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# Shirking in the National Hockey League

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Shirking in the National Hockey League

by

Luke D. Cain

\* \* \* \* \*

Submitted in partial fulfillment  
of the requirements for  
Honors in the Department of Economics

UNION COLLEGE  
June, 2011

## **Abstract**

CAIN, LUKE D. Shirking in the National Hockey League Department of Economics, June 2011.

Advisor: Stephen Schmidt

Shirking has been examined in baseball and basketball, but never hockey. If Shirking is found to be evident in hockey, then management should give players shorter contracts and should pay a discount price if a long-term contract is given. The dependent variable for this study is shirking. There are many different independent variables and they are all different measures of performance (except for dummy variables for team and position). Most studies of hockey have minimal measures of performance, which are usually offensive statistics, but I will include defensive statistics as well. The sample for the study is players who participated in the 2007-08 and 2008-09 NHL seasons. These players also had to be under a contract that saw them make more than \$500,000 during the 2008-09 campaign. The salary data was compiled from NHLnumbers.com while the statistical data was taken from NHL.com. I am running a five stage regression analysis to test my shirking hypothesis. One possible measurement problem is that there is only data from two seasons, but there are still over 550 players tested. Shirking was not found in the NHL. The more years remaining on a player's contract does not decrease performance. However, a player's performance decreases as their likelihood of retirement at the end of their current contract increases. I will refer to the former traditional shirking because that is what most of the literature examines when testing for shirking. I will refer to the latter as non-traditional shirking.

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## **Chapter 1: Introduction**

Professional athletes sign contracts for millions of dollars and are paid regardless of how they perform. This leads many people to believe that players who sign multi-year contracts do not perform as well after signing one because their performance in the short-term will not change their current pay, and they will still have a chance to increase performance when their contract is closer to expiration: “If ever there’s a time for a player to walk the walk, it’s right before he’s about to walk” (Sports Illustrated, as is cited in Krautmann and Solow 2009). This decrease in performance is a result of a decrease in effort and the decrease in effort is known as shirking.

Evidence of shirking has been found in both baseball and basketball, but has never been examined in hockey. Performance in hockey is difficult to measure because there are many intangible assets that make up a player’s performance. Number of points scored is the most important performance variable, which is why high point producers have the highest salaries, but there are many other players who do not produce as many points but are still handsomely rewarded. In this paper I attempt to include measures of intangible assets as well as traditional measures of performance. Using these measures, I found that shirking does not occur in the National Hockey League (NHL) unless a player is in his last contract before retirement.

Are the findings in this paper correct? This is a function of the methodology and the data, but it should be shown that both areas are solid and properly supported. Another question that arises is the implication of these results. There are questions of what the results mean for managers who have to sign players as well as players who have to negotiate contracts. There is also the dilemma of how much to reduce pay for players who are likely to retire at the end of the contract due to shirking. Each of these issues are discussed and dealt with. Sometimes more

than one possibility is given because, in some instances, there is more than one solution to the same situation.

I focus the last discussion in this paper on what future researchers should examine. This is the first paper on shirking in the NHL and, as such, the area of study should be developed. I suggest some avenues for future research and expect other avenues to open.

Chapters two and three examine previous research on shirking and provide background information for those less familiar with the sport of hockey. Previous research on shirking in baseball and basketball provide solid models and ideas to help with my analysis of shirking in hockey. Previous research on performance in the NHL and salary determination provides a beginning model for evaluating player performance on more factors than simply points. The background information chapter is an overview for why certain performance variables were chosen to measure a player's performance. The importance of each performance variable is discussed.

Chapters four and five outline the shirking model and the data. In the model chapter I explain the theory of shirking, its implications, and I include graphical analyses. I then focus on the five-step regression equation used to determine whether shirking does occur in the NHL. In the data chapter I discuss where the data came from, what it explains, and how.

Chapter six examines the results of the five-step regression equation. Interpretations are not made in this chapter; it is simply an outline of the results and whether certain variables were significant, using a 5% significance level.

Chapters seven and eight discuss why certain results occurred and the implications of these results. The chapter seven discussions focus on why different results occurred. Chapter

eight gives advice to both players and managers based on the results. The results can be used in contract negotiations, and I explain how.

This final element of my paper is to determine the cost that teams incur based on shirking. Traditional shirking (decreased performance as years remaining increases) does not occur. Non-traditional shirking (decreased performance as the likelihood of retirement increases) does occur. The determination of the cost analysis will be outlined in the model chapter. The results chapter will display the results and the discussion and conclusion will explain why certain results occurred and their implications.



## **Chapter 2: Background Information**

### **A. Anecdotal Shirking Evidence**

For decades, people involved in both sports and economics have attempted to determine if a player's performance deteriorates after signing a long-term contract – if players shirk. An executive for player negotiations with the Cleveland Indians stated in 1986, “The experience of individuals clubs, and the industry as a whole is that for whatever reason, the player's performance is not the same following the signing of a new multi-year contract” (Butler).

Shirking is often claimed using anecdotal evidence, where an individual player is said to be proof that shirking exists. For example, Ilya Kovalchuk, in the last year of his contract (which was 2009-2010), scored 41 goals and added 44 assists for 85 points. So far this season he is on pace to have only 28 goals and 28 assists (through 59 games). This occurred after he signed a 15 year, \$100 million contract this summer. On the other hand, Alexander Ovechkin, after signing a 13 year \$124 million contract, scored 19 more goals than the year before and had one more assist for an increase of 20 points. Many more examples are available of players underachieving and overachieving which suggests that this debate cannot be solved through anecdotal evidence.

### **B. Hockey Statistics**

Statistics in hockey are hard to measure. It is a game unlike almost any other. It is unlike football as there are not frequent starts and stops in the play. It is also unlike baseball where the game is reset after every pitch. Because of these differences, both football and baseball can be dissected, through statistics, with greater precision. For example, in baseball, a pitch is a ball or a strike, the batter either hits the ball or he does not, the fielder either makes the out or makes an error, and when the play is over, everything starts again. Collecting statistics for a sport like

baseball tends to be easier because many plays in baseball are concrete. Conversely, hockey plays are made “on-the-fly” and there can be many “right” plays in the same situation. The problem of gathering statistical data and measuring individual performance in hockey is less when examining offensive players, but amplified when looking at defensive performance.

Offensive production is measured by awarding the player who puts the puck in the net a goal and the last two players who pass the goal-scorer the puck, assists. Measuring an individual’s ability to prevent the opposing team from scoring is difficult. The variables that I am using to judge performance are points, blocked shots, plus/minus rating, giveaways to takeaway ratio, ice time per game, short-handed ice time per game, face-off percentage, hits and games played.

Points are important because when a team scores more goals than their opponent, they win the game. Although assists are usually seen as less important, without them the goal would not have been scored. Offensive performers are usually the highest paid players on a team.

Blocked shots are important because it means that the player stopped a possible goal. Also, when a player blocks a shot it means that he was in the proper position; between the man he was guarding and the net. Positional play in hockey is very important but it is virtually impossible to measure, so some statistics, such as blocked shots, will help to measure this otherwise difficult variable.

The plus/minus statistic determines, with a few technicalities, how many goals a player’s team scores when he is on the ice, versus how many are scored against his team when he is on the ice. Every time a player’s team scores when he is on the ice, except while the other team has a power-play (meaning the player’s team has taken a penalty so they have less players on the

ice), a player is given a plus-1 rating. Every time a goal is scored against a player's team when he is on the ice, except when the opposing team has a power-play, they are given a minus-1 rating. The problem with this statistic is that a goal may be scored which has nothing to do with a specific player, but that player still receives a plus or a minus. However, over the course of a season, the statistic becomes useful as the goals that are scored, whether for or against, that are not a player's responsibility, are likely to even-out. This leads to the better, more productive, players having high positive ratings and the less-effective players having less positive ratings.

The giveaway to takeaway ratio is similar to the plus/minus rating. Every time a player has control of the puck and due to his actions, the other team gains control of the puck, that player is penalized with a giveaway. Every time the other team has control of the puck and due to the actions of a certain player they, or their team, gain possession of the puck, that player is awarded with a takeaway. This variable, unlike the plus/minus rating, examines the play of the individual player and not the play of his line-mates or players on the other team. The statistic is important for performance because if one's team has control of the puck, then they are able to score and the other team is not. The better this ratio is for a player (meaning more takeaways than giveaways), the more often he is gaining possession of the puck for his team, and the better chance they have to win.

