TANKING IN THE NATIONAL HOCKEY LEAGUE

by

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ABSTRACT

SHELLEY HAYDEN. Tanking in the National Hockey League. (Under the direction of DR. CRAIG DEPKEN II)

Tanking, the incentive for a sports team to lose game(s) at the end of the regular season to secure a favorable draft position, is a researched problem in multiple major sports leagues. Attempts to diminish the incentive to tank have been implemented through draft lottery policies in leagues such as the National Hockey League (NHL) and the National Basketball Association (NBA). NHL game outcomes from gambling market money lines and game characteristics from the 2005-2006 through 2015-2016 seasons are analyzed using a multinomial logit model. Results show that tanking is taking place in the NHL with teams that have been eliminated from playoff contention having a higher probability of a loss outcome and a lower probability of a win outcome, relative to other outcomes. International implications of the research on tanking can be applied to sports markets world-wide to maintain league integrity, fan interest, and maximize revenue.

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INTRODUCTION

The North American sports industry was valued in 2014 at $60.5 billion and is predicted to increase to $73.5 billion by 2019 (Heitner, 2015), with the National Hockey League (NHL) being one of the four biggest leagues. In a study done by ConvergEX Group, the NHL was determined to be the most recession-proof sports league in North America and have the fans with the highest average income and youngest average age of the top four sports leagues (Koba, 2013). Gambling markets predict game outcomes by using money lines, which can be used as a benchmark in economic research (Sauer, 1998). In this paper the money lines are converted to game outcomes which are analyzed along with game characteristics to determine if there is evidence of tanking.

Tanking is when a team purposefully loses at the end of the regular season in order to gain a better draft position. Losing for a gain in draft position has been a suspected issue in the NHL for good part of its history and the league has made changes to suppress the incentive to lose on purpose. Tanking erodes competitive balance within the league and creates fan discontent which erodes the integrity of the NHL as a whole. International sports markets can learn from research done on North American leagues and apply findings to other sports markets to maximize league integrity, fan interest, and revenue.

Gambling markets, using money lines, predict the outcome of each game; regular season games between the 2005-2006 and 2015-2016 seasons are analyzed to determine outcome as well as game characteristics. Each game is given a status of undecided, clinched a playoff berth, or eliminated from the playoffs in order to determine if behavior changes based on such characteristics towards the end of the regular season. This paper shows that through econometric analysis, tanking behavior is present in teams that have been eliminated from the playoffs because of an increased probability for a loss outcome and a decreased probability of a win outcome.

LITERATURE REVIEW

The National Hockey League (NHL) was formed in 1917 with a mere five teams located in Canada and has today expanded to thirty teams located in Canada and the United States (Statistics and facts on the National Hockey League). NHL annual revenue was $2.2 billion in the 2005-2006 season and had grown to $3.3 billion by the 2011-2012 season, with attendance increasing 1000% over the last 50 years (Treber, Mulcahy, & Sharma, 2016). In 2016, NHL total revenue was reported as $4.1 billion, with each team averaging $136.7 million in revenue (Statistics and facts on the National Hockey League). The average team's revenue in the 2005-2006 season was just $75.57 million and has increased 80% to the current revenue of $136.7 million (Statistics and facts on the National Hockey League). Many factors contribute to the past and potential revenue growth of the NHL although fan interest is one of the most vital to the survival and growth of the league. Hockey has many fans that are voracious about the sport and gain much pleasure from supporting his or her team throughout and after the season; any league mistakes that lead fans to abandon his or her passion for hockey is a mistake that will reduce the amount of revenue the NHL can earn. The drafting order of new hockey players has always been designed to place the strongest incoming players in the weakest teams to keep competitive balance as well as fuel fan interest in teams that had not performed well. Although the simplicity of a draft system where the best player goes to the worst team makes logical sense, it can also in theory create competition among the weakest teams to win worst place in order to capture the best incoming player. Such tactics, whether legitimate or rumored, create fan discontent in the league as a whole and erode the avidness in hockey fans which in turn can negatively affect fan attendance and revenue. The league's interest is to maintain competitive balance among teams which helps to ensure a growing fan base; it currently does this through a draft lottery system (Richardson, 2000).

