään 2005 käyttöönotetun uuden työehtosopimuksen tuomia muutoksia pelaajakauppaan.

Tämä tutkimus toimii lähtökohtana tuleville tutkimuksille ammattilaisjääkiekossa. Se selvittää pelaajakaupan rakenteita ja kriittisiä vaikuttavia tekijöitä pelaajakauppaan liittyvässä päätöksenteossa. Joukkueiden eriävät pelaaja-arvostukset mahdollistavat pelaajakaupan molemmanpuoliset hyödyt. Avaintekijät pelaajakaupassa ovat neuvotteleville seuroille mahdolliset ulkopuoliset vaihtoehdot, kaupan viivästymisestä syntyvä hyöty joukkueille sekä seurojen suhteellinen kärsivällisyys. Tämä tutkimus nostaa esille myös useita kysymyksiä jatkotutkimuksia varten niin yleisesti urheilun taloustieteen saralta kuin erityisesti ammattilaisjääkiekkoon liittyen. Tärkeimpinä kysymyksinä voidaan pitää pelaajien arvon määrittelyn ongelmaa sekä pelaajan *ex ante* ja *ex post* arvoa joukkueelle pelaajakaupan tapahtuessa.

Asiasanat	peliteoria, urheilun taloustiede, neuvottelupelit, pelaajakauppa, jääkiekko
Muita tietoja	

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BARGAINING FOR PLAYERS

Player Trade in the National Hockey League

Master's Thesis
in Economics

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1 INTRODUCTION

Economics of sport are a rapidly expanding field of study. From the 1950's to present day a significant share of those studies has focused on the professional team sports and the leagues in North America. A majority of research has involved the labor markets in sports, that is, the acquisition and exchange of players by sports clubs. This paper attempts to study one aspect of the player markets in the National Hockey League (NHL): the player trade between NHL franchises.

As the sole source of player mobility during the season the player trade plays a significant role in team development. Due to reserve rules that still bound a player to a club for the entire duration of his contract, all player transfers originate from the clubs. While research focus has been on the labor markets in professional sports and even in the allocation of talent as a result of the Entry Drafts, the exchange in players has been left with little or no attention. It is therefore of interest to take a closer look at the decision-making in the player trade in the NHL. While an extensive study on the player trade markets and Nash Bargaining Solution has been conducted by Carmichael and Thomas (1993), their focus was on a European football league, which is fundamentally different from the North American professional team sports environment. Nonetheless, the study of Carmichael and Thomas was an inspiration for this paper.

The aim of this paper is to study the decision making on the part of the clubs who trade players with each other. For this purpose, the bargaining models familiar from game theory are used. The different aspects and conditions to trade are analyzed in turn using the game theoretical setting. This paper attempts to explain some of the factors affecting the player trade bargaining and the resulting changes to the teams.

This paper starts with a brief look into what is sports economics, and what has been written in the field on player trade, for one, and on the National Hockey League for another. The main arguments and ideas relating to sports economics and player trade in particular are briefly discussed. Followed by that, the structure and operation of the National Hockey League is examined in Chapter 3. The main regulations governing the league and especially player trade are explained. The rules of player trade are explored.

The Chapter 4 focuses on the player trade. The motives of clubs to trade are considered. The argument for gains from trade is examined and the possible connection between trade activity and competitive performance is studied. The player trades from season 2000–01 to 2007–08 are investigated in order to compare the earlier discussed motives for trade.

In 2005 the NHL and the National Hockey League Players' Association (NHLPA) agreed upon a new Collective Bargaining Agreement (CBA) after a season-long lock-out. This new agreement changed the way teams were now built and introduced a salary cap to the NHL. The impact this new CBA had on the player trade is briefly examined at the end of Chapter 4.

The bargaining models of game theory are studied in Chapter 5. The models are applied to the NHL player trade environment. Costs from delayed agreement, risks of breakdown and outside options are all considered in turn. Inside options, that is, the gains from a delay in agreement are also explored. These models are then used to find the critical factors in determining the talent redistribution resulting from a trade, as per the motives and the relative bargaining powers of the clubs involved.

This paper aims to serve as a starting point for the discussion on player trade in professional team sports and in particular professional ice hockey. It attempts to isolate the relevant issues and provide some answers to the questions on player trade. While acknowledging that the player market is more complex than can be modeled by studying the trading alone, this paper hopes to raise questions and guide future studies into related field.

2 ECONOMICS OF SPORT

The economics of sports is a growing field of study. The ground-breaking 1956 paper "The Baseball Players' Labor Market" by Simon Rottenberg introduced issues still under study by sports economists. Many of the early papers followed the lead of Rottenberg and focused on baseball, and its league Major League Baseball (MLB) in North America, or the labor issues present in sports. As other leagues grew and stabilized their position in the sports world, they too started to attract the attention of the economists.

The study of economics of sports is much dominated by the study of professional team sports, and American professional leagues in particular. Many of the questions in sports economics are universal between all American professional leagues and several studies these days use data from more than one league. The 1971 study by Mohamed El-Hodiri and James Quirk provides a good general model of a sporting league and later a thorough and encompassing study on American sports leagues was written by John Vrooman in 2000, reprising his earlier articles.

The European leagues, which in sports economics usually come to mean the big football leagues of England, Spain, Germany, Italy and France, are seen to be different in few fundamental characteristics, and thus do not fall in line with the North American model of the league. The very existence of several top level leagues as opposed to the sole dominance of North American leagues in their respective sports is one of the most obvious differences. A closely related issue is the labor markets. In European football leagues the teams compete for the best players with all European teams instead of just their own league members, and conversely, can increase their player portfolio from outside the league. In North America the player pools are closed, so that there is a fixed supply of talent for each team. An increase of player talent by one club means a decrease by another.

While ice hockey's National Hockey League fits the North American model of professional team sports relatively little research has been conducted within the sport. The specific aspects of ice hockey were studied by J. C. H. Jones in his 1969 paper when he constructed a theoretical model of the NHL. Like many other studies on the economic structure of the sports league, Jones' was concerned with the antitrust issues with which the professional leagues are still battling today.

2.1 Competitive Balance in sports

At the very core of sports business is the conflicting "inverted joint product" (Késenne, 2007, 2) that points out the interdependency in sports. No single team can produce the good, a game, by itself. Nor can two teams produce a sufficient championship battle, but a wider league is needed, with the corresponding organizing body. This interdependency and the following problem of competitive balance has been the subject to several studies.

The uncertainty of outcome hypothesis states that the closer the competition between the teams within the league, the greater the interest of consumers and thus higher the club revenues. The hypothesis considers a significant externality existing in sports. A clearly dominant team might still draw in large crowds purely due to the star power of its players or because fans like to see their teams win. The negative externality of a dominant team is the decreasing interest in games not involving the dominant team. (Downward & Dawson, 2000, 21) Thus the competitive balance within the league is important to the survival of the clubs and therefore the league as a whole.

Knowles, Sherony and Haupert (1992) demonstrated that the uncertainty of outcome has a significant effect on game attendance for MLB. The uncertainty of outcome has then been used to justify a wide range of rules and regulations. These have ranged from roster limits and payroll caps to revenue sharing, reversed draft and restricted free agency.

Késenne (2000a) argued that the revenue sharing increases competitive balance in the case of profit and utility maximizing clubs. Larsen, Fenn and Spenner studied the competitive balance in the NFL (National Football League) and the impacts free agency and the salary cap might have on it. Their 2006 paper is a good study on competitive balance on its own and also provides a good review of current research on the issue. Fenn, von Allmen, Brook and Preissing (2005) studied the structural changes in the NHL and its effects on the competitive balance. The impact of a salary cap was also the focus of Késenne (2000b), who concluded that a salary cap might improve competitive balance. But while such cap would improve the player salary distribution it would lead to a non Pareto-optimal point with decreased total league revenues.

In his 1995 paper “A General Theory of Professional Sports”, and again in his reprising paper in 2000, John Vrooman studied the three defining features of professional leagues: free agency, revenue sharing and the payroll cap. Using MLB, NFL, and NBA (National Basketball Association) Vrooman questioned the role of competitive balance as a league objective. He argued that the gains in terms of increased competitive balance by payroll caps and revenue sharing schemes are more about making the good teams as bad as the bad ones.

The general consensus is that competitive balance is of crucial importance to a sports league, and the debate arises in the best method of promoting such balance. The invariance principle has been universally agreed upon from theoretical standpoint since the early 70’s. (Fenn et al, 2005, 215) The invariance principle states that “changing from a reserve clause (or a maximum wage) to free agency should have no effect on competitive balance" (Dobson & Goddard, 2001, 136) as free agency merely shifts rents from the teams to the players with no effect on the allocation of talent and therefore competitive balance. Szymanski (2007) considers this issue once again, using both American and European leagues as a source of study. He argues that while competitive balance is something to strive for, there might be too much competitive balance, and that slight differences in strength are better than teams of equal strength.

Fort (2005) points out how Rottenberg's invariance principle preceded the more commonly known Coase's Theorem on resource allocation and property rights. Fort wonders at the extent that sports economics choose to use Coase's Theorem while Rottenberg's invariance principle would suffice. In deed, the two models, when applied to the context of professional sports, say the same thing.

2.2 Labor markets: drafting, salary caps and free agency

The 2001 paper by Rosen and Sanderson offers an overview of the labor issues in professional sports, through the basic demand and supply determinants. The authors reflect on the impact of collective bargaining agreements and the free agency, as well as the salary caps and competitive balance. In a more detailed study, Bougheas and Downward (2003) point out the three labor market policies used by the professional leagues to influence club financing and results: the drafting system, salary caps and reserve option arrangements. All three of these are used to increase competitive balance and to protect the survival of lower-revenue franchises in the league. The drafting system affects directly the introduction and allocation of new talent in the league. It therefore has an indirect effect to club finances. Salary cap has a direct and often drastic effect, as it places a maximum cap on either aggregate or individual player salary, or both. The salary cap implemented into the NHL is discussed in detail in section 4.2 in this paper. The different versions and definitions of salary caps used in North American professional sports leagues are discussed in closer detail in Zimbalist (2010).

Reserve option arrangements limit player mobility and player transfers. The former is concerned with free agency, which is team changes originating from the player himself as he chooses to sign a contract with a new team, and latter with transfers where a club sells the rights of a player contract to another club. Scully's 1974 paper on MLB labor markets discovers monopsony power in the markets, exploited by the teams. Scully suggests free agency system as one of the methods of decreasing these player economic rents. Surdam (2006) studied the Coase theorem in MLB and the effects of player movements both prior and after increased free agency. Krautmann and Oppenheimer (1994) question the general view on Coase Theorem's applicability and claim free agency leads to a different allocation of labor than the reserve clause system.

As players' salaries are the biggest source of costs for a franchise, the big question in club finances is the determination of player compensation. A case of interest in salary discussions is always the relationship between the pay and the performance. In sports the performance of individual player is measured to a great detail, possibly more so than in most lines of work, providing researchers sufficient data for empirical testing. Jones and Walsh (1988) and Lavoie (1989) studied the salary determination in the NHL. While Lavoie focused on discrimination, in particular against French Canadian players, Jones and Walsh studied the factors affecting player salaries from player specific attributes to franchise specific aspects. Lambrinos and Ashman (2007) in turn compared the arbitration method in the NHL to the negotiated player salaries, and in effect determine the key variables used in salary determination.

In the North American model of professional team sports most of the new talent is introduced to the league through a drafting system where clubs get to reserve the rights for young talent. Conventional wisdom says the earlier the pick, more desirable the player and the best players get drafted first. For this end, the reversed draft order is in use in all the leagues, as letting the weakest teams pick first is considered to improve the competitive balance. The actual drafting strategies and problems they create were touched upon by Brams and Straffin (1979) when they modeled the draft as a Prisoners' Dilemma game. Fry, Lundberg and Ohlman (2007) build a model of the decision-making process of a single club participating in an entry draft.

The underlying assumptions of the high value of earlier draft picks was brought to question in the 2007 paper by Quinn, Geier and Berkovitz, when they showed that NFL quarterbacks drafted early performed no better than later picks when given equal playing time. Their empirical analysis did show a bias towards earlier picks in that players drafted early received more playing time and thus more opportunities to perform well. The similar conclusion was reached by Staw and Hoang (1995) for the NBA. They studied the sunk-cost effect in professional sports player policies, and discovered that for the first five years of professional play player's draft number had more influence on the playing time the player received than his actual performance.

2.3 Team building: trade and transfer

Given the increase of free agency in professional team sports, the trades and transfers of players has become a more interesting field of study. Teams no longer keep the same group of players year after year. Changes brought to the rosters by free agency force teams to change the group of players under contract to balance the team again and that is done through the transfer market.

Carmichael and Thomas (1993) studied the transfer market of players from a game theoretic point of view. They found the player transfers between clubs in English Premier League of professional football to follow the bargaining theory, in particular the models of Nash (1950, 1953). Their study has been used as a foundation for this work, despite the obvious differences between the transfer market in English football and the National Hockey League player trade. In Premiership League the transfers are fundamentally purchases of a player, where the issue under bargaining is the amount of money to be paid for the selling club as compensation. As also noted by Carmichael and Thomas, should such a transfer take place, the player gets to renegotiate the terms of his contract with the new club. This too is completely different for the NHL, or any league fitting the North American model of a sports league. Despite these differences, the results of Carmichael and Thomas are a valid starting point in looking into the application of bargaining games to NHL player trade, and into any player trade within a professional sports league framework.

Bougheas and Downward also remained in the European sports markets in their 2003 study on transfer market, although their study did include consideration for the American league structure. They built a simple model of the transfer market and evaluated the gains of a new player from the viewpoint of the team, given the levels of talent already existing within the team and the different talent levels the new player has. They also considered the uncertainties involved in acquiring a new player and included a probability function of the player’s playing time for the new team.

Haugen (2006), in a rare study of the kind, studied the player trade from game theoretical aspects. He modeled the trade as a two-player game with Nash equilibria. The model relies on monetary payments and as such is comparable more to the European football more than to the American leagues. Most studies taking a game theoretic approach focus on the salary negotiations between a free agent player and a club, and not the player trade negotiations. Nash bargaining model is used for that purpose for example by Downward and Dawson (2000).

2.4 Focus on the National Hockey League

The focus in economics of sports is very much on baseball and the MLB, and as the smallest of the big American leagues the NHL is often ignored. It has its own supporters, however, and for example J. C. H. Jones, James Quirk and Marc Lavoie have studied ice hockey extensively. The changes in the rules governing the NHL, such as the introduction of the salary cap brought on by the 2005 Collective Bargaining Agreement, have brought NHL closer to the other leagues in structure, and make comparisons between the leagues easier.

A particular curiosity in the economics of sports studies in ice hockey is the relocation and small markets problem. With the trend of franchises relocating from Canada to the United States, it has come apparent that the very survival of the game and its traditions are in the balance. In an aptly titled 1988 study "Location and Survival in the National Hockey League" Jones and Ferguson build a model of professional sports franchises to study the effect of location on attendance, market power and long run team quality. They find a significant importance in a Canadian location, reflecting the deeply embedded role of ice hockey in the Canadian culture.

The Canadian love of hockey is not apparent in the NHL, however, given the high amount of franchises that have relocated to the US. Cocco and Jones (1997) went as far as declaring Canadian hockey franchises an endangered species. They found that the main reasons for this are the "relatively inferior locational quality on revenue" (Cocco and Jones, 1997, 1551) and the high salary costs. The suggested fixes include the now-implemented salary cap, and revenue sharing and governmental subsidization schemes.

NHL's recent rule change to two referees prompted a study in economics of crime, where the effect of increased police visibility (the extra referee) to crime rate (penalties) was studied. (Heckelman and Yates, 2003) The main reasons to implement rule changes are either protecting the players, as is the case in increased referees meant to 'clean the game' from rule infractions that often increase the risk of injury, or making it more exciting and interesting to watch for the fans. Rules favoring goal-scoring and faster play are examples of the latter. Besides changing the on-ice rules, the NHL has changed the rewards system that gives points for the victory. Banerjee, Swinnen and Weersink (2007) studied one of those changes, a new point system regarding overtimes, and its effects on team strategies.

In labor economics the salary determination of players is often the focus of studies (see for example Jones and Walsh, 1988, Lavoie, 1989, for the NHL). The study of possible discrimination of French Canadians is often included in these studies as they were, for a long time, the only easily identifiable and large enough minority to study. In recent years, however, European players have become more and more common in the NHL. Fenn et al (2005) studied the influence this internationalization of the player pool has had on the NHL and competitive balance in particular. Richardson (2000) studied the salary determination in the NHL. That includes estimating the marginal revenue products of the players and evaluating the degrees of monopsonistic exploitation, competitive balance and invariance proposition, all familiar from earlier studies in baseball and to a degree in football and basketball.

3 THE NATIONAL HOCKEY LEAGUE

The professional sports world is dominated world-wide by soccer and the big markets in North America are a playing field of the big four leagues. While the largest ice hockey league by all accounts, National Hockey League is still considerably smaller than baseballs MLB, basketballs NBA or footballs NFL. Popular mainly in North America and Europe, hockey is played in several independent national leagues. The only internationally played league is, quite ironically, the National Hockey League, with clubs from the United States and Canada. Despite several high quality leagues in Europe, and the resent creation of the moneyed Russian league, the National Hockey Leagues is still considered to be the toughest and hardest, with most of the best players in the world playing for NHL teams.