Average ice-time per game and short-handed ice-time per game are measures of a player's offensive and defensive performance. Players with more time on the ice are trusted by their coaches more than players who are not on the ice as much. Sometimes this trust is for the player to score goals, and sometimes it is for players to stop the other team from scoring. The players who receive the most ice-time are usually the ones who are good at both scoring goals and stopping the other team from scoring. Short-handed ice-time per game is the measure of the

ice-time a player receives while the opposing team is on the power-play (as was discussed above the team that is short-handed has one or two less players on the ice because they have taken penalties). This statistic is almost solely a measure of a player's defensive ability. Although, on rare occasions, a team will score while they are short-handed, their purpose is to stop the other team from scoring. Because the team has fewer players on the ice, it is more important in these situations to use the best defensive players and thus it is a good measure of defensive performance.

There are two potential problems when looking at ice-time statistics. First, they depend partially upon the subjective judgment of the team's coach. There is the possibility that the coach is not playing the best players. However, coaches are highly trained individuals with the help of assistant coaches and general managers to determine who should be playing the most. Therefore, it is likely that the coaches are using their personnel correctly. The second potential problem is that the amount of ice-time a player receives depends upon how strong his team is. An average player in the league will receive more ice-time if he is on a below average team than if he is on an above average team. The individual does not change, but the circumstances he is in lead to a perceived increase or decrease in performance.

Face-off percentage is a statistic that is usually only relevant for centers because they take the majority of face-offs. To start every period, following every goal, and after every whistle in a hockey game there is a face-off. As soon as the referee drops the puck for a face-off, the game continues until the next whistle. Face-offs are important because the team that wins the face-off gains possession of the puck, meaning their team has the ability to score while the other team does not.

The amount of hits that a player delivers is a good statistic for a player's intangible assets and because both offensive and defensive players deliver hits, the statistic is relevant for all players. For example, Alexander Ovechkin, one of the top goal scorers and point producers in the NHL is also one of the hardest, and most frequent, hitters. Also, there are many defensive forwards who are very physical and deliver hits of a regular basis. Hits are important because they can 'wear a team down' over the course of a game and season, they can intimidate, and they make scoring more difficult for the opposition. Therefore, the more a player delivers hits, the more valuable he is to his team.

Games Played is another statistic that depends upon coaches or management decisions, but this paper assumes that the coach is playing the right players, and the players who are not as effective, or are hurt, are not being played.

### **Chapter 3: Literature Review**

Currently, there are no papers that examine shirking in the National Hockey League. Literature available on shirking in professional sports focuses on Major League Baseball (MLB), and the National Basketball Association (NBA). The conclusions reached through the MLB and NBA papers are mixed – some find that there is no shirking effect; others find that there is a shirking effect; still others argue that it depends on the measure of performance used (some only use basic statistics, while others use a more in-depth performance measure).

#### **A. Shirking in the Literature**

The papers that find shirking to be nonexistent have done so using more than one approach. Maxcy et al (2002) examines players in the last year of their current baseball contract and their first year of a long-term contract. These players are then compared to players of similar skill around the league. Skill is measured through expected performance, which is derived from a player's performance over the past three seasons. If performance has been declining, performance expectations drop. If performance has been improving, performance expectations rise. By comparing players who are in the year immediately before or after an expired contract, to others of similar skill, the sample size increases dramatically. No evidence of shirking was found, but this paper relied on the ability to determine which players in the league had similar skill. This problem is magnified in hockey because players of the same skill can perform differently depending on the ability of the players on their team and their line-mates. Furthermore, different teams have different philosophies, some of which are more defensive and others which are more offensive. Players who are in an offensive system are more likely to have greater offensive production than a player of comparable skill in a more defensive system. A rough example of these differences in philosophy is how a coach expects his team to win. An

offensive-minded coach wants his team to win by scoring lots of goals, while defensive-minded coaches want to win by limiting the amount of goals the opposition scores. Shown here is that hockey players of similar skill should perform differently based on circumstances.

One interesting aspect of the Maxcy et al (2002) paper is that although there is no evidence of shirking when looking at performance, players who are near the end of their contracts tend to play more and do not sit out as much due to injuries. This suggests that either players who are near the end of their contracts are more willing to play through minor bumps and bruises, or that coaches and management push these players to play injured. If the former is true, then the players examined do shirk by taking more games off for minor injuries. If the latter is true, then coaches and management are much more careful with the players that they are invested in for the long term and less careful with players who are near the end of their contracts. Both possibilities suggest a lack of morality in the sports world; however, it is outside the parameters of this study to determine why players with longer contracts miss more games due to injury.

Another paper finding no evidence of shirking in MLB is Krautmann (1990). He uses a more theoretical approach and although he does use statistics, he does not use regression analyses and has a sample size of only 110. He believes that players and management want to sign a contract after an above average season. The player wants to sign a contract after one of these “good” seasons because he wants to “cash-in” on his improved performance. Management wants to sign the player because they expect that these above average seasons will continue into the future and they want to secure their asset (player). However, the player is more likely to return to his mean in the year immediately following an above average season. After the long contract, or contract extension, is signed, and the player does return to his mean, he is accused of shirking.

This paper determines if a player is truly over-performing or under-performing based on an analysis of the standard deviations of his historical performance. Any performance by a player within two standard deviations of his mean is not considered shirking or over-performance but is rather considered regular fluctuation around the mean. Although the theory behind this is strong, the author does not take into consideration the effects of experience and age, which affect a player's performance over time. Also, regression analyses are a better method to determine whether shirking is an invention, or whether it is a real phenomenon. Regression analyses are better because they can hold constant other variables, such as age, when determining if a player's fluctuations are within two standard deviations, while looking at the data does not allow for control of other variables.

Marburger (2003) argues that the introduction of free agency in 1976 (allowing players more negotiation power) led to a shift in property rights from the owners to the players. He finds no evidence of shirking for those players who sign contracts longer than 2 years. However, Marburger did find that players, since the change in property rights, who received only 1 and 2 year contracts outperformed players with the same contract length from before property rights were switched. So, although shirking is not found in this paper, there is evidence of opportunistic behavior by players due to a greater incentive as their contract is set to expire; free-agents can negotiate with multiple teams and thus they can find themselves the best deal. Before the shift in property rights, players could not do this. Therefore, performing at a high level one or two years before a contract expires can be very rewarding financially. My paper examines performance depending on how many years a player has remaining on his contract. If Marburger's paper had done the same, then perhaps they would have found evidence of shirking in the first few years of a long-term contract. This would be true because players are performing



better with short contracts and thus they should be able to perform better with long contracts. Using this reasoning, players were shirking before the change in property rights in 1976, and continue to do so today. It just is not transparent until it is compared to performance when a player is in the final year or two of their contract. Both of these papers, Marburger (2003) and Maxcy et al (2002), do not find any evidence of shirking when examining performance, but they do find differences between players who have more than 2 years remaining on a contract and players who do not.

Articles by Krautmann and Solow (2009), and Krautmann and Oppenheimer (2002), both written about MLB, find that players shirk more as the length of a contract increases. Krautmann and Oppenheimer find that the coefficient of performance on length was negative and thus a player's performance decreases as length of a contract increases - a decrease of more than 30% was found. When length was not included in the regressions, there was no evidence of shirking. Krautmann and Solow used a similar approach as they examined performance over the length of the entire contract. They found that the fewer years a player had remaining on a contract, the less the player shirked. The only time this is not true is when a player is likely to retire. When a player is likely to retire, they have no incentive to reduce shirking as their contract is set to expire

According to Krautmann and Solow, there is a linear relationship between shirking and the number of years remaining on a player's contract. Whether this holds true in hockey is unknown. My paper will follow the Krautmann and Solow framework and examine player performance and the number of years remaining on a contract. This would have implications for salary negotiations. Knowing that performance decreases with contract length may be helpful; knowing how performance changes over the course of a contract is more helpful.

