Investigating Player Salaries and Performance in the National Hockey League

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Abstract

This thesis examines salary structure types (hierarchical or compressed) as predictors of team performance in the National Hockey League (NHL). Additionally, an analysis of goalie statistics is completed in order to determine what, if any, performance measures relate to salary. Data in this research were collected from the 2005-06 season up to the 2010-11 season.

Salary inequality/equality (Gini coefficient) was used in a regression analysis to determine if it was an effective predictor of team performance (n = 178) (winning percentage). The results indicated that a hierarchical salary structure increased team performance, although the amount of variability explained was very small.

Another regression analysis was completed to determine if any goalie performance measures (n = 245) were effective predictors of individual salary. A regression analysis was employed and indicated that goalie performance measures predicted 19.8% of variance to salary. The only statistical significant variable was games played.

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Chapter One: Introduction

The salaries of professional athletes have been the subject of significant scrutiny in the popular press, but have received less attention in academic research. Professional sport offers a unique opportunity to examine whether a salary is related to the performance of both organizations (teams) and employees (players). Salary statistics have become widely available and are a rich analytical resource. Employees from professional sport leagues keep track of statistics that provide offensive and defensive information, as well as individual salaries. These statistics enable individual performance scrutiny in relation to remuneration level. This provides a context dissimilar to other professions where an individual's salary is often unavailable to the public. Additionally, based on a person's job it may be harder to measure individual contribution to organizational success. An example would entail measuring and quantifying the success of a physical trainer for a hockey team. However, in the case of professional athletes, interest and measurability have led to further scrutiny and measurement of how salary relates to performance.

Using statistics to determine future individual performance was popularized by Michael Lewis (2003) in his book *Moneyball: The art of winning an unfair game*. Lewis (2003) outlined the story of Major League Baseball (MLB) general manager Billy Beane of the Oakland Athletics. Wolfe, Wright, and Smart (2006) describe how Beane

> exploited the inefficiency (baseball's labor market) by implementing a radical human resource management innovation— an employee (player) performance

> measurement and feedback system that allowed him to field a highly competitive team while having one of the lowest payrolls in Major League Baseball. (p. 112)

This caught the attention of many sport fans as *Moneyball* became a best-selling book and movie.

Additionally, other books such as *Hockeynomics*, written by Norman, (2009) examine various statistics to identify the best players in the National Hockey League (NHL), as well as determining which players are the most cost effective. The Sports Network (TSN) has a specific segment on its website designated to team and individual performance rankings based on statistical formulations. Many Canadians consider hockey to be Canada's sport (Norman, 2009), and, as a result, there are many popular press magazines, books, and television shows which deal with the analysis of hockey. Furthermore, the history of players' salaries has also been heavily documented *(USA Today* Salary Database, 2011).

History of Salaries

Historically, professional athletes have not always had fair treatment in potential salary earnings. For sports such as hockey and baseball, players were owned by teams through a reserve clause (Staudohar, 1996). This reserve clause allowed a team to retain the rights to sign a player the following year, once they signed a contract for the present year; this meant the team essentially had the option of owning the player's rights forever (Staudohar, 1996). The reserve clause did not allow for free agency because player movement was highly restricted and did not allow players to earn their potential market value. In the 1950s and 1960s, players across different leagues unionized to gain some power over ownership. Once this was accomplished, the reserve clause was eliminated from future collective bargaining agreements (CBA) (Staudohar, 1996). Within the first CBA (for MLB) only certain players were eligible for free agency, thereby creating a decrease in supply and an increase in demand of available players. As a result, over the course of the twentieth century and the beginning of the twenty-first century, the market price of players has risen dramatically (Staudohar, 1996). Table 1 outlines the fluctuations in average salary of players in the NHL from the 1984-85 season to the 2010-11 season. The 2000-01 to the 2010-11 season average salary was calculated by taking the team with the highest and lowest individual salary averages, adding their averages and dividing the total by two. The table also outlines the highest earning athletes and their salary for a given season.

Clearly, the salaries of players have changed dramatically (an approximate 1300% increase in highest paid salary from 1984-85 season to the 2010-11 season); this change coupled with the symbiotic relationship between sport and media has created an appealing avenue for academics to study the phenomenon of salary and its effect on both team and individual performance. Therefore, understanding different types of salary structures is fundamental to exploring the connection between individual salary and team performance.

Table 1 – *NHL Season Individual Salaries -1984-85 to 2010-11*

Season	**Avg Salary**	**Highest Salary**	**Highest Paid Player**
1984-85	$149,000.00	$725,000.00	Dave Taylor
1985-86	$159,000.00	$775,000.00	Dave Taylor
1986-87	$173,000.00	$825,000.00	Dave Taylor
1987-88	$184,000.00	$900,000.00	Dave Taylor
1988-89	$201,000.00	$1,620,000.00	Mario Lemieux
1989-90	$232,000.00	$2,284,000.00	Mario Lemieux
1990-91	$263,000.00	$2,432,000.00	Wayne Gretzky
1991-92	$369,000.00	$2,786,000.00	Mark Messier
1992-93	$463,000.00	$3,342,000.00	Wayne Gretzky
1993-94	$558,000.00	$7,353,000.00	Wayne Gretzky
1994-95	$600,000.00	$6,545,000.00	Wayne Gretzky
1995-96	$1,017,190.00	$6,545,363.00	Wayne Gretzky
1996-97	$839,994.00	$11,321,429.00	Mario Lemieux
1997-98	$1,088,576.00	$17,000,000.00	Joe Sakic
1998-99	$1,190,808.00	$14,000,000.00	Sergei Federov
1999-00	$1,222,191.00	$10,359,852.00	Jaromir Jagr
2000-01	$1,464,610.50	$10,000,000.00	Peter Forsberg, Paul Kariya
2001-02	$1,822,237.50	$11,000,000.00	Peter Forsberg, Jaromir Jagr
2002-03	$2,025,433.50	$11,483,333.00	Jaromir Jagr
2003-04	$1,979,774.00	$11,000,000.00	Peter Forsberg, Jaromir Jagr
2004-05	N/A	N/A	N/A
2005-06	$1,352,385.50	$8,360,000.00	Jaromir Jagr
2006-07	$1,564,601.50	$8,360,000.00	Jaromir Jagr
2007-08	$1,839,470.00	$10,000,000.00	Daniel Briere, Thomas Vanek, Scott Gomez
2008-09	$2,238,307.00	$10,000,000.00	Danny Heatley
2009-10	$2,093,949.00	$10,000,000.00	Vincent Lecavalier
2010-11	$1,936,586.00	$10,000,000.00	Vincent Lecavalier/Roberto Luongo

(Fort, 2011, Staudohar, 1996, p.136 & *USA Today* Salary Database).

Salary Structure and Performance

This research study uses different concepts to explain the interplay of players' individual performances on the outcomes of teams for different sports, as well as the differences between types of salary structures. The following major theoretical concepts apply to this thesis:

- <u>Hierarchical salary structures</u>: employees' salaries are highly dispersed. For example, Bloom (1999) describes hierarchical salary structures as "a greater proportion of pay is concentrated in relatively few levels, jobs, or individuals that are near the top of the distribution" (p. 25). This type of salary structure is used sometimes for promotional purposes, and employs money as a means of rewarding those that are successful.
- <u>Compressed salary structures</u>: employees' salaries are condensed. For example, Bloom (1999) describes compressed salary structures as "one in which pay is less dispersed and is spread more equally across jobs or individuals, and it may have fewer pay levels" (p. 25). This type of pay structure is used to promote cohesion and teamwork among employees.
- <u>Pooled interdependence</u>: suggests that the individual actions of those playing a sport are independent from one another, but are dependent on the outcome. For example, when a baseball player bats, their performances are based solely on their own batting ability. However, a collection of individual performances (batting) results in a team outcome (win or loss). Keidel (1985) describes pooled interdependence in baseball as an individual having more of an effect on a team's performance than in other sports.

- Sequential interdependence: suggests that it takes a number of subgroups working together as a team in order to achieve a collective outcome (Clutterbuck, 2007). A sport that exhibits this characteristic is football (Keidel, 1985).
- Reciprocal interdependence: this refers mostly to team sports in which a number of players' outputs are needed for an outcome (win or lose). The outcome of team performance is linked to overall group performance (Keidel, 1985). Sports that exhibit this characteristic include hockey, basketball and soccer.
- Tournament theory: examines the relationships between hierarchical and compressed salary structures, as well as pooled and reciprocal interdependence in understanding salaries. Tournament theory investigates the role of individual performances relative to a rank order pay system (Frick, 2003). This suggests that players that perform better will receive higher pay, and players who are paid less will try and improve their performances to increase their salaries (Chuang, Tao, & Yu, 2011; Frick, 2003; Huselid, 1992). Tournament theory supposes that a hierarchical pay structure increases both team and individual performance (Frick, 2003). The majority of previous research completed regarding player and team performance in relation to salary has used tournament theory (Bognamo, 1990; Chuang et al, 2011; Frick, 2003; Huselid, 1992; Lynch, & Zax, 2000). However, academic literature has failed to examine the issue of salary determination for professional hockey in relation to both team and individual performance.

A map of the conceptual terminology used in this study is presented in Table 2.

Table 2 – *Map of Conceptual Terminology*

<table>
<tr><th colspan="4">Salary Structure Types</th></tr>
<tr><td colspan="2">Hierarchical Salary Structure</td><td colspan="2">Compressed Salary Structure</td></tr>
<tr><td colspan="2">• Employees’ salaries are highly dispersed.
• Bloom (1999) describes hierarchical salary structures as “a greater proportion of pay is concentrated in relatively few levels, jobs, or individuals that are near the top of the distribution” (p.25).
• Used for promotional tool purposes, rewarding those that are successful.</td><td colspan="2">• Employees’ salaries are condensed.
• Bloom (1999) describes compressed salary structures as “one in which pay is less dispersed and is spread more equally across jobs or individuals, and it may have fewer pay levels” (p.25).
• This type of pay structure is used to promote cohesion and teamwork among employees.</td></tr>
<tr><th colspan="4">Interdependence Sport Types</th></tr>
<tr><td>Pooled Interdependence</td><td colspan="2">Sequential Interdependence</td><td>Reciprocal Interdependence</td></tr>
<tr><td>• Suggests that the individual actions of those playing a sport are independent from one another, but are dependent on the outcome.
• Example of a sport would be baseball. A batter hits the ball individually, but a collection of bats are needed for a win</td><td colspan="2">• Suggests that it takes a number of subgroups working together as a team in order for a collective outcome (Clutterbuck, 2007).
• A sport that exhibits this characteristic is football (Keidel, 1985).</td><td>• This refers to team sports in which a number of players’ outputs are needed for an outcome (win or lose).
• The outcome of team performance is linked to overall group performance.
• Examples of sports include hockey, basketball and soccer.</td></tr>
<tr><th colspan="4">Theoretical Terminology</th></tr>
<tr><td colspan="4">Tournament Theory</td></tr>
<tr><td colspan="4">• Tournament theory investigates the role of individual performances relative to a rank order pay system (Frick, 2003).
• This suggests that players that perform better will receive higher pay, and players who are paid less will try and improve their performance to increase their salary
• Tournament theory supposes that a hierarchical pay structure increases both team and individual performance (Frick, 2003).</td></tr>
<tr><th colspan="4">Methodological Terminology</th></tr>
<tr><td colspan="4">Gini Coefficient</td></tr>
<tr><td colspan="4">• The Gini coefficient was created by an Italian economist named Corrado Gini.
• The Gini coefficient measures levels of economic equality or inequality within a range of 0 and 1. Zero represents perfect equality (i.e., everyone is paid the same amount), while 1 represents perfect inequality (i.e., one person on a team is making all of the money).
• For the purposes of this thesis it will be used to measure salary dispersion among team and players.</td></tr>
</table>

Previous Studies

Tournament theory has been used in a number of studies across various sports, including baseball, football, soccer, basketball, and hockey. According to Keidel (1985), major differences in the outcomes of the studies were as a result of pooled and reciprocal interdependence. Research into pooled interdependent sports such as baseball found that hierarchical salary structures equated to better team and individual performance; while research into reciprocal interdependent sports such as soccer, basketball, and hockey generally found that compressed salary structures induced better team and individual performance (Keidel, 1985). However, the four studies completed using hockey as the unit of analysis did not have similar results. Sommers (1998) determined that a compressed salary structure was linked to better performance. Gomez's (2002) results were similar to Sommers in that a compressed salary structure increased winning percentage. Conversely, Frick, Prinz, and Winkelmann (2003) concluded hierarchical salary structures increased winning percentage, but only to a small degree. Marchand, Smeeding, and Torrey (2006) linked a hierarchical salary structure to better performance. Marchand et al. (2006) called for further research in order to more clearly understand the link between salary, team, and individual performance in hockey. Additionally, little literature exists examining the predictor variables between goalie statistics and salary (Berri & Brook, 2010).

Rationale for this Study

Studies have focused on team and individual performance in relation to player salary; the conclusions drawn from these studies indicate a number of contradictions. As previously mentioned, four different studies have been completed using the NHL; these four studies' results were not congruent with each other. One common connection between the four studies is that data were derived from seasons where the NHL did not use a salary cap. Therefore, there is a need to examine player salaries in relation to the salary cap. This study will use information and data from the period since the NHL instituted a salary cap system.

In professional sports, it is common for leagues to place a limit on the amount of money a team can spend on players' salaries. Leagues can either have a 'soft' cap or a 'hard' cap if they implement a salary cap system. A 'soft' cap means that there is a limit a team can spend on team salaries, but they can go over the limit. If they go over the imposed limit, then they are subject to penalties such as luxury taxes, which can involve a percentage of every dollar gone over the limit (Levine, 1995). 'Hard' caps set a limit that a team cannot surpass. The NHL employs a 'hard' salary cap system (Levine, 1995).

One reason behind a league having a salary cap is that, in theory, the cap creates competitive balance amongst all league teams. In any professional league, there are teams that are more financially successful than others. Kesenne (2000) argues that salary caps prevent teams from spending a significant amount of money on players, and poaching the best players in a league. Prior to the imposition of the salary cap, smaller market teams were unable to compete with financially successful teams because they did not have the capital to sign talented players with large salaries (ESPN, 2004). After the 2004-05 NHL lockout, a salary cap was instituted as part of the new CBA. Prior to this CBA, there was not a salary cap. This detail is significant because only one study has investigated NHL salaries and goalie performance since the implementation of the salary cap for the 2005-06 season (Berri & Brook, 2010). Furthermore, since the NHL uses a 'hard' cap, teams have to abide by the salary cap maximum and minimum. The salary cap floor establishes a requirement for a team to follow a minimum salary for players individually, and collectively. The purpose of a salary cap floor is to ensure that teams spend a minimum per season so that an organization does not purposely fail in order to get a high draft pick the following season (CBA – NHL and NHLPA, 2005).