In the 2008–09 season the average operating profit of a NHL franchise was $6.1 million. On the whole, the league earned aggregated revenue of $2.82 billion, including the revenue NHL franchise owners got from non-hockey related sources[1], up $70 million from the previous season. The average franchise worth went up $3 million from the 2007–08 season to $223 million. (Badenhausen, Ozanian and Settinmi, 2009)

In the past few years the league has launched several programs and products to boost the popularity of the sport. Good, and successful, examples would be the season openers played in Europe, or the Winter Classics. Played on football or baseball arenas, these outdoors games are spectacles that return hockey to its roots, to the backyard rinks and frozen-over ponds of childhood hockey games. This nostalgia-inspiring marketing has proved effective. The Winter Classic on January 1, 2009 at Wrigley Field, with Chicago Blackhaws hosting the defending champion Detroit Red Wings was watched by 2.8 million US households. 40,818 people watched the game live at Wrigley Field. (Eichelberger, 2009; Burnside, 2009)

The increased interest shows up also in ticket sales. The league-wide gate receips went up 1.5% in the 2008–09 season, bringing in $1.19 billion. The average attendance per game ranged from almost 13,773 (New York Islanders) to 22,247 (Chicago Blackhawks). (NHL Attendance Report, 2009) Sponsorships have followed, increasing to $339 million, which constitutes a 1.9% increase from the previous year. The largest source of increased revenue is local TV contracts. Chicago, Detroit and Toronto esch signed big local contracts at the start of the season, bringing media revenues to $356 million and up 15% from the 2007–08. Despite the TV ratings on Versus and NBC, the two broadcasters with rights for NHL games, being low, both saw an increase of 24% and 11%, respectively. Yet another sign of increased fan attention, and a demonstration of a successful strategy on online presence, are the 12.2 million unique visitors that

[1] For example, from renting out the stadium for events.

logged on to the nhl.com website during the 2009 play-offs, up 33% from the year before. (Badenhausen et al. 2009)

3.1 Teams and game schedule

The National Hockey League underwent its last change in terms of club number in 2000 when Minnesota Wild and Columbus Blue Jackets begun play in the 2000–01 season, following the 1997 decision expanding the number of clubs to 30. These 30 clubs are divided into two conferences, Eastern and Western, with 15 clubs each, as shown in Table 1.

Table 1 National Hockey League

WESTERN CONFERENCE		**EASTERN CONFERENCE**	
Northwest Division	Calgary Flames Colorado Avalanche Edmonton Oilers Minnesota Wild Vancouver Canucks	**Northeast Division**	Boston Bruins Buffalo Sabres Montréal Canadiens Ottawa Senators Toronto Maple Leafs
Central Division	Chicago Blackhawks Columbus Blue Jackets Detroit Red Wings Nashville Predators St. Louis Blues	**Atlantic Division**	New Jersey Devils New York Islanders New York Rangers Philadelphia Flyers Pittsburgh Penguins
Pacific Division	Anaheim Ducks Dallas Stars Los Angeles Kings Phoenix Coyotes San Jose Sharks	**Southeast Division**	Atlanta Thrashers Carolina Hurricanes Florida Panthers Tampa Bay Lightning Washington Capitals

Both conferences are further divided into three divisions, with five clubs in each division. The clubs are assigned to a division based roughly on geographical location, as can easily be seen from, for example, the Atlantic Division.

The regular season of the NHL consists of 82 games by each team[2], half at the home arena and half as the visiting team, followed by intra-conference play-off games for the

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[2] In this paper a consistent use of both terms 'club' and 'team' is attempted with the distinction that 'club' is used to refer to all off-ice activities and operations, and 'team' means the on-ice team consisting of players.

best 8 teams in each conference. The winners of each conference will then play each other in the final series for the championship, The Stanley Cup. During the regular season the teams are arranged in the standings within the two conferences, but so that the three Division leaders are placed as the top three within their conference according to their points. After these three the rest of the teams are arranged by total points. This ensures that at least one team from each division will make it to the first round of play-off games.

The play-offs constitute of four rounds. The play-off pairs are arranged so that the best team in the conference will play against the worst play-off qualifying team (8^{th} overall), the second best the 7^{th} team and so on. All play-off rounds are played as best-out-of-seven, meaning that a team has to win four games in order to proceed to the next round. At the end the two teams left, one from each conference, will play a best-out-of-seven series as the fourth round of the play-offs to determine the champion.

The regular season game pattern has changed in the past years, mostly due to the new Collective Bargaining Agreement (CBA) of 2005. In the 2000–01 season teams played against teams of their own division 5 times and 4 games against the other teams of their conference. They faced-off against the other conference teams once or twice during the regular season. There were few exceptions, mainly for reasons of local rivalries or traditional Original Six face-offs[3], where for example Toronto Maple Leafs (Eastern Conference, Northeast Division) faced Canadian teams such as Edmonton Oilers (Western Conference, Northwest Division), or fellow Original Six team Chicago Blackhawks (Western Conference, Central Division) three times, as opposed to the one or two suggested by the game pattern. By 2003–04 teams played their own division teams 6 times, own conference teams 4 times and other conference teams once or twice each.

The 2005 CBA changed the pattern of games played to further emphasize local rivalries, increasing the number of games played against ones own division teams to 8 in regular season. The teams faced the other ten teams of their own conference 4 times each. The biggest change was in the amount of games against the opposing conference. Whereas earlier every team had faced every other team in the league at least once, now teams only played against the clubs of two divisions from the opposing conference, or more specifically, hosted one division and visited one. Teams of an Eastern Conference division do not face-off with the five teams from one Western Conference division at all during the regular season. For example, in the season 2006–07 Central Division teams

[3] The Original Six: The Detroit Red Wings, the Chicago Blackhawks, the New York Rangers, the Montréal Canadiens, the Boston Bruins and the Toronto Maple Leafs. “The survivors of a league that had grown at times to as many as 10 franchises, and had seen teams change names and cities with regularity in the 1920's and 30's, would settle in an era of stability, known as the age of the ‘Original Six.’ … [T]hese few teams would symbolize hockey for fans across North America.” (National Hockey League)

only played against teams from Atlantic and Northeast Divisions from the Eastern Conference. The divisions the teams play against rotate annually so that in 2007–08 Central Division teams faced Northeast and Southeast Divisions, but not Atlantic Division.

3.2 Team Rosters

The size of the team is strictly regulated. As of 2005–06 season a NHL club can hold an Active Roster of 23 players at any one time during the league year. In no occasion can the Active Roster be below 18 skaters and 2 goaltenders. The limit of 23 can be exceeded, however, on Trade Deadline at the clubs discretion. (2005 CBA 16.4)

In the case of injury or illness of a player that prevents him from playing, the player can be placed on Injured Reserve List. No player on the Injured Reserve count towards the 23 player Active Roster limit. They do, however, count towards the Actual Club Salaries (see 3.4), that is to the total amount of salaries paid by the club. A player must stay on Injured Reserve for the minimum of seven days before being added back to the Active Roster. (2005 CBA 16.11)

In case a player is brought back from Injured Reserve, and the team had another player as his substitute during the injury, this now extra player can be placed on Non-Roster Reserve. Players on Non-Roster Reserve can also include players who are unable to perform in a game for reasons other than injury or illness. The Non-Roster players do not count towards the Active Roster, but do contribute to the Actual Club Salaries.

The only exemption to the Active Roster limits is the so-called Goaltender Exemption. Each team has two 48-hour Goaltender Exemptions meaning that for 48 hours the team can have three goaltenders in its Active Roster. The goaltenders can, unlike skaters that are brought in as a substitute for a player on Injured Reserve, all dress up for the game. The salaries of all three goaltenders, if the Exemption is used, contribute to the Actual Club Salaries under the salary cap. (2005 CBA Article 16)

3.3 Changes in team rosters

The changes in player rosters can take place in several ways. While the clubs have reserve rights for players so that while a player is under contract to one club no other clubs can negotiate with the said player, players can opt to negotiate and sign a contract with another club after his previous contract expires. In addition, clubs can place a player on Waivers from which other clubs can claim the player, or clubs can trade player contracts with each other. Players are added to the general league-wide player pool by annual Entry Draft of new players or, in some cases, by signing them directly from other hockey leagues[4].

The 2005 Collective Bargaining Agreement (CBA) between the National Hockey League and the National Hockey League Players' Association defines trade as follows:

> *Trade means the transfer, other than as a result of a claim by Waivers, from on Club's Reserve List or Free Agent List to another Club's Reserve List or Free Agent List of a Player's SPC, the rights to a Player (including his SPC, if applicable) on such Club's Reserve List or Free Agent List, and/or the rights to a draft choice in the Entry Draft.*

As specified in the Article 11, Section 16 of the 2005 CBA cash trades are forbidden, and therefore all trades made are in terms of SPC's (Standard Player Contract) and draft choices. All trades are monitored by the League in order to see that they comply with the restrictions and rules of the league.

The Standard Player Contract is the sole acceptable form of contracting a player to a club. The contract specifies the length of employment and the salary paid for the player each year. Before the 2005 CBA a player could receive bonuses based on, for example, performance, either that of his or of the team, or for signing the contract. These too would be specified in the SPC. In the event of a trade the new club undertakes all the obligations listed in the SPC. The terms cannot be renegotiated in the middle of the contract by any of the parties involved.

While the League Year is defined to start on July 1 of a calendar year and end including June 30 the next calendar year (2005 CBA, Article 1, "League Year") trading is not allowed throughout the year. All trades for a particular season played have to be completed by the trade deadline, specified by the CBA as the "fortieth (40th) day immediately preceding the final day of the Regular Season" (2005 CBA 13.12). After that date trades are not allowed until the season has ended. The SPC's can be traded until June 30 of the season they expire, which sometimes prompts teams to trade the player while they still can, and use the expiring contract to improve their team through a trade instead of the open market.

As mentioned above, player trade is not the sole method of changing teams' rosters. Below the other changes are explained, in order to distinguish the roster changes caused by them from the actual player trade. These other changes are not included in this study, but their effects have been tried to keep in mind and accounted for whenever possible.

[4] Only players over a certain age can be signed to the NHL without being drafted first by a NHL club. For specific criteria, see 2005 CBA 8.9 in particular.

3.3.1 Restricted and Unrestricted Free Agents

At the end of his SPC player will become either a Restricted Free Agent (RFA) or an Unrestricted Free Agent (UFA), depending on several factors such as age and years played in the NHL. As an UFA the player is free to negotiate with any other club, and his former club is in no preferential position concerning the future negotiations. If the player is a RFA, however, the former club, the old club, has the “Right of First Refusal”. What that means is that while other clubs are free to offer the player a SPC, called an Offer Sheet, the old club has a right to refuse the contract to another club. The offer made by the new club now becomes the binding offer of the old club to the player, with the terms agreed upon by the new clubs Offer Sheet.

If the old club does not wish to exercise its Right of First Refusal, the new club and the player “shall be deemed to have entered into a binding agreement” (2005 CBA 10.3(c)) with the terms specified by the Offer Sheet. The new club is then obligated to compensate to the old club for the loss of the player according to previously agreed upon principles, outlined in the CBA. These compensations are in terms of Entry Draft Choices, and depend upon the salary of the player under the new SPC, in effect, the higher the future salary, the higher Draft Choice obtained in compensation by the old club[5].

While the compensation does make the movements of RFAs similar to trades where a draft choice is given in return for the rights for a player the ‘renegotiation’ of the player salary makes this a more complicated issue. It is important to notice, however, that the Offer Sheet is not a result of normal club-player negotiations, but purely one-sided offer by the new club. It does, however, if we take the value of the SPC as a measure of the value of the player, re-evaluate the player. Also important, is that the old club has no influence on the value the new club puts on the RFA. Because of this one-sided nature of Offer Sheets the signings of RFA are excluded from this study.

The RFA signings do have an effect on trade in terms of motivation for trade, as the draft choices used as compensation have to be those originally belonging to the club and not acquired for the purpose of being used as compensations specifically. Therefore club may be forced to trade in order to reacquire a draft choice previously used in a trade. While this is a marginal effect, it is however one that bears keeping in mind.

[5] For details, see CBA 10.4

3.3.2 Waivers

The waivers are a way for clubs to offer a player currently under contract to other clubs in the league. If a player is placed on waivers the other clubs have 24 hours to place a claim for him, and the club placed lowest in the current standings has the winning claim. This process is required on the event that a club wishes to send a player to a minor league team, or if they wish to buy out a standing SPC. A player can be 'sent down' to the minors or their contract can be bought by the club for two thirds of the salary stated on the SPC only if he clears the waiver, that is, no other club is interested in him.

Under the 2005 CBA these cases remained the same, but re-entry waivers are added. Re-entry waivers take place when a club has a player, earning a salary above a certain pre-set level, playing in a minor league team and they wish to 'call him up', to add him to their NHL roster. This is important given the salary cap introduced by the 2005 CBA (see 3.4) so that clubs could not 'hide' high-salary players in the minor leagues (where their salaries do not count towards the total under the cap) and then call them up for the important late-season games.

In the event that a player is placed on waivers and claimed by another club, the old club is entitled to a small compensation, specified in the CBA. As these compensations are very miniscule, however, for the purposes of this paper these transfers of players are excluded. The transactions resulting from waivers are one-sided, and the club placing the player on waivers has no say on who can claim said player.

3.3.3 Entry Draft

The Entry Draft is relevant to the player trade for three reasons. First, it is the main method of introducing new players to the league. Second, Entry Draft picks are used for bargaining and as currency of trade. Finally, Entry Draft picks are sometimes the very object of trade, and the players are traded in order to obtain certain draft picks. It is therefore important to look at the rules and procedures of the Entry Draft.

Held each year in June the NHL Entry Draft is the only way NHL clubs can claim rights to a player not previously in the NHL reserve lists[6]. In practice this mostly means young players, who just fulfill the age requirement of 18 years in order to be eligible.

[6] The reserve list consists of "all Players to whom a Club has rights including all Unsigned Draft Choices, all Players signed to an SPC… and all Players who have signed an SPC but who have … returned to Juniors." The reserve list can have no more than 90 players. (2005 CBA Article 1, "Reserve List")

The Draft consists of seven rounds (nine under the previous CBA, before 2005) with 30 selection choices in each round. (2005 CBA 8.1–8.2)

The order of selection is a modified reversed order, with the Stanley Cup winner having the last pick. The basic principle of reverse order selection is to give the weakest teams the biggest chance of getting the top talent of the year up for claim. However, as this could promote intentional bad performance at the end of the season, after the team has lost its play-off possibilities, in order to get as high a draft choice as possible, the NHL has adopted the modifications outlined in Exhibit 4 of the CBA already prior to 1995. (2005 CBA 8.5) Under the modifications the club with the weakest team is not guaranteed the first pick, but it does have the greatest chance of getting it.

In effect, the teams that do not make the play-offs are ranked in reverse order of total points for a weighed drawing. The team with worst record will be #1 with the team with the best record is #14. The odds of getting the first pick range from 25.0% for the #1 team to 0.5% for the team #14. However, no team can improve its selection position due to the weighed drawing by more than four places compared to the order of strict reverse selection. That means that even if the tenth team won lottery for the first pick, it would select sixth in the Entry Draft. (2005 CBA Exhibit 4)

As the Entry Draft picks are used in trade, the results of the selection order draw as well as the general standings that result in the order of selection become all the more important. As a currency, the First Round pick is naturally more valuable than a pick in the Third Round. Also, it can be seen that the within the same, say first, round the picks of the clubs that are at the top of the list are of higher value than those finishing high up in the standings and therefore getting the very last picks. From season 2007–08, for example, Tampa Bay Lightning and Los Angeles Kings finished the last two and therefore have weighed odds of 25.0% and 18.8%, respectively, for the first pick. These can then be seen as more desirable in trades than the pick of the Detroit Red Wings, the 2008 Stanley Cup winner.

The window for trading draft picks is not limited. Indeed in several occasions trades are made involving picks further in the future. For example in January 2006 Philadelphia Flyers traded RW Jon Sim to Florida Panthers for Florida's 6^{th}-round choice in the 2007 Entry Draft (NHL Official Guide and Record Book, 2005–06). Further on, Philadelphia is free to trade this acquired draft choice up until the choice is used in the Entry Draft. Once the draft choice is used, the club has the option of either keeping the player in their reserve list or make him an offer of a SPC. The rights for a player acquired by the Entry Draft are also "transferable without Waivers to any other Club by standard assignment" after which the new club has the full rights of the originally selecting club (2005 CBA 8.8).

3.4 Hockey Related Revenues and Team Payroll Range

After the lock-out season of 2004–05 the NHL and the NHLPA signed a new Collective Bargaining Agreement that introduced some drastic changes into the ice hockey played in North America. While some changes, such as the reduction of the Entry Draft from nine to seven rounds, did not have a direct effect on the daily operations of the clubs some, such as the salary cap, had an enormous impact. All in all, the new CBA provides, or aims to do so, for more competitive balance and better survival of the franchises.

One of the main purposes of the 2005 CBA was to tie together the revenues and expenses of ice hockey, namely the Hockey Related Revenues (HRR) and the salaries paid by the club to the players, the League-wide Player Compensation. To this end the salary cap, i.e. Team Payroll Range, already in place in the other three major professional sports leagues in North America[7], was introduced.

In order to fully understand the Team Payroll Range, one has to take a look at the HRR. The CBA defines the Hockey Related Revenues for a league year as

> *"the operating revenues from all sources … on an accrual basis, derived or earned from, relating to or arising directly or indirectly out of the playing of NHL hockey games or NHL-related events in which current NHL Players participate or in which current NHL Players' names and likenesses are used, by each such Club or the League…" (2005 CBA 50.1)*

To this end the HRR includes, but is not limited to the following list of revenues earned by Club, League, Club affiliated entity or League affiliated entity[8]:

- NHL regular season and play-off gate receipts
- NHL pre-season games
- Special games, such as international exhibition games
- Broadcast; including but not limited to NHL national, international and national digital broadcasts, local cable broadcasts, local over-the-air television broadcasts and radio broadcasts
- Club Internet and Publications
- In- and Non-Arena Novelty Sales
- Luxury Boxes/Suites and Club/Premium Seats

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[7] Both National Basketball Association (NBA) and National Football League (NFL) have implemented salary-caps. Major League Baseball (MLB) has a system of "competitive balance tax". See National Basketball Players Association 2005 CBA Article VII, National Football League Players Association 2006 CBA Article XXIV Section 4, and Major League Baseball Players Association 2007–2011 CBA Article XXIII, respectively, for details.

[8] For a more detailed description of the categories included, as well as those excluded, and of the extent of their inclusion/exclusion, see CBA 50.1

- Fixed and Temporary Signage and Arena Sponsorships

Simply put, the HRR includes, as the term suggests, all revenue from anything that has a link to the hockey games played by the clubs, be it a direct link (gate receipts) or indirect (club Internet and publications).