Krautmann and Oppenheimer (2002) state that the best players are the ones who receive the most money and the longest contracts. I argue that the best players also receive a premium for being one of a handful of elite players in the league. For this reason a premium is paid to them because they attract more fans, they make the players around them better, and they can be as productive as two average players. In the 2009/2010 NHL season only four players had more than 100 points, while the 100<sup>th</sup> leading scorer in the league had 50 points (there are approximately 600 players who play regularly in the NHL each season). So, one player who scores more than 100 points in a season is, using a very raw and basic measure of performance, more than twice as valuable as two players who are in the top 15<sup>th</sup> percentile for points. In other words, it takes two well-above average players to produce as much as one elite player. Eighteen players (excluding goalies) play each game. Having one elite player who produces double while only using one roster position is very valuable.

However, theoretically, players should be willing to accept a lower salary as the length of their contract increases. The player assumes less risk and has greater security the longer the contract. A drop in production or a serious injury can end a player's career, but they still get paid the remainder of their contract. Buying this security should result in the player receiving a lower salary.

Two factors are involved when examining long-term contracts. First, players who receive these contracts are usually the best players and are paid a premium. Second, players should give up salary to have the security of a longer contract. Disentangling these opposing forces is a study in itself which is why I do not follow the format of Krautmann and Oppenheimer who look at the return to performance and contract length. Instead, I follow the

Krautmann and Solow approach and will examine performance depending on how many years remain on a player's contract.

The other option when measuring shirking is to examine a player's performance the year before a contract expires and the year after a new contract is signed. Stiroh (2007) took this approach and applied it to the NBA. Stiroh found that shirking does occur in basketball; performance rises in the last year of a player's contract and falls the year following the signing of a new contract. Although these findings are important, I want to know the magnitude of shirking as an additional year is added to a contract, not just that performance increases or decreases in the year prior to, or after, the expiration of a contract. Stiroh's paper is simply an illustration of another method to determine if athletes shirk but it does not answer the question that my paper poses.

Two papers determine that the existence of shirking is dependent upon how performance is measured. Berri and Krautmann (2006) studied the NBA and found that, using traditional measures of performance such as points, assists, rebounds etc., shirking was found. However, if performance is measured using a more economic model, that measures the magnitude that each of these statistics has on a team's winning percentage, shirking was not found. Conversely, Krautmann and Donley (2009) examined shirking in MLB. They found that using the traditional measures of performance, namely OPS (on-base % plus slugging average), shirking was not found, but when using a more economic measure, a combination of Marginal Physical Product and Marginal Revenue, shirking was found. Determining an economic measure of a hockey player's performance would be its own study and thus, this paper will use traditional measures of performance. However, literature written on hockey leaves out some less obvious but very important measures of performance. By including these other measures, I hope to gain a truer

model of a player's performance and should be able to come to the proper conclusion on shirking in the NHL.

The model developed by Krautmann and Solow (2009) has four main parts; the first looks at the relationship between performance and experience; the second is a measure of shirking based on the player's past performance and how another year of experience will either help or hinder them; the third examines a player's likelihood of retirement. Finally, all three parts of the model are brought together to determine if a player shirks and the degree that it occurs. It also tests whether this changes if the player is planning on retiring at the end of their contract. A more in-depth explanation of the model is given in the Regression Equation section (4.B).

## **B. Measuring Hockey Performance in the Literature**

The last important pieces of literature to my subject are the papers that examine salary determination and, indirectly, performance in hockey. It is hard to judge performance in hockey using statistics because of the "flowing" nature of the game. There are many intricacies that are hard to put into a statistic, such as good positioning. Past research by Curme and Daugherty (2004), Lambrinos and Ashman (2007) and Jones and Walsh (1988) have focused on the determinants of a hockey player's salary. The determinants of salary should be strongly related to the determinants of a player's performance. These papers focus mostly on goals, assists and penalty minutes (there are other variables such as how many times a player played in the all-star game, but these variables only affect salary, not performance). The studies do not include hits, blocked shots, plus/minus rating, faceoff percentage, giveaway to takeaway ratio, ice time statistics or games played. Statistics that only examine points are good at measuring offensive

performance, but defensive players excel in other areas. In Lambrinos and Ashman's paper (2007), the variables used explain 68% of forward's salaries but only 57% of defensemen salaries. The extra variables that I have included should be able to explain a greater percentage of both offensive and defensive player's performance.

The Lambrinos and Ashman paper has a more sophisticated list of variables that affect salaries in the NHL than the other papers on the topic. On top of goals, assists and penalty minutes, they include power-play goals, game-winning goals and plus/minus. My measure of performance does not include penalty minutes, power-play goals and game-winning goals. A team's enforcer is paid to fight and take penalties, but for the majority of players, taking a penalty does not help the team and should not be considered positive performance. However, it cannot be considered negative performance because, as was just mentioned, some players are supposed to take penalties for intimidation purposes. Game-winning goals and power-play goals are not included because the correlation between the number of goals a player scores and their power-play and game-winning goals is very high. The better goal-scorers are usually used on power-plays, so they should have more power-play goals. Also, game-winning goals can be scored at any point during a game. For example, if a player scores the first goal of the game in the first period, and the opposing team does not score for the entire game, the player who scored the first goal is awarded a game-winning goal. However, the fact that he was awarded a game-winning goal is, in part, due to the opposing team not scoring. Sometimes goals are scored to break a tie near the end of a game, and players who tend to score those goals are more valuable because they play better under pressure, but there are no statistics measuring that phenomenon.

## **Chapter 4: The Shirking Model**

### **A. An Investigation of Why Shirking Occurs**

Players in the National Hockey League are paid their marginal revenue product. Value is given to different measures of performance and, based on this performance, a contract is offered. For example, goals are highly valued, so the player who scores a lot of goals has a high marginal product resulting in a high salary. However, while a player's marginal product changes over the course of his contract, his salary does not. The shirking model states that a player's marginal product will be greatest in the year immediately preceding the expiration of a contract. It also states that their marginal product will decrease the further the player is away from their contract expiring.

Shirking occurs because effort causes negative utility, shown in Figure 1. The graph shows that an increase in effort results in a decrease in utility. This model suggests that for a player to maximize utility, effort will be decreased.

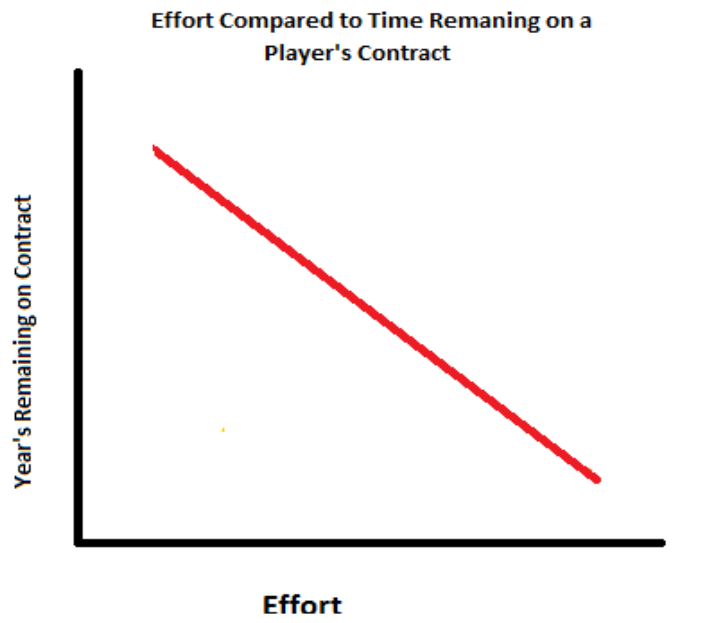
Using the same theory as Krautmann (1990), that management and owners are short-sighted, a player's effort will decrease as the amount of years remaining on a contract increases. This is shown in Figure 2.

This decrease in effort is evident not only in games, but also in practice, workouts and focus level. Players decrease effort because their contracts are almost entirely based on a fixed salary. Most players do not have substantial performance bonuses in their contracts, which removes the incentive to exert maximum effort. Players who exert maximum effort and increase their performance do not receive an increase in salary and players who exert minimum effort and decrease their performance do not receive a decrease in salary. With no incentive package

**Figure 1**



**Figure 2**



present, players are thought to display opportunistic behavior and exert less than maximum effort. This decrease in effort should increase as the years remaining on a player's contract increases.

As a player gets closer to the expiration of a contract, they exert more effort. In the year immediately preceding the expiration of a contract, maximum effort is exerted. General Managers pay for future performance, not past performance, which adds to the situation. The best predictor of future performance is past performance and, to be more direct, the best predictor is last year's performance. Theoretically, although the performance of a player over the course of his entire contract may play some role in his next contract, greatest weight should be given to the year immediately preceding the signing of a new contract.