The draft lottery system was implemented in 1995 after a long history of the team with the worst record receiving the first pick in the upcoming draft (Richardson, 2000). Prior to the draft lottery, there were many rumors that some NHL teams were losing games purposely at the end of the season to secure this desirable and potentially beneficial top lottery position; one example occurred in the 1992-1993 season when the Ottawa Senators were accused by many, including in a Sports Illustrated Article, of intentionally losing the last game of the season (Wolff, 1993). Wolff details that one man, financially invested in the Ottawa team, discussed being willing to pull the starting goalie among other tactics to secure the loss which would give the Ottawa Senators first draft pick. Other suspected instances of tanking include the Pittsburgh Penguins dismal late-season performance in the 1983-1984 season and the Quebec Nordiques' 1990-1991 season in which coach Dave Chambers later said he was told to "go with the players he had and not to worry about wins and losses" (Wolff, 1993). The NHL Commissioner, Gary Bettman, addressed allegations of tanking and used them to champion the complicated task of implementing a draft lottery system (Elliott, 1994).

The amateur draft format used by the NHL is a way to maintain overall competitive balance throughout the league by adding the best new players to the teams with the fewest performance points in the previous regular season (Tingling, Masri, & Martell, 2011). A typical draft format has the team with the worst record choose first and then the second worst team chooses next and so on, but this motivates the lowest ranking teams to battle for the worst record especially if the top drafted player is significantly better than the second drafted player (Gerchak, Mausser, & Magazine, 1995). This motivation could be even higher if the top draft pick is someone well known and can draw in more fans, making a team more popular and potentially increasing revenue (Gerchak, Mausser, & Magazine, 1995). Having an early draft position is thus very valuable to a team, and this provides an incentive to exert less effort in the last few games in order to secure a more favorable draft placement (Gerchak, Mausser, & Magazine, 1995).

Highlighting draft placement importance, Tingling, Masri and Martell (2011) found in a study of the NHL in years 1978 through 2008 that 90.6% of players drafted in the first round played at least one game and 64.1% played at least 160 games, whereas 65.1% of players drafted in the second round played at least one game and 28.6% played at least 160 games. The first round of the draft consists of 30 players, one per team, and subsequent draft picks occur in latter rounds (Tingling, Masri, & Martell, 2011).

The draft for the NHL started in 1963 as a casual meeting between the six existing teams at that time and is now a popular two day event in the spring in which the thirty teams chose one after another from a pool of new players (Tingling, Masri, & Martell, 2011). The basic format for the draft is that the 14 teams that did not make the playoffs start the draft with placement inverse to ranking with the 16 teams that made the playoffs following in an order inverse to regular season and playoff record (Tingling, Masri, & Martell, 2011).

In 1995, a new draft format for the first round was introduced in which the 14 teams that did not make the playoffs had a lottery allowing one team to move up a maximum of four places in the draft with ordering inverse to ranking besides the one placement move; the odds of winning the lottery decreased as the point record increased (Gerchak, Mausser, & Magazine, 1995). The team with the lowest points had a 30% chance of winning the lottery, but at worst would get the second pick because no team could move down more than one place. The second lowest point team had a 21% chance; the third team a 15.1% chance; the fourth team a 10.9% chance, and so on until the tenth team had a 0.5% chance (Gerchak, Mausser, & Magazine, 1995).