Since the institution of the salary cap, NHL general managers and executives of teams across the league must be more strategic with their payroll. The evaluation process of players for both signing and drafting is integral to a team's success. This study will directly examine the type of salary structure (hierarchical or compressed) that serves to predict team performance. Finally, the study will investigate the predictive ability between individual player performance and salary, which is crucial for determining whether a player should be signed. This study has significant implications for both NHL executives and for the justification of the NHL's hard cap system.

Purpose of the Study

This study investigates salary distribution in relation to team and player performance in NHL professional hockey clubs for the regular season. This purpose will be addressed through two research questions:

1. Do salary structure types (hierarchical or compressed) serve to predict team performance for NHL professional hockey clubs?
2. How do NHL goalie performance measures relate to professional goalie salaries?

Assumptions

This researcher assumes there is a linear relationship between salary structure and team performance (Avrutin & Sommers, 2007; Bloom, 1999; DeBrock, Hendricks &

Koenker, 2004; Depken, 2000; Frick et al, 2003; Jewell & Molina, 2004; Marchand et al., 2006; Mondello & Maxcy, 2009; Sommers, 1998; Torgler, & Schmidt, 2007; Wisemen & Chatterjee, 2003). Additionally, the researcher assumes that there is a linear relationship between players' salaries and performance (statistics) (Bloom, 1999; Frick, 2003; Marchand et al, 2006; Torgler & Schmidt, 2007). Both assumptions are important because they indicate the primary set of relationships which the study's research questions seek to investigate.

Additionally, the researcher makes the assumption that tournament theory is the most pragmatic theory for the investigation of the relation between salary and performance. Previous authors certainly support the use of tournament theory for understanding the relationships between player salaries and professional athlete and team performance (Avrutin & Sommers, 2007; Bloom, 1999; DeBrock et al., 2004; Depken, 2000; Frick, 2003; Frick et al., 2003; Jewell & Molina, 2004; Marchand, et al. 2006; Mondello & Maxcy, 2009; Sommers, 1998; Torgler, & Schmidt, 2007; Vasilescu, 2007; Vasilscu, 2008; Wisemen & Chatterjee, 2003).

Implications, Limitations & Delimitations

The results of the study will have significant implications for professional ice hockey teams and their player management practices. These will include determining the types of salary structures teams should optimally use, which players teams should sign, and how much money teams should award on contracts to players. The results will also inform goalies as to which statistics are highly predictive of salary. Furthermore, only one study has been conducted after the 2004-05 NHL lockout (i.e., since the inception of a hard salary cap) (Berri & Brook, 2010). Marchand et al., (2006) indicated that future studies should examine the NHL after the lockout.

This study is limited by the accuracy of the second hand data that the researcher gathers from websites given that the researcher has no way of verifying the data's accuracy. In addressing the second research question, this study is limited to goalie salaries from the NHL. Additionally, this study is further limited to the hockey seasons from 2005-06 to 2010-11 because the NHL implemented a 'hard' cap salary system. The study will consider seasons where the NHL had a 'hard' cap; all previous studies have used data from years where there was not a salary cap.

Summary

Salaries of professional athletes have been a fascination of the public for many years. There is ample non-academic literature regarding the remuneration of professional athlete contracts. Salaries of professional athletes have changed over the course of the latter half of the 20^{th} century. A number of studies have been conducted across various sports to determine the relationship between salary and performance. Tournament theory is the dominant framework for these studies, but conflicting results have been reported in previous research on hockey. This study investigates salary distribution in relation to team and player performance amongst NHL hockey clubs. The two research questions examine salary structure types (hierarchical and compressed), as well as the individual performance of goalies in relation to salary.

Chapter Two: Review of Literature

The purpose of this study is to investigate salary distribution in relation to team and player performance in NHL professional hockey clubs. Specifically, the researcher seeks to address two salary structure types, hierarchical and compressed, to determine their relationship to team performance for NHL teams, and goalie statistical measures in relation to individual salaries from 2005-06 through 2010-11. The following factors will be discussed to develop the necessary background for this study: (a) salaries in professional sport/entertainment industry; (b) salary theory; (c) tournament theory; (d) sport performance – interdependence; (e) salary structures and performance; and (f) individual performance and salary.

Salaries in the Professional Sport/Entertainment Industry

The salaries earned by professional athletes and entertainers are generally higher than the public. For example, the average salary of a Canadian citizen before taxes in 2009 was $37,200 (StatsCan, 2009). The average salary earned by an NHL player at that time was $2,093,949. The increase in pay of athlete salaries led to the NHL's 2004-05 lockout and is one of the main reasons why the National Football League (NFL) did not have a CBA with the National Football League Players Association (NFLPA) until July 25th, 2011 (Browning, 2011). The average salary of a NHL player for the 1994-95 season was $600,000 (Staudohar, 1996). In the 2003-04 NHL regular season, a player's average salary was $1,979,774. During the 2010-11 season, the last in this analysis, a player's average salary was $1,936,486. The rise in player's salaries led the NHL and team owners to lose money, which was a cause of the 2004-05 season cancellation (Canadian Press, 2005). According to TSN (2008), a key element of the new CBA being accepted was a salary cap. The owners wanted a salary cap and after a season long lockout the National Hockey League Player's Association (NHLPA) agreed as they had lost bargaining power in the negotiations. The 2005-06 season salary cap was set at $39 million per team (TSN, 2008). Three years after the lockout, the average players' salary increased by 11% (TSN, 2008). In 2008, the salary cap was set at $50.3 million (TSN, 2008). The fluctuation of salaries between the 1994-95 season to the 2010-11 season changed dramatically. With average salaries and the hard cap on the rise, it becomes even more important for managers of teams to strategically manage the money accounted for players salaries. Managers must decide whether to sign 'star players' to large contracts and risk not being able to sign other players due to a lack of funds, or to pay all players relatively the same wage.

Salary Theory

According to Bloom (1999), there are two types of salary structures: hierarchical and compressed. Hierarchical pay structures are highly dispersed; a small number of individuals earn a significant amount of money, while the other employees make a fraction of that amount. This type of pay structure is often used to create a competitive work environment to reward success (Bloom, 1999). Conversely, a compressed salary structure is condensed; all employees earn similar wages. The rationale for using a compressed pay structure is the promotion of cohesion among employees (Bloom, 1999). Additionally, in each case, attention needs to be drawn to individuals' perceptions about their wages and effort in relation to others within the same organization.

Akerlof and Yellen (1990) discuss the fair wage effort hypothesis that dictates individuals will change their level of effort and output based on fair and actual wages. Bose, Pal, and Sappington (2010) extend this idea in their paper entitled *Equal pay for unequal work: Limiting sabotage in teams*. The paper examines the ability and likelihood of an athlete sabotaging a team's outcome (win or loss). The researchers conclude that sabotage (e.g., individual actions that negatively affect a team, such as not passing a ball) can arise in a team where equal pay policies are not prevalent. To know which type of pay structure induces better team and individual performance is vital for professional sport organizations' success.

There have been a number of studies completed examining the relationship between salary structures and team performance. The studies have investigated the salary structures of MLB, National Basketball Association (NBA), NFL, NHL, Bundesliga (soccer league in Germany), and the English Premiership League (EPL; European Football). As well, a number of the studies have used tournament theory to explain the phenomenon of salary structures and team performance. The majority of these studies found that teams with a compressed salary structure performed better than those with hierarchical salary structure (Avrutin & Sommers, 2007; Bloom, 1999; DeBrock et al., 2004; Depken, 2000; Frick et al., 2003; Gomez, 2002; Jewell & Molina, 2004; Mondello & Maxcy, 2009; Sommers 1998; Torgler, & Schmidt, 2007; Vasilescu, 2007; & Vasilescu, 2008). Other studies found that teams with a hierarchical salary structure performed better than those with compressed salary structures (Frick et al., 2003; Marchand et al., 2006; Wisemen & Chatterjee, 2003). Additionally, one of the most frequently used tools in measuring disparity in salaries and identifying types of salary structures is the Gini coefficient (Avrutin & Sommers 2007; Bloom 1999; Frick et al., 2003; Gomez, 2002; Jewell & Molina 2004; Marchand et al., 2006; Sommers 1998; Vasilescu 2007; Wisemen & Chatterjee 2003).

According to Wiseman and Chatterjee (2003), the Gini coefficient is a measurement to determine salary inequality. The Gini coefficient has a scale of zero to one. Zero represents perfect equality among individual salaries and one represents perfect inequality. A team that has a high Gini coefficient has a hierarchical salary structure, while those with a smaller Gini coefficient have a compressed salary structure. A full explanation of the Gini coefficient is provided in Chapter Three. In order to fully understand the dynamics of salary structure and its effect on team and individual performance, an examination of tournament theory is necessary. This theory seeks to explain team and individual performance based on pay structure.

Tournament Theory

Tournament has been used as the theoretical framework for the majority of the literature surrounding sport performance and salary. According to Huselid (1992), tournament theory examines “the efficiency and incentive properties of reward systems based on rank-ordered rather than absolute individual performance” (p. 336). Tournament theory is an economic theory that describes marginal productivity to compensation. As such, it is possible to deduce that a starting player on a professional sports team should have a higher salary than a backup player. Tournament theory suggests that since the backup player makes less money, he/she will work harder than the starter to receive the starting job and, consequently, the backup will earn more money. Chuang et al., (2011) describe tournament theory as “a compensation scheme where the level of pay varies with the relative rank order of an individual in an organization rather than his absolute level of performance in the presence of costly monitoring of workers' efforts and output" (p. 6). This theory suggests that players work harder and perform better with a hierarchical salary structure (i.e., the difference between the highest and lowest earning player on a team is significant) than a compressed salary structure where no single player makes the majority of the money. Frick (2003) indicates that tournament theory suggests that intra-team pay structures need to be hierarchical to induce better player performance.

The majority of the literature on tournament theory examines individual professional sports. Bognamo (1990) examined bowling and found that an increase in pay structure had a positive correlation to performance. Ehrenberg and Bognamo (1990a; 1990b) analyzed two Tours (1984 and 1987) of the Professional Golf Association and found that there was a positive correlation between pay structure and performance. Other studies that found a positive correlation between pay structure and performance include Becker and Huselid (1992) on the National Association for Stock Car Auto Racing (NASCAR) and Lynch and Zax (2000) on running races. Fernie and Metcalf (1996) examined jockeys who received a salary versus those paid according to the amount of the race purses they had won. Jockeys paid based on results had a higher performance than those on salary. Various studies have linked individual performance to pay structure; however, all of the studies deal with individual sports and the outcomes are highly based on the individual performance of those athletes. This is unlike team sports where players are dependent on the performance of other team members in determining the outcome of competition.

Conversely, there are theoretical understandings which contradict tournament theory. David Levine was one of the pioneers in studying the effects of cohesion in wage disparity. In his article, *Cohesiveness, Productivity and Wage Dispersion*, Levine (1991) stated that, "in participatory firms where the firm's policies lead work groups to favor increased productivity, the increased cohesiveness increases the group's ability to enforce norms of high effort; thus higher cohesiveness will lead to higher productivity" (p. 250). Levine clearly states that in organizations where employees are paid similar wages, employees experience increased productivity and cohesion. One important factor when measuring team and individual performance is the differences in sports and the interplay of teammate's decisions on both team and individual success.

Sport Performance – Interdependence

Addressing the level of interdependence between sports is important because varying levels of cooperative effort have a direct effect on both team and individual outcomes. Interdependence refers to how much individual actions have an effect on final group outcomes (Keidel, 1985). As explained earlier, pooled interdependence suggests that individual actions of those playing a sport are independent from one another, but are dependent in determining the outcome. Sequential interdependence refers to subgroups' collective efforts for an overall outcome. Conversely, reciprocal interdependence refers to sports in which a number of players' collective outputs are needed for an outcome (win or loss). In this context, the outcome of team performance is linked to overall group performance. These parameters have been used in research by Harder (1992) to describe the differences of individual performance in baseball and basketball. His research indicated that there was a difference between these two sports based on the level of independence. He found that basketball was more dependence-driven because under-rewarded players' selfish behaviour resulted in a negative effect on team outcomes. Conversely, he found that in baseball under-rewarded players did not affect team outcomes. This research suggests that individual actions between reciprocal, sequential or pooled interdependence sports matters when analyzing team and individual performance because different players' actions have different results on team outcomes. Sports characterized as having reciprocal interdependence are basketball, soccer, and hockey. In the four studies that analyzed hockey in relation to pay structure and team performance, there has not been a clear consensus as to whether a hierarchical or compressed pay structure is most effective for both team and individual performance.

Salary Structures and Performance

Several important factors pertinent to analyzing team and individual performance literature include the type of sport, procedures used to analyze the data (methods), and what the outcome may be (pay structure). These factors are important because different sports have different types of interdependence (pooled, sequential and reciprocal). The methods used by the researcher may result in different outcomes than previous studies. Finally, it is important to understand which pay structure is more effective, as they may result in sport specific outcomes. The majority of literature regarding pay structures and team performance has examined baseball.

Baseball

There have been many studies completed using baseball as the sport of analysis. Richards and Guell's (1998) study of baseball success and salary structure addresses whether salary affected large and stable crowds, winning percentage, and championships.

Data were collected from 1992 through 1995 and included statistics such as winning percentage, team salary, mean salary, as well as success in division and world-series championships. An Ordinary Least Squares (OLS) regression model was used to analyze the data. Richards and Guell concluded that a compressed salary structure had a positive effect on the ability of teams to win games and championships; however, salary structure was not found to affect attendance.

Bloom (1999) analyzed seasonal data from the 1985 through 1993 MLB seasons. Bloom used winning percentage as the dependent variable and found that the higher the wage disparity, the lower the team's performance was (i.e., indicating a negative relationship). This indicated that a team with a compressed salary structure had a higher winning percentage than one with a hierarchical salary structure.

> Bloom (1999) summarized his findings by suggesting, some writers have proposed that compressed pay distributions can be beneficial for group performance because they may inculcate feelings of fairness and common purpose, foster cooperative, team orientated behavior. Hierarchical is supposed to induce higher performance as it means more money. (p. 25)

Bloom's hypotheses were supported as they found that increased pay distributions (hierarchical salary structures) had a negative effect on team performance. In other words, there was a positive relationship between the Gini coefficient and performance.

Depken (2000) examined MLB data from 1985 through 1998 using winning percentage as the dependent variable in his analysis. He used a panel-data approach to test the disparity between team salaries and found that "as intra-team wage disparity increased, overall team performance is reduced, but it is possible for a team to have a very high total salary but a relatively low salary disparity, and vice-versa" (p. 91). This study suggests that having a hierarchical salary structure has a negative effect on team performance. Frick et al., (2003) also found that there was a negative relationship between salary inequality and team performance in their study of baseball.