Intuitively, if a general manager is wondering how a certain player will perform next season, he is going to give more weight to the season that was just completed, as opposed to a season five years ago. Over five years many factors change such as experience, age and skill development. These changes are usually subtle when examined from one year to the next but more definitive when looked at over five years. However, the year preceding the new contract is still heavily weighted as it gives the best indication of what the future performance will be. When recent seasons are more heavily weighted the player can mask poor performances in past seasons with good performance in the last year of the contract. This gives the player the ability to shirk early in a contract, and improve as the contract comes closer to expiration.

The only time the last season played should not be heavily weighted in contract negotiations is when the player was injured. In this case, the most weight should be given to the



player's last full season played. However, an injury that reduces the ability of the player, or is seen as recurrent, is considered in the contract negotiations.

To truly maximize a salary, maximum effort needs to be exerted over the course of the entire contract. While early years of the contract are not weighted as heavily as the final year, they are considered. Most players, like most people, discount the future and a small increase in future salary (for players with long-term contracts), is not worth an increase in effort now. This creates a double effect working toward the player shirking. The further a player is away from the expiration of the contract, the less that year will affect the salary of the next contract that is signed. Compounding that with the human inclination to discount the future, and the player is more likely to shirk the further they are from the end of the contract.

The final intricacy of the shirking model deals with the players who have plans for retirement at the expiration of their contract. These players have no incentive to increase effort as their contract is set to expire because they will not sign a new contract. Therefore, they can shirk at the same rate over the course of the entire contract.

## **B. Regression Equation**

I am using the same regression equation that Krautmann and Solow (2009) used in their paper. At the most basic level, shirking is the deviation of a player's expected performance,  $E(\text{PERF}_{t+1})$ , from their actual performance,  $\text{PERF}_{t+1}$ . The following is the formal equation:

$$\text{Shirk}_t = E(\text{PERF}_{t+1}) - \text{PERF}_{t+1} \quad (1)$$

If a player's actual performance is less than their expected performance, then they are said to be shirking. However, if a player's performance is greater than their expected performance then they overachieved, or they negatively shirked.

A player's actual performance is determined by looking at their statistics, but determining the expected performance is more difficult. Expected performance is a function of a player's age, injury history, and position. Multiple regressions have to be run in order to reach a player's expected performance. First, estimates must be made of player's performance based on age (Krautmann and Solow use experience instead of age but the two are basically measuring the same effect), and other variables that can have an effect on performance, which in the case of hockey, is position:

$$\text{Perf}_t = \beta_0 + \beta_1 \text{AGE}_t + \beta_2 \text{AGE}_t^2 + \beta_3 \text{POS}_t + \epsilon_t \quad (2)$$

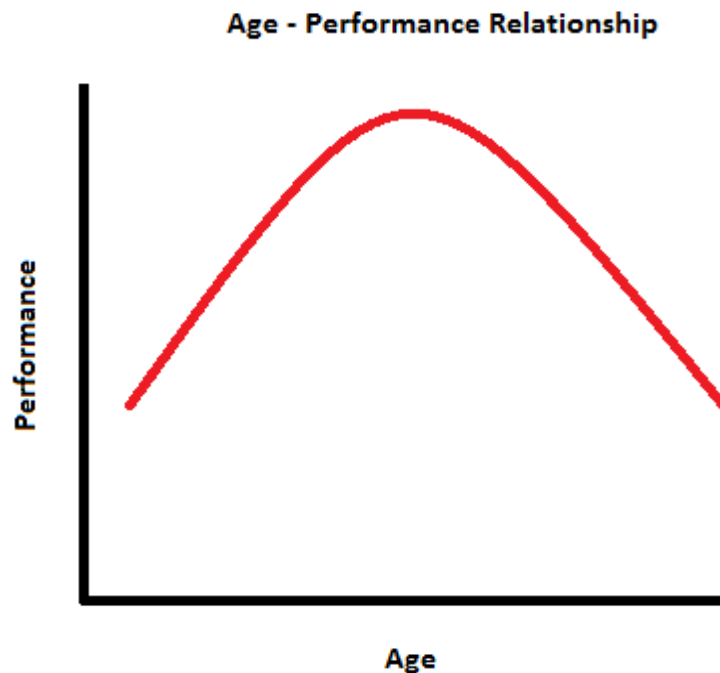
The effect of age has two opposing forces. As a player gets older, experience is gained, skills are perfected and positioning and "tricks" are learned and developed. On the other hand, as a player ages, the effects of another year of hockey start to "wear down" a player physically making them more prone to injuries and they can be perceived as fragile. Also, their reaction time usually diminishes. These two, opposing forces, lead to the assumption that age has a parabolic shape in terms of performance.

When a player is young, the effect of another year in the league gives the player a great deal of valuable experience and the negative effect of being one year older is almost negligent. In fact, the extra year may allow the player to develop more physically. The reason that age-squared is present in the equation is because after a certain point, the negative effects of being one year older outweighs the positive effects of having another year of experience. The graph of

a player's performance against his age should be a parabola. The time when a player's performance peaks is considered a player's "prime" and in hockey, players are thought to be in their prime in their mid to late 20's. The nature of the parabola is that at the beginning of a career the positive effects of an extra year's experience greatly outweigh the negative effects of being one year older. The distance between these two effects diminishes until they are equal as is shown in Figure 3. This occurs at the peak of the parabola. Each year after the peak, the negative effects of being one year older outweigh an extra year of experience and a player's performance deteriorates.

Position is also included in this equation because different positions are more likely to excel in different performance statistics. For example, forwards are more likely to score goals while defensemen are more likely to block shots and get hits. In addition, defensemen usually

Figure 3



get more ice-time than forwards because teams normally dress only three lines of defensemen while there are four lines of forwards. Including this variable should control for the changes in performance, based on position.

There are many performance variables, so regression (2) has to be run for each performance statistic to get the age and position effect. Once these estimates are determined, the effect of one more year of performance is determined for each performance statistic. An increase in age of one year has the following effect based on equation (2):

$$\frac{\partial PERF}{\partial AGE} = \hat{\beta}_1 + 2 * \hat{\beta}_2 * Age$$

For each performance variable, this has to be applied to get a player's expected performance:

$$E(PERF_{t+1}) = Perf_t + (\hat{\beta}_1 + 2 * \hat{\beta}_2 * Age) \quad (3)$$

Expected performance is then transported into equation (1) and shirking can be found for each performance variable. However, the main goal is to see the effects of shirking as years remaining on a contract increases. Another hypothesis was that a player in their last contract will continue to shirk no matter how many years remain on a contract.

Some players do not know if they will retire or continue to play professional hockey after their current contract expires. Presumably, this decision is based on three factors; their age at the end of their current contract (AGEEND), which is equal to their current age plus the number of years remaining on their contract; the number of games missed (Krautmann and Solow use the player's time on the disabled list, but hockey does not have the same system . Therefore, I use games missed and assume that if a player missed games due to injuries or a coach's decision, both would make the player more likely to retire); and their performance. As a player's

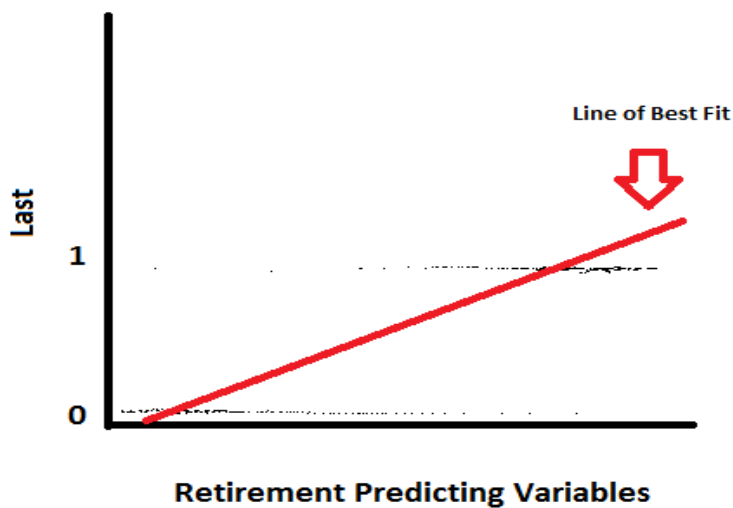
performance decreases they are more likely to retire because they are less confident about their ability to play the game and are offered less money (if they are offered anything at all) for their next contract. The equation to estimate the probability that a player will retire has all three of these elements:

$$\text{Last}_{t+\delta} = \lambda_0 + \lambda_1 \text{Games Played}_{t+\delta} + \lambda_2 \text{PERF}_{t+\delta} + \lambda_3 \text{AGEEND}_{t+\delta} + \epsilon_{t+\delta} \quad (4)$$

Because the performance variables are on the right side of the equation, this regression only has to be run one time. Each performance variable is put into the regression and this can give a probability of retirement based on Games Played, AGEEND and all the performance variables.