The Team Payroll Range created by the 2005 CBA defines a Lower Limit and Upper Limit at or in between which the Averaged Club Salary must be, allowing for exceptions in cases of long-term Player injury or illness, or Performance Bonus Cushion (see 2005 CBA 50.5(h) for details). For the purposes of this calculation Averaged Club Salary is used, as a distinction from Actual Club Salary[9]. The Averaged Club Salary is calculated daily as the aggregate of Averaged Amount Player Salaries and Bonuses for players on the club's Active Roster, Injured Reserve, Injured Non Roster and Non Roster; the deterred salaries and bonuses earned that league year and all Ordinary Course Buyout Amounts paid that league year[10]. The Averaged Amount Player Salaries means in this the average yearly salary of a player under multiyear SPC. For example,

> *[a] Club signs a Player to a three-year SPC providing for $500,000 in Player Salary and Bonuses in Year 1, $600,000 in Year 2, and $700,000 in Year 3. The charge to the Club's Averaged Club Salary in all three years of the SPC is $600,000. (2005 CBA 50.5(d) (ii) (B) Illustration #1)*

This Averaged Club Salary must fit within the Team Payroll Range defined by the Lower and Upper Limits. The Upper and Lower Limits are defined by the following equation

$$(HRR \times ApplicablePercentage - Benefits) \div teams = Mid.PayrollRange \qquad (3.1)$$

where the Applicable Percentage is percentage of HRR that is equal of the Players' Share each league year. The Applicable Percentage is 54 if the HRR is below $2.2 billion, between 55 and 56 if the HRR is equal or above $2.2 billion but below $2.4 billion, between 56 and 57 if HRR is equal or above $2.4 billion but below $2.7 billion, and 57 if HRR is equal or above $2.7 billion. The 'Benefits' in (3.1) means the aggregate of benefits such as pension funding and insurance payments.

The Midpoint of Payroll Range on the right-hand side of the equation is adjusted upwards by a factor of 5 % each league year yielding the Adjusted Midpoint. This Adjusted Midpoint is then used to construct the Payroll Range by creating the Upper and Lower Limits $8 million above and below, respectively, of the Adjusted Midpoint.

[9] "Actual Club Salary" means "the entire aggregate amount committed by each Club in a League Year, annualized, but calculated daily, to be paid or earned as Player Salaries and Bonuses in that League Year". (2005 CBA 50.2(c))

[10] For details, see CBA 50.5(d)

The limits are calculated using preliminary HRR and Benefits, based upon the Initial HRR Report, in order to provide for a prediction of the limits by June 30. These preliminary calculations are then adjusted to correspond with the actual figures and the Team Payroll Range is, if needed, adjusted accordingly. The calculation of the Payroll Range is further illustrated by the following example.

> *Assume that the Initial HRR Report for Year 2 calculates Preliminary HRR for Year 2 to be $1.9 billion, and Preliminary Benefits to be $66 million. Calculating the Range for Year 3 would occur on or before June 30 immediately preceding Year 3 as follows:*
> *The Midpoint is ((54 % of $1.9 billion) - $66 million) / 30 clubs =*
> *($1.026 billion - $66 million) / 30 = $960 million / 30 = $32.0 million*
> *The adjusted Midpoint is calculated by increasing $32.0 million by 5 %, to $33.6 million. Therefore, the Upper Limit would be $41.6 million … and the Lower Limit would be $25.6 million. (2005 CBA 50.5(b) Illustration)*

As the HRR and the Team Payroll Range are directly linked, it is important to notice that the limits the clubs face for their aggregated Player Salaries can vary gravely from one league year to another.

The difference between Averaged Club Salary and the Upper limit is the Payroll Room, the amount available for use by the team in signing new SPC's or trading for players. Assuming that a Club has the Averaged Club Salary of $38 million and the upper Limit is $40 million, the Club cannot sign a SPC of more that $2 million of Averaged Player Salary. This requirement of sufficient Payroll Room under the Upper Limit holds for both new SPC's and players (SPC's) traded for by the team. If such a signing or an acquisition through trading occurs after the season has started, the team must have Payroll Room for the remaining of the Averaged Player Salary for that league year. (2005 CBA 50.5)

The final restrictions related to player salaries that are worth mentioning have to do with the trade of SPC. As a change from the pre-CBA 2005 days, no reimbursements of salary by the previous club to the new club are allowed. The new club must take on the burden of the whole salary and possible bonuses itself. Nor is any cash transactions allowed when reassigning player rights. This sets some further limits to the player trade negotiations and options a club has.

4 PLAYER TRADE IN THE NATIONAL HOCKEY LEAGUE

It is assumed in this paper that the teams involved in player trade are simply attempting to increase their competitive strength, and thus the winning percentage, both in short and in long run. Any motives derived from profit- or revenue-maximizing behavior, or the impacts winning percentages have on revenue are left outside the scope of this analysis. For an interesting study into the impacts of league-wide talent distribution and allocation on winning percentages, and the subsequent effects on team-specific and total revenues, see Szymanski (2004). For an analytical treatment of professional sports leagues and their objectives and subsequent behavior, see for example Késenne (2007).

Carmichael and Thomas (1993) point out the twofold primary purpose any formal transfer market should have. For one, the transfer market should "facilitate and organize the acquisition and exchange of players by clubs to enable the reconstitution of teams with the aim of increasing playing strengths and improving team performance." A second purpose is to "facilitate the movement of players between clubs in their search for better opportunities, higher earning or increased job satisfaction" (Carmichael & Thomas, 1993, 1467–1468). In the NHL player trade, however, only the first of these purposes apply. As the trade of player contracts is irrelevant of players' wishes, and since players are not allowed to renegotiate their contracts with their current or a new team until the contract expires, the second purpose mentioned only applies to player movement as it results from free agency and not to player transfers in the form of trades.

4.1 Expected Talent in Use and the criteria of trade

A hockey team can be simplified into a modified version of the model of Bougheas and Downward (2005). In their model each team has a roster of players, *R*, each with some degree of talent, *t*. These players are allocated to *M* positions within the team. For hockey, *M* is the lineup needed to a game: 2 goaltenders, 8 defensemen and 12 forwards.[11] As the roles of the individual lines differ, with first and second traditionally playing a more offensive role and third and fourth more defensively, each of the position can be though of as slightly different that the other, even if in reality players often play in several positions during the season.

The total talent in a team is assumed, for simplicity, to equal the sum of individual talents of the players. That is, for team *i* the total talent, t_i, is defined as

$$t_i = \sum_{m=1}^{M} t_i^m \qquad (4.1)$$

[11] For simplicity and symmetry full four lines of 3 forwards and 2 defensemen each are assumed.

where M is the different positions that need to be filled. The teams may assign different values to a player, that is, consider the player to be of a different talent t, depending on the position m in which the use the player.

Another source of the value t team i assigns to a player is team-specific information. It is assumed that a player has some team-specific value (Vrooman, 2000) that can arise from on-ice or even off-ice performance. As in any team sport, no player plays alone and everyone's productivity also depends on the other players. This team-specific value, the worth of the player within a given line-up, is assumed to be better known by the team holding the player. The current team of the player is also better informed how much of the players value is team-specific. Some players may also have considerable off-ice value through marketing and crowd-pulling power (Carmichael & Thomas, 1993, 1472), magnitude of which the current team is better informed on. This creates information asymmetries to player valuation and evaluation. (Bougheas & Downward, 2005)

The increase in competitive strength is the most obvious reason for trade. Fundamental assumption of rational utility-maximizing decision-makers makes it equally obvious that teams only engage in trade when they benefit from it; that is, when the net change in talent is positive for them. Bougheas and Downward (2003) derived the expected surplus in talent in use by adding a new player to the team. Small modifications to their model let us set a limit for rational club owner engaging in the player trade in the NHL.

Bougheas and Downward assumed three sets of talented players: players with basic talent, t, who are in excess supply; players with higher, yet low talent t_l; and players with high talent, t_h, where $t < t_l < t_h$. The latter two types of players are of limited supply. Only the talent that is used in a game matters, not the over-all talent available to the team. Any player's contribution to the team is only a fraction p of his talent. The fraction p, $0 < p < 1$, is the probability of the player appearing on the field. That way p summarizes both the share of the player's time in the game, and also the risk of injury and other uncertainty factors that affect his playing time. (Bougheas & Downward, 2003, 93–4) Contrary to the football Bougheas and Downward modeled, in ice hockey the share of individual players input is smaller. In football most players play the full duration of the game whereas in ice hockey the constant line changes mean a single player plays only a small share of the total game time, goaltenders being the obvious exception.

It is assumed that a team has an endless supply of players with basic skills. Therefore the talent in use is the fraction p of any low or high talent player, and $(1 - p)$ of basic skills. The table below summarizes the different talent combinations team can have for any given position m, the expected talent in use and the expected surplus the additional second player brings to the team.

Table 2 Talent in Use and Expected Surplus (Bourgheas, Downward, 2003[12])

Available Players	Expected Talent in Use	Expected Surplus in Talent
$\{t\}$	t	
$\{t_l\}$	$pt_l + (1 - p)t$	$p(t_l - t)$
$\{t_h\}$	$pt_h + (1 - p)t$	$p(t_h - t)$
$\{t_l, t_l\}$	$p(2 - p)t_l + (1 - p)^2 t$	$p(1 - p)(t_l - t)$
$\{t_l, t_h\}$	$pt_h + p(1 - p)t_l + (1 - p)^2 t$	$p(t_h - pt_l) - p(1 - p)t$
$\{t_h, t_l\}$	$pt_h + p(1 - p)t_l + (1 - p)^2 t$	$p(1 - p)(t_l - t)$
$\{t_h, t_h\}$	$p(2 - p)t_h + (1 - p)^2 t$	$p(1 - p)(t_h - t)$

In row 2, for example, the team has a low talent player to the position m. This talented player then is expected to play with probability p, and with probability $1 - p$ the team has to replace him with a player with only the basic skills. On row 5, on the other hand, the team already has a low talent player for the position, and adds a player with higher talent level to the team. It is assumed, that the team always prefers to use the more talented player, so with probability p the player with talent t_h plays. The low talent player plays the fraction p of the remaining play time $(1 - p)$, and for the reminder the team is forced to use the player with basic skills. Thus the expected talent in use is $pt_h + p(1 - p)t_l + (1 - p)^2 t$, as shown.

The surplus of talent that is created with any addition of second player is simply the difference between the expected talents in use for the two mixes of players. So, for example, if the team adds a high talent players to the low talent one, the surplus created by this addition is the Expected Talent in Use $\{t_l,t_h\}$ minus Expected Talent in Use $\{t_l\}$, that is, row 2 is subtracted from row 5. These surpluses generated by the last player that is added are shown in the third column. Consequently, when a club trades away a player, it suffers a loss in Expected Talent in Use. For example, if a trade is made that changes the Expected Talent in Use combination for a given position m from $\{t_h,t_h\}$ to $\{t_h,t_l\}$, the team suffers the loss of $p(1 + p)t_h + p(1 - p)t_l$.

Overall, the talent gained by trade must be greater than the talent lost, for the club to engage in a trade. If Entry Draft picks are used in the trade, then the combined expected talent in use of the players and draft picks acquired must be larger than the expected talent lost in players and draft picks. A positive net Expected Surplus in Talent can therefore be used as a condition for a trade.

An important distinction of the North American professional sports leagues from the European leagues is the fixed supply of playing talent. The player pool is closed in the NHL, as entry of new players is limited by the Entry Draft. For a team looking to improve their competitive strength there are no outside markets for player talent, but all improvements must come through trades with other NHL clubs. This sets limits to both

[12] The table is a corrected version of the one presented in the Bougheas & Downward, 2003. The expected surplus in talent in the event of $\{t_l, t_h\}$ is $p(t_h - pt_l) - p(1 - p)t$, not $p(t_h - pt_l) - (1 - p)t$, as in the original study.

the variety of players available for a club and also to the possible trade combinations achievable.

The teams only agree to the trade if they benefit from it. So any potential exchange of players must leave both teams with positive net Expected Surplus of Talent. The differences in Expected Surplus in Talent can originate from either different talent level of the rest of the team or different evaluations of the players talent. The latter is often the case when players of different positions are traded, or teams are after a specific set of skills. Occasionally teams may trade short-term potential to long-term, especially if the club is still just building the team through signing promising players and drafting younger talent.

Using the Expected Talent in Use by Bourgheas and Downward, the gains from trade can be calculated. Assuming the team has talent endowments of $\{t_h,t_h\}$ and $\{t_l,t_l\}$ for positions m_1 and m_2, respectively. This gives the club the Expected Talent in Use of $p(2 - p)t_h + (1 - p)^2t$ for m_1 and $p(2 - p)t_l + (1 - p)^2t$ for m_2. Now, should the club trade so as to achieve a talent distribution of $\{t_h,t_l\}$ for both positions m_1 and m_2, the Expected Talent in Use gained is equal to $p(t_h - t_l)$, and the talent lost through the trade is $p(1 - p)(t_h - t_l)$. As $0 < p < 1$, the gain from the trade is larger than the loss, resulting in net gain in Expected Talent in Use for the club. A similar argument can be presented to the other club involved in the trade.

As of 2005 the clubs in the NHL have operated under a salary cap. This imposes an additional limitation to acquiring talent from both the free market by signing free agents and from other teams through trades. The salary cap is in effect a budget limitation to the club, dictating the maximum total salary paid to the players under contract. Any trade in which the team is involved in must be in accordance to the salary cap rules. That is, the ‘space’ below the cap, the salary cap minus the total salaries paid, must be more or equal to the increase of salary expenditure resulting from the trade. Consequently, the salary cap also introduced additional motives for trade. Clubs may now trade away high-paid players simply to make more room under the cap for the future. Trading away a player with a high-salary multiyear contract leaves the club more possibilities to trade for a player or signing one from the free market.

The criteria for any trade taking place in the National Hockey League are therefore multiple. There needs to exist two teams both looking for a trade with compatible combinations of players and possible draft picks they are both willing to trade. For both of these teams the resulting net Expected Surplus of Talent needs to be positive for them to agree to the trade. In addition the teams need to have the necessary room under the club salary cap to accommodate the net change in player salaries resulting from the trade.

4.2 Trade by numbers

In the period of 2000–08 seven seasons of NHL ice hockey were played. During those seasons over 800 trades took place, in which over 1300 times a player was assigned to a new team. The breakdown of trades by season is shown in Table 3 below. (NHL Official Guide and Record Book[13])

Table 3 Total Player Trades per season in 2000-2008

Season	2000-01	2001-02	2002-03	2003-04	2005-06	2006-07	2007-08
Trades, total	117	110	123	122	88	105	76
Players only -trades	25	40	33	37	28	31	41
Players traded	184	216	222	203	156	204	129

The total trades figure includes all trades listed for the clubs. An important change in the figures made for this paper comes from the role of summer trades. While the NHL lists trades made in May and June for the season that is still in play, given the season officially ends on June 30, for the purposes of this paper those trades have been moved to the next season. The reasoning behind that is that the trades made in May and June do not have any effect on the season they are listed for, but only influence the upcoming seasons. Thus for example May and June trades from 2002 are not calculated for 2001–02 season, despite them taking place during the official season, but for the 2002–03 season. Because of this transfer of summer trades the aggregate figures for trades are different in this paper on season-to-season base from the official figures.

Table 3 shows the total amount of trades involving players per each season under study. The trades that were purely an exchange of players are on the second row. As can be seen, most trades completed included at least some draft picks. The last row shows the number of times a player exchanged teams. As in any ‘Players only’ –trade there must be at least two players moving in opposite directions, the number of players being lower than twice the amount of trades shows that there were quite a few trades were players were exchanged to draft picks. On the other hand, however, a quick perusal of the trade lists shows that several multiplayer trades with more than two players involved took place. It is safe to say, then, that there exist several different variations to the trade combinations.

The trades of drafts picks alone are not considered in this paper because of their highly speculative nature. Draft picks are by nature uncertain to a much greater extent than player trades. A draft pick can be seen as an option to a certain amount of potential

[13] All trade data of this chapter is compiled from the trade lists of several years’ editions of the NHL Official Guide and Record Book.

in the form of a player, as very rarely the player drafted is ready to play at the NHL level in the upcoming season. Draft picks create ‘empty’ numbers to the data also because they can be traded ahead of time, so that a pick for summer 2005 Entry Draft can have been traded already in spring 2003. This way the trade would be included for the trade figures for 2003–04 season, despite the fact that it would affect the team only after summer 2005, i.e. in the 2005–06 season. Because of this uncertainty and delay in having an effect, trades of Entry Draft picks alone are not included in the figures used in this study.[14]

4.3 Trades and the season

Intuitively, one would assume that active periods in trading occur before the start of the season as teams are built, and right before the trade deadline in early spring, as clubs try to ensure the team makes the play-offs. The trade deadline is also the last opportunity to strengthen your team for the upcoming play-off games, and make sure you get the best possible team on the ice. Anyone who has followed the Entry Draft will also have noticed that during and prior to the event players get traded as currency for draft picks. So it would seem there are three periods during which trade activity is increased: prior to the start of the season, at the trade dead-line in the spring and at the Entry Draft.

Table 4 below shows the number of trades for each month. For seasons 2006–07 and 2007–08 the trade deadline was in February instead of March.

Table 4 Trades by month

	00-01		01-02		02-03		03-04		05-06		06-07		07-08	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
May	5	4,3	2	1,8	3	2,4	4	3,3	0	0,0	0	0,0	2	2,8
Jun	30	26,1	28	25,5	24	19,4	15	12,4	11	12,5	12	11,4	15	20,8
Jul	3	2,6	8	7,3	4	3,2	8	6,6	1	1,1	13	12,4	5	6,9
Aug	3	2,6	3	2,7	0	0,0	3	2,5	1	1,1	3	2,9	1	1,4
Sep	0	0,0	1	0,9	3	2,4	2	1,7	4	4,5	3	2,9	2	2,8
Oct	3	2,6	3	2,7	9	7,3	7	5,8	7	8,0	2	1,9	1	1,4
Nov	7	6,1	6	5,5	5	4,0	3	2,5	7	8,0	8	7,6	3	4,2
Dec	10	8,7	8	7,3	9	7,3	8	6,6	10	11,4	4	3,8	4	5,6
Jan	10	8,7	12	10,9	14	11,3	10	8,3	11	12,5	11	10,5	8	11,1
Feb	14	12,2	3	2,7	11	8,9	17	14,0	4	4,5	49	46,7	31	43,1
Mar	30	26,1	36	32,7	42	33,9	44	36,4	32	36,4	-	-	-	-

[14] As discussed in 2.2, the rationale behind and effectiveness of drafts in allocating the strongest new talent to the weakest teams has been brought to question by economists.