Wiseman and Chatterjee (2003) conducted a correlation analysis between pay and performance in baseball. They used winning percentage as their dependent variable and used the Gini coefficient to analyze the disparity of wages. Their results were similar to previous research in that a smaller Gini coefficient due to a compressed salary structure indicated a greater winning percentage for a team.

DeBrock et al. (2004) used the Herfindahl-Hirschman Index (HHI) to examine actual wages as a measure for salary distribution. The HHI measures distributional inequality and is similar to the Gini coefficient in that its scale ranges from zero to one; zero equals perfect equality, while one represents perfect inequality. Their dependent variables were winning percentage and attendance. They found that salary inequality had a negative relationship to performance. In summary, a compressed salary structure induced better team performance.

Jewell and Molina (2004) studied data from 1985 through 2000 to find a relationship between payroll inequality and performance. The dependent variable was winning percentage and the Gini coefficient was used to measure salary equality/inequality. They were able to calculate "that a 1% increase in the Gini coefficient led to a 0.2% decrease in winning percentage" (p. 132). This study suggests that in baseball a compressed salary structure generates a higher winning percentage.

Avrutin and Sommers (2007) analyzed data from 2001 through 2005 in MLB to determine whether a hierarchical or compressed salary structure increased winning percentage. Through their analysis, they concluded that a compressed salary structure did not lead to better performance. Their results contradicted previous research as the authors found that a hierarchical salary structure was better for team performance. Vasilescu (2007) refutes other research results by suggesting that,

> Most MLB teams have wage structures which are too spread out, with a larger degree of inequality than the optimum. This explains why all previous papers have found a negative relationship, since all were measuring the slope of this function at the mean (or median) of the wage distribution measure, where it is negative. (p. 2)

Vasilescu (2007) also suggested that a major flaw in previous studies is there was a linear relationship between wage inequality and team performance. Vasilescu's research indicated the relationship was non-linear. He deduced that teams that had a higher winning percentage had a lower Gini coefficient than those with lower winning percentages.

A secondary study by Vasilescu (2008) used a data set that consisted of teams' winning percentages and on-base percentages from MLB to determine whether wage inequality had an effect on team performance. However, very little additional information was provided specifically about the data set used. Vasilescu suggested that using winning percentage as the dependent variable, as most previous studies had done, produces biased and inconsistent estimates as wins are counted more than once. Monte Carlo experiments were used as the method of analysis. Monte Carlo experiments attempt to reveal linear models through complex computerized algorithms. Through Monte Carlo experiments, the researcher was able to find the relationship between wage inequality and winning to be non-linear. Vasilescu suggests that there is an optimum level of wage inequality and one which maximizes the probability of winning any game. Due to this fact, his evidence supports tournament theory as a means of understanding performance and salary in baseball.

Chuang et al. (2011) examined the effect of salary on team performance using three different frameworks: the careers concern model, tournament theory, and pay equality theory. They analyzed MLB data from 1985 through 2008 and used an equation to measure team performance. The Gini coefficient measured the equality of salary distribution. The authors found that there was a negative relationship between a hierarchical salary structure and team performance.

Finally, Annala and Winfree (2011) conducted a study that examined equity theory, which dictates that "players will provide effort based on the compensation that they receive" (p. 168). They also used relative deprivation theory to explain their results. This theory explains that "individuals feel deprivation when they compare their compensation to a reference group" (p. 168). Annala and Winfree used data from 1985 through 2004 and calculated Gini coefficients. They discovered greater inequality in salary distribution led to a negative impact on overall team performance (i.e., Gini coefficient had a negative relationship to team performance).

Through the analysis of previous research on baseball regarding salary structure and team performance, it is clear that sports which have characteristics of pooled interdependence perform better with a compressed salary structure. This research also indicates that tournament theory does not explain wage disparities in baseball; however, sports such as soccer, basketball and hockey, which have characteristics of reciprocal interdependence, may differ.

Football

Football is a sport classified as relying on sequential interdependence. Mondello and Maxcy (2009) conducted a study to see if team performance increased when the team had a heavily incentive-based pay structure (hierarchical), or salary-based pay structure (compressed). The researchers examined the pay structures of NFL teams from 2000 through 2007. A total of 254 club year observations were made and a regression analysis was completed using these statistics. The authors also used a two factor fixed effects model, which included fixed and random effects. The results showed that salary dispersion had a significant positive effect on on-field performance. Conversely, Frick et al. (2003) found no direct link between salary inequality and a team's performance in their examination of the NFL.

Soccer

Hall, Szymanski, and Zimbalist (2002) investigated payroll and performance to ascertain whether pay created performance or vice versa. Using English Premier League (EPL) payroll data from 1980 through 2000, they found that the more money teams spent on players, the more talent they were able to attract and, as a result, these teams were more successful on the field. Additionally, they discovered that for every additional dollar the team spent on salary in comparison to the league average, a team's winning percentage increased. The EPL does not have a salary cap and teams can spend any given amount of money on a player's salary. In conclusion, the researchers found that a hierarchical salary structure led to an increase in team performance.

Torgler, and Schmidt (2007) conducted a study in which they analyzed data from the Bundesliga (i.e., the top German soccer league) regarding salary structure and the success of teams. They collected data from the 1995-96 through to the 2003-04 season. There were a total of 1040 players used in the study. The authors found that hierarchical salary structures resulted in poorer team performance.

Basketball

Compared with the results identified above in soccer, Frick et al. (2003) found the opposite result when they studied basketball. Their study used payroll data from the 1990 through 2000 NBA regular seasons to calculate Gini coefficients. They found there was a positive effect of salary inequality with a team's performance which indicated that a hierarchical salary structure is better for team performance in basketball.

Hockey

Sommers (1998) conducted a study using data from the NHL 1996-97 regular season to measure team performance. He found that a smaller Gini coefficient indicated better team performance; in this case, points earned were the unit of analysis. The results indicate that a compressed structure would produce a better performing team.

Gomez (2002) examined team performance over the course of the 1994-95 through 1997-98 seasons. His original findings suggested that a hierarchical salary structure was linked to higher winning percentages; however, after he controlled "for the winning "legacy" of teams with fixed effects estimators, then the sign on salary inequality reverses and confirms that salary inequality is detrimental to performance" (p. 25).

Gomez regressed the seasonal differences between salary inequality and team payrolls to account for the winning “legacy” factor. An increase in 0.1 of the Gini coefficient had a negative 1.7 percent on winning percentage. Gomez’s results further indicate that a compressed salary structure promotes winning percentage; however, Frick et al. (2003) found differing results in their study. They found a small relationship between salary and team performance (winning percentage) in their study of the NHL for the seasons 1988, 1993, and 1995 through 2000. The relationship was small and it suggested that hierarchical salary structures increased a team’s performance.

Finally, Marchand et al. (2006) examined the NHL seasons between 2000 and 2004 to determine whether salary inequality had a positive or negative relationship on performance. The authors found that there was a positive relationship between inequality and performance (winning percentage and points earned), which differs from both Sommers’ (1998) and Gomez’s (2002) findings.

Sommers (1998) used points as their dependent variable and Frick et al. (2003) used winning percentage. Both, however, used the Gini coefficient as the independent variable. Marchard et al., (2003) used two percentile ratios alongside the Gini coefficient. Although inequality of salary was statistically significant, they found that the farther teams advanced in the playoffs, the more compressed salary structures were. They divided mean salaries by *star effect* and *journeymen effect*. *Star effect* accounted for every player above the mean salary, and *journeymen effect* accounted for the bottom half.

Marchand et al. (2006) also outlined that for future studies,

> ... the unanswered question is whether these relationships will hold under the new CBA with a firm upper cap on salaries. While the answer is several years away, it

will be important to compare the productivity effects of the new CBA with the ones found in this study (p.14).

In sum, the results of the four papers were different, which provides a strong rationale for conducting this particular study. Furthermore, all sports that display characteristics of reciprocal interdependence had varying results for both hierarchical and compressed salary structures; this gives further justification for studying this topic as clarity is needed.

Individual Performance and Salary

There have been few studies focused on the individual performance of players in team sports in relation to their salary. As mentioned earlier, different sports have different degrees of interdependence with sports such as hockey, basketball, football, and soccer being highly co-dependent on teammates for productive performance, while a baseball player's offensive production is highly dependent on individual skill, not their teammates. The following section outlines individual performance and salary related academic literature.

Baseball

Harder (1992) examined pay for performance in players that were either under- or over-rewarded for their performance. The purpose was to determine if under-rewarded players would exhibit behaviours that would negatively affect their teams. He created an equation to measure both offensive and defensive statistics in baseball. He found players who were under-rewarded did not decrease their effort as it might jeopardize their future careers. Harder (1992) was able to develop different equations based on previous studies regarding salary determination. The

> independent variables were selected on the basis of theoretical and empirical relevance and included performance, seniority, salary-determination procedures (e.g., free agency), All-Star status, race or ethnicity, organizational variables, and position played. The goal of the analysis was to explain the greatest degree of variance with theoretically meaningful variables (p. 324-325).

Bloom (1999) created an equation to measure individual player performance in MLB in relation to salary. He found there was a negative relationship to performance when there was a hierarchical salary structure. This negative relationship also suggests that players on teams with hierarchical pay structures are not performing at their optimal level.

Hall, et al. (2002) used payroll data from 1980 through 2000 to determine what type of relationship existed between wage and performance; however, no directional relationship existed until data from 1995 to 2000 illustrated a bi-directional relationship (is both negative and positive). This study is important because it shows the clear link between wage and performance.

Chuang et al. (2011) created an individual performance equation for baseball. The equation measured “the relationship between individual performance and individual salary, which as such considers the effect of salary structure and individual player salary on individual performance” (p. 10). In hierarchical salary structures, they found that athletes who were paid a larger amount performed better than those paid a small amount. They also found that a smaller salary structure equated to poorer individual performances by athletes who had high salaries.

Soccer

Torgler and Schmidt (2007) studied the Bundesliga (a German professional soccer league) and determined individual performance based on income. The study indicated players' individual performances were negatively correlated to hierarchical pay structures. The negative correlation indicated that players who received a small salary on a hierarchical salary structure team would not perform at an optimal level. They found a linear relationship between payroll to performance, but not vice versa. In other words, performance did not have an affect on salary but rather salary affected performance.

Basketball

Wallace (1988) studied individual performance and its relationship to salary in the NBA using fifteen independent variables. Using data from the 1984-85 seasons, variables included were: draft position, years playing, all-star appearances, position, and player mobility. All data outcomes were ratio based according to minutes played. Wallace found that when a player changed teams there was a significant and negative effect on his performance. He also found that scoring and rebounding were positively correlated to salary. This study is helpful as it gives examples as to which variables are highly correlated to salary.

Harder's (1992) article tested performance of over and under-rewarded players. Alongside his study of baseball, he also studied basketball, a sport that features reciprocal interdependence. He found that under-rewarded players negatively affected their team's performance by exhibiting selfish behaviour, while over-rewarded players statistics suggested that their actions were more team orientated. The statistics were measured as a ratio based in minutes played.

Hockey

Gomez (2002) examined individual performance of players in relation to salary. He looked at a number of variables such as, points per game, experience and place of birth. He gathered information from two seasons and excluded goalies within the study. His results suggested that individual performance was negatively affected by salary inequality.

Finally, Marchand et al. (2006) examined the effects of salary on team and individual performance in the NHL. They collected data over four seasons (2000-01 through 2003-04) related to individual and team characteristics. The Gini coefficient was used to measure inequality in salaries and the authors found salary inequality to be positively related to individual performance. Those players that were above the mean salary who were classified as *star effect* players performed better with higher inequality (i.e., a hierarchal salary structure).

Berri and Brook (2010) researched NHL goalies by examining "voting records for the Vezina Award (best goalie of the year award in the NHL) and salary data from free agent goalies to ascertain how the goalie position is evaluated by general managers in the NHL" (p.157). They looked at a number of variables including save percentage, goals against average, age, and minutes played. Their results suggested that there was no relationship between current pay and current save percentage between goalies. However, when examining unrestricted free agents, one and two years prior to signing a new contract save percentage was statistically significant. Additionally, they found that there were few individual differences between goalies in the NHL, which left the authors wondering “if there is very little difference in the performance of goalies, why would any team pay much more than the minimum salary to acquire a goalie?” (p.167).

The literature offers no clear answer for individual performance of athletes as to whether a hierarchical or compressed salary structure promotes individual output for both pooled and reciprocal interdependent sports. Further studies need to be completed that measure individual performance in relation to salary.

Summary

The degree to which salaries affect both the team and individual performance of professional athletes has only recently become a focus for academics. The two types of salary structures that have the potential to impact team and individual performance are hierarchical and compressed. Tournament theory is the dominating framework employed to study how salary relates to team and individual performance. Pooled, sequential and reciprocal interdependence are important when analyzing performance statistics as each sport has a different degree of individual impact on the final score of a game. For example, baseball players have more of an individual impact on the outcome of a game because they bat individually, whereas for many other sports passing and team cooperation are needed to score. Based on the sport and whether it has characteristics of pooled, sequential or reciprocal interdependence, it is easier to measure both team and individual performance. There have been a number of studies examining various sports using tournament theory. The four studies completed in professional hockey yielded different results for team and individual performance. Marchand et al. (2006) suggested that further research needs to be conducted in this area and, therefore, the purpose of this study is to investigate salary distribution in relation to team and player performance amongst NHL clubs.

Chapter Three: Methods

This chapter outlines the research methods employed to analyze the predictors between player performance and salary structure. The first research question was examined by conducting a regression analysis. The independent variable used was the Gini coefficient which was derived from team salaries. The dependent variable was team winning percentage. Furthermore, the researcher also examined the predictors between salary and individual performance statistics by way of another regression analysis. This chapter will include the samples needed to answer both research questions, the study variables, the validity and reliability of the data, and the statistical measures that were necessary to analyze the research questions.

Research Question One

1. Do salary structure types (hierarchal or compressed) serve to predict team performance for NHL professional hockey clubs?

Sample

The researcher collected and analyzed data from six NHL regular hockey seasons (2005-06 through 2010-11). The rationale for this decision was multifaceted. First, the researcher examined the NHL after the 2004-05 lockout to determine the impact of salary structure on a team's ability to win under a salary cap system. Secondly, Marchand et al. (2006) suggested that a study should be conducted post lockout to see what affect a salary cap had on salary structures and winning percentages. All thirty NHL teams were included in the analysis. Using thirty teams over the course of six seasons totaled 180 observations. Salary data were accessed from the *USA Today* salary database, as well as from the NHL's website. This was supported by previous research as Marchand et al. (2006) completed their study by accessing data from these two resources and the NHLPA's website. The validity and reliability of these data will be discussed later in the chapter.