However, this regression has a dummy variable on the left side of the equation, so in order to get a more realistic probability of retirement, I used a probit model. As is shown in Figure 4, if a simple regression was run, the line of best fit would have a very low r-squared value.

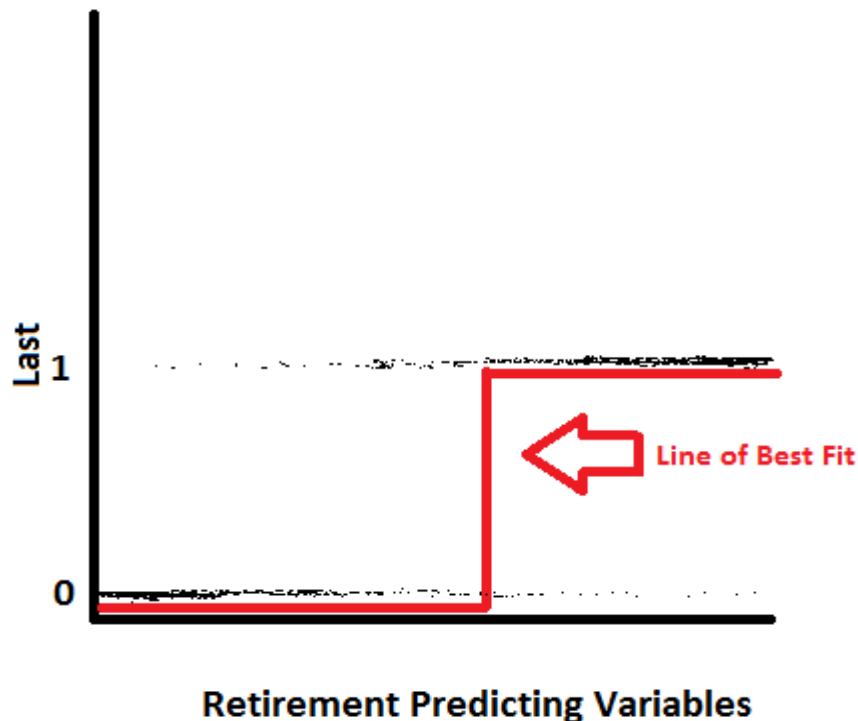
Figure 4



The graph shows that each player has a unique combination of the variables that predict retirement and based on the knowledge of whether the player retired or not (Last = 1 for player retired, or Last = 0 if a player did not retire), a probability can be formed for each player. Because the contract data for this analysis is from 2008-09, only players with one or two years remaining on their contracts can be used on the left side of the equation – Last. For players who are still in the midst of their contract, it is unknown whether or not they will retire when it expires. For the analysis, a player who was still in the midst of a contract was given an N/A for the dummy variable Last.

Figure 5 shows how the probit model fixes the problem illustrated in Figure 4.

Figure 5



Note that the line of best fit is not on the actual data points because otherwise the data points would not be visible.

As the graph shows, the probit model gives a much better fit to the points. It also forecasts the predicted values of each player's probability of retirement. The further right a player is on the X-axis, the greater the player's probability of retirement.

The final regression determines the performance effects of an extra year remaining on a player's contract, the effect of it being a player's "Last" contract, and the interaction between these two terms:

$$\text{Shirk}_t = \alpha_0 + \alpha_1 \text{Years Left}_t + \alpha_2 \widehat{\text{Last}}_t + \alpha_3 \text{Years Left}_t * \widehat{\text{Last}}_t \quad (5)$$

The shirking hypothesis suggests that  $\alpha_1$  should be positive, meaning that for each additional year a player has left on his contract, the more he is going to shirk. The hypothesis also suggests that  $\alpha_3$  should be negative and approximately equal to  $\alpha_1$ . As Years Left moves toward zero, it is expected that shirking diminishes as long as the player expects to sign a new contract.

Therefore,  $\alpha_0$  should be close to zero. As Years Left moves toward zero, and the player expects to retire, shirking should not change because there is no incentive to increase performance. As Years Left becomes zero, both  $\alpha_1$  and  $\alpha_3$  become zero, and because  $\alpha_0$  is expected to be a number close to zero,  $\alpha_2$  needs to be positive to keep the shirking effect of a player who plans on retiring.

In Equation (5), Shirk is on the left side and therefore I have to calculate shirking for each performance variable. It may be found that shirking is present for some performance variables and not others. Ideally, it would be better to have a single measure of performance like they have in baseball, but until someone can combine all the elements of a hockey player's performance into an aggregate measure, authors will have to use individual shirking regressions.

The five-step regression analysis is completed using the following steps.

1. Estimate equation (2) for each performance variable to determine the affect of age and position.
2. Determine the expected performance for each variable using equation (3)
3. Determine the amount that players shirked each variable using equation (1).
4. Determine the likelihood that players will retire using equation (4).
5. Finally, using equation (5), find the amount players shirk each variable based on the amount of years remaining on their contracts and the likelihood that this is their last contract.

### **C. Determining the Cost of Non-Traditional Shirking:**

To determine the value of each performance variable, they have to be regressed against salary:

$$\text{Salary} = \beta_0 + \beta_1 \text{Blocks07} + \beta_2 \text{PlusMinus07} + \beta_3 \text{Hits07} + \beta_4 \text{Points07} + \beta_5 \text{SHTOI07} + \beta_6 \text{TOI07} + \epsilon \quad (6)$$

Contract data is from the 2008-09 season so the statistics that should matter the most are those from 2007-08 (for player's who had to re-sign a contract after the 2007-08 season). For players who did not sign new contracts, their performance would not change their salary.

I am examining a player's probability of retirement so I will focus on a 10% increase in the probability of retirement. The coefficients corresponding to  $\widehat{Last}_{Hockey}$ , which were determined through the shirking regressions imply a 100% increase in a player's probability of retirement. It is more practical to judge the cost based on 10% increments; each coefficient under  $\widehat{Last}_{Hockey}$  will be multiplied by 0.1 to obtain the 10% increments.



Regression (6) gives a monetary value of each performance variable. Determining the value lost (which I will call “cost”) of a player who shirks is done by multiplying the amount of shirking in each performance variable by the value of that variable to a team. The value of shirked blocked is equal to Blocks Shirked \* Value of a Block. The overall cost of a player shirking is equal to Value (which changes for each performance variable)\* (Blocks Shirked+ GiveTake Shirked+ Hits Shirked + PlusMinus Shirked + Points Shirked + SHTOI Shirked + TOI Shirked). The cost of shirking will only be calculated for  $\widehat{Last}_{Hockey}$  for reasons outlined in the Discussion section.

## **Chapter 5: Data**

My sampling only includes players with performance statistics (from NHL.com), and contract data and age information (both from NHLnumbers.com) from the 2007-08 and 2008-09 seasons. Almost all players making \$500,000 or less are on “two-way contracts,” (contracts with a provision for paying players less for minor league play than for NHL play). Almost all these players spend very little time at the NHL level. Therefore, I only sampled players making more than \$500,000. Players who only played in one season are also omitted from the sample. By playing in only one of the seasons the players do not have the information needed to run the necessary regressions.

I sampled 568 players. Each of the thirty NHL teams play eighteen players per game (excluding goalies), for a total of 540 active players. However, poor performance and significant injuries often forces teams to give playing time to more than eighteen players (in 2008-09 885 players appeared in at least one game). Using my criteria outlined above, 568 players appear in my sample which is a good representation of the regular NHL players.