Table 4 also displays the monthly percentage shares of total trades. It shoes that the intuition was correct in that trade activity is high in months that include the trade deadline or the Entry Draft, March (February for the last two seasons under study) and June, respectively. Some of June trades are also explained by the official season ending. Teams who do not wish to re-sign a player that would be a restricted free agent come July, might wish to trade him and thus gain a player who is under contract for the next season. On the opposite side of the deal, a team may welcome the rights for a player, even if the actual contract still needs to be negotiated.

The assumption that there would be trades made prior to the start of the season is incorrect, and in fact August and September display some of the lowest trade figures across the board. The probable explanation to this is that during off-season clubs are acquiring players from the free markets, that is, signing free agents instead of trading. Once the season is underway, however, trading becomes the main method of acquiring new talent.

If one looks closer at the trades made at trade deadline, for example the two last days of trading, an interesting phenomena pops up. It seems that practically everyone is taking part. It would imply that there are several motives for trade at the trade deadline. For teams fighting for the play-off spot the reason is obvious, as they want take the last opportunity to increase their competitive strength. Teams who appear strong play-off candidates wish to do the same. In the long season injuries happen and player get tired, and the stronger the team is going into the post season the better the chances of coming out on top. The teams on the bottom of the standings on the other hand may have already turned their eyes to the future and are willing to trade for draft picks or future building blocks for the seasons to come. Alternatively there are motives to make room under the salary cap with considerations towards the upcoming free agents.

4.4 Making the opponent stronger

The mutual gains from trade were discussed earlier as a criterion for trade taking place. In effect, then, when agreeing to a trade the club is agreeing to make their trading partner stronger competitively. As discussed in 3.1 the number of times the teams play against each other has varied throughout the years, until in 2005 the new CBA drafted up a schedule where the teams face their own division teams 8 times each, own conference teams 6 times each and ten out of the 15 opposite conference teams once.[15] Intuitively, then, it would be beneficial for a team to trade with a club against which

[15] This was changed, again, for the 2008–09 season, but the emphasis for intra-division games is still strong, with 6 games against each team in clubs' own division. (www.nhl.com)

they are playing relatively more rarely during the season. This way the change in the increase in the competitive level they face in the league, assuming no other clubs strengthen their teams through trading in that time, is minimized.

However, this cannot be confirmed taking place in reality. Table 5 shows the distribution of trade averages as trades per club for Own Division, Own Conference and Opposite Conference, per season. The trades made by clubs are calculated as trades with own division teams, trades with own conference teams outside of own division and trades with the teams from the opposing conference. These aggregates were then divided then by the amount of clubs in each category. For example, in 2000–01 season, on average the clubs made 2.5 trades with each club in their own division.

Table 5 **Trades per Own Division, Own Conference and Opposing Conference**

Season	2000-01	2001-02	2002-03	2003-04	2005-06	2006-07	2007-08
Own Division Av. Per Club	2.5	4.0	3.0	3.3	1.5	2.5	1.3
Own Conference Av. Per Club	4.7	3.9	3.9	4.8	2.4	3.1	2.9
Opp. Conference Av. Per Club	4.0	3.7	4.9	4.1	3.8	4.3	2.8

The difference in number of trades is not constant in direction, and at all times very small. It is easily explained by variety in trades available, as there are only four clubs to trade with in ones own division, ten in the rest of the conference and 15 in the opposing conference. Intuitively one could argue that the odds of finding the trade you are looking for in the opposing conference are bigger, resulting in more trades with those clubs. The trade can therefore be seen more as player than team specific.

4.5 Trade and on-ice success

Earlier it was discussed that the club will only trade if it sees itself gaining competitive strength through doing so. Building further on this assumption of net gain from trade, it could be argued that the team gets stronger by each trade it completes, and the more it trades, the stronger it gets competitively. As trades during the season can also often be resulting from the existing team it is intuitively appealing to assume teams trade for players that compliment the existing talent pool and make the team better on the ice by filling in the weaknesses observed.

The definition of a competitively strong team is multifold. Obviously the winning percentage is a good indication of on-ice strength, and thus it is used for theoretical approaches. Due to the success in the league being determined according to standings, however, it would also make sense to consider where the team places at the end relative to others. The higher standings would indicate a successful season. Further more, while the winning percentage and points gathered from won games are calculated for all games, the teams are ranked within conferences and divisions. Therefore the regular season standings are a fair estimate of on-ice success.

By definition the standings rank the teams in order of relative success. The assumption of gains from trade would imply a correlation between high number of trades and high position in standings. In Figure 1 we have the regular season standings together with all player-related trades made by the club.

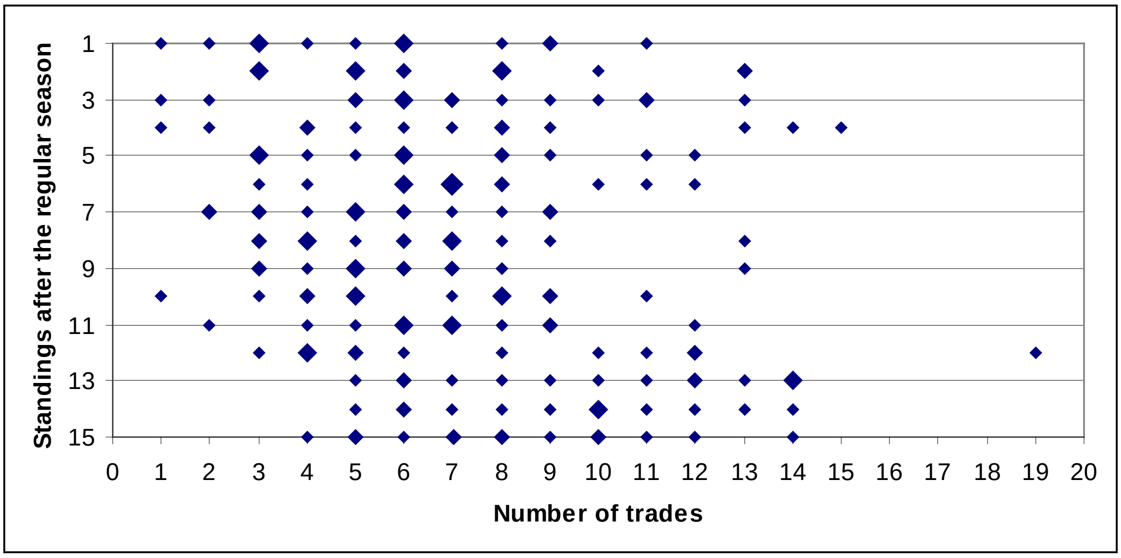

Figure 1 Standings after regular season vs. trades during 2000–08, all teams

On the Y-axis the final standing after regular season is in a descending order simply to reflect the fact that the smaller the numerical value the higher the standing of the team. The lowest standing possible is 15, as the teams are ranked within the Conferences. The size of the diamond reflects the frequency of the observation. As can be seen, there is at best slight correlation between trades and standings. It can be argued that the trade figures may have several trades completed near the trade deadline. These trades would not have had much time to influence the performance of the team. The trades and regular season ranks are thus compared with one year lag in Figure 2.

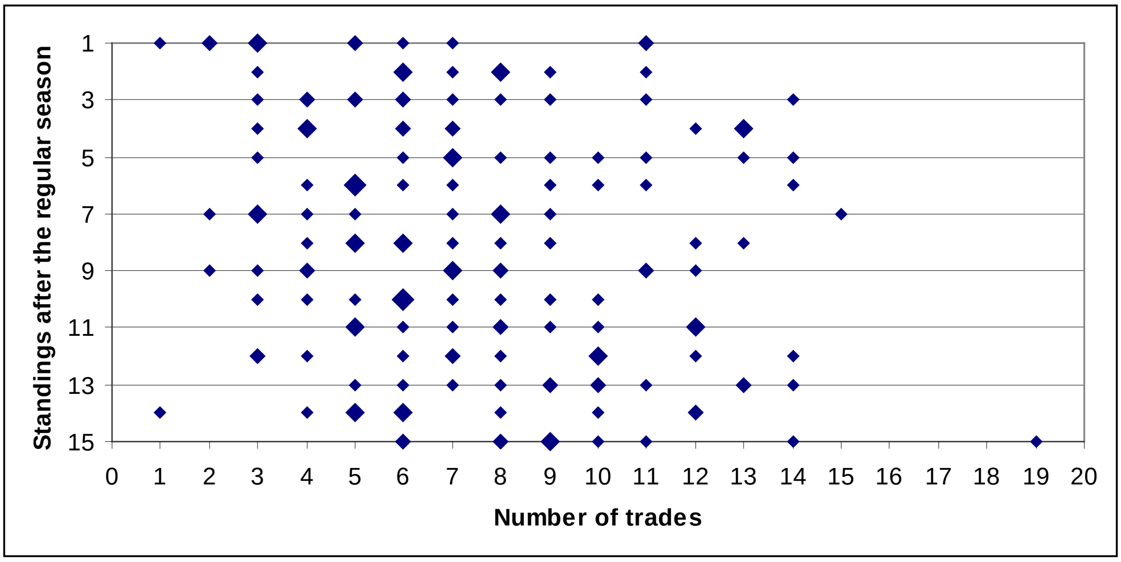

Figure 2 **Standings after regular season with one-year time lag vs. trades during 2000–08, all teams**

The comparison of trade numbers with the standing year later does not give any more distinct correlation between the trades and the standings. It would appear, then, that trading activity alone has little effect on the teams standing after regular season. The regular season standings, however, do not give us anything but the names of the 14 teams that do not get to play for the championship. The real success is measured by the team's play-off run, and eventually the Championship.

In the seven seasons played between 2000 and 2008, all but two teams made the play-offs at least once. The three teams that made the play-offs only once in that time were all eliminated on the first round (Atlanta in 2006–07, Chicago and Phoenix in 2001–02). On the other end of the table, two teams made the play-offs every season (Detroit and New Jersey) with five teams having a record of six out of seven post-seasons (Colorado, Dallas, Ottawa, Philadelphia and San Jose). Interestingly enough, only four times the Stanley Cup winner has been one of these play-off regulars (twice Detroit), with four of them having no championships during the 2000–08 period. Consistent play-off appearance does not directly translate to Championships, then.

As the play-offs are played as best-out-of-seven series, it takes four to seven games for a team to get to the next round. The Stanley Cup final series is played after three rounds. As the number of games played per play-off round varies from team to team and to season to season the number of rounds played in the play-offs is used here. The higher the number of rounds, the further the team got and closer to the championship. This gives us an approximation for the play-off success of the teams.

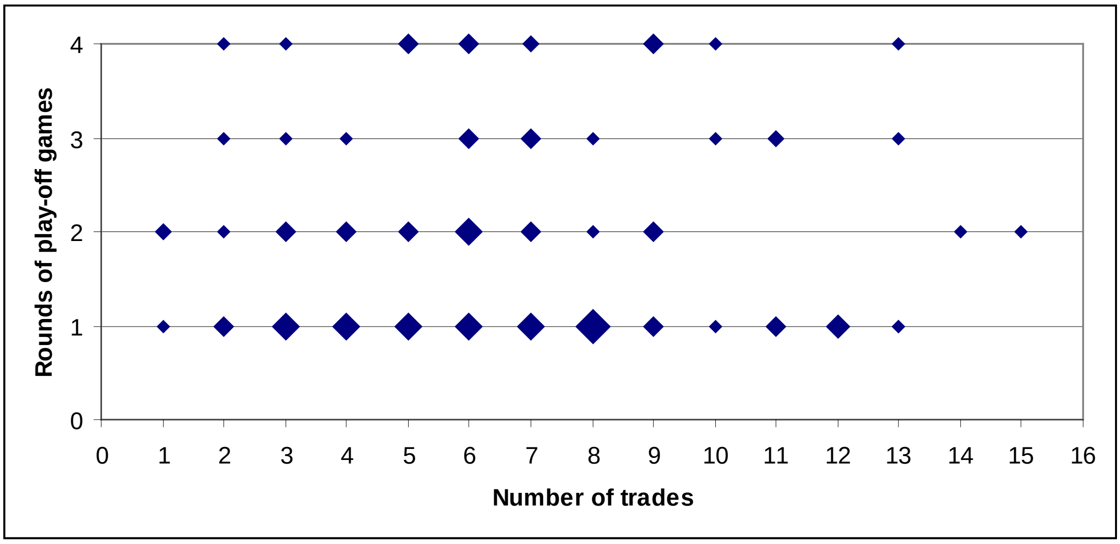

Figure 3 **Play-off round reached vs. number of trades that season during 2000–08, all play-off teams**

Figure 3 seems to indicate that moderate trade activity is connected to a more successful play-off run. This could be due to effective trade deadline moves bringing in players that compliment the existing talent pool, for example. But it is worth keeping in mind that the simple comparison of trades and standings or length of play-off season does not give the whole picture. Observing performance and trade activity only in one season is simplifying the issue. After all, the players traded for earlier are still affecting the team performance this year.

Looking at the team-specific figures for high performing teams, such as Detroit Red Wings or New Jersey Devils, both of which have made the play-offs every year in 2000–2008 period, one notices a distinctive feature of low trade activity. Detroit has an average amount of trades of 2.4, per season, with at most 3 trades per season. For New Jersey the figures are 4.3 and 9, respectively. The other play-off regulars, those with six play-off seasons, have average trades between 5.2 and 7.8, except for Philadelphia (10.2) with the maximum trades in one season between 9 (San Jose and Dallas) and 15 (Colorado). For the earlier mentioned Atlanta, Chicago and Phoenix, the average trades per season are 8.0, 9.0 and 10.3, respectively, with highest trade activity in a season at 12, 10 and 19 trades, respectively. Figure 4 shows average trade figures for both high and low performance teams.

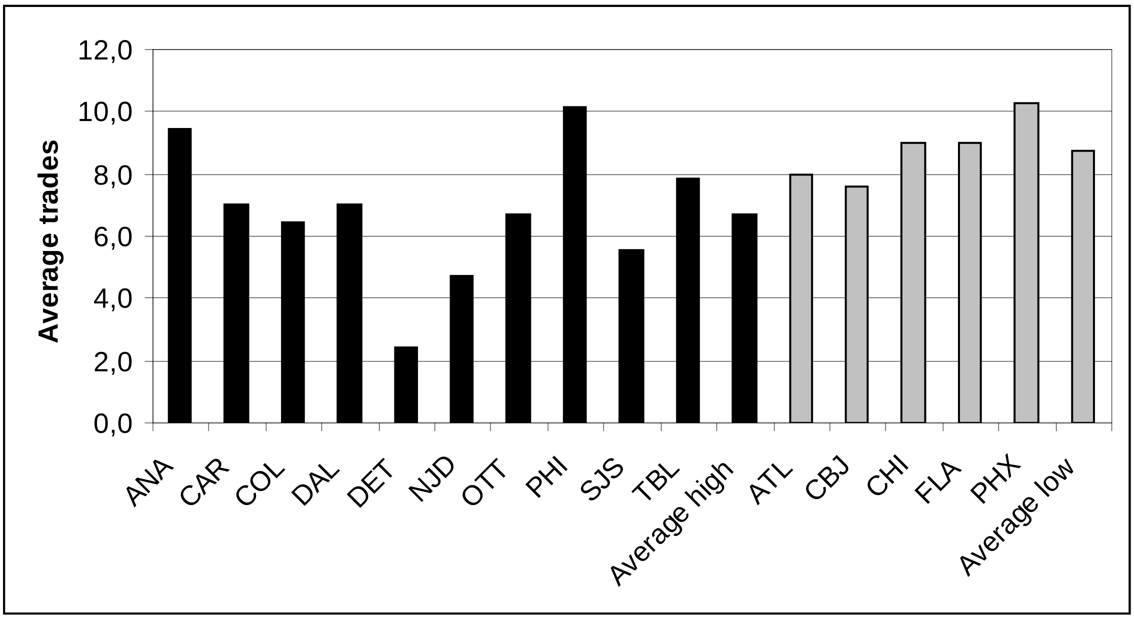

Figure 4 Average trades in 2000–08 for high and low performing teams

The high performing teams in Figure 4 include Anaheim, Carolina and Tampa Bay, despite them not having an impressive play-off record (4, 3 and 4 times in the play-offs, respectively), simply because these teams have managed to win the Stanley Cup. The low performance teams include the teams that have made the play-offs either once or not at all during the 2000–08 seasons.

While the over-all trade average is clearly larger for the low performing teams (8.8) than high performing teams (6.7), the variety of team specific averages is too large for any conclusions to be made. It would seem that more trades do not lead to greater success in the play-offs any more than during the regular season, but the results are far from conclusive.

It is important to remember that while the trades are the sole main source of team changes during the season, clubs have several other ways to change their talent in use. Even during the season there are waivers from which teams can claim players, and players can be moved between the NHL and the minor league affiliate. During the off-season teams can sign free agents and draft players new to the entire league. Due to the high number of player transfers, however, and given trades are the only immediate action the clubs can take during the season to change their talent in use, it is important to take a closer look at the decision making in a trade environment from the perspective of a club and at the trades made by the teams.

4.6 Inside the trade

While the bargaining models below discuss the side of the clubs in player trade, and the analysis above the resulting team performance after the trades, it is also worth considering who gets traded in the NHL player markets. Because the trade is made solely in players and draft picks, it is important to also take a look at what types of players get traded and indeed what are the players changing teams in one trade. Studying the period from the 2000–01 to the 2007–08 season also allows us to see if there has been changes in what types of players are traded with and without the salary cap introduced in 2005 Collective Bargaining Agreement.

During the seven seasons under study 1327 times a player exchanged teams as a part of a trade between two NHL clubs. These changes do not include player mobility due to free agent players signing with a team different from past years, but purely trades made by teams. The statistics of the players were compiled and the aggregate statistics of each player at the time of his trade was calculated. Only NHL statistics were considered in this. While the players do play for minor league teams or in the European leagues and these performances are more than likely to have an impact on the evaluation of players' expected production in the team, especially when evaluating young players with little or no NHL experience, for conveniences sake these were left outside this study. The comparisons between several European leagues and the American minor leagues would have been too complicated given the scope of this study, and it is assumed that the NHL statistics give some indication of the players' level. Furthermore, it can be argued that experience is sometimes looked for in a player, so specific NHL experience is influential.