Variables

The first research question employed two variables: the Gini coefficient and the winning percentages of teams from 2005-06 season to the 2010-11 season. Total team salaries were acquired from the *USA Today* salary database. The second piece of information needed for the research question was winning percentage. A number of studies have already examined salary structure and team performance and have used winning percentage as their dependent variable (Avrutin & Sommers, 2007; Bloom, 1999; Gomez, 2002; Marchand et al., 2006; Sommers, 1998; Vasilescu, 2007; Wisemen & Chatterjee, 2003). Winning percentage can be accurately calculated by dividing a team's wins from games played. This information was acquired online from the NHL.com.

Use of Secondary Data

The use and analysis of secondary data have been documented in academic research as adding usefulness and reliability. There are a number of advantages associated with using secondary data for research. Kiecolt and Nathan (1985) suggested that secondary data allow researchers to save both time and money in using pre-existing data sets. Additionally, secondary data can be derived from a number of different research designs. However, there are disadvantages to secondary data. Kiecolt and Nathan (1985) outline that a potential major issue involves data availability. There may be issues with a researcher's access or the very existence of the required data needed for the study. Additionally, when analyzing secondary data other issues that may arise are the uncertainty of data quality, as well as an inability to see original errors in data collection (Kiecolt & Nathan, 1985). Only secondary data were used for both research questions as all of the required data were available on the internet.

Validity and Reliability

The data used for this thesis were acquired from the *USA Today* salary database, and NHL.com. According to Marchand et al. (2006), the *USA Today* database was created and compiled by "sports reporters and editors based on information obtained from documents, agents and staff research" (p. 18).

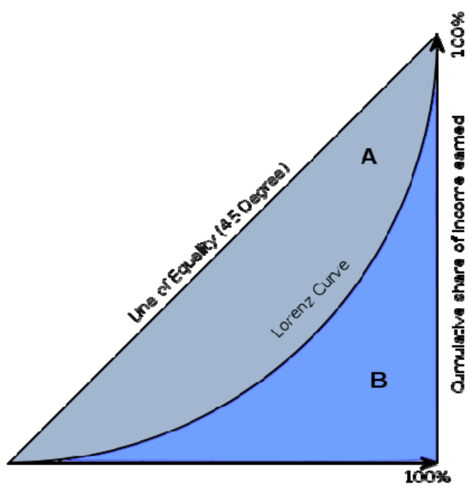
Previous research has utilized this approach and accepted it as providing valid salary data. Furthermore, in the case of a player engaged in a multi-year contract, the terms for only the current year were used, plus a prorated signing bonus, if applicable. Incentive and award clauses were not included. (Marchand et al., 2006, p.18)

Gini Coefficient

The Gini coefficient was created by an Italian economist named Corrado Gini. He wrote three major articles regarding the Gini coefficient in 1912, 1914, and 1936. The Gini coefficient measures levels of economic equality or inequality within a range of 0 and 1. Zero represents perfect equality (i.e., everyone is paid the same amount), while 1 represents perfect inequality (i.e., one person on a team is making all of the money). A significant number of studies regarding salary structure and team performance have used the Gini coefficient as a measure of salary equality/inequality (Avrutin & Sommers, 2007; Bloom, 1999; Frick et al., 2003; Gomez, 2002; Jewell & Molina, 2004; Marchand et al., 2006; Sommers, 1998; Vasilescu, 2007; Wisemen & Chatterjee 2003). The Lorenz curve is a visual depiction of the Gini coefficient. According to Hainsworth (1964) "the main value of a Lorenz-type diagram (shown in Figure 1) is that it allows for visual and quantitative comparison of the cumulative relationship between two variables with the overall arithmetic mean relationship" (p. 426).

In a Lorenz curve, the 'y' axis represents total salaries of professional hockey teams, while the 'x' axis represents the lowest to highest of team salaries; the 45 degree angle represents perfect equality.

Figure 1 - *The Lorenz Curve*



The Gini coefficient can be determined by finding the ratio between the line of equality (45 degree line; see Figure 1) and the Lorenz curve (which is marked by A) over the total area under it (B) plus the Lorenz curve (A). This equation can be seen as the Gini coefficient:

$$\frac{A}{(A+B)}$$

Bloom (1999) outlined that a team Gini coefficient can be calculated as:

$$\text{Team Gini coefficient } = 1 + \frac{1}{n} - \frac{2}{n^2 \bar{s}}(s_1 + 2s_2 + ... + ns_n)$$

Here, $s_1 \ldots s_n$ is individual player salary on a given team arranged in order of decreasing salary, s is the mean salary of this team, and n is the number of players on this team. A separate Gini coefficient is computed for each team in each year. (Chuang et al., 2011, p. 11).

The Gini coefficient was calculated by using a free online statistics calculator. This same website (www.wessa.net/co.wasp) was used by Sommers (1998) in his analysis of team salary structures for the 1996-97 regular season. Once the Gini coefficient was calculated, a regression analysis was employed to determine if salary structure helped to predict teams winning percentages.

Regression Analysis

A regression analysis serves to find a prediction between the dependent and independent variable. The independent variable used in the first research question was the Gini coefficient and the dependent variable was winning percentage. An OLS regression was conducted. According to Moore and McCabe (2006), a regression line "is a straight line that describes how a response variable *y* changes as an exploratory variable *x* changes" (p.145). The OLS method "minimizes the sum of squares of the vertical distances of the observed *y*-values from the line" (p.145). Previous studies have used an OLS regression to determine the strength and direction of the variables potential predictions (Avrutin & Sommers, 2007; Marchand et al., 2006). The OLS regression analysis was computed using the Statistical Package for the Social Sciences (SPSS) software, version 19.

Research Question Two

2. How do NHL goalie performance measures relate to professional goalie salaries?

Sample

In an attempt to further understand player salaries and performance in professional hockey, the researcher examined starting goalies in the NHL over the course of six regular seasons (2005-06 through 2010-11). The rationale for this decision involved an interest in examining salary and individual players' performance. As per the new CBA, the NHL has a hard salary cap system which means that salary management has become vital for a team's success. If a team was able to project an accurate way of measuring performance in relation to salary, or determine a financial value for an individual, salary cap management would become easier. In this study, the researcher intentionally only collected data from NHL.com involving goalie performance. The researcher purposely limited the number of observations to goalies that had played at least 30 games (Marchand et al., 2006). This delimitation ensured that only starting goalies were included within this study, and eliminates the statistics of 'backup' players whose performance measurements may not be true to their skill with a limited number of games played.

Variables

The regression analysis had one dependent variable and a number of independent variables. The dependent variable in this equation was the goalie's individual salary. There were a number of possible independent variables that could have been used for goalie performance measures. All variables that were included in the study were acquired from the NHL.com. The researcher was under the assumption that because the NHL posts these statistics that they would consider them strong measures of performance. The researcher was using a data driven approach so all variables were included from the website. Table 3 identifies the list of potential variables that were included in the study alongside their short and full names. To avoid multi-collinearity, certain statistics were omitted (i.e., goals allowed and shots on net when save percentage was already included in the study).

Table 3– *Potential variables for study*

Variable	**Full name**
GP	Games Played
W	Wins
L	Losses
OT	Overtime Losses
GAA	Goals Against Average
SV%	Save Percentage
SO	Shutouts
SOW	Shootout Wins
SOL	Shootout Losses
SOS%	Shootout Save Percentage

Use of Secondary Data

This researcher used a data driven approach in determining the statistics used in the regression analysis. By using NHL.com, the researcher took all pertinent statistics related to goalie performance and analyzed them in a regression analysis. However, before the regression analysis was completed a number of regression assumptions needed to be checked, (i.e., a Pearson's correlation analysis). This analysis ensured that all statistics used were not highly correlated to one another.

Validity and Reliability

The data collected were from the same secondary sources as from the previous research question. Therefore, the reliability of the data collected depends on those sources; at the same time, the databases and web sites used for data collection have been used in previous studies, which adds legitimacy to data set reliability (Marchand, et al., 2006).

Regression Analysis

In order to answer the second research question, a simultaneous regression was used. The rationale for this analysis was two-fold: first, simultaneous regressions include all variables in its analyses and, second, this type of regression is used for exploratory purposes. Since there has been little academic research completed regarding predictors of salary for professional hockey goalies, this type of regression analysis was deemed appropriate. In a regression analysis, there is a dependent variable which stays constant throughout the analysis. Here, the dependent variable was individual player salary. The rationale for the study aimed to determine which measures (i.e., statistics) best served to predict a player's salary. Unlike the dependent variable, there could be a number of independent variables. These independent variables were illustrated earlier in the chapter. Each of the independent variables were measured in relation to the dependent variable to determine whether they were effective predictors of salary. The simultaneous regression was computed using the computer program SPSS software, version 19.

When a regression analysis is used, a formula dictates how many observations are needed based on how many independent variables are included in the study. This ensures the experiment has enough power. Moore and McCabe (2006) describe power as, "the probability that a fixed level α significant test will reject H_0 when a particular alternative value of the parameter is true" (p. 431). The formula to determine if a hypothesis has enough power is as follows:

$$n > 50+8(\text{IV})$$

For every independent variable added to a regression analysis, an additional eight observations are necessary on top of the mandatory fifty. The *n* represents a total number of observations and this total must be greater than the right side of the equation to have enough power. For example, if this study used a total of ten independent variables, the study would need to have greater than 130 observations to ensure the experiment would have enough power.

$$n > 50+8(10)$$

$$n > 50+80$$

$$n > 130$$

By having enough power in this research study it also reduced the chance of Type II error. Type II error occurs when a statistical test fails to reject the null hypothesis.

Summary

This chapter described the methods used to answer the research questions posed in the study. The thesis only included data from NHL regular seasons from 2005-06 through 2010-11. This was because the focus of the study was on the NHL's post lockout timeframe and the introduction of a hard salary cap system. Only secondary data were used for the analyses; there are both positive and negative effects of using secondary data as previously outlined. Regression analyses were used for both research questions. The statistical measure used as a predictor to team performance was the Gini coefficient. This chapter has included information regarding sample collection, different variables for analysis, use of secondary data, validity and reliability, and, finally, the statistical measures that were used to analyze the data.

Chapter Four: Results and Discussion

This chapter will focus on the statistical results analyzed in this study. The purpose of the study was to examine player salary in relation to performance. The first research question examined salary inequality and team winning percentages. The second analyzed salary data in relation to individual goalie performance statistics. The results section of this chapter includes descriptive statistics, regression analyses assumptions, results, and finally, the main findings of both research questions. The discussion portion of this chapter will focus on the results of the study in relation to previous academic work. Discussion of the rationale to support tournament theory, how reciprocal interdependence affects hockey, the effect of the CBA on team performance, individual performance and salary and, finally, other reciprocal interdependent sports will be compared in relation to both team and individual performance.

Descriptive Statistics

Outlining the descriptive statistics provides a better understanding of data and ensures there are not any issues with its central tendencies (i.e., outliers, shape of the curve, and variation). The descriptive statistics included are the mean, mode, standard deviation, and, finally, the minimum and maximum values. It is critical to include these last two descriptive statistics because both variables (i.e., winning percentage and Gini coefficient) have a scale from 0 to 1 and knowing where each variable falls within the range is important.

Research Question 1

The first research question analyzed two variables: winning percentage and the Gini coefficient. There were a total of 178 observations. The mean and standard deviation for winning percentage were (M = 0.499; SD = 0.089). The mode was 0.500. The lowest winning percentage across six seasons was 0.256, and the highest was 0.707. The Gini coefficient's mean and standard deviation were (M = 0.432; SD = 0.44). The variable had multiple modes; the smallest of which was 0.314. The lowest (minimum) Gini coefficient was 0.314, and the highest (maximum) was 0.543. Descriptive statistics can be found in Appendix A – Table 5. The Lorenz curve for team salaries from 2005-06 to 2010-11 seasons can be found in Appendix B – Figure 5.

Research Question 2

In the second research question we examined the predictive nature of individual performance measures of NHL goalies to goalie salary. A total of eight independent variables were used in the regression analysis. There were a total of 245 observations. The mean and standard deviation of all variables included in the regression analysis were: games played (M = 51.3; SD = 13.45), losses (M = 18; SD = 6.14), overtime losses (M = 5.6; SD = 2.53), goals against average (M = 2.7; SD = 0.35), save percentage (M = 0.908; SD = 0.011), shutouts (M = 3.18; SD = 2.34), shootout wins (M = 3.19; SD = 2.15), shootout losses (M = 3.2; SD = 1.8), and shootout save percentage (M = 0.662; SD = 0.134). Descriptive statistics can be found in Appendix A – Table 10.

Regression Analysis

Regression analyses were performed in relation to both research questions and, in what follows, various factors are discussed in the context of the specific focus of the questions.

Research Question 1

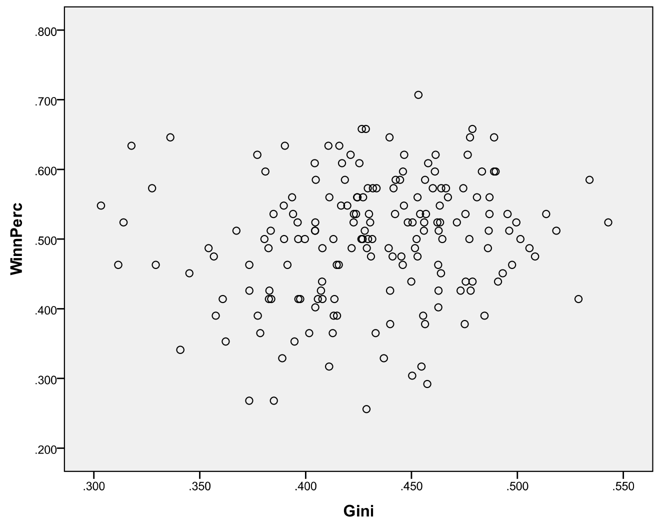
In what follows, a brief description of the assumptions about regression analysis relevant to the first research question is provided.

Assumptions.

It is important to outline the assumptions of a regression analysis in order to ensure the reliability of the analytical outcome. These assumptions include: missing data, a linear relationship between the variables, univariate normal distribution, normal distribution, univariate outliers, multi collinearity, and multivariate normal distribution.

First, there were no missing data in the data set. A scatter plot (see Figure 2) was created to determine if there was a linear relationship between winning percentage and the Gini coefficient; the scatter plot indicated that there was. The darker dots on the scatter plot provide a slight indication of a linear relationship (i.e., the higher the winning percentage the higher the Gini coefficient).

Figure 2 – *Winning Percentage and Gini Coefficient Scatter Plot*



Histograms were created to examine the univarite normal distribution. Both variables were normally distributed (as shown in Figures 3 and 4). The winning percentage and Gini coefficient variables did not show signs of kurtosis or skewness. The assumption was accepted. There were not any univariate outliers, thus, this assumption was accepted.