The following table, Table 1, shows the descriptive statistics for player’s performance in the 2007-08 NHL season. Several statistics listed here (and in Table 2) require an explanation. Although every faceoff has a single winner and loser, the mean is well below 50% because players who did not participate in a face-off are given a percentage of zero. Players at the center position take almost every faceoff in a game and in the regression analysis, position is controlled for. The mean of the Giveaway/Takeaway Ratio is not zero because every giveaway does not mean there was also a takeaway, but every takeaway does imply a giveaway. It is for this reason that the mean is negative (giveaways are minuses in this statistic).

<b>Table 1</b>		
2007-08 Performance Statistics		
	Mean	St. Dev.
Goals	10.54	10.02
Assists	18.05	13.99
Points	28.59	22.35
Blocks	42.97	40.44
Faceoff %	29.48	26.54
Games Played	63.27	20.98
Giveaway/Takeaway Ratio	-3.96	16.29
Hits	66.93	48.82
Plus/Minus	0.48	10.14
SHTOI	1.51	1.29
TOI	16.6	4.64

It should also be noted that TOI includes SHTOI, but it is necessary to include it separately (for reasons discussed in the Background section). So, SHTOI is, in a sense, being double counted. However, SHTOI is a relatively small number compared to TOI so it should not be a problem. Finally, for TOI and SHTOI, a mean of 1.50 is one minute and thirty seconds. The numbers following the decimal are on a scale from 0-99, not 0-60, so a simple calculation is needed to change SHTOI and TOI into minutes and seconds. The rest of the statistics are self-explanatory.

Table 2 shows descriptive statistics for player performance in the 2008-09 NHL season. Most statistics in 2008-09 are similar to their counterparts from a year earlier, but there are some upward trends. Goals were up by approximately half a goal per player and assists were up by more than one assist per player. Blocks increased by 6 per player and hits increased by almost 10 per player. These increases are likely regular fluctuations around the mean, although it is

<b>Table 2</b>		
2008-09 Performance Statistics		
	Mean	St. Dev.
Goals	11.01	10.02
Assists	19.19	13.78
Points	30.28	22.08
Blocks	48.94	43.91
Faceoff %	29.14	25.15
Games Played	65.84	17.57
Giveaway/Takeaway Ratio	-3.53	16.63
Hits	75.57	51.72
Plus/Minus	0.05	10.62
SHTOI	1.49	1.21
TOI	16.66	4.47

possible that a change in the style of play between the two seasons may have also been a contributing factor.

Table 3 examines contract and salary data from the 2008-09 season. As the table shows, more than 40% of the contracts examined are in their final year. Also, more than 70% of them are either in their last year, or second last year. The years remaining statistic is not the length of a contract, but rather the years remaining on a contract. For reasons discussed above,

<b>Table 3</b>	
Salary Statistics	
	Salary (\$)
Minimum	508,000
Maximum	10,000,000
Mean	2,329,006
St. Dev.	1,909,689
Years Remaining	Number of Contracts
1-year	241
2-year	159
3-year	79
4-year	43
> 4-years	46

\$508,000 is the lowest salary in the sample.

I used two different measures to calculate if it was a player's "last" contract. First, it was considered a player's last contract if he retired from hockey completely and did not play professionally the year following the expiration of his contract. This is called "Last Hockey". The other rationale is if the player's next contract was not with the NHL. This includes all the players from Last Hockey and adds players who signed their next contract in the minors or in Europe. Table 4 shows the summary of these statistics. The table shows that there were 35 players ( $78-43 = 35$ ) who continued to play professional hockey after their contract expired, but they did so in a league other than the NHL. The Re-signed data refers to players who re-signed contracts and continued to play hockey in the NHL. The contract data is from the 2008-09 season and therefore, only players with one-year or two-years remaining on their contracts can be said to have either been in their last contract or have re-signed another contract. The players who had more than two-years remaining in 2008-09 are listed under Current Contract; it is unknown whether they will retire or re-sign.

<b>Table 4</b>		
Last Contract Data		
	Last Hockey	Last NHL
Last Contract	43	78
Re-signed	357	322
Current Contract	168	168

## Chapter 6: Results

### A. Two Tests of the Shirking Hypothesis

I ran two sets of regressions that are outlined in the Regression Equation section 4.B. For each of the final two sets of regressions (regression (5) using  $\widehat{Last}_{Hockey}$  or  $\widehat{Last}_{NHL}$ ), there were nine independent regressions. Section 4.B also outlines the shirking tests. Shirking is occurring when  $\alpha_1 > 0$ ,  $\alpha_3 < 0$  and approximately equal to  $\alpha_1$ ,  $\alpha_0 = 0$ , and  $\alpha_2 > 0$ . My null hypothesis is that shirking does occur in the NHL. The first set of regressions uses Last Hockey as the measure of last contract. These results are given in Results Table 1. The performance variables given under “Shirked Stat” are representative of how much the players shirked. For example, the first row is for Blocks and this refers to how many blocks the player shirks, not how many blocks he has every season. This is true for all variables except Games Missed, which simply refers to the amount of games a player missed in a season.

As is shown in the table, the coefficient of Years Left is only significant for Games Missed and Plus Minus, while being nearly significant for Points. The coefficient on Years Left\* $\widehat{Last}_{Hockey}$  is only significant with Games Missed and Plus Minus. However, the sign on Games Missed does not support the shirking hypothesis. It suggests that the longer a player’s contract, the more games he will play (or the fewer games he will miss). The coefficients for  $\widehat{Last}_{Hockey}$  are significant which suggests that players perform worse if they believe their current contract will be their last. As expected, the R-squared value is highest for Points, but surprisingly it is also quite high for Time On Ice. The interaction term between Years Left and  $\widehat{Last}_{Hockey}$  is only significant for Gamers Missed and Plus Minus, and again, the sign for Games Missed does not support the shirking hypothesis.

Results Table 1

Shirked Stat	Constant	Years Left	$\widehat{Last}_{Hockey}$	Years Left*( $\widehat{Last}_{Hockey}$ )	R-Squared
Blocks	<b>-9.73</b>	1.03	<b>34.79</b>	-3.53	0.038
T-Stat	-4.32	1.21	3.48	-0.96	
Faceoff	-0.32	-1.05	19.38	3.39	0.034
T-Stat	-0.14	-1.2	1.89	0.89	
Give/Take	-1.76	0.69	0.48	-1.31	0.004
T-Stat	-1.42	1.47	0.088	0.06	
Games Missed	<b>27.47</b>	<b>-3.81</b>	<b>-17.94</b>	<b>6.46</b>	0.058
T-Stat	15.75	-5.79	-2.32	2.26	
Hits	<b>-13.94</b>	0.66	<b>40.62</b>	1.49	0.044
T-Stat	-4.24	0.53	2.79	0.28	
Plus Minus	<b>-2.71</b>	<b>1.29</b>	<b>10.58</b>	<b>-3.55</b>	0.019
T-Stat	-2.45	3.09	2.16	-1.96	
Time On Ice	<b>-0.47</b>	-0.01	<b>5.48</b>	0.05	0.146
T-Stat	-2.2	-0.08	5.8	0.14	
SH Time On Ice	-0.14	0.01	<b>0.96</b>	-0.04	0.037
T-Stat	-0.6	0.53	3.04	-0.6	
Points	<b>-6.16</b>	0.74	<b>27.8</b>	1.91	0.164
T-Stat	-5.24	1.66	5.33	0.99	

Using a 5% significance level, significant coefficients are shown in Bold.

Results Table 2 shows the coefficients, t-stats and r-squared values for each of the performance variables. In these regressions, the player is considered to be in his last contract if in 2009-10, or 2010-11 the player was no longer in the NHL. This includes players in the minors, in Europe and those retired from hockey.

As is shown below, the coefficients and T-Stats are higher when using  $\widehat{Last}_{NHL}$  instead of  $\widehat{Last}_{Hockey}$ . For Years Left, Points becomes significant and the two that were significant in Results Table 1, remain significant. Blocks Shirked also move substantially closer to the 5% significance level. It is interesting that when using this measure of a player's last contract, none of the interaction terms, Years Left\*Last, are significant, which is different from Results Table 1.