Jones and Walsh (1988) studied the salary determination in the NHL in the late 70's. They examined the extent to which differences in skill, the structural elements of monopoly and monopsony, and discrimination determined the player salaries by position. While their empirical analysis used data from the 1977–78 season, it still gives us a good guideline to the measurements of player value in the modern day NHL.

After free agency and before salary caps in professional leagues, the salaries paid to the athletes served as the best measurement of the players' estimated talents. While the different roles within the game made the comparison of simple sports statistics of, for example, a forward and a goaltender, difficult, the salary clubs were willing to offer the player in free markets served as a unit of measurement on the talent and estimated worth of the player. It is reasonable to assume that the same variables that determined the worth of the player when measured in salary dollars in open markets are still the main variables the clubs use to weight the talents of the players.

Jones and Walsh modeled the salary formation as a function of several skill- and franchise-related variables. They learned that the franchise characteristics had little significance in determining the salaries of defensemen and goaltenders. Furthermore, the variables representing scoring prowess, experience, star status (number of NHL trophies and All Stars games appearances) and star potential (dummy for first round draft pick) are significant for both skater positions: defensemen and forwards. Points have a larger significance for forwards, but defensemen benefitted more from having either star status or potential. The combination of defense, intimidation and intensity captured by the penalties (in minutes) only proved to have an effect on the salaries of forwards.

For obvious reasons different statistics were needed for goaltenders. Jones and Walsh find that defensive performance in terms of goals against average per game, experience, and star status all have significant effect on goaltenders' salaries. Unlike for skaters, goaltenders did not get a pay increase by having star potential in the form of being first round draft picks. (Jones & Walsh, 1988, 592–447)

Out of the 1327 players traded 759 were forwards, 451 defensemen and 116 goaltenders. The relative portions correspond roughly to the division of player positions in a team, under the earlier assumption of 22 players per team with four full lines. Forwards represent 57% of players traded, while they occupy 55% of the spots on the team. For defensemen the corresponding shares are 34% and 36%, and for goaltenders 9% both. The division of forwards into centers, left wings and right wings varied slightly throughout the statistical analysis. Most of the statistics were calculated simply for forwards, however, as the roles of forward can vary even within the season, and a player can play both center and wing position in the team. Rarely, though sometimes, players switch from forward to defenseman or vice versa.

Out of all the trades that took place in 390 players moved in both directions as opposed to players traded for Entry Draft picks, for example. That is, in 390 trades both clubs involved gained and lost at least one player each. This represents slightly over half of all trades completed in the period. Majority of the trades (269 trades) involved only two players, being in effect an exchange of two players, with a possible draft pick exchanging clubs as well. Only 19 trades involved 5 or more players.

In 4.1 one of the sources claimed to create differences in how clubs value players and thus for mutual gains from trade was through trading players of different play position. Out of the two-player trades completed in the 2000–2007 period over two thirds were with players in different positions. Out of the three- or four-player trades in 40 per cent and 19 per cent, respectively, no players in similar position moved in both directions. It would seem, that while in player exchanges with only two players the emphasis was on trading two very different players for each other, in multiplayer trades players in similar position but of different talent levels were traded, or alternatively the similarity of play positions was just coincidental.

4.7 The effects of the 2005 CBA on player trade

The 2005 CBA changed the trading environment significantly, as it introduced a salary cap to the league. In effect, the clubs now had to consider also the player salary and the available room under the cap in addition to player-specific characteristics. That is not to say player salaries were insignificant before the CBA, naturally the teams had a budget limiting their players purchases, but the CBA means no smoothing cash transfers to help the new players fit under the club's budget limit.

Whether due to this new, stricter, limitation to possible trades or some other factor, clubs seemed to move to trade more potential and less experience than before the 2005 CBA. Overall, the amount of players traded dropped after the lock out. In the years under study before the new CBA, from 2000–01 to 2003–04 seasons, slightly over 800 players were traded, averaging 209 players per season. After the CBA took effect almost 500 players, 164 per season, on average, were traded during the 2005–06 to 2007–08 seasons.

While the share of completely inexperienced NHL-players was the same in both periods, down to a difference less than a percentage point, other measures of experience showed a considerable decline. The pre-CBA trades involved players with approximately 282 games compared to the average of 257 games played by players traded post-CBA. The seasons played in by the time of the trade showed a similar trend. When three quarters of players had played during 9 seasons at the time of the trade before 2004–05, the corresponding figure was only 7 afterwards. The change in the share of forwards out of all players traded stayed within a percentage point, whereas defensemen lost two percentage points in favor of the goaltenders.

The change to more inexperienced players happened mostly in forwards and goaltenders, however. For defensemen, the games played and season showed identical figures before and after the introduction of the salary cap. The forwards showed a drop of almost 60 games and 2 seasons, going from 503 games and 9 seasons to 447 games and 7 seasons, in the three quarters figures. The change was most visible in goaltenders. The games played average for goaltenders was a shy over 200 before the CBA and dropped a hundred games to 116 after the CBA. Part of that decrease is explained, however, by the share of players with no NHL experience almost doubling, from 5.9% to 10.4% post-CBA. The share of players with no NHL experience in forwards also rose, if only few percentage points (12.5% to 14.2%), and in defensemen is actually decreased from 16.6% to 14.3%.

It is an intuitively pleasing assumption that when clubs shift to trade more potential than fulfilled promises, the value measures naturally become more important. In trades, that is proves to be the case when one looks at the rounds in which the players traded were drafted. As the draft can be assumed to measure, if not the actual potential, at least the club's belief in the potential of the player, earlier draft pick comes more valuable.

Overall, however, the share of players traded, who had been drafted originally, fell after the CBA took effect. The role of what Jones and Walsh (1988) called "star potential", the first round draft pick, rose. When earlier 20.5% of all players drafted and traded were first round picks, 28.3% had a draft pick from the first round after 2005. All first six rounds displayed shares of the total two to three percentage points higher each post-CBA season than before it. The relative importance of being drafted early, of the perceived potential in a player, seems then to have risen due to the 2005 Collective Bargaining Agreement.

5 BARGAINING GAMES AND THE NHL

The player trade in the National Hockey League is heavily regulated and limited. Barter, limited time frame, unequal costs of bargaining, impatience, value determination difficulties, owner-specific values of goods and uncertainty are all characters present in player trade bargaining situation. The following is an attempt to model NHL player trade with the help of some game theoretic frame work, given the specific characteristic of the trade.

The NHL player trade can be thought of as a bargaining situation between two clubs, over a division of players. Due to the fixed supply of labor and the lack of other leagues to exchange players with the clubs in the National Hockey League, like in other North American professional team sports leagues, are limited to trading with each other over a fixed number of players. If one considers a case of two clubs negotiating over a player trade, the clubs are limited to the players in each others reserve lists. The division of the players between the two clubs is effectively renegotiated through the trade. Because the situation is simply a reallocation of limited, fixed talent pool between the two clubs involved, the bargaining models of game theory seem an appropriate model to study the decision making of NHL clubs.

The aim of the clubs entering a bargaining situation is to maximize the surplus in talent discussed in 4.1. It is worth noting, that while it is a bargaining situation, the league is a closed system with limited number of clubs. It is therefore in the best interest of both players in the bargaining game to act honestly and not try to deceive the other player. There are no long run gains from deceiving, only disadvantages.

Berri and Brook (1999) summarized the concept of net surplus talent in their analysis of player(s)-for-player(s) trade. They formulated the game-theoretical model for the trade as a maximization problem of marginal player performance value. In their model club *i* has a marginal payoff in wins, π_i, which it tries to maximize. The marginal value of each player the club *i* acquires is represented by λ_i. For each player the club *i* trades away it suffers a loss; ρ_i is the marginal value of player performance lost in the trade. The net change in player performance has the payoff of

$$\pi_i = \sum \lambda_i - \sum \rho_i \, , \tag{5.1}$$

where the sums are those of all players traded for and away, respectively.

The object of the club is to maximize π_i. However, the values of λ_i and ρ_i are often not known to the club before the trade. Despite the clubs having perfect knowledge of the past performance of a player, it is not a given how the player will perform in the future. Therefore the clubs are left approximating the marginal values in player performance. Berri and Brooks estimated this with the club value function Θ_i. Then

$$\theta\pi_i = \sum \Theta\lambda_i - \sum \Theta\rho_i \, , \tag{5.2}$$

where the club again attempts to maximize π. While *ex ante* the club i will only trade if it thinks $\theta\pi_i > 0$, the approximation of marginal player performances might lead to a trade where it turns out $\theta\pi_i < 0$. The difficulties on the part of the clubs to estimate the marginal values λ and ρ lead to Pareto suboptimal trades. (Berri &Brook, 1999, 136) Berri and Brook attempt in their study to better measure the player production in the NBA, and conclude that some trades made have indeed left clubs worse off than without the trade. (Berri & Brook, 1999, 135–151) However, only the *ex ante* situation is of interest for this paper, and the possible differences with *ex post* player performance are left for future studies.

5.1 Nash Bargaining Solution

In his 1953 paper John Nash constructed a strategic approach to the bargaining situation game. Nash's game is a non-cooperative game of two players with complete information. That is, both players know the structure of the game as well as the utility functions involved. The game takes place over the set S of mixed strategies s_i, where s_i represents "the course of action player i can take independently of the other player" (Nash, 1953, 129). While the joined courses of actions would form a similar space, only the subset B, consisting of those points that are realized by cooperation, in the (u_1,u_2) plane is important. For each joint courses of actions (s_1,s_2) there are pay-offs $p_1(s_1,s_2)$ and $p_2(s_1,s_2)$ for Players 1 and 2, respectively. p_i, a bilinear function of s_1 and s_2, gives the utilities u_1 and u_2 for players 1 and 2, respectively, for each joined action.

Nash models the game in four stages. In stage one each player chooses a threat strategy t_i (i = 1, 2) that he will be confined to should the two players not reach an agreement. The second stage is when the players inform each other of their respective threats. In stage three each player independently decides upon his individual demand d_i, a point on his utility scale. This is the level of utility demanded by player i in cooperation, that is, if $u_i < d_i$ player i refuses to cooperate. In the fourth stage the pay-offs are determined. If there is a (u_1,u_2) in B where $u_1 \geq d_1$ and $u_2 \geq d_2$, then the pay-off to each player i is d_i. If the demands on the other hand are incompatible and cannot be simultaneously satisfied, the threats are executed and the pay-off for player i is $p_i(t_1,t_2)$.

In effect the four stages of the game describe a two-move game. Stages two and four are simply mechanisms of the game, and only stages one and three involve actions, or moves, by the players. Furthermore, the moves in stage one, the choice of threats, is included to the information the players have in stage three when deciding their demands. Stage three can be considered as a game on its own, with the threats as determinants of the pay-offs in case of no cooperation.

Nash uses point N to represent the pay-offs in the case threats are materialized. Therefore N is the point $[p_1(t_1,t_2),\ p_2(t_1,t_2)]$ in B, where the coordinates of N can be abbreviated to u_{1N} and u_{2N} for Players 1 and 2 respectively. Using a function $g(d_1,d_2)$ which gets the values of +1 when the demands of the players are compatible and 0 when they are not, the pay-offs can be defined as

$$p_1 = d_1 g + u_{1N}(1 - g) \tag{5.3}$$

and

$$p_2 = d_2 g + u_{2N}(1 - g). \tag{5.4}$$

The problem with the pay-off functions above and the demand game they define is that the result is a multitude of equilibrium points. To solve this Nash introduces a 'smoothing' to the game that will make the pay-off function a continuous one, thus allowing the study of the limiting behavior of the equilibrium points. This smoothing is done by introducing a continuous function h to approximate the discontinuous g. The function $h(d_1,d_2)$ can be thought of as "representing the probability of compatibility of the demands d_1 and d_2" (Nash, 1953, 132). It is assumed that $h = 1$ on B and approaches 0 very rapidly as (d_1,d_2) moves away from B. The game is simplified even more by setting the threat pay-offs as zero, so that $u_{1N} = u_{2N} = 0$. This gives the smoothed game pay-offs $P_1 = d_1h$ and $P_2 = d_2h$.

When P_1 is maximized over a constant d_2 and P_2 over a constant d_1, the pure strategy demands pair (d_1,d_2) is the equilibrium point. Similarly, if (d_1,d_2) is the point P where d_1d_2h is maximized over all area of positive d_1 and d_2, and both d_1h and d_2h are maximized over constant d_2 and d_1, respectively, P is the equilibrium. If P, or u_1u_2h, is maximized, and ρ is the maximum of u_1u_2, the value of u_1u_2 in P must be at least ρ. Point Q in Figure 5 is where u_1u_2 is maximized, and $\alpha\beta$ is the hyperbola $\rho = u_1u_2$.

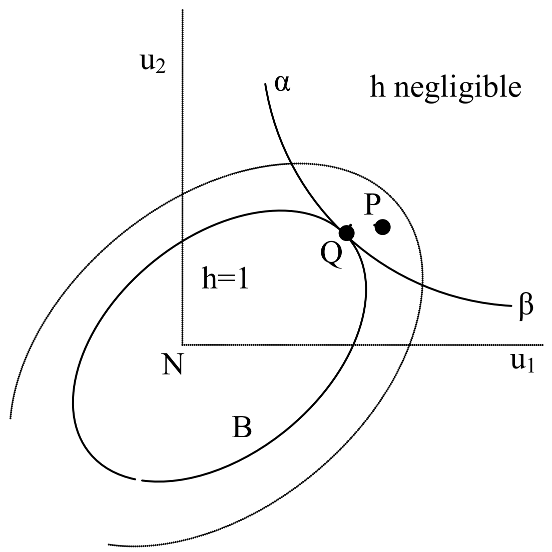

Figure 5 Nash bargaining solution (Nash 1953, 133)

ρ touches B at Q, and as less and less smoothing is used, that is, h decreases more rapidly when moved away from B, any maximum point P moves closer and closer to B. As Q is the only contact point between B and the hyperbola ρ, all maximum points such as P must approach it. Therefore Q is the only equilibrium point. (Nash 1953, 129–33)

The threat points used in the model by Nash assigned a certain utility to the pre-selected threat strategy. In the above it was set as zero, which is intuitively appealing considering it is the pay-off for not cooperating. However, the model does not exclude other possible values threats can take.

The bargaining model of Nash can be used to analyze the player trade in the NHL. The two players of Nash's game are the two clubs involved. The set S is the set of mixed strategies s_i available for club i (i = 1,2) and the subset of joint strategies realized by cooperation, B, is the different combinations of players and draft picks that would facilitate the trade, given the budget constraints imposed by the salary cap for both clubs involved. The subset B exists in the (u_1,u_2) plane, where u_i (i = 1,2) is the utility for club i from the cooperation or trade. That is, the expected talent in use the team has as a result of the trade taking place.

For each joined mixed strategies (s_1,s_2) representing the different player combinations traded by each club, there are payoffs given by the bilinear functions p_i so that club 1's payoff is $p_1(s_1,s_2)$ and club 2's $p_2(s_1,s_2)$. The utilities from payoffs p_i are now given by the talent function t_i familiar from 4.1, and reflect the different valuation the teams have for players and their relative talents. As the model discussed in 4.1 showed, the gain in talent the teams experience depends on the existing team construction. This will result in different valuation of the payoffs gained by a club through any individual trade.

The threat points in the Nash model are the status quo, the teams the clubs have without any trade taking place. They are denoted t_{1N} and t_{2N} for clubs 1 and 2, respectively. Each club enters the trade with a demand function d_i, (i = 1,2) which creates the criteria for trade. For any trade to take place $d_i \leq u_i$. As concluded earlier the net surplus talent must be greater than (or equal to) zero for trade to take place. A club can then define d_i as expected surplus talent in use it requires to agree to a trade.

The Nash model found the equilibrium at the point where u_1u_2 is maximized. In our analysis the utility functions are defined as $(t_1 - t_{1N})$ and $(t_2 - t_{2N})$ for clubs 1 and 2, respectively. Thus the equilibrium point is given by the values of t_i (i = 1,2) that maximize $(t_1 - t_{1N})(t_2 - t_{2N})$, that is, the expected net surpluses in talent achieved through the trade.

5.2 Building the bargaining game model

As we wish to examine the bargaining process and not just the solution, we turn to the strategic models of bargaining, most notably the models by Ariel Rubinstein. This way more of the special aspects of the bargaining situation in NHL can be incorporated into the analysis. In effect, the models consider costs of bargaining, the breakdowns and impatience of the players. Also outside and inside options to bargaining and their effects on the bargaining solution are considered.

The simplest bargaining model is the so-called Ultimatum Game. The game describes a situation where a given entity is divided between two players as agreed upon by them in two moves. In an explicit form the Ultimatum Game consists of the following two-player sequence of alternative moves:[16]

- Player 1 moves first and makes an offer to Player 2, suggesting a way to split up a cake, C, between the two, so that Player 1 gets the share x_1 and Player 2 x_2, with $x_1 + x_2 = C$.
- Player 2 can either accept offer of Player 1, in which case the cake is split as suggested (x_1,x_2), or reject the offer, and the players get nothing. The game ends after the move by Player 2.

The game is played under perfect and complete information, where the players know each others possible actions and payoffs, as well as past moves. (While the latter condition seems redundant at the Ultimatum Game, it becomes significant once the time frame and number of offers is expanded.)

Assuming both players are rational and aim to maximize their profits the Ultimatum Game can be solved by backwards induction. No matter what the offer (x_1,x_2) of Player 1, Player 2 will always get either more or at the very least the same by accepting the offer than by rejecting it. Therefore Player 2 will always accept the offer. Knowing this, Player 1 will offer (C,0) to Player 2, a situation where Player 2 is indifferent between accepting and rejecting the offer and will therefore accept it, and Player 1 gets all the cake.

In the NHL player trade the players are, as above, the clubs involved in trade negotiations. Out of the simplifications made for the Ultimatum Game model, perfect and complete information seems intuitively the least likely to hold for real life. However, given the extensive amount of scouting the clubs do regarding the players of other teams as well as the availability of statistics on player performance, we can assume complete information. And as the clubs are in all events of the game aware of the histories in that game, assumption of perfect information holds. All differences due

[16] See for example Osborne, 2004, 181–7 or Rasmusen, 2001, 295–6 for discussion on the Ultimatum Game.

to team-specific information regarding player performance can be included into the team valuation variables, with which clubs value a player differently.