Figure 3 – *Winning Percentage Histogram*

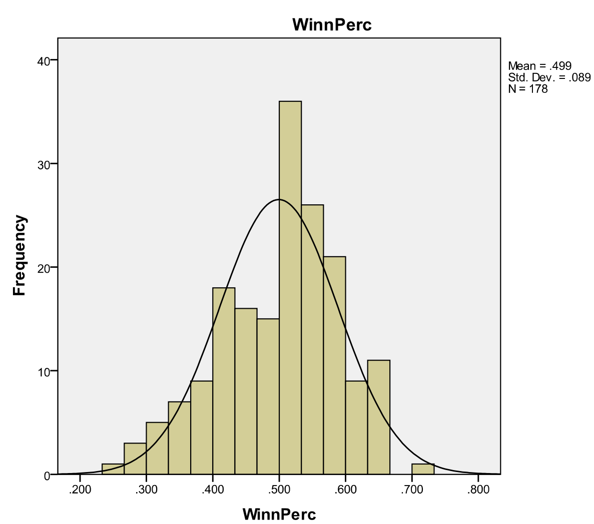
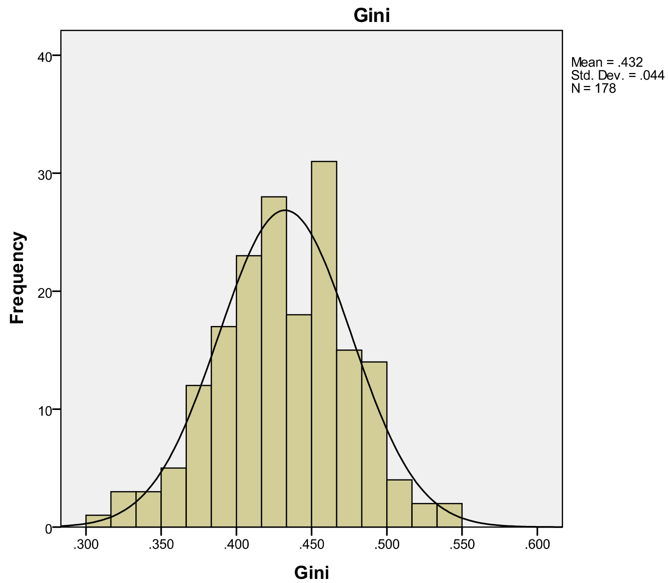


Figure 4 – *Gini Coefficient Histogram*



A Pearson correlation test was done to assess the multi collinearity assumption to determine if winning percentage and the Gini coefficient were highly correlated. The Pearsons *r* equated to 0.158, which showed that the two variables were not highly correlated (see Appendix A – Table 6). This assumption was accepted.

The next assumption that was examined was multivariate normal distribution. Mahalanobis distance was used and compared to a chi square table with a *p* value of 0.01; there was 1 degree of freedom. The chi square chart indicated that anything above Mahalanobis distance number of 6.63 would be considered an outlier. There were a total of two outliers; both were eliminated from the study[1]. This assumption was accepted.

Analysis.

A simple linear regression was completed to determine if the Gini coefficient was an effective predictor of team performance (winning percentage). The regression analysis

[1] The two teams eliminated from the study were the Minnesota Wild (2005-06) and the Carolina Hurricanes (2008-09).

showed the Gini coefficient to be a significant predictor of salary. The results of the regression were; [$R^2 = 0.025$, $F(1, 176) = 4.483$, $p < 0.036$]. The R^2 indicates the strength of the predictor variable; the Gini coefficient accounted for 2.5% of winning percentage. The beta values were positive [$\beta = 0.158$] which suggests to the researcher that the prediction is positive (see Appendix A – Tables 7 - 9). In other words, an increase in the Gini coefficient equated to an increase in winning percentage.

Research Question 2

In what follows, a brief description of the assumptions about regression analysis relevant to the second research question is provided.

Assumptions.

As mentioned from the first research question it is important to outline the assumptions of a regression analysis in order to ensure the reliability of the analytical outcome. These assumptions include: missing data, a linear relationship between the variables, univariate normal distribution, normal distribution, univariate outliers, multi collinearity, and multivariate normal distribution.

There were no missing data recorded in this study, and therefore the assumption regarding handling missing data was accepted. The next assumption that was met was univariate normal distribution. Histograms were completed for all variables (see Appendix B – Figures 6 -14). The skewness and kurtosis of the variables included in this study are shown in Table 4. Games played was slightly negatively kurtotic at -1.103. No other variables exceeded the range of -1 to 1 in either skewness or kurtosis. As a result, it can be deduced that all variables were normally distributed. This assumption was accepted. Due to the large variance of range in the given variables, there were a number of univariate outliers. This assumption was not accepted.

Table 4 – *Skewness & Kurtosis of Research Question Two*

Variable	**Skewness**	**Kurtosis**
Salary	0.916	-0.222
Games Played	0.101	-1.103
Losses	0.183	-0.784
Overtime Losses	0.113	-0.499
Save Percentage	-0.357	-0.285
Shutouts	0.784	0.362
Shootout Wins	0.881	0.454
Shootout Losses	0.417	-0.072
Shootout Save Percentage	-0.359	0.845

In the second research question, the researcher examined a number of different variables as predictors of goalie salary. A Pearson's correlation analysis was completed to determine if any of the variables were highly correlated. Wins and games played were highly correlated to 0.871. Due to the strong relationship between these two variables wins was removed from the study. Save percentage and goals against average were highly correlated to 0.815. As a result goals against average was eliminated from the study (see Appendix A – Table 11). A scatter plot matrix was completed (see Appendix B – Figure 15). All variables had a linear relationship. Thus, the assumption was accepted.

The next assumption that was examined was multivariate normal distribution. Mahalanobis distance was used and compared to a chi square table with a p value of 0.01; the degrees of freedom was 9. The chi square chart indicated that anything above 21.66

would be considered an outlier. There were a total of three outliers, all of which were eliminated from the study[2]. This assumption was accepted.

Analysis.

A simultaneous regression was employed to determine which goalie performance measures were the best predictors of salary. The rationale for this method of analysis was two-fold: first, simultaneous regression includes all variables in its analysis, and, second, this type of regression is used for exploratory purposes. Further reasoning included that there has been limited previous research conducted regarding goalie statistics and salary (Berri & Brook, 2010). The regression was statistically significant, [$R^2 = 0.198$, $F\,(8,235) = 7.26$, $p < 0.001$]. The eight variables included in the regression analysis equated to 19.8% of the prediction to salary. Games played was the only statistically significant variable; [$\beta = 0.311$, $p < 0.05$] (see Appendix A – Tables 12-14).

Main Findings

In relation to Research Question 1: Do salary structure types (hierarchical or compressed) serve to predict team performance for NHL professional hockey clubs?, the following findings emerged as significant. As per the regression analysis, it was determined that the Gini coefficient significantly predicted winning percentage ($p < 0.05$). This statistic means that salary structure is important for predicting team performance. However, when the regression analysis was completed the $r^2 = 0.025$. This statistic showed that the Gini coefficient (salary structure types) only equated 2.5% of the prediction to salary. This is a very small percentile as there is still 97.5% of the predictors

[2] The three goalies that were eliminated from the study were Jonathan Quick – Los Angeles Kings (2010-11), Martin Brodeur – New Jersey Devils (2006-07), and Vesa Toskala – San Jose Sharks (2006-07).

unaccounted for in this study. The statistics signify that the Gini coefficient is a positive predictor; however, it is not a strong predictor. The beta levels suggest that there is a positive prediction between the two variables [$\beta = 0.158$, $p < 0.05$]. This indicates that the higher the Gini coefficient, the higher the winning percentage will be. In sum, salary structures do serve to predict team performance; however, the level of prediction is very small. Furthermore, the more dispersed a team's salary is (hierarchical salary structure) the higher their winning percentage will be.

In relation to research question two: How do NHL goalie performance measures relate to professional goalie salaries?, the following results emerged as significant. A total of eight independent variables were used in the regression analysis to determine which goalie statistics were the best predictors to salary. Salary and goalie statistics were statistically significant ($p < 0.001$). The $r^2 = 0.198$ indicated to the researcher that the predictor variables used in the study accounted for 19.8% of goalie performance measures ability to predict salaries. One of the eight independent variables used in the study was statistically significant; the variable was games played ($p < 0.05$). Games played had a positive beta, which suggests that there is positive prediction between this variable and salary. A surprising result was that save percentage was not statistically significant ($p > .584$).

Games played is linked to team performance. None of the results showed individual performance measures to be statistically significant. In hockey, as suggested by the results of the study, goalie performance is important for the overall team's performance. The data also suggests that goalies with higher salaries play more games, [$\beta = 0.311$, $p < 0.05$]. The results of the thesis indicate that individual goalie performance measures do not relate to salary, but do relate to overall team records (games played equates to total wins and losses). This provides evidence that hockey is a sport that has characteristics of reciprocal interdependence. Reciprocal interdependent sports refer to team sports in which a number of players' outputs are needed for an outcome (win or loss). The outcome of team performance is linked to overall group performance.

Discussion

In what follows, an extended discussion of the team salary structure and individual performance regression results will be completed.

Team Salary Structure

The results of this research provide interesting insight into the understanding of team and player performance in relation to salary. Tournament theory holds that team and player performance are increased when salary is highly dispersed in an organization (Frick, 2003). The results of the study indicate that tournament theory is an effective explanation of salary and performance in the NHL after the 2004-05 lockout. The evidence suggests that hierarchical pay structures predict better team performance. This chapter focuses on the results of the study in relation to previous research, including rationale to support tournament theory, how reciprocal interdependence effects hockey, the effect of the CBA, and, finally, how other reciprocal interdependent sports affect team performance and salary.

Four studies have been completed analyzing salary and team performance in the NHL. Marchand, et al., (2006) recommended that a study be completed some years after the new CBA to determine what impact its implementation had on the NHL in regard to salary dispersion and performance. The results of this study suggested that an increase in the Gini coefficient would result in an increase in team winning percentage, (i.e., the more dispersed a team's salary in a hierarchical salary structure, the greater their winning percentage will be). The results of this study are congruent with two of the four previous studies completed. Both Frick et al., (2003) and Marchand et al., (2006) found that hierarchal salary structures induced better team performance, whereas both Gomez (2002) and Sommers (1998) found that compressed salary structures induced better team performance.

Sommers (1998) examined the 1996-97 NHL hockey season and found that the more compressed a team's salary structure, the greater their total number of points accrued. Frick, et al., (2003), Gomez (2002), and Sommers (1998) all examined similar seasons. Both Frick et al., (2003) and Gomez (2002) looked at a number of seasons in their studies, whereas Sommers (1998) used the statistics from only one season. All the researchers that analyzed more than four hockey seasons, including this study, had results which suggested that hierarchal salary structures were more beneficial to a team's winning percentage, with the exception of Gomez (2002). It was not until Gomez accounted for one of his variables called the winning "legacy" did his results indicate that a compressed salary structure increased winning percentage. Rationale for not including the winning 'legacy' into this study was literature-based, as the majority of research articles reviewed did not use a method to account for salary inequality and changes in team payroll over seasons. In future research, sample size may be important when attempting to examine the predictors between salary structure and team performance.

A study of the four seasons prior to the lockout (2000-01 through 2003-04) by Marchand et al. (2006) suggested that hierarchical salary structures increased winning percentages. It could be deduced that since the 2000-01 season, teams with higher salary dispersion have been more successful. Although this study's results were statistically significant the Gini coefficient did not account for a large variance of winning percentage. However, from a statistical standpoint the results suggest that the 2004-05 lockout did not have a large effect on salaries and performance in the NHL. As seen in Table 1, although salaries decreased slightly post lockout, they steadily began to rise and are currently stalled. The lockout also did not affect the dispersion of salary between players. There is still a stark difference between the average earned salary of a player and that of a player earning the league maximum. The new CBA helped the league set a salary ceiling, so there is a limit that any individual player can earn annually. This new ceiling helps to limit salary dispersion as seen in the maximum Gini coefficient. This limit also allows teams to sign top tier players to a maximum salary, while still having enough money left to sign other players to large contracts. The same can be said for the salary cap floor which is set by the league that dictates the lowest amount a team can spend on an individual player and on a team as a whole. This may be an explanation as to the why the range of the Gini coefficient was relatively small throughout the sample.

The current study's results indicate that the Gini coefficient was only a small predictor of winning percentage. With the current CBA, a hard salary cap system affects how teams manage their payroll. This includes which teams offer contracts to which players and how much is offered. Although the level of prediction between the two variables was quite small, its statistical significance should not be ignored. With a steady increase in the league salary cap, teams are able to award large contracts to a number of individuals. As the prediction between the Gini coefficient and winning percentage was positive, the results suggest that larger contracts to a few individual players increases the likelihood of a team's winning percentage being higher. Managers may be relying heavily on individual players to perform at a higher level than other players on a team. Although there has been a steady increase in the hard salary cap since 2006, individual players earning season high salaries have remained relatively the same (see Table 1). As a result general managers have salary cap room to sign other 'star players' before team's salary caps levels are achieved.

Previous research suggested that hierarchical salary structures increased a team's performance (Frick et al., 2003, Marchand et al., 2006); however, with the implementation of the hard salary cap system, the researcher anticipated that compressed salary structures would increase a team's winning percentage, but the results suggested otherwise. The more dispersed a team's salary structure, the more wins they had. This dispersion may be a result of a 'star player.' In their research papers both Frick et al. (2003) and Marchand et al. (2006) suggested that star players increase the dispersion of salary among teams. This dispersion might result from the number of players (only six) that in hockey are allowed on the ice at one time. It is understandable that teams that are paying higher salaries to a few individuals should want them on the ice for a longer period of time. Furthermore, Marchand, et al.'s (2006) results suggest that the effect of a 'star player' far outweighed the benefits of journeymen (a player with average talent) for a team's success. This point is further illustrated by Frick et al. (2003) in that "'star players' may be of paramount importance for the team's performance – which, in turn will lead to a highly skewed distribution of player salaries without negatively affecting the performance of those at the lower end of the pay hierarchy" (p.479-480). Results of this research add further evidence to these findings as when a team has a higher Gini coefficient, they also have a higher winning percentage. The effect of the 2004-05 lockout did not have a great deal of influence on teams salary structures.

One of the main purposes of this study was to determine the effect of the hard cap salary system on how teams manage their money, as outlined by Marchand et al. (2006) for future areas of research. The results were somewhat surprising from this perspective as the predictive value of the Gini coefficient to winning percentage was rather small. Frick et al., (2003) had similar results as their research indicated that a hierarchical salary structure increased winning percentage. The predictive results between the Gini coefficient and winning percentage was also rather small in their study. In the current paper, the prediction of the Gini coefficient only accounted for 2.5% of the variance to winning percentage (dependent variable). There are still a number of other factors that could potentially affect a team's winning percentage that were not accounted for in this study. These factors could include: internal organizational matters such as injuries and game preparation, relationships between individuals on the team, coaching staff, coaching style, organizational pressure, and organizational culture. Each of these factors could potentially affect a team's ability to win.