Results Table 2

Shirked Stat	Constant	Years Left	$\widehat{Last}_{NHL}$	Years Left*( $\widehat{Last}_{NHL}$ )	R-Squared
Blocks	<b>-15.36</b>	1.45	<b>45.97</b>	-2.42	0.11
T-Stat	-6.28	1.66	5.36	-0.74	
Faceoff	-0.54	-0.83	9.89	2.26	0.015
T-Stat	-0.2	-0.88	1.07	0.63	
Give/Take	-1.09	0.63	-2.44	-0.95	0.008
T-Stat	-0.78	1.27	-0.5	-0.51	
Games Missed	<b>25.47</b>	<b>-3.7</b>	-2.26	4.57	0.06
T-Stat	12.94	-5.25	-0.33	1.73	
Hits	<b>-20.43</b>	0.98	<b>50.31</b>	3.12	0.1
T-Stat	-5.68	0.76	3.99	0.65	
Plus Minus	<b>-4</b>	<b>1.4</b>	<b>13.07</b>	-2.83	0.029
T-Stat	-3.23	3.15	3	-1.7	
Time On Ice	<b>-1.2</b>	0.08	<b>6.33</b>	-0.1	0.24
T-Stat	-5.27	1.04	7.94	-0.34	
SH Time On Ice	-0.15	0.03	1.01	-0.06	0.052
T-Stat	-1.83	1.03	3.63	-0.57	
Points	<b>-10.28</b>	<b>1.16</b>	<b>33.21</b>	1.34	0.28
T-Stat	-8.35	2.62	7.68	0.81	

Using a 5% significance level, significant coefficients are shown in Bold.

It should be noted that the coefficients under  $\widehat{Last}_{Hockey}$  and  $\widehat{Last}_{NHL}$  is not a reflection of a player's increased age. Players are more likely to retire as they get older.  $\widehat{Last}_{Hockey}$  and  $\widehat{Last}_{NHL}$  are based on probabilities of retirement. Older players do not perform as well, but these results are not due to a player being old because the effect of age was accounted for in section 4.B, equation (2). Therefore, this decrease in performance is due to a player not performing at potential because they know they will not have to sign another contract.

The above tables allow me to reject the null hypothesis and suggest that shirking does not occur in the NHL.  $\alpha_2$  is positive and significant in most cases which supports the shirking



hypothesis, but this alone does not prove shirking; it proves that players act opportunistically when they do not plan on signing another contract.

## B. The Cost of Non-Traditional Shirking

Results Table 3 shows the value that each performance variable has on a player’s salary. Three of the performance variables have negative coefficients, meaning that if a player increases that performance variable (which should be a good thing), their salary will decrease. A closer look is needed to see what is actually going on. For PlusMinus, the T-stat is very small and the value is also small. A player does not have a great deal of control over his own PlusMinus, as it is often affected by something out of his control, so I will assume this value is zero. The Give/Take ratio is negative, probably because offensive players (who are paid more) try more “moves” when they have the puck and this will lead to more giveaways. More defensive

**Results Table 3**

2007 Performance Variables	Value (\$)
Blocks	1,405
T-Stat	0.66
Give/Take	<b>-12,543</b>
T-Stat	-3.16
Hits	497
T-Stat	0.38
PlusMinus	-3,646
T-Stat	-0.62
Points	<b>40,629</b>
T-Stat	11.65
SHTOI	-56,106
T-Stat	-0.88
TOI	<b>130,214</b>
T-Stat	6.26

Using a 5% significance level, significant coefficients are shown in Bold.

players are inclined to make the safe play, which is not considered a giveaway, but it does not usually lead to offense. Furthermore, offensive players are likely to have the puck more often because of their skill and thus they have a better chance of giving it away. It is for these two reasons that the coefficient for Give/Take is negative. The coefficient for SHTOI is negative because it is usually the more defensive players who are on the penalty kill. In some cases they are better at it because they have more experience in those situations, and in other cases it is because the team wants to protect their offensive, and more valuable, assets. Penalty killers have to block many shots, which can lead to injuries, so teams do not like to use their top players in these situations.

Faceoff percentage and Games Missed are left out of the analysis. Players in their last contract play more games, meaning they do not cost their team anything because they do not shirk. Faceoff percentage is not included because of the problematic nature of the variable in terms of percentages and the very low T-stat associated with Faceoff Percentage tests. Therefore, I discarded that statistic from the shirking cost analysis.

The coefficients that are negative will be treated as zero, because a team is not going to pay less for a player who does a good thing. The coefficients that are positive will be used as they are shown, independent of their significance level. Some aspects of a player's salary will not appear significant (such as blocks), but teams do take these stats into consideration with defensive players, so it is important to use them, even if they are not significant at the 5% level.

The cost of non-traditional shirking is as follows:

$$\text{Shirking Cost} = (1450)(3.479) + (497)(4.062) + (40629)(2.78) + (130214)(0.548)$$

Shirking Cost = \$191,369/year for a 10% increase in a player's likelihood of retirement. This amount is per year because the performance variables used are yearly, and the shirking calculations are per year.

## Chapter 7: Discussion

### A. $\widehat{Last}_{Hockey}$ vs. $\widehat{Last}_{NHL}$

The difference between  $\widehat{Last}_{Hockey}$  and  $\widehat{Last}_{NHL}$  has been discussed, but the reasons for the discrepancies between the results, using these two measures, have not been discussed. The players included in  $\widehat{Last}_{NHL}$  but not  $\widehat{Last}_{Hockey}$  can be broken into two main categories; the first are young players who did not prove themselves in the NHL and their next contract is in the minors; the second are older players who still want to play professional hockey and they go to Europe (either because the NHL does not want them or they want to be a more important player on their team). These players maintain an incentive to exert effort.

Young players in the NHL make approximately five times more money than their counterparts in the minors. This leads to a huge incentive for “bubble” players to exert maximum effort in order to stay in the NHL. Older players who decide to finish their careers in Europe maintain an incentive to perform well in order to maximize their salary in Europe. Although NHL players are paid very competitive salaries in Europe, they are still subject to change based on performance. European teams want to pay a player his marginal revenue product. Therefore, better performance before playing in Europe leads to a higher salary.

$\widehat{Last}_{NHL}$  (Results Table 2) indicates more shirking than  $\widehat{Last}_{Hockey}$  (Results Table 1). However, I just illustrated that the players who are included in  $\widehat{Last}_{NHL}$  but not  $\widehat{Last}_{Hockey}$  have an incentive package. The players who appear in both categories (meaning players who retired), do not have a monetary incentive package. This suggests that shirking in  $\widehat{Last}_{NHL}$  should be lower because a greater incentive should lead to greater effort. Therefore, the exertion of effort

does not guarantee improved performance. It appears that the apparent increase in shirking from  $\widehat{Last}_{Hockey}$  to  $\widehat{Last}_{NHL}$  is due to reverse causality; the decrease in performance led to players going to the minors or to Europe, they did not shirk because they knew they were not playing in the NHL next season. The problems associated with  $\widehat{Last}_{NHL}$  make it less desirable to the research than  $\widehat{Last}_{Hockey}$ . For the rest of the paper I will use  $\widehat{Last}_{Hockey}$  when talking about shirking as the likelihood of retirement increases.

## **B. Interpreting Traditional Shirking**

The results indicate that shirking, in the traditional sense, does not occur in the NHL. By traditional, I mean that as the number of years remaining on a contract increases, performance decreases. The results indicate that this is not happening in hockey, except with the Plus/Minus variable. As I indicate in the Background Information chapter, Plus/Minus is not a great measure of an individual's performance, meaning it likely occurred by chance. Krautmann and Solow (2009) found that traditional shirking is happening in baseball; why are the results different in these two sports? The culture of each sport may be creating the difference or it could be due to the differences of the individuals who play the sports. Presumably all people react to incentives and this should not change based on the sport someone plays.

One reasonable explanation is that hockey players are under more pressure to perform at a high level than baseball players, not because of the nature of the sport, but because of the pressures put on them by their teammates. In baseball, when a player underperforms he is not helping his team win, and in this way his teammates are affected, but he is not bringing down the performance of his teammates. In hockey, if a player is performing poorly he is hurting his teammates by not helping the team win but he is also lowering the performance of his line-mates

and the players he is on the ice with. This leads to a double set of pressures from his teammates; there is the pressure to help the team win from all of the potential shirker's teammates, as well as the added pressure from the players that the potential shirker plays with on a regular basis. If one of the potential shirker's line-mates is in the last year of his contract, he wants to perform as well as possible in order to maximize his next contract's salary, and in order for him to perform as well as possible, he needs the members of his line to be performing as well as they can. Hockey is very much a team sport, where an average player can produce above average statistics if he is playing with above average players, and an above average player can produce average statistics if he is playing with average players.