The core of the bargaining game, the cake C is the additional talent that can be gained by the clubs through trade in players. Or, if put in other words, the cake can be thought of as the collection of talent, or players, that the clubs are willing to trade. This group of players is then reassigned to the two clubs as per the bargaining solution achieved. The salary cap limits the trade options to both clubs. The group of possible trade combinations under the salary cap is smaller than it would be without a cap. This limitation on the trade options is assumed throughout the following analysis, without being specifically mentioned.

While the Ultimatum Game is very limited, relaxing some of its restriction and assumptions lets one apply it to several situations. Below some of the limitations set in the description of the Ultimatum Game are loosened and the new games that emerge are examined. Probably the most obvious restriction to remove is the time limitation and the assumption that the game ends after the move from Player 2.

5.3 Costs of delayed agreement

When the time limitation is released in the Ultimatum Game, we can reformulate the game to the following:

- Player 1 moves first and makes an offer to Player 2, suggesting a way to split up a cake, C, between the two, so that Player 1 gets the share x_1 and Player 2 x_2, with $x_1 + x_2 = C$.
- Player 2 can either accept offer of Player 1, in which case the cake is split as suggested (x_1,x_2) and the game ends, or reject the offer.
- If Player 2 rejects the original offer, he then makes an offer (y_1,y_2) to Player 1.
- Player 1 can then either accept the offer or reject it, the former resulting in splitting the cake (y_1,y_2) and the game ending, and the latter to Player 1 making the next offer. And so on.
- The game is played under perfect and complete information, where the players know each others possible actions and payoffs, as well as past moves.

The only way these additional time periods and bargaining rounds have any effect on the outcome payoffs is if time is valuable. That is to say, early agreement is preferred by the players to a later one. Should the time of agreement reached be insignificant to the players, only the last offer of the game would matter. The game-tree in Figure 6 graphs the situation in a two-period model.

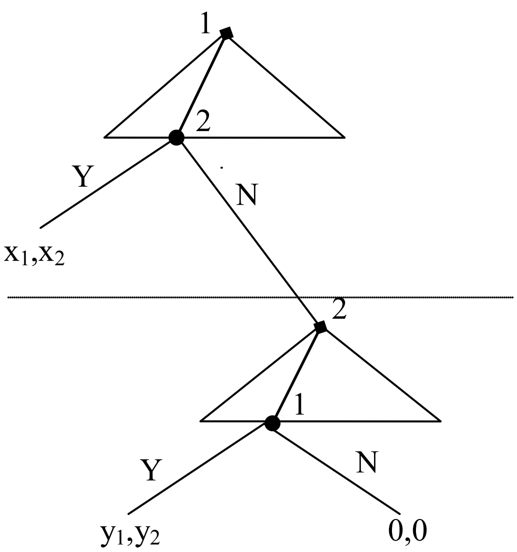

Figure 6 Two-round Ultimatum game game-tree (modified from Osborne, 2004, 466)

Starting from the top, Player 1 makes an offer to Player 2. The knots represent the decision made by the players, and the triangle is the spectrum of possible offers that can be made. The total amount shared by the players is 1. Player 2 can now accept the offer (*Y*) which would lead to the pay-offs (x_1,x_2) and the game ending. If Player 2 rejects the offer (*N*) the game moves to the knot at the top of the second triangle. Now Player 2 makes an offer which Player 1 can then accept (*Y*) or reject (*N*). Rejection would lead to (0,0) and game ending. Acceptance would result in pay-offs (y_1,y_2) as suggested by Player 2.

The subgame that starts from the offer of Player 2 is the same as the Ultimate Game described above, and the solution is the same as well. Player 2 will offer (0,1) to Player 1 who will then be indifferent between *Y* and *N* and accepts the offer. Knowing this subgame equilibrium Player 2 always refuses the offers of Player 1 where $x_2 < 1$. Should one more period be added, and the game ended with Player 1 making the last move (i.e. offer) and Player 2 reacting (accepting or rejecting), we would return to the original Ultimatum Game solution where Player 1 gets everything and Player 2 nothing. There is, therefore, absolute last move advantage. It would not make a difference how many periods there are in the game. The last subgame would always be the Ultimate Game. (Osborne, 2004, 465–466, Rasmusen, 2001, 299–300)

5.3.1 Finite time frame in a bargaining game

In the real world time is valuable. Situations where players can go on bargaining forever without any costs are rare, and therefore earlier agreements are preferred. The costs of prolonged negotiations are most often described by a discounting factor. Every new period the game gets into discounts the value of the outcome to a player by a fixed discounting factor δ.

Supposing there is a fixed discounting cost δ_i for any Player i, where $0 < \delta_i < 1$, we can modify the game-tree in Figure 6 to get the one in Figure 7.

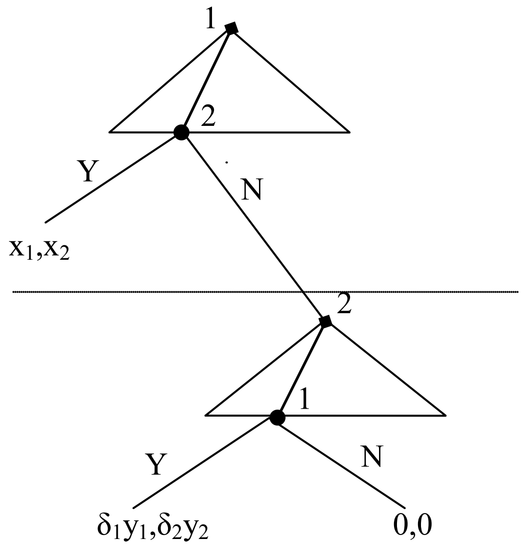

Figure 7 Two-round game-tree with discounting cost (modified from Osborne, 2004, 467)

With the discounting the pay-offs after a second-round agreement are $(\delta_1 y_1, \delta_2 y_2)$. Now the subgame equilibrium is (0,1) offered by Player 2 and accepted by Player 1. The final pay-offs are $(0,\delta_2)$. This can be placed as the pay-off resulting from a rejection to the offer of Player 1. By rejecting the initial offer Player 2 is guarantied a pay-off of δ_2. Therefore he will reject all offers from Player 1 where $x_2 < \delta_2$. Knowing this Player 1 will make an initial offer of $(1 - \delta_2, \delta_2)$, which Player 2 will accept.

A third time period, in which it is the turn of Player 1 again to make an offer, would change the pay-offs to $(1 - \delta_2(1 - \delta_1), \delta_2(1 - \delta_1))$. In the subgame where Player 1 makes his second offer he knows the game ends after that round regardless of the reaction of Player 2, so the offer is (1,0), which Player 2 accepts. Knowing this subgame equilibrium Player 2 offers $(\delta_1, 1 - \delta_1)$, which Player 1 accepts. This is because he is indifferent between a pay-off of δ_1 now and a pay-off of 1 in the following round (which would be discounted to equal δ_1). The offer of $(\delta_1, 1 - \delta_1)$ is the subgame equilibrium of the game that starts on the second round. Player 1 knows $1 - \delta_1$ is the limit on what Player 2 will accept, as that is the pay-off he is certain of getting in the second round. Therefore Player 1 will initially make an offer of $(1 - \delta_2(1 - \delta_1), \delta_2(1 - \delta_1))$. Player 2 accepts. (Osborne, 2004, 466–8)

Increasing the number of time periods to any, yet limited, number allows the use of similar backward induction to find the equilibrium offer. As the number of periods over which bargaining takes place increases, the solution nears the solution derived for games over infinite number of time periods.

5.3.2 Infinite time frame in a bargaining game

In his 1982 paper Rubinstein defined the infinite horizon game and offered Perfect Equilibrium for a game with fixed discounting factor. He concluded that given the players have fixed discounting factors where at least of them is strictly positive and at least one is strictly less than 1, the only perfect equilibrium is

$$M = \frac{1 - d_2}{1 - d_1 d_2}, \tag{5.5}$$

where M represents the share of the player making the first offer (Player 1), and δ_1 and δ_2 are the discounting factors of players 1 and 2, respectively. (Rubinstein, 1982)

The infinite horizon game is stationary in that every subgame starting with an offer made by Player 1 is exactly identical to any other such subgame and to the whole game. This stationery in the game suggests stationary strategies for the players involved. Therefore the following stationary strategies can be formed for the players:

· Player 1 offers x^*, and accepts offer y if and only if $y_1 \geq y_1^*$

· Player 2 offers z^*, and accepts offer w if and only if $w_2 \geq w_2^*$,

where w^*, x^*, y^* and z^* are some offers made in form (w_1,w_2) and so on for all. To solve for a strategy pair fitting abovementioned criteria we can argue that, as “in a finite horizon game every proposal is accepted in equilibrium”, “[a] reasonable guess is that the same is true in the infinite game” (Osborne, 2004, 470) This provides us with $x_2^* \geq w_2^*$ and $z_1^* \geq y_1^*$ which for equilibrium are $x_2^* = w_2^*$ and $z_1^* = y_1^*$. Now the strategy pair is one in which

· Player 1 offers x^*, and accepts offer y if and only if $y_1 \geq y_1^*$

· Player 2 offers y^*, and accepts offer x if and only if $x_2 \geq x_2^*$

Considering the subgame where Player 2 first rejects an offer, the next offer is that of y^* by Player 2, as suggested by his strategy. And in accordance to his strategy, Player 1 accepts the offer y^*. Knowing that would take place in the following round, Player 2’s rejection point in the original round can be defined as $\delta_2 y_2^*$. That is to say, Player 2 will reject all offers where $x_2 < \delta_2 y_2^*$ and accept all for which $x_2 > \delta_2 y_2^*$. Therefore at the equilibrium $x_2^* = \delta_2 y_2^*$ and by symmetry $y_1^* = \delta_1 x_1^*$. Rearranging with $x_2^* = 1 - x_1^*$ and $y_1^* = 1 - y_2^*$ generates x_1^* and y_1^*, where

$$x_1^* = \frac{1-\delta_2}{1-\delta_1\delta_2} \tag{5.6}$$

and

$$y_1^* = \frac{\delta_1(1-\delta_2)}{1-\delta_1\delta_2}. \tag{5.7}$$

Thus the subgame perfect equilibrium is

$$x^* = \left(\frac{1-\delta_2}{1-\delta_1\delta_2}, \frac{\delta_2(1-\delta_1)}{1-\delta_1\delta_2}\right) \tag{5.8}$$

$$y^* = \left(\frac{\delta_1(1-\delta_2)}{1-\delta_1\delta_2}, \frac{1-\delta_1}{1-\delta_1\delta_2}\right), \tag{5.9}$$

with x^* representing the outcome if Player 1 makes the first offer and y^* the outcome following an initial offer of Player 2. (Osborne, 2004, 468–471)[17]

Osbourne (2004) also notes some important properties of the subgame perfect equilibrium. As an agreement is reached already in the first round of bargaining the solution is efficient. Neither player has to endure any bargaining costs. The solution shows a clear first-mover advantage. Even if the discounting factors are equal ($\delta_1 = \delta_2 = \delta$) there is an asymmetry in the solution. Player 1's payoff in this case would be $(1 - \delta) / (1 - \delta^2)$, which gives him a clear advantage. The size of that advantage depends on the magnitude of δ, as the pay-off would approach ½ as δ approached 1. Finally the solution also displays the effects of any changes or differences in patience of the players. As the discounting factor can be though of as an indicator of the impatience of the players, any changes in it will affect the final pay-offs. If the patience of Player 1, (δ_1), is fixed Player 2's share increases as he becomes more patient. As the game is symmetrical, the same is true the other way round. As a player becomes more patient, his share approaches 1.

5.3.3 Time as a factor in player trade

The model for finite time frame might be applicable under some specific circumstances, such as close to the trade deadline or during the Entry Draft. The discounting factors played a big role in the final division, but more than that the shares were determined by who got the final turn in making an offer. The finite time frame changed the final subgame into an Ultimatum Game and in that the club making the offer has the biggest bargaining power.

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[17] For deeper analysis and more mathematical approach see Rubinsten (1982).

Most of the time, however, the game is played over infinite, or at least undetermined timeframe. So the model for infinite timeframe bargaining is more appropriate. Rubinstein's Perfect Equilibrium determined the shared of the two players as

$$x^* = \left(\frac{1-\delta_2}{1-\delta_1\delta_2}, \frac{\delta_2(1-\delta_1)}{1-\delta_1\delta_2} \right), \tag{5.10}$$

where the first term is the share of the club 1 who starts the bargaining and δ_1 and δ_2 are the respective discounting factors of clubs 1 and 2.

The costs of bargaining are of several kinds in player trade. The two traditional interpretations of the discounting factor δ both apply. The impatience interpretation where lower discounting factor reflects the relatively more patient club is fairly intuitive in the player trade environment. Impatience can be seen as the need for the trade to take place, or indeed as a need for getting a particular player to ones team. For example, a club in desperate need of a goaltender would have a considerably higher discounting factor in a goaltender trade situation than a club that has relatively good goaltender situation.

On the other hand the discounting factor reflects the loss of the increasing gains a player brings to the club. If a situation is considered where a new player is traded for, the benefits are both constant and accumulative. The increase in the playing strength is immediate, and can be considered as a constant over each game; the player brings his specific combination of talent and skills to the team. The indirect, or accumulative, benefit of the new player comes over time as the player learns to play within the play system of the team and the players in the team learn to play better with each other. By a delay to achieve an agreement in trade bargaining the club loses the direct benefit of having a new player in the team, as well as the indirect benefits. The discounting factor as an indication of the costs of not reaching the immediate agreement reflects this loss in playing strengths.

The discounting factor comes to play for each period an agreement is postponed. The definitions of a period can vary from one version of the model to the next, and depends on the situation to which the model is applied. In case of building a hockey team the intuitive answer is a game of ice hockey. The gained skills of an additional player cannot be utilized until the team takes the ice, and every game in which the team plays with the additional player it experiences gains from the trade. Symmetrically, every game the team player without the new player the club is bargaining for, costs them the lost gain in competitive strength compared to the situation of a completed trade. The issue of playing without the trade taking place while negotiating is returned to when the model for inside options is introduced.

We can take a case where a club starts a bargaining process because it looks to increase its competitive strength, say it is looking to add an effective goal-scorer to better improve its chances in the fight for the play-offs. It is safe to assume, then, that the club is fairly impatient, or has a strong desire to complete the trade. Therefore, the discounting factor for this club, δ_1, is fairly small. If the other club in the bargaining has either secured or lost the play-off position the discounting factor for that team, δ_2, is relatively higher as the trade is not so urgent for them. This creates a disadvantage to club 1, and lets club 2 exploit the relative bargaining power it has due to a less pressing need to complete the trade.

Off-season trades, excluding those prior and during the Entry Draft, remove the time factor. In the modeling this can be achieved by either making the lengths of a time period approach 0, or the discounting factor equal to 1. Both ways the discounting effect disappears. This resonates with the reality in that as there are no games played during the off-season, the length of bargaining activity does no matter as long as it is completed by the beginning of the season. As discussed earlier, off-season trades outside of draft-related ones are not very common, as the clubs are focusing on signing players from the free markets.

The Entry Draft date in June is a busy trade period, only the motivation for a trade is slightly different. Mostly players are traded to facilitate a trade in draft picks. The bargaining including draft picks or players clubs want to use in draft pick -related trades need to be completed by the Draft. Trades are allowed as longs as the draft picks involved are not called. The effect of the discounting factor becomes large as teams are rushed to complete the trade in time.

The deadline of Draft Day or the season starting is a natural end for the time horizon in the bargaining. Similar limit on time horizon is provided by the trade deadline nearing the end of the regular season. The only difference is that whereas the trade deadline ends all trading, the Draft only limits trade possibilities (in that some tradable entities, the picks for that year, are now gone) and the season starting introduces costs for bargaining.

5.4 The risk of breaking points in bargaining games

The situation discussed above is still a simplification of the reality. The negotiating situation can change rapidly due to, for example, player injuries. Even if the injury does not happen to a player the clubs are bargaining over, the resulting change in team overall talent distribution is enough to change the game of bargaining. The clubs may return to the negotiating table, but it will be a different game as the parameters have changed. So for the purposes of game theoretic analysis, the game ends. To model events like this in the bargaining game setting, we need to introduce the breaking points to the earlier model.

The breaking point in the bargaining situation can be placed in several different points within the game. Breaking point can break up the bargaining regardless of the players' actions. In the model that adds another mover to the game tree: Nature or chance, *c*, which can intervene at any point, with some exogenous certainty. To simplify the issue, let us assume that Nature can only move after an offer has been answered, in effect, after it has been rejected (as accepting ends the game). Let the probability with which nature breaks the negotiations be α, with $0 < \alpha < 1$. Further, say Nature moves after every rejection, before the next offer is made. Then the game tree can be draw up as below.

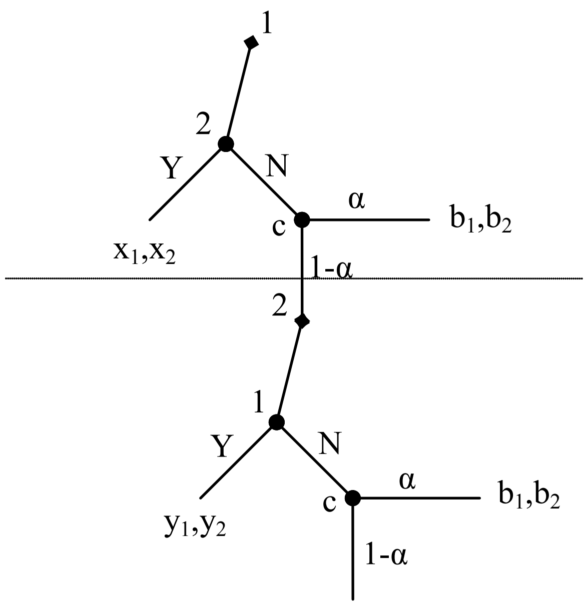

Figure 8 Breakdowns in a game tree (modified from Osborne, 2004, 474)

For clarity the triangles representing the possible alternative variations of offers made are excluded, but the same concept applies as in earlier game-tree presentations. The diamond represents the action of making an offer, to separate it of the other two kinds of actions in the game. The offer drawn is a representation of any offer made. The earlier discussed discounting costs are replaced by risk of a breakdown. Passage of time is not therefore directly costly to the players, but increases the risk of a breakdown and therefore an unfavorable result.