Pooled, sequential and reciprocal interdependent sports offer different perspectives on both team and individual performance. Examples of sports that exhibit reciprocal interdependence are basketball, soccer and hockey, whereas baseball can be considered a sport that exhibits characteristics of pooled interdependence and football as a sport that exhibits sequential interdependence. A comparison between the results of this particular study and the studies that have already been completed is imperative in understanding the scope of the research results.

In comparison to other reciprocal interdependent sports (soccer and basketball), there has not been a consensus on what salary structure equates to more successful teams (i.e., examples of success could be defined as, but are not limited to, winning percentage and total points earned). The results vary based on the study and sport. Some of the research completed suggests that a compressed salary structure promotes winning (Frick et al., 2003; Torgler, & Schmidt, 2007), whereas other studies suggest that teams are more successful with a hierarchical structure (Hall et al., 2002). An important difference between these sports is the maximum players allowed on the field at one time. In sports where few individuals are allowed on the playing surface at once (hockey and basketball) hierarchical salary structures may increase teams winning because of the signing of ‘star players’. For example, in Frick et al.’s (2003) study, intra-team wage dispersion was beneficial to basketball teams. The same results can be found in hockey (Frick et al., 2003, Marchand et al., 2006). Sports such as football and soccer, which allow a larger number of individuals on the playing surface may benefit from having salary structures which are more compressed. This could be related to each individual player having a greater responsibility because of increased playing time. Frick et al. (2003) agrees with the notion that the larger the team size, the less an impact an individual has on the outcome of a game. Overall, it is evident through both past and present research that both team and individual performance is affected by salary.

Individual Performance

There have been few studies completed regarding the direct effect of individual goalie performance measures in predicting salary. Tournament theory would suggest that players who perform better will receive higher pay, and players who are paid less would try and increase their performances to increase their salaries (Chuang et al., 2011; Frick, 2003; Huselid, 1992). The purpose of the second research question was to determine which goalie statistics best predicted salary. The results indicated that individual performance measures do predict salary. The results indicated that *games played* was the only significant variable. In other words, goalies that play more games have a higher salary. Theoretically speaking, better goalies play, and get paid more. The data shows that tournament theory is supported for individual performance of goalies. There are two major points that can be taken away from the results in comparison to past literature: first, the important role of reciprocal interdependence in hockey and, second, how the role of reciprocal interdependence varies among other sports.

No individual performance measures such as GAA or save percentage were found to be significant predictors of salary. An ad hoc explanation as to why no individual performance measures were significant is because hockey is a sport that is reciprocally interdependent. As illustrated earlier, the only variable found to be significant was games played. *Games played* is not controlled by the goalie, but rather the coach of the team and as a result can not be completely deemed as an individual performance statistic. Previous research has examined player physical characteristics (Gomez, 2002), and player individual (forward/defence) performance measures (Marchand et al., 2006). The only study to specifically examine goalie statistics was completed by Berri and Brook (2010).

Their results suggested that current statistics were not significant to salary, however, when examining one and two years prior to a goalie signing a new contract their save percentage was statistically significant. Berri and Brook (2010) concluded, "...predicting the future is quite difficult. When we further examine performance data for goalies, we can see why making predictions in this labour market is so difficult" (p. 162). The ability to determine future performance is not only difficult in hockey, but also in other sports.

Other research conducted in soccer offers a different perspective on individual performance and salary. Torgler & Schmidt, (2007) examined soccer players' performance in relation to salary and found that an increase in salary dispersion led to a decrease in team performance. The results of this study found a negative correlation between those players who received a small salary that were on a team with a hierarchical salary structure. Ultimately, the players did not perform to their optimal level. This may be due to the larger number of individuals on a soccer field as opposed to a hockey arena. Frick et al. (2003) discussed the idea that because there is an increased amount of players playing a game, each individual has a greater responsibility due to his or her increased playing time. Based on this, these players were most likely receiving similar playing time as individuals who had higher salaries, their effort level may not have been as strong as if there had been a compressed salary structure in place. In sum, depending on the sport, the playing time given to each player, may have an effect on his or her performance, based on the salary structure the team is using.

Hall et al.'s (2002) study regarding player performance and salary is important because it showed a clear link between salary and performance. The results of this study further support this notion. However, specific performance measures need to be more accurately measured and identified in order for sport managers to make sound, knowledge based decisions. It is becoming increasingly evident that each sport is unique in its performance measures and how player's performance should be identified and gauged by sport managers. Sport leaders in professional sport must help discover and classify these performance statistics in order to properly manage their payroll and offer appropriate contract offers. However, if goalie performance measures are not accurately predicting salary (i.e., the results of this study) then it is important to ask whether goalies in the NHL are overvalued.

With a lack of academic literature regarding goalie performance and valuation of goalie performance, an examination of popular press articles was engaged. In hockey culture it is believed that goalies are the most important players on the ice at any given time. This point is further illustrated by David Johnson of hockeyanalysis.com, "I must say that my belief is that a goalie is by far the most valuable member of a team" (Johnson, 2010, para. 12). Norman (2009), in the book *Hockeynomics*, also expounded on the importance of goalies: "There are certainly times when a netminder is the root cause of a win" (p. 240). It is evident through popular press material that goalies have a significant impact on a team and a game. One could deduce, based on the discussions of these authors, that goalies are not over valued.

Summary

This chapter included results and discussion of those results in relationship to literature that provided the foundation for this study. First, explanations of the underlying assumptions of the regression analyses were discussed. Additionally, the results of the study were outlined with in-depth analysis of what the statistics were and what they meant in relation to the research questions. With both research questions answered, a broader examination of what the results meant in comparison to past literature was discussed. This discussion related the results to literature surrounding tournament theory, reciprocal interdependence, and the effect of the salary cap on salary dispersion on team and individual performance. The chapter also offered an explanation as to why hierarchical salary structures are related to an increase in winning percentage, the effect of ‘star players’ and finally, individual performance in relation to hockey and other reciprocal interdependent sports.

Chapter 5: Conclusions, Limitations, & Future Research

Conclusions

Professional sport offers a unique opportunity to examine whether or not salary is actually related to performance of both organizations (teams) and employees (players). In this research we examine salary structure types (hierarchical or compressed) as predictors of team performance in the NHL. We also analyze goalie statistics in order to determine what, if any, performance measures help predict salary.

1. There was a significant statistical prediction between team performance and salary structure (Gini coefficient). The Gini coefficient was found to be a weak predictor as it only accounted for 2.5% of winning percentage. The beta levels were positive which suggested to the researcher that hierarchical salary structures increase team performance. The results support the notion that tournament theory is an effective explanation of team performance.

Although the Gini coefficient was found to be a statistically significant predictor of team performance it should be noted that it is not an effective predictor of performance. It may not have as much of a practical significance as compared to its statistical significance. It is from this respect that the applicability of the results to 'real world' situations may not be strong.

2. In the matter of individual performance of goalies in relation to salary, the regression analysis found there to be a significant predictor between salary and individual goalie performance measures. Of the eight independent variables only games played was statistically significant. The beta level was positive, which

suggests that a goalie that plays more games has a higher salary. The data also suggests that the better the team performance the better the goalie statistics.

Limitations

Some limitations of this thesis include the data used. The reliability of the data is based on the reliability of the website where it was accessed. Although previous articles have used the same source for their study it is important to address that there is a possibility that the data may be incorrect. As a result, if the data were wrong then that would mean that the results of the study are incorrect. Another limitation of the study is that it does not address how the players feel about salary dispersion. This was a quantitative study and as a result it did not include the thoughts and feelings of both managers and players. However, access to the managers and players would be extremely difficult to achieve. Additionally, another limitation of the study was the variables used for the second research question. The variables used in the study were accessed from NHL.com and were assumed to be the best statistics to measure goalie performance. Teams may have other statistics or drills to evaluate performance. The researcher would not have been able to directly observe goalie performance against those drills.

Finally, a further limitation of the study was that the first research question only had one independent variable in the regression analysis. This may be a reason why the analysis only accounted for 2.5% of variance to winning percentage.

Future Research

There are a number of potential studies that could be created using this thesis as a foundation for future research. Future studies based on the current study could examine the effects of the Gini coefficient on playoff teams. Although this study's results suggest that the more dispersed a team's salary structure, the higher their winning percentage would be, previous research dictates that during the playoffs, the opposite is true. Research by Marchand et al., (2006) suggested that the further into the playoffs teams made it without being eliminated, the smaller their Gini coefficients were. A continuation of this study post lockout would give insight into how the lockout affected teams that made the playoffs and how far they advanced into the playoffs from the 2005-06 season onwards.

Further, an analysis to determine the fluctuation of the importance of team salary compression and/or dispersion in relation to team success would be a fruitful area of research. Success could be defined as, but not limited to, winning percentage, division titles, and/or championships won. This approach would increase the understanding of a historic and economic climate of the NHL, as well as how the league has progressed or recessed over its existence. Additionally, it would provide a perspective on the historical power imbalance between players and owners.

Future research should also focus on the effects of reciprocal interdependence on individual player's performance statistics and their effect on salary determination for players. Although this study only examined goalie performance in relation to salary, it did not give a strong indication of what skills or personal performance measures were attributed to salary numeration. Future studies should focus both on forwards and defensemen and their specific individual performance measures to determine whether their statistics are related to salaries. If not, it would give greater evidence to support the notion that hockey is a sport that is defined by reciprocal interdependence.

Additionally, a future study could analyze the effect of guaranteed versus unguaranteed contracts. The differences between these lies in that an individual who is under contract in a league under a guaranteed contract (e.g., NHL) is ensured the monetary value that the player's contract dictates, regardless of injury or performance. Unguaranteed contracts do not provide this insurance because teams are not obligated to pay players if they do not play. An example of such a league would be the NFL. If a player is cut from a team, their contract is no longer valid and the team is not obligated to pay the player. Research examining the differences between guaranteed versus unguaranteed contracts could potentially determine if unguaranteed contracts yielded higher performance from athletes because their contracts are based on performance. As well, future studies could examine salary prior to contract signing as opposed to salaries of player's current contracts. Berri and Brook (2010), in their study of goalie performance, limited their research to examine only unrestricted free agent goalies. Their results suggested that the current contracts of goalies studied where not significant predictors of current performance statistics.

The conclusions of this study involve the idea that there are industry specific, professional sport indices related to identifying performance. For example, shots taken from certain areas of the offensive zone, save percentage on the power play, etc. However, in completing this research such detailed statistics were not available. Future studies could try and gain access to such data as it may add to the accounted variance of goalie salaries. Additionally, this paper did not attempt to find an "optimal" Gini coefficient for team performance. Avenues for futures research could attempt to identify this “optimal” range or Gini coefficient level as it relates to maximized team performance.

This chapter included final conclusions from both research questions as well implications for their statistical and practical significance. Limitations of this study were also included and finally, future areas of research were discussed. Due to the exploratory nature of this study a number of options were expressed that will hopefully enable future research attempts related to player salaries and performance in professional sport.

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Appendix A – Supplementary Tables

Table 5 - *Descriptive Statistics of Winning Percentage and Gini Coefficient*

Statistics

		WinnPerc	Gini
N	Valid	178	178
	Missing	0	0
Mean		.49940	.43240
Std. Error of Mean		.006692	.003303
Median		.51200	.43114
Mode		.500[a]	.314[a]
Std. Deviation		.089277	.044063
Variance		.008	.002
Skewness		-.394	-.200
Std. Error of Skewness		.182	.182
Kurtosis		-.138	-.087
Std. Error of Kurtosis		.362	.362
Range		.451	.229
Minimum		.256	.314
Maximum		.707	.543
Sum		88.893	76.967

a. Multiple modes exist. The smallest value is shown

Table 6 - *Pearson Correlation – Winning Percentage and Gini Coefficient*

Correlations

		WinnPerc	Gini
Pearson Correlation	WinnPerc	1.000	.158
	Gini	.158	1.000
Sig. (1-tailed)	WinnPerc	.	.018
	Gini	.018	.
N	WinnPerc	178	178
	Gini	178	178

Table 7 - *Regression Summary – Winning Percentage (dependent variable) and Gini Coefficient (independent variable)*

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.035	1	.035	4.483	.036[a]
	Residual	1.376	176	.008		
	Total	1.411	177			

a. Predictors: (Constant), Gini

b. Dependent Variable: WinnPerc

Table 8 - *Model Summary of Research Question One*

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.158[a]	.025	.019	.088412	.025	4.483	1	176	.036

a. Predictors: (Constant), Gini

Table 9 – *Beta Levels of Research Question One*

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.361	.066		5.512	.000
	Gini	.319	.151	.158	2.117	.036

a. Dependent Variable: WinnPerc

Table 10 - *Descriptive statistics of all variables in Research Question Two*

		Salary	Games Played	Losses	Overtime Losses	Save Percentage	Shutouts	Shootout Wins	Shootout Losses	Shootout Save Percentage
N	Valid	245	245	245	245	245	245	244	244	244
	Missing	0	0	0	0	0	0	1	1	1
Mean		2634526.73	51.29	18.06	5.62	.90859	3.18	3.19	3.20	.66231
Std. Error of Mean		135849.483	.859	.393	.162	.000731	.150	.138	.115	.008610
Median		1700000.00	51.00	18.00	6.00	.91000	3.00	3.00	3.00	.67150
Mode		800000[a]	31	18	6	.916	2	2	4	.667
Std. Deviation		2126380.756	13.452	6.148	2.532	.011435	2.342	2.156	1.803	.134493
Skewness		.916	.101	.193	.116	-.357	.784	.881	.417	-.359
Std. Error of Skewness		.156	.156	.156	.156	.156	.156	.156	.156	.156
Kurtosis		-.222	-1.103	-.784	-.499	-.294	.362	.454	-.072	.845
Std. Error of Kurtosis		.310	.310	.310	.310	.310	.310	.310	.310	.310
Range		9550000	47	28	11	.059	11	10	9	.833
Minimum		450000	30	6	0	.879	0	0	0	.167
Maximum		10000000	77	34	11	.938	11	10	9	1.000

a. Multiple modes exist. The smallest value is shown

Table 11 - *Pearson Correlation of all variables in Research Question Two*

Correlations

		Salary	Games Played	Losses	Overtime Losses	Save Percentage	Shutouts	Shootout Wins	Shootout Losses	Shootout Save Percentage
Pearson Correlation	Salary	1.000	.436	.338	.264	.162	.233	.201	.201	.024
	Games Played	.436	1.000	.683	.550	.331	.497	.522	.430	.140
	Losses	.338	.683	1.000	.299	-.045	.150	.257	.227	.110
	Overtime Losses	.264	.550	.299	1.000	.236	.210	.122	.765	-.253
	Save Percentage	.162	.331	-.045	.236	1.000	.575	.249	.301	.053
	Shutouts	.233	.497	.150	.210	.575	1.000	.313	.257	.125
	Shootout Wins	.201	.522	.257	.122	.249	.313	1.000	.103	.489
	Shootout Losses	.201	.430	.227	.765	.301	.257	.103	1.000	-.347
	Shootout Save Percentage	.024	.140	.110	-.253	.053	.125	.489	-.347	1.000