Furthermore, if a player with a multi-year contract performs very well when one of his line-mates are in the last year of a contract then, when the opposite is true, the line-mate who now has the multi-year contract may return the favor and perform at a high level. However, if the player with a multi-year contract exerts minimal effort, and the player in the last year of his contract suffers because of this, when the opposite is true, it would be very difficult to convince the player who suffered due to the shirking of his line-mate to exert more effort than was necessary. In hockey, line-mates are very important to a player's performance and the pressures from these individuals may be the reason that NHL players do not shirk.

Another possibility for the discrepancy between my findings and Krautmann and Solow's findings is that hockey coaches have a wide range of players to choose from while baseball managers are more limited. Baseball teams carry only a few bench players in every game. Hockey teams have twelve forwards and six defensemen and most players of the same position are interchangeable. When a player shirks in hockey the coach can keep the player in the line-up but give them less ice-time. The fans still get to watch the player, which keeps them happy, but

the player is punished for shirking. Baseball coaches can take a player out of the line-up, but they do not usually change the amount of playing time due to a lack of substitutes. Also, fans want to see “star” players; if they are shirking it is hard to take them out because of the uproar that fans will cause. However, if a “star” is still in a team’s line-up but is played less, which can be the case in hockey but not baseball, there is less tension because fans still get to watch the player.

The different results may also stem from a difference in data collection. My data is based on two years while Krautmann and Solow use approximately ten years of data. This allows expectations to be changed every year based on past performance and age, while my data only has one base year and one expected performance level.

The last explanation for the differences between the two papers is that hockey general managers may have a better grasp of the market than baseball managers. Each year’s performance in a player’s contract may be taken into consideration when determining the player’s next contract in hockey. In baseball, managers may only examine recent performance data. Players in each sport would adapt to the market and exert their optimal effort level. Hockey players would exert more effort because every year of performance is relevant, while baseball players would be able to shirk before contracts are near expiration.

### **C. Interpreting Non-Traditional Shirking**

NHL hockey players do not decrease performance as the number of years on a contract increase, but performance does decrease when players are more likely to retire. Traditionally, shirking has examined performance and proximity to contract expiration but, like Krautmann and

Solow (2009), I also examine the effect of retirement on shirking. Like them, I found that the increased possibility of retirement leads to more shirking.

Why do hockey players act similarly to baseball players under these circumstances but not with traditional measures of shirking? Retirement leaves a player with no monetary incentive to exert effort. Teammates, fans and coaches can influence a player to exert effort, but this does not appear to be enough incentive. Monetary incentive and effort seem to be strongly correlated; as monetary incentive disappears, so does effort.

The results indicate that a 10% increase in a player's likelihood of retirement leads to approximately three fewer points. Although this decrease is small, a player's likelihood of retirement can change drastically based on contracts. For example, a thirty year old player given a two-year contract is unlikely to retire at the end of the contract (say,  $Pr_{\text{retire}} = 10\%$ ). If that same player is given a ten-year contract (very long contracts are becoming more common in the NHL) he is very likely to retire at the end of it (say,  $Pr_{\text{retire}} = 80\%$ ). This leads to a decrease of nearly twenty points per season.

Another explanation for non-traditional shirking is players who are set to retire at the end of their current contracts want to avoid injuries. This suggests that players are going to keep themselves out of as many dangerous situations as possible. Blocking shots and hitting are two areas that result in many injuries. Non-traditional shirking was found in these two areas in Results Table 1. Shot blocking is a key element to penalty kills and the results tables show that SHTOI decreases as  $\widehat{Last}_{\text{Hockey}}$  increases. This is likely due to a lack of shot-blocking. It appears that the driving force behind the decrease in these statistics is injury avoidance.



Finally, points probably decrease due to a lack of effort and a decrease in ice-time. Effort decreases because of the loss of monetary incentive and ice-time decreases due to shirking in other areas. A player with decreased effort can be a liability defensively and this, coupled with players avoiding situations which may lead to injury, leads to less ice-time. Ice-time should be strongly correlated to most statistical categories, including points.

#### **D. Traditional vs. Non-Traditional Shirking**

These findings have a bigger implication than simply knowing that there is decrease in statistics when a player is more likely to retire. They suggest that NHL managers take into account a player's performance over all the years of the contract that just expired. This explains why traditional shirking does not occur and why non-traditional shirking does. Players do shirk when they have the opportunity to (e. g. when they are going to retire), but they do not before that. This is one explanation for the discrepancy between the two measures of shirking.

#### **E. Cost of Shirking:**

Value lost due to shirking costs teams money. The results indicate that a 10% increase in the likelihood of a player retiring costs the team almost \$200,000 (when only examining seven of the variable used in my study, of which two were not used due to negative coefficients). Managers should do analyses when signing players to contracts to determine their likelihood of retirement upon expiration of a contract. These findings suggest that salary should be reduced by approximately \$200,000 for every 10% increase in a player's likelihood of retirement. For example, if a player is 10% more likely to retire for every season after he turns 32 years old and he wants to sign a three-year contract, that contract should be reduced by \$600,000 total - \$200,000 per year.

The size of the contract without the reduction due to shirking should be determined as usual. The reduction should be added on after the value of the player is found; when shirking is assumed to be zero. Although players will disagree with the salary reduction, the managers have the statistics for support. This may lead to more contract negotiation battles and probably more arbitration hearings. However, if managers take a hard stance against shirking and continue to do so regardless of the consequences, shirking should diminish and possibly disappear.

## **F. Future Research**

This is the first paper that has been written on shirking in hockey, so future research should be able to build off of it. One suggestion for future research is to expand the number of base years used to determine a player's "average" performance and to get a better estimate of the effects of age on a player's performance. Expanding the number of years used would also increase the number of players who retired and would give a better estimation of  $\widehat{Last}_{Hockey}$ .

Future research should also try to create an aggregate measure of performance by assigning a rating system to different performance variables. For example, a goal could be worth 1, an assist worth 0.8, a blocked shot worth 0.09, and so on. It would be hard to find the right ratings to assign each variable, but this could be helpful in simplifying the analysis while still having a performance measure that takes into consideration more than just points.

## **Chapter 8: Conclusion**

Traditional shirking does not occur in the NHL, but non-traditional shirking does. A player in the last contract does shirk in about two-thirds of the performance variables examined. These results have some important implications for NHL general managers who have to make contract offers to free agents. A general manager should not be dissuaded from signing players to a multi-year contract because performance does not fall as the years remaining on a contract increases. However, General Managers should reduce the salary of a player based on their likelihood of retirement because shirking does increase as retirement likelihood increases. Recently there has been a trend of signing players to contracts of record breaking length (Mike Richards 12 years, Ilya Kovalchuk 15 years, Rick Dipietro 15 years, to name a few). The players who get contracts of this length are almost sure to retire when the contract is over (Kovalchuk will be 42 years old when his contract expires, and almost nobody plays in the NHL after the age of 40). Therefore general managers should be wary of signing players to contracts of this length unless they reduce the player's salary to compensate for it.

General Managers should also run their own statistical analysis for each player they are looking to sign to see the likelihood that the contract they are offering them will be their last. They can do this by examining the amount of games a player has missed over the past few seasons, examining the age player will be at the end of the contract, and by examining the player's recent performance trends. If these three elements suggest that the player will retire at the end of the contract, then they should only sign that player if they can do it at a discounted rate.

Traditional shirking was not found to be a problem in the NHL, but the results are still useful to both the players and the managers. The players can use this information when they bargain for longer contracts and managers can sign players to longer contracts without the fear of a large decrease in performance (assuming they are not going to retire at the end of the contract). Managers can also use the probability of a player retiring to determine the amount that a player will non-traditionally shirk and the appropriate reduction in their salary. Managers can then offer contracts accordingly. Although shirking was not found in the NHL, this paper should still be read by managers and players. They should realize the implications that this paper poses in salary and contract-length negotiations and they should use this analysis to their benefit. Finally, if managers take a stand against non-traditional shirking, they should be able to reduce and eliminate it. This will take time and, meanwhile, non-traditional shirking should be examined every year to see if progress is being made. If managers reduce contracts, players should change their behavior to an optimal level. Presumably this would be a level with less shirking.

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