Following the presentation in Osborne (2004) the utility functions for the players are replaced by Bernoulli payoffs, derived from the players' attitudes over risk. The payoffs from the possible breakdown B are represented by (b_1,b_2), the Bernoulli payoffs of the players. It is further assumed that the breakdown is the worst possible outcome, that is, there exists an agreement that both players prefer to *B*. (Osborne and Rubinstein, 1990, 74) The stationary strategies s_1 and s_2 from 5.3.2 are then

- Player 1 offers $x^*(\alpha)$, and accepts y if and only if $y_1 \geq y^*(\alpha)$
- Player 2 offers $y^*(\alpha)$, and accepts x if and only if $x_2 \geq x^*(\alpha)$,

where each player is indifferent between accepting the offer by the other and the payoff, the expected value of u_i, in the next round. Formally, if

$$u_1(y_1^*(\alpha)) = \alpha b_1 + (1-\alpha)u_1(x_1^*(\alpha)) \tag{5.11}$$

and

$$u_2(x_2^*(\alpha)) = \alpha b_2 + (1-\alpha)u_2(y_2^*(\alpha)). \tag{5.12}$$

The role of α and b_i can be emphasized when assuming both players are risk neutral, so that $u_i(x_i) = x_i$ for each player i. Then the equations above result in

$$x_1^* = \frac{1 - b_2 + (1-\alpha)b_1}{2-\alpha} \tag{5.13}$$

$$y_1^* = \frac{(1-\alpha)(1-b_2) + b_1}{2-\alpha}, \tag{5.14}$$

where x_1* is the share of Player 1 when he is the one making the first offer, and y_1* is the share of Player 1 when Player 2 starts the game.

The value of α is important in determining the gains from starting the game. If α is close to zero the advantage gained from starting the game is small. As α approaches zero, x_1* and y_1* both approach ½(1 – b_2 + (1 – α)b_1, or, when rearranged, b_1 + ½(1 – b_1 – b_2). So under conditions of α approaching zero and risk neutral NHL clubs, the unique subgame equilibrium proposals are close to (b_1 + ½(1 – b_1 – b_2) , b_2 + ½(1 – b_1 – b_2)) In other words, the clubs divide equally the excess they gain by trading instead of the game breaking down and the clubs resulting with the payoffs b_1 and b_2. The only differences in the payoffs come from the breakdown payoffs the clubs are sure to get.

5.5 Outside options shift the bargaining power

Another real-life infringement on the bargaining is all the other options out there. As a club is negotiating with a club, there are 28 clubs left in the National Hockey League who might have a proposal of trade to make. If the club is looking for a specific type of player to add through the trade, by all logic there is more than one team who has a player fitting the criteria. And if the criteria are more relax, or indeed the club is simply looking to make room under the salary cap or get a draft pick of certain level, the probability of an outside option existing increases. It is therefore much more intuitively pleasing to focus on the outside option model of the bargaining game than the model with breakdowns.

In game theory the outside option is a certain utility a player can gain by leaving the bargaining. Accepting an outside option naturally ends the bargaining game. The option can exist to one or both players, and it can occur in any point of the game. The outcome of the game depends on the point at which the player with an outside option can utilize it, and in some cases there are multiple subgame equilibriums. (Osborne and Rubinstein, 1994, 129) Different versions are studied below.

The two games studied in this section are similar in large degree. They both follow the Rubinstein's infinite time frame game model in 6.3.2. The discounting cost for both players is δ, that is, $\delta_1 = \delta_2 < 1$. The outside option exists for Player 2 and yields payoffs of (0,*b*). Choosing the outside option means quitting the game and thus the game ends. As long as $b > 0$, Player 2 has an advantage over Player 1 as he has a valuable alternative, whereas Player 1 is limited to the present negotiation. In the first model, Player 2 can opt out only after rejecting an offer from Player 1. In the second game he can opt out after Player 1 rejects an offer. The second game gives the same results as would a game where Player 2 could opt out after his and Player 1's rejection. For simplicity, the less complex case is studied.

If Player 2 can opt out after his own rejection at any period *t*, the payoffs are 0 and $\delta^t b$ for Players 1 and 2 respectively, where $b < 1$ and *t* is the time period so that for the first round $t = 0$. The game tree below illustrates the progression of the game, showing the first two periods of bargaining.

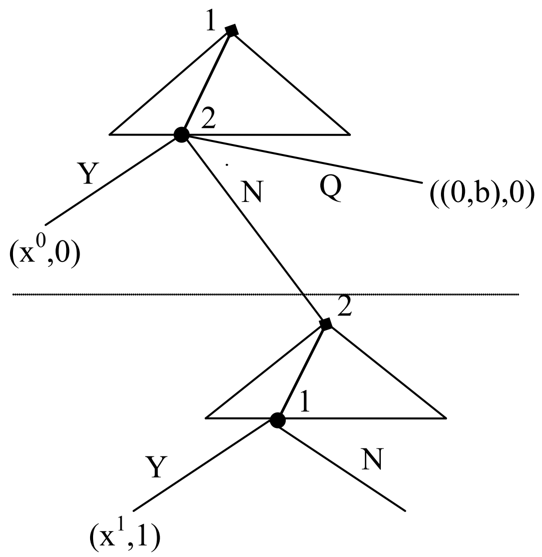

Figure 9 Outside option for Player 2 after an offer by Player 1 (modified from Osborne, 2004, 476)

In Figure 9 x^t is used to describe the suggested division of the cake (x_1,x_2) at period *t*. Thus the outcome $(x^0,0)$ that would occur should Player 2 accept Player 1's initial proposal, is simply the payoffs (x_1,x_2) at time period 0. *Q* is the exit strategy for Player 2 that is available when responding to an offer from Player 1, and ends the game with payoffs (0,*b*) at time 0. The game has several solutions depending on the value of *b*. However, as long as $b > 0$, Player 2 has an advantage over Player 1 in that he has a valuable option outside the game Player 1 is limited to. The importance of that advantage depends on the value of *b*.

If $b < \delta/(1 + \delta)$ the outside option is not worth leaving the negotiation for to Player 2 and the game has a unique subgame perfect equilibrium. This equilibrium is the same as the one in a game without the outside option. Player 1 will always offer division $(1/(1 + \delta)\ ,\ \delta/(1 + \delta))$ and accept any offer y where $y_1 > \delta/(1 + \delta)$. Player 2 in turn will always offer $(\delta/(1 + \delta)\ ,\ 1/(1 + \delta))$ and accept any offer x where $x_2 \geq \delta/(1 + \delta)$. The game has an immediate solution of $(1/(1 + \delta)\ ,\ \delta/(1 + \delta))$.

Another immediate subgame perfect equilibrium occurs if $b > \delta/(1 + \delta)$. Player 1 always offers $(1 - b, b)$, the division that would keep Player 2 in the game and thus making it possible for Player 1 to gain at least something. He will accept any offer y where $y_1 \geq \delta(1 - b)$. Player 2 accepts any offer x where $x_2 \geq b$, quits the game in favor of the outside option if $x_2 < b$, and offers $(\delta(1 - b)\ ,\ 1 - \delta(1 - b))$. The immediate outcome is $(1 - b, b)$. This solution also holds if $b = \delta/(1 + \delta)$.

If the opportunity for Player 2 to opt out occurs after Player 1 has rejected an offer (or after either one of them rejects an offer) he has more leverage in the negotiations. The game tree is very similar to that in Figure 8, only instead of the random move by Nature we have Player 2's action.

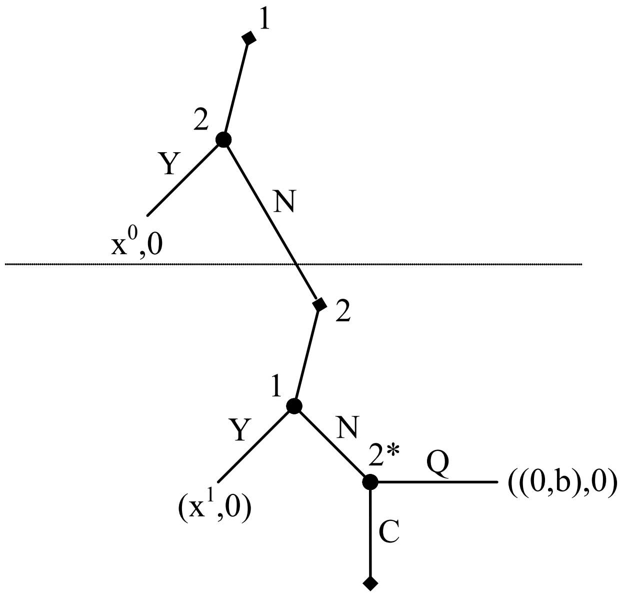

Figure 10 Outside option for Player 2 after a rejection by Player 1 (modified from Osborne, 2004, 476)

As in the previous game, if the outside option b is worth less than what is available for Player 2 in the negotiations with Player 1, that is, if $b < \delta^2/(1 + \delta)$, the outside option is irrelevant to the outcome of the game. The game is played as a normal bargaining game where immediate equilibrium of $(1/(1 + \delta)\ ,\ \delta/(1 + \delta))$ reached.

If $\delta^2/(1 + \delta) \leq b \leq \delta^2$, multiple subgame perfect equilibria exists. There is an immediate agreement of $(\xi\ ,\ 1 - \xi)$ for all ξ □ $[1 - \delta, 1 - b/\delta]$. That means Player 2 can use the outside option as a credible threat strategy, and gain equilibrium $(\xi\ ,\ 1 - \xi)$

where $1 - \xi$ is greater than b. In every subgame perfect equilibrium Player 2 gets at least a pay-off of $\delta/(1 + \delta)$.[18]

The event where $\delta^2 < b < 1$ has only one subgame perfect equilibrium. In this version of the game Player 1 always offers a division of $(1 - \delta, \delta)$ and accepts all offers. Player 2 accepts all offers in which $x_2 \geq \delta$ and always proposes division (0,1). Player 2 always opts out.

If a player has an option outside of the bargaining he can use it to his advantage, but only under certain circumstances. If the player with no outside option, Player 1, gets to make the last offer before opting out is possible, he can ensure that Player 2 gets exactly, and no more than, the outside option b. If Player 2 can opt out after Player 1's rejection as well as his own, he can use the outside option as a credible threat to make a "take-it-or-leave-it" offer, and thus gain more than b and more than in a bargaining without the outside option. (Osborne and Rubinstein, 1990, 58-63; Osborne, 2004, 475-477)

The outside option is a very realistic assumption on most player trade situations in the NHL. As the bargaining game in Figure 10 is the same as one where Player 2, of club 2, can opt out after a rejection from either club, it is more corresponding with reality, and thus worth focusing on. The model provides club 2 a pay-offs of b from the outside option. This can be seen as the value club 2 can gain from a trade with a third club. It can even be a parallel bargaining process with the pay-off of b to club 2. The crucial thing is the value of b in relation to the net talent gained from the current bargaining game with club 1.

The outside trade only makes a difference in the relative bargaining powers of the two clubs if it is valuable enough. If the value of the trade with club 3 is less than what club 2 would get with club 1 anyways, it will not affect the bargaining outcome. Club 2 has no incentive to utilize its outside option as long as $b < \delta^2/(1 + \delta)$. On the other hand, if $\delta^2 < b < 1$, club 2 will always prefer the trade with club 3, the outside option. If club 1 gets to make a final offer, it can match the outside option and offer $(1 - b,b)$, which club 2 would accept.

But if club 2 can opt out after rejections from either club, it can exploit the outside option and use it as a credible threat. If $\delta^2/(1 + \delta) \leq b \leq \delta^2$ there exists multiple subgame perfect equilibria. Club 2 gets at least the pay-off $\delta/(1 + \delta)$. It can use the outside trade with club 3 as leverage to get a trade out of club 1 that is better than the trade with club 3 (b) and what club 2 would get in a bargaining without the outside option.

[18] See Osborne and Rubinstein, 1990, 61-62 for the proof.

5.6 Gains from delaying agreement in bargaining

As discussed already in 6.3, the clubs often keep playing ice hockey while the bargaining is taking place. The costs of delayed solution are the lost gain from trade. But what the models in 6.3 did not account for is the gain the team still has, before the trade is complete, from the player(s) is would trade away. These players are still making a contribution to the team during the bargaining. The inside option model of bargaining game takes this player contribution into consideration.

Let us assume an alternating offers bargaining game with constant costs of bargaining and infinite time frame, as before. The two clubs bargain over the division of the cake the size of π ($\pi > 0$), which can be thought of as the surplus talent available overall. The bargaining has a cost for the clubs, with the discounting rate r_i ($i = 1,2$) for clubs 1 and 2, respectively. If the players reach an agreement at time $t\Delta$ ($t = 0, 1, 2, 3, \ldots$, and $\Delta > 0$), where Δ is the length of the time period, the payoff for club i for the share x_i of the cake, π_i, is

$$\pi_i = \frac{g_i\left[1 - \exp(-r_i t\Delta)\right]}{r_i} + x_i \exp(-r_i t\Delta). \tag{5.15}$$

The first term on the right half of the equation defines the utility club i gains from its inside option while the bargaining parties temporarily disagree. The second term is its discounted share of the overall cake.

The inside option is defined by the rate of utility, g, the club gets while the bargaining is incomplete. That is, if an offer is rejected at time $t\Delta$, then in the time interval Δ before the counteroffer is made at time $(t + 1)\Delta$, the club gets some utility. In the player trade this means having the players the club would trade away still performing for the club and producing player performance value for the club, at the rate of g. Were the bargaining clubs to permanently disagree, that is to reject each and every offer the other club makes, the inside option gains would be g_i/r_i (i = 1,2). To ensure gains from trade, must $g_i/r_i < \pi$. Thus we have a game were at any subgame perfect equilibrium the payoff to club i is always greater than or equal to g_i/r_i.

The game has a unique subgame perfect equilibrium (SPE), with the strategies of clubs 1 and 2 as follows:

- Club 1 offers x^* and accepts offer y if and only if $y_1 \geq y_1^*$
- Club 2 offers y^* and accepts offer x if and only if $x_2 \geq x_2^*$

where

$$x_1^* = \frac{g_1}{r_1} + \frac{1-\delta_2}{1-\delta_1\delta_2}\left(\pi - \frac{g_1}{r_1} - \frac{g_2}{r_2}\right) \tag{5.16}$$

and

$$y_2^* = \frac{g_2}{r_2} + \frac{1-\delta_2}{1-\delta_1\delta_2}\left(\pi - \frac{g_1}{r_1} - \frac{g_2}{r_2}\right). \tag{5.17}$$

The equilibrium equations show, that club i's share is strictly increasing in g_i, and strictly decreasing in g_j ($j \neq i$). That means club i's bargaining power is strictly increasing in its own inside option and strictly decreasing in the inside option of the other club. If $g_1 = g_2$ and $r_1 = r_2$, however, the clubs are identical and the only difference in the division of the surplus talent comes from the first-mover advantage.

The first-mover advantage will disappear at the limit as $\Delta \to 0$. Then the unique subgame perfect equilibrium shares of the cake to clubs 1 and 2, respectively, converge to the Split-the-Difference Game shares

$$Q_1 = \frac{g_1}{r_1} + \eta_1\left(\pi - \frac{g_1}{r_1} - \frac{g_2}{r_2}\right) \tag{5.18}$$

and

$$Q_2 = \frac{g_2}{r_2} + \eta_2\left(\pi - \frac{g_1}{r_1} - \frac{g_2}{r_2}\right), \tag{5.19}$$

where $\eta_1 = r_2/(r_1 + r_2)$ and $\eta_2 = r_1/(r_1 + r_2)$.

The limiting equilibrium partition (Q_1,Q_2) is independent of who makes the first offer. The interpretation is fairly simple. The two clubs agree to give each club i a share equal to g_i/r_i and then split the rest between them.

The limiting SPE payoff pair (Q_1,Q_2) is the unique solution of the maximization problem

$$\max(u_1 - d_1)^{\eta_1}(u_2 - d_2)^{\eta_2} \tag{5.20}$$

with $(u_1,u_2) \in \Omega$, $u_1 \geq d_1$ and $u_2 \geq d_2$, where

$$\Omega = \{(u_1,u_2) : 0 \leq u_1 \leq \pi \text{ and } u_2 = \pi - u_1 \tag{5.21}$$

$$d = (g_1/r_1, g_2/r_2). \tag{5.22}$$

This shows that the limiting SPE payoff pair is identical to the asymmetric Nash Bargaining Solution. (Muthoo, 1999, 137–141) In 6.1 the Nash Bargaining Solution was defined as the values of t_i which maximize the $(t_1 - t_{1N})(t_2 - t_{2N})$ and assumed no costs for time ($r_i = 0$). The threat points in the Nash Bargaining Solution are then the inside options of permanent disagreement in never-ending negotiations.[19]

It is possible to extend the inside options bargaining game to include the outside options discussed above as well. This would mean allowing the clubs to consider third-party offers while engaged in a bargaining. The game is very similar to that of 6.5. Let us denote the outside option point with the utility pair (w_1,w_2), where $w_1 < \pi$, $w_2 < \pi$ and $w_1 + w_2 < \pi$, so that there exists gains from trade. The inside options are defined as above. The guarantee of utility of at least g_i/r_i for club i (i = 1,2) no longer holds. Club j ($j \neq i$) can now opt out, resulting in the division (w_1,w_2). The outside option now defines the new minimum talent gained in the game by club i to be at least $\delta_i w_i$. It is important

[19] See Muthoo, 1999, 151–152, for details.

to note that there need not be any relationship between the inside and the outside options. Thus w_i can be less that, equal to or greater than g_i/r_i.

The unique subgame perfect equilibrium strategies for the two clubs are as follows:

- Club 1 offers x^* and accepts offer y if and only if $y_1 \geq y_1^*$, and opts out after any offer of $y_1 < y_1^*$ if and only if $x_1^* \leq w_1$
- Club 2 offers y^* and accepts offer x if and only if $x_2 \geq x_2^*$, and opts out after any offer of $x_2 < x_2^*$ if and only if $y_2^* \leq w_2$.

where

$$(x^*, y^*) = \begin{cases} (Q_1, Q_2) & if\ w_1 \leq Q_1, w_2 \leq Q_2 \\ (\pi - w_2, w_1) & if\ w_1 \leq Q_1, w_2 > Q_2 \\ (w_1, \pi - w_1) & if\ w_1 > Q_1, w_2 \leq Q_2 \end{cases}, \qquad (5.23)$$

and Q_1 and Q_2 are defined as above in the Split-the-Difference game.