Table 12 - *Regression Analysis for Research Question Two*

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.177E14	8	2.721E13	7.260	.000[a]
	Residual	8.808E14	235	3.748E12		
	Total	1.098E15	243			

a. Predictors: (Constant), Shootout Save Percentage, Save Percentage, Losses, Overtime Losses, Shootout Wins, Shutouts, Shootout Losses, Games Played

b. Dependent Variable: Salary

Table 13 - *Model Summary of Regression Analysis Research Question Two*

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.445[a]	.198	.171	1935990.674	.198	7.260	8	235	.000

a. Predictors: (Constant), Shootout Save Percentage, Save Percentage, Losses, Overtime Losses, Shootout Wins, Shutouts, Shootout Losses, Games Played

Table 14 – *Beta Levels of Research Question Two*

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	-7502564.294	12688597.552		-.591	.555		
	Games Played	49329.813	19979.991	.311	2.469	.014	.215	4.658
	Losses	40101.821	31258.142	.116	1.283	.201	.418	2.394
	Overtime Losses	54378.351	86397.892	.064	.629	.530	.326	3.072
	Save Percentage	7749096.633	14128784.179	.042	.548	.584	.588	1.699
	Shutouts	34892.425	72536.222	.038	.481	.631	.534	1.873
	Shootout Wins	2661.233	80283.665	.003	.033	.974	.515	1.943
	Shootout Losses	-52483.124	115528.807	-.045	-.454	.650	.356	2.812
	Shootout Save Percentage	-622819.320	1202554.179	-.039	-.518	.605	.590	1.696