The (Q_1,Q_2) utility pair is the limiting SPE payoff pair when the player have no outside options, and only inside options. In the situation where $w_i \leq Q_i$ the outside options exists, but are sufficiently unattractive and thus irrelevant. The game is played as if there were no outside options. If the clubs outside option is sufficiently attractive ($w_i > Q_i$), the equilibrium partition is determined solely by the outside option. The inside options of both and the outside option of the other club becomes irrelevant. (Muthoo, 1999, 146–149)

The clubs bargaining power then depends on the outside option it might have, and on the utility it gains from a delay in the bargaining. If the club benefits from a delay in trading players relatively more than the club it is bargaining with, it can exploit this to its advantage. In addition the existence of inside options, the fact that while the clubs are negotiating the terms of the trade the players involved still produce value in player performance, changes the reference point to which the outside options are compared.

5.7 A bargaining model for player trade

The above discusses the different real-life aspects that complicate the simple bargaining situation, namely the costs of time, risks of breakdowns, outside options to bargaining and the gains from delayed agreement. Some or all of these modifications are present in a player trade negotiation situation. The analysis is further complicated by the nondivisible nature of the goods traded (the hockey players) and the different valuations the bargaining partners, the clubs, assign to these players.

Bourgheas and Downward (2003) constructed a model to express the Expected Talent in Use for a sports team given three different levels of talent available and two players assigned into each position of play. The analogy is easily transferred to ice hockey. Traditional model of an ice hockey team assigns two lines, each consisting of the three forwards (left wing, center and right wing) and two defensemen (right and left), to offensive role and two to defense-focused role. In addition to this there are two goaltenders in the team. While a generalization, the allocation of two players into each role resonates with the model of Bourgheas and Downward. The Expected Talent in Use model discussed in 4.1 is therefore useful for player trade analysis.

The Expected Talents in Use were given by the talent endowment the club has for any particular position m_i. As a sum on talent endowments were given in Table 2. It is worth noting that teams are not, in reality, limited to the two players assigned to each position m_i by the allocation suggested above. Often players exhibit development during the season, or alternatively fail to reach the expected potential, and teams shuffle their lineup accordingly. The talent levels of Bourgheas and Downward can then be thought of simply as the *ex ante* expected player performance levels suggested by Berri and Brook (1999). Also, even if a team trades a player from position m_i, it can often move players with some specific talent level for the position m_i from position m_j, $(i \neq j)$,, where the t_i does not have to equal t_j. This would, in effect, constitute an internal trade between the two positions and with possible net increase in Expected Talent in Use for the team.

It was shown in 4.1 how teams gain from trade. Berri and Brook (1999) stated the *ex ante* condition for positive net gain from trade in terms of talent, as discussed in the beginning of this chapter. While the application of a bargaining theory's zero-sum approach in combination with the closed pool of players to trade with is intuitively contradictory, the very differences in player valuation and the role the existing talent endowments in generating surplus talent by a new player give reason to assume mutual gains from trade.

The equilibrium expressed in Equation 5.23, together with the equilibrium shares from Equations 5.18 and 5.19 summarize the most crucial characteristics involved in a player trade bargaining. Recalling the Equation 5.23 assigns the strategies x^* and y^* as follows:

$$(x^*, y^*) = \begin{cases} (Q_1, Q_2) & \text{if } w_1 \le Q_1, w_2 \le Q_2 \\ (p - w_2, w_1) & \text{if } w_1 \le Q_1, w_2 > Q_2 \\ (w_1, p - w_1) & \text{if } w_1 > Q_1, w_2 \le Q_2 \end{cases}, \tag{5.24}$$

and the w_i is the value of the outside option available for player *i* and the shares Q_1 and Q_2 are

$$Q_1 = \frac{g_1}{r_1} + h_1\left(p - \frac{g_1}{r_1} - \frac{g_2}{r_2}\right) \tag{5.25}$$

and

$$Q_2 = \frac{g_2}{r_2} + h_2\left(p - \frac{g_1}{r_1} - \frac{g_2}{r_2}\right), \tag{5.26}$$

with $\eta_i = r_j/(r_i + r_j)$, $(i \neq j)$. The Split-the-Difference Game in 5.6 assumed the discounting rates of the two players are the same, yet that is not necessary.

The outside options available to each club outside the current negotiation, w_i, only affect the bargaining outcome if significant in value. As long as one of the clubs can gain more by leaving the negotiations in favor of a trade with a third party, the outside option dictates the bargaining solution in the original game. The outside option available for one club can then be used in its advantage to bargain a better trade. The availability of outside options is at the same time common and case-specific in the NHL player trade. Should the club only be looking to shed some high-salary players in favor of potential talent and to make room under the salary cap, it is safe to assume there are multitude of trade alternatives available. If, however, the club looks to fill a specific role in its roster, the parameters of the trade they are looking for can be very specific and only one or few such trades might even be achievable.

The difference between in Q_1 and Q_2 can come from two sources: the value of inside options g_i or from the relative discounting rate r_i. The smaller the value of r the more patient the player is. The increased patience generates more inside gains from delay of agreement (g_i/r_i) and allocates a larger share of the cake left for division to the player as η_i increases with r_i, given a constant r_j. As discussed already in 6.3.3 the causes of patience or impatience are multifold. The clubs may be looking to fill a hole in the line-up. The window for trades may be closing in with the trade deadline or Entry Draft rendering trading impossible. Or the clubs might have different tolerance for risks of negotiations breaking down as discussed in 6.4. The source of impatience is unimportant as long as the relative patience of the clubs can be estimated.

6 CONCLUSIONS

There are relatively few studies so far in the field of economics of sport on the player trade in professional sports leagues. The purpose of this paper has been to examine the trade of ice hockey players in the National Hockey League, given the specific characteristics governing the trade. The game theoretic models of bargaining were used to explain the decision-making of hockey franchises. Furthermore, the players traded both prior and after the 2005 Collective Bargaining Agreement were studied in order to see what, if any, changes the new rules and limitations set by the CBA have caused on the player trade.

The underlying assumption throughout is the existence of gains from trade. These gains can occur as a result from overall increase of player performance talent in the team. Clubs can fill gaps in their lineup through trades during the season or exchange a player for one they view as better. The different valuations of players are another source of gains from trade. As clubs form an opinion regarding the value of the player without knowing how that player will perform in the future, these valuation are estimates as best. Different estimates can create trade benefits for both clubs, even when trading seemingly equal players to each other. Furthermore, the surplus of talent provided by a player is determined by the existing endowment of talent in the team.

The bargaining theory highlighted three important aspects in player trade bargaining. The existence of outside trading options gives a club a possible leverage to use in order to get a more beneficial trade outcome out of the current bargaining. This outside option is only relevant, however, if it is more valuable than what the club would get in bargaining without the outside option.

As most trades are made during the regular season, the delay of agreement gives benefits, in addition to costs, to the clubs involved. While the trade is negotiated, the team is benefiting from the player performance from those players it would eventually trade away. The relative gains from these player performances affect the distribution of talent reached by bargaining. The more a club gains by this inside option the more bargaining power it has in the trade negotiations.

Closely related to the inside option is the relative patience of the club. Patience, or the lower cost of time, helps the club to bargain for a better trade. These costs of time can be due to clubs great need for a particular player they are trading for or due to the trade deadline approaching. Whatever the source of the cost of time, the relative impatience of a club makes them settle for a less advantageous trade than might otherwise be available.

In the 2005 the new Collective Bargaining Agreement changed the player trade due to several new regulations, most importantly those relating to cash deals and the salary cap. As the salary of the player was no longer such a convenient measurement on team valuation of the player, and as the salary cap placed more limitation to the possible trade combinations, the changes brought on by the new CBA were examined. The players traded were examined over the whole 2000–08 period, with special attention to the differences before and after 2005. The new CBA shifted the trades towards less experienced players in number of both NHL season and NHL games played. The role of an early draft pick was also heightened in the post-lockout trades under the new CBA. Clubs were trading more potential and more value was given to the estimates of player value in terms of draft pick.

The study raised several questions that are of interest, but outside the scope of this paper. The player value was taken as a given for each club, defined by a club-specific exogenous function. It would be interesting to follow the studies of Jones and Walsh (1988) and Lavoie (1989) with an up-to-date study where the player value instead of salary is studied as a function of player and team characteristics. While the leagues in North America are close to identical in economic structure, it would be interesting to also study if the clubs' estimation on player value are as varied and as uncertain as in the study of Berri and Brook (1999) on NBA player trade.

An obvious factor in player trade in the NHL, the Entry Draft picks, was excluded in this study. That was because the Entry Draft picks are of considerable uncertainty in performance value, that is, the outcome in player performance of a given pick in the draft is considerably more uncertain than that of a player already in the NHL. The draft picks were also excluded because of the studies from other North American leagues finding the value-ranking of draft choices to be less than correct. Before the extent to which it is know that a second round pick is more valuable than a pick in the third round, these alternatives to players traded were excluded. Of course, with such a study the models on this paper are easy to adjust to accommodate the draft picks as a certain potential player performance.

REFERENCES

Badenhausen, Kurt – Ozanian, Michael K. – Settimi, Christina (2009) <http://www.forbes.com/2009/11/11/nhl-team-values-business-sports-hockey-values-09-intro.html>, retrieved 6.16.2010

Banerjee, Anurag N. – Swinnen, Johan F. M. – Weersink, Alfons (2007) Skating on this ice: rule changes and team strategies in the NHL. *Canadian Journal of Economics / Revue canadienne d'Economique*, Vol. 40, No. 2, 493–514

Berri, David J. – Brook, Stacey L. (1999) Trading Players in the National Basketball Association: For Better or Worse? In: *Sports Economics: Current Research*, ed. by John Fizel – Elizabeth Gustafson – Lawrence Hadley, 135–151. Praeger Publishers, Westport, CT.

Binmore, Ken – Osborne, Martin J. – Rubinstein, Ariel (1992) Noncooperative models of bargaining. In: *Handbook of Game Theory, Volume 1*, ed. by R. J. Aumann – S. Hart, 179–225, Elsevier Science Publishers B.V.

Binmore, Ken – Rubinstein, Ariel – Wolinsky, Asher (1986) The Nash bargaining solution in economic modelling. *Rand Journal of Economics*, Vol. 17, No. 2, 176–188

Bougheas, Spiros – Downward, Paul (2003) The economics of professional sports leagues: some insights on the reform of transfer markets. *Journal of Sports Economics*, Vol. 4, No. 2, 87–107

Brams, Steven J. – Straffin, Philip D., Jr (1979) Prisoners' dilemma and professional sports drafts. *The American Mathematical Monthly*, Vol. 86, No. 2, 80–88

Burnside, Scott (2009) "Another successful outdoor tilt gives NHL its signature event" http://sports.espn.go.com/nhl/columns/story?columnist=burnside_scott&id=3804478, retrieved 16.6.2010

Carmichael, F. – Thomas, D. (1993) Bargaining in the transfer market: theory and evidence. *Applied Economics*, Vol. 25, 1467–1476

Cocco, Angelo – Jones, J. C. H. (1997) On going south: the economics of survival and relocation of small market NHL franchises in Canada. *Applied Economics*, Vol 29, 1537–1552

Collective Bargaining Agreement (2005), National Basketball Players Association

Collective Bargaining Agreement (2006), National Football League Players Association

Collective Bargaining Agreement (2005), National Hockey League and National Hockey League Players' Association

Collective Bargaining Agreement 2007-2011, Major League Baseball Players Association

Downward, Paul; Dawson, Alistair (2000) Economics of Professional Team Sports. Routledge: London, England

Eichelberger, Curtis (2009) NHL Borrows From NFL as IT Pursues Bigger TV Contract" <http://www.bloomberg.com/apps/news?pid=20601109&sid=aGY7pu.INAhA>, retrieved 16.6.2010

El-Hodiri, Mohamed – Quirk, James (1971) An economic model of a professional sports league, *The Journal of Political Economy*, Vol. 79, No. 6, 1302–1319

Fenn, Aju J. – Allmen, Peter von – Brook, Stacey –Preissing, Thomas J. (2005) The influence of structural changes and international players on competitive balance in the NHL. *Atlantic Economic Journal*, Vol. 33, 215–224

Fry, Michael J. – Lundberg, Andrew W. – Ohlmann, Jeffrey W. (2007) A player selection heuristic for a sports league draft. *Journal of Quantitative Analysis in Sports*, Vol. 3, No. 2, Article 5, 1–33

Fort, Rodney (2005) The Golden Anniversary of "The Baseball Players' Labor Market". *Journal of Sports Economics*, Vol 6, No. 4, 347–358

Haugen, Kjetil K. (2006) Research notes: an economic model of player trade in professional sports: a game theoretic approach. *Journal of Sports Economics*, Vol. 7, No. 3, 309–318

Heckelman, Jac C. – Yates, Andrew J. (2003) And a hockey game broke out: crime and punishment in the NHL. *Economic Inquiry*, Vol 41, No. 4, 705–712

Jones, J. C. H. (1969) The Economics of the National Hockey League. *The Canadian Journal of Economics / Revue canadienne d'Economique*, Vol. 2, No. 1, 1–20

Jones, J. C. H. – Ferguson, D. G. (1988) Location and survival in the National Hockey League. *The Journal of Industrial Economics*, Vol. 36, No. 4, 443–457

Jones, J. C. H. – Walsh, William D. (1988) Salary determination in the National Hockey League: the effects of skills, franchise characteristics, and discrimination. *Industrial and Labor Relations Review*, Vol. 41, No. 4, 592–604

Késenne, Stefan (2000a) Revenue sharing and competitive balance in professional team sports. *Journal of Sports Economics*, Vol.1, No. 1, 56–65

Késenne, Stefan (2000b) The impact of salary caps in professional team sports. *Scottish Journal of Political Economy*, Vol. 47, No. 4, 422–430

Késenne, Stefan (2007) The economic theory of professional team sports: an analytical treatment. Edward Elgar Publishing Limited: Cheltenham, United Kingdom

Knowles, Glenn – Sherony, Keith –Haupert, Mike (1992) The demand for major league baseball: A test of the uncertainty of outcome hypothesis. *American Economist*, Vol 36, No. 2, 72–80

Frautmann, Anthony C. – Oppenheimer, Margaret (1994) Free agency and the allocation of labor in Major League Baseball. *Managerial and Decision Economics*, Vol. 15, 459–469

Lambrinos, James –Ashman, Thomas D. (2007) Salary determination in the National Hockey League is arbitration efficient? *Journal of Sports Economics*, Vol. 8, No. 2, 192–201

Larsen, Andrew – Fenn, Aju J. – Spenner, Erin Leanne (2006) The impact of free agency and the salary cap on competitive balance in the National Football League. *Journal of Sports Economics*, Vol. 7, No. 4, 374–390

Lavoie, Marc (1989) Stacking, performance differentials, and salary discrimination in professional ice hockey: a survey of the evidence. Soc*iology of Sport Journal*, Vol. 6, 17–35

Muthoo, Abhinay (1999) *Bargaining Theory with Applications*. Cambridge University Press: Cambridge, UK.

Nash, John F., Jr. (1950) The Bargaining problem. *Econometrica*, Vol. 18, No. 2, 155–162

Nash, John (1953) Two-person cooperative game. *Econometrica*, Vol. 21, No. 1, 128–140

National Hockey League Statistics. <http://www.nhl.com/ice/statshome.htm#?navid=nav-sts-main>

NHL Attendance Report (2009), <http://espn.go.com/nhl/attendance/_/year/2009>, retrieved 16.6.2010

NHL Official Guide and Record Book

Osborne, Martin J. (2004) An introduction to game theory. Oxford University Press: New York, NY

Osborne, Martin J. – Rubinstein, Ariel (1990) Bargaining and Markets. Academic Press, Inc.: San Diego, CA

Osborne, Martin J. –Rubinstein, Ariel (1994) A course in game theory. The MIT Press: Cambridge, MA

Quinn, Kevin G. – Geier, Melissa – Berkovitz, Anne (2007) Passing on success? Productivity outcomes for quarterbacks chosen in the 1999–2000 National Football League player Entry Drafts. Paper presented at the 2007 IASE Conference in Dayton, OH in May 2007.

Rasmusen, Eric (2001) Games and information; an introduction to game theory. 3. ed. Blackwell Publishing Ltd: Malden, MA

Richardson, David H. (2000) Pay, performance, and competitive balance in the National Hockey League. *Eastern Economic Journal*, Vol. 26, No. 4, 393–417

Rosen, Sherwin – Sanderson, Allen. (2001) Labour markets in professional sports. *The Economic Journal*, Vol. 111, No. 469, Features., F47–F68

Rottenberg, Simon (1956) The baseball players' labor market. *Journal of Political Economy*, Vol. 64, No. 3, 242–258.

Rubinstein, Ariel (1982) Perfect equilibrium in a bargaining model. *Econometrica*, Vol. 50, No. 1, 97–109

Scully, Gerald W. (1974) Pay and performance in Major League Baseball. *The American Economic Review*, Vol. 64, No. 6, 915–930

Staw, Barry M. – Hoan, Ha (1995) Sunk costs in the NBA: why draft order affects playing time and survival in professional basketball. *Administrative Science Quarterly*, Vol. 49, No. 3, 474-94

Surdam, David G. (2006) The Coase Theorem and player movement in Major League Baseball. *Journal of Sports Economics*, Vol. 7, No. 2, 201–221

Szymanski, Stefan (2004) Professional team sports are only a game: the Walrasian fixed-supply conjecture model, content-Nash equilibrium, and the invariance principle. Journal of Sports Economics, Vol. 5, No. 2, 111–126

Szymanski, Stefan (2007) The Champions League and the Coase Theorem. *Scottish Journal of Political Economy*, Vol. 54, No. 3, 355–373

Vrooman, John (1995) A general theory of professional sports leagues. *Southern Economic Journal*, Vol. 61, No. 4, 971–990

Vrooman, John (2000) The economics of American sports leagues. *Scottish Journal of Political Economy*, Vol. 47, No. 4, 364–398

Zimbalist, Andrew (2010) Reflections on Salary Shares and Salary Caps, *Journal of Sports Economics*, Vol. 11, No. 1, 17–28