a. Dependent Variable: Salary

Appendix B – Supplementary Figures

Figure 5 – *Lorenz Curve from 2005-06 to 2010-11 seasons*

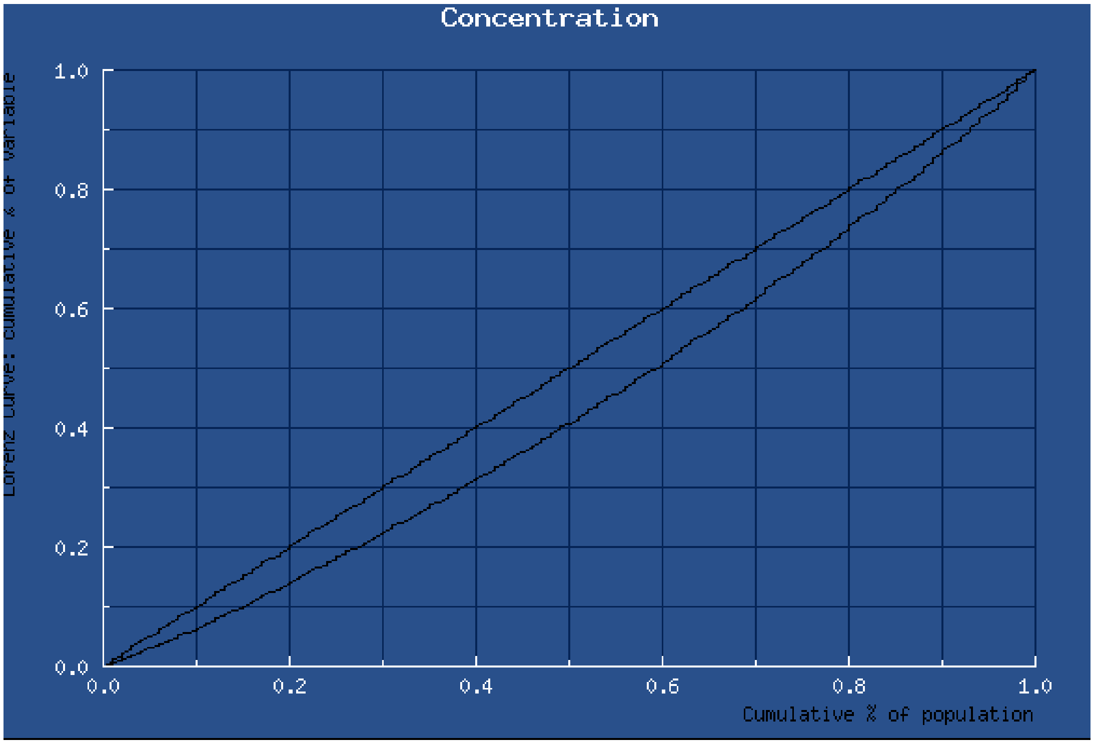

Figure 6 - *Salary Histogram*

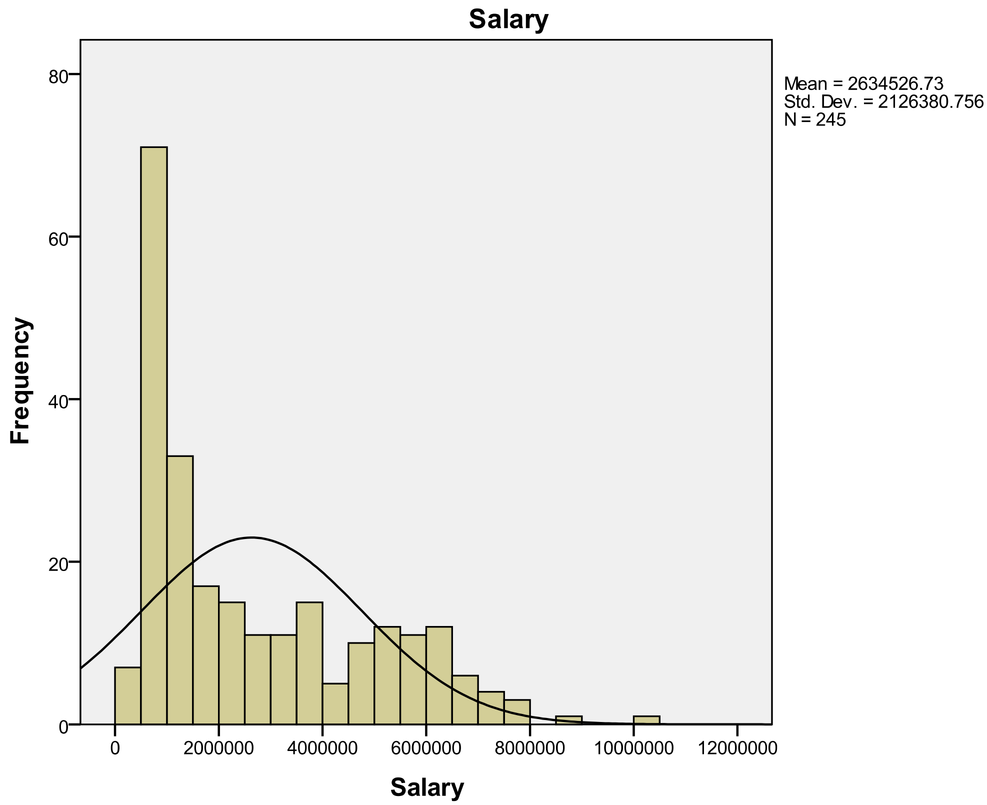

Figure 7 - *Games Played Histogram*

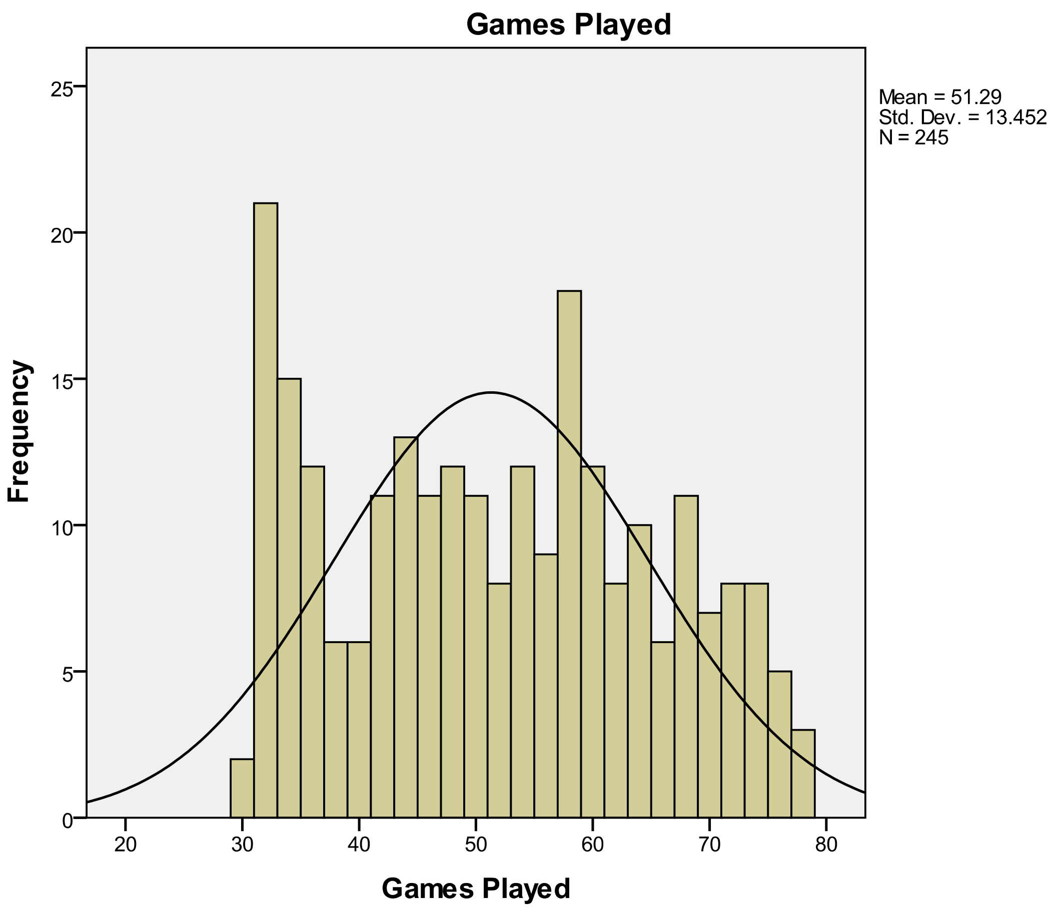

Figure 8 – *Losses Histogram*

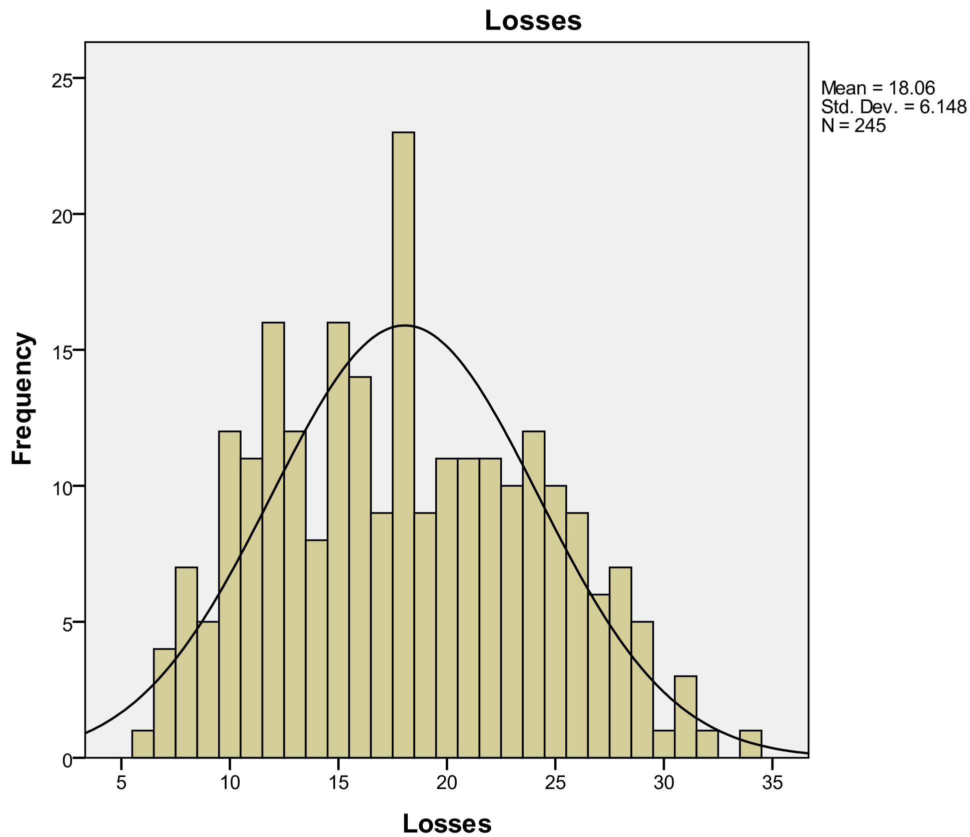

Figure 9 – *Overtime Losses Histogram*

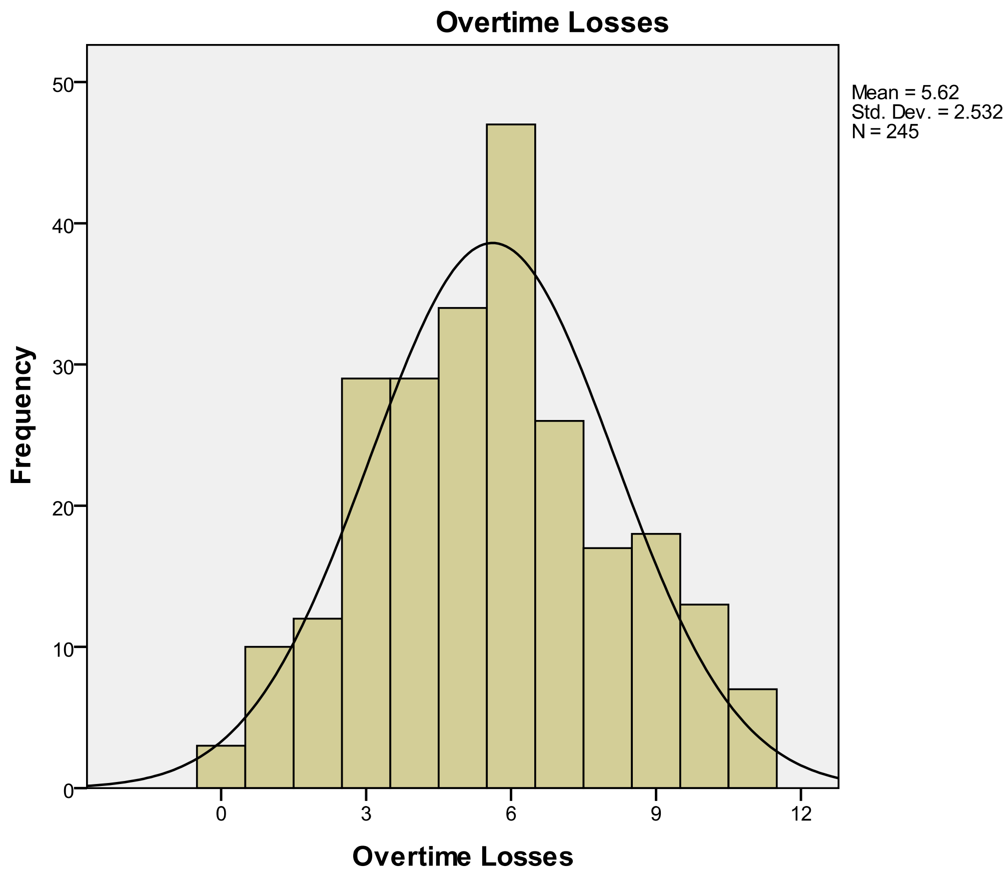

Figure 10 – *Save Percentage Histogram*

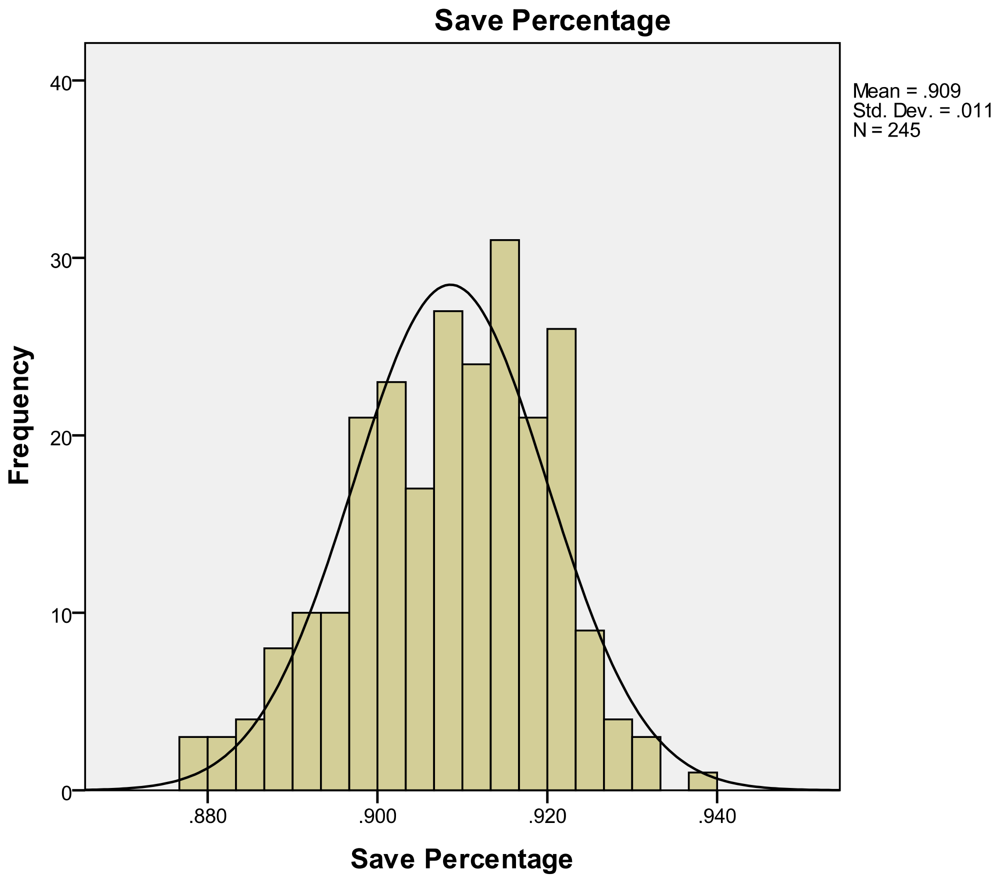

Figure 11 – *Shutouts Histogram*

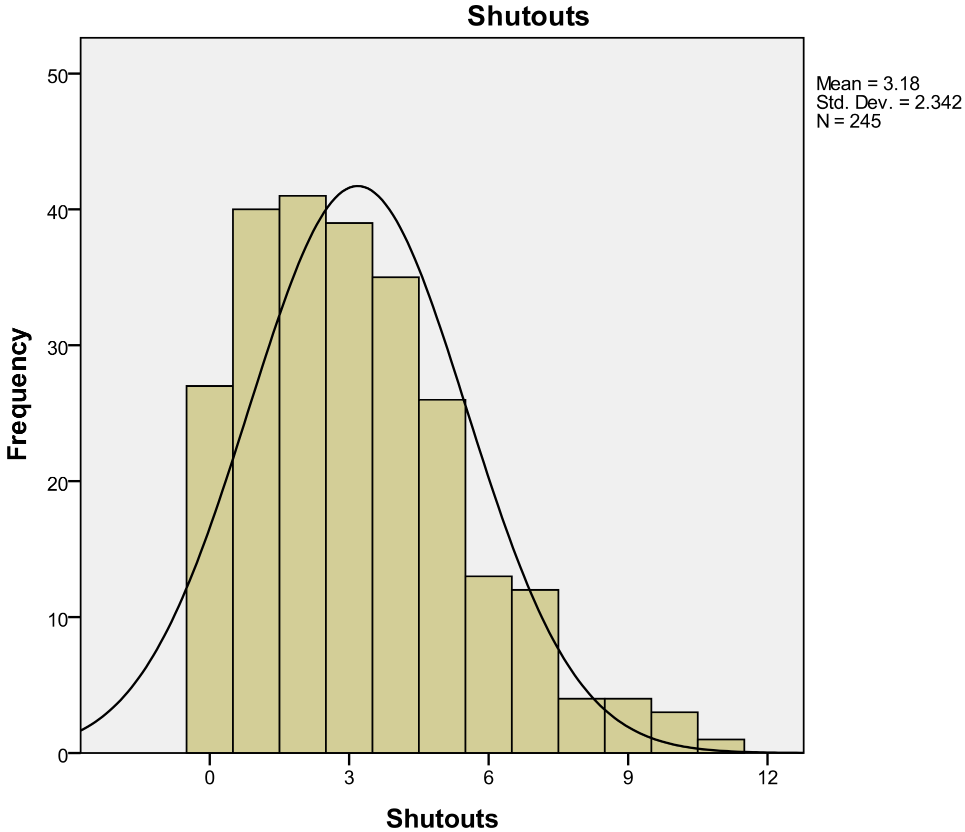

Figure 12 – *Shootout Wins Histogram*

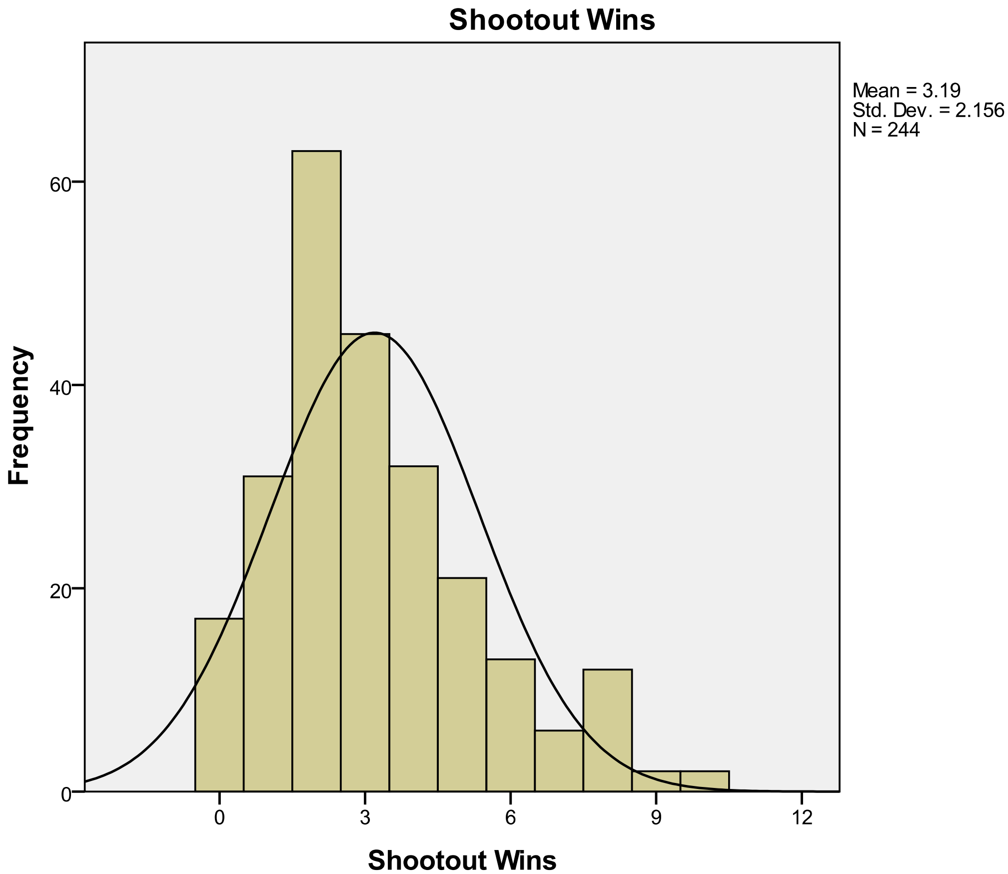

Figure 13 – *Shootout Losses Histogram*

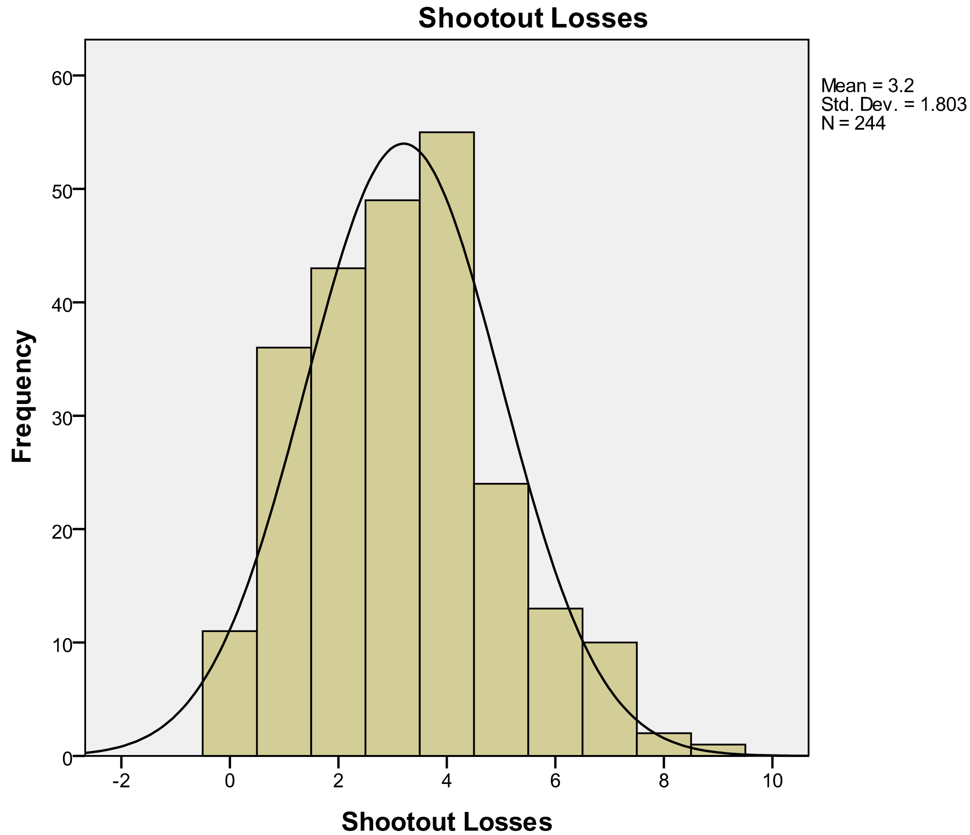

Figure 14 – *Shootout Save Percentage Histogram*

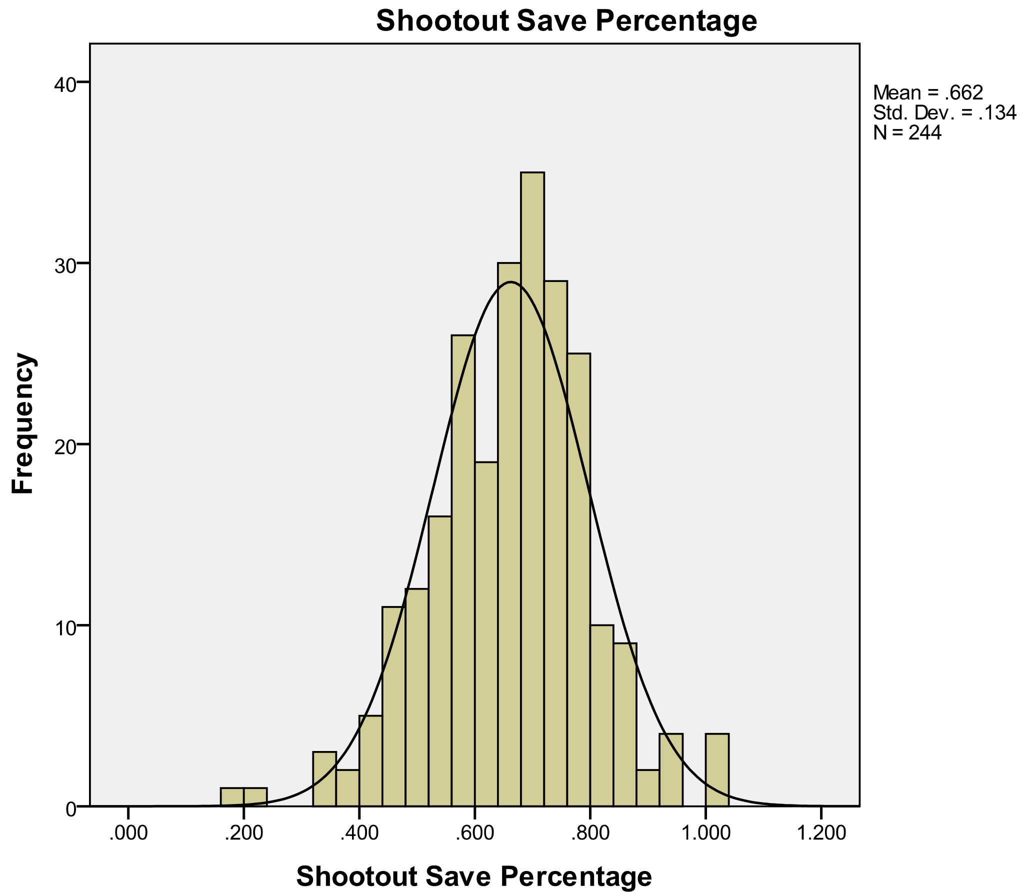

Figure 15 – *Scatter Plot Matrix Research Question Two Variables*