Gerchak, Mausser and Magazine (1995) found that the actual probability of each team's placement in the draft did not change much with the new lottery system introduced in 1995, but it gave the impression of the league doing something about suspected tanking. In 2013, the lottery rules changed so that all 14 non-playoffs team had a chance to win the top draft pick with these odds from fewest points to most: 25%, 18.8%, 14.2%, 10.7%, 8.1%, 6.2%, 4.7%, 3.6%, 2.7%, 2.1%, 1.5%, 1.1%, 0.8%, 0.5% (NHL Announces Changes to Draft Lottery Format, 2014). In 2015, the odds in the lottery were adjusted to give the four lowest point teams a lower probability, relative to previous odds, of winning the top pick and the four highest point non-playoff teams a higher probability, relative to previous odds, of winning the top pick; the odds from fewest points to most being 20%, 13.5%, 11.5%, 9.5%, 8.5%, 7.5%, 6.5%, 6.0%, 5.0%, 3.5%, 3.0%, 2.5%, 2.0%, 1.0% (NHL Announces Changes to Draft Lottery Format, 2014). Starting with the 2016 draft, the lottery will be expanded to determine who wins the top three picks instead of only the first one, which means the worst team in the league is not certain to get the second pick and could get as low as the fourth pick (NHL Announces Changes to Draft Lottery Format, 2014). Draft lottery odds over the years are detailed in Table 1; the changes in the NHL draft over the years demonstrate the effort of league officials to decrease a team's motivation to lose games at the end of the season intentionally.

TABLE 1
NHL Changes to Draft Lottery Odds

Non-Playoff Team (inverse ranking)	1995 Draft Lottery Odds	2013 Draft Lottery Odds	2015 Draft Lottery Odds
1	30.0%	25.0%	20.0%
2	21.0%	18.8%	13.5%
3	15.1%	14.2%	11.5%
4	10.9%	10.7%	9.5%
5	8.0%	8.1%	8.5%
6	5.9%	6.2%	7.5%
7	4.2%	4.7%	6.5%
8	2.8%	3.6%	6.0%
9	1.6%	2.7%	5.0%
10	0.5%	2.1%	3.5%
11		1.5%	3.0%
12		1.1%	2.5%
13		0.8%	2.0%
14		0.5%	1.0%

Betting markets, through points spreads, have shown that tanking is assumed to happen in the latter part of the regular season in the NBA, specifically when a team that is eliminated from the playoffs is facing a team in its same conference (Soebbing & Humphreys, 2013). Because the research done on tanking in the NBA is based on point spreads and not the probability of a game being won or lost, it is more difficult to determine if tanking actually takes place (Soebbing & Humphreys, 2013). The evidence that tanking is taking place may not be strong, but the evidence that betting markets take into account tanking in certain situations is strong (Soebbing & Humphreys, 2013). Unlike point spreads which predict the point difference in a game, money lines are used by gambling markets to predict who the winner or loser will be (Berkowitz, Depken, & Gandar, 2016). Money lines can look different, depending on the outcome predicted, but in most cases are quoted as a negative number for the favored team and a positive number for the underdog team. When money lines are both negative (-109, -101), it conveys that both teams are similarly inclined to win. A common example of a money line bet, such as (-200, +150) requires a $200 bet to payout $100 if the favored team wins and a $100 bet that will payout $150 if the underdog team wins.

Sauer (2005) uses three steps to convert money lines into probabilities a team will win. The first step converts the money line into payout per dollar; using the example above, the winning unit bet for the favored team to win is 100/200 = .50 and the winning unit bet for the underdog team to win is 150/100 = 1.50. The second calculation is converting the payout per dollar into probability, p = 1/(1+payout per dollar), yielding p=.667 for the favored team and p=.40 for the underdog. The two probabilities sum to greater than 1 because the bookies make money, which leads to the final calculation that converts the probabilities into normalized fair probabilities; $p^F = p_1/(p_1+p_2)$ and $p^F = p_2/(p_1+p_2)$, which yield .625 and .375. The three step calculation presented by Sauer (2005) implies betting markets believe, in this example, that the favored team has a 62.5% chance of winning and the underdog a 37.5% chance of winning.

The efficient market hypothesis is one that had been studied to determine if betting markets reflect all available information; if all available information is not taken into account it is possible to arbitrage that omission and make a profit (Woodland & Woodland, 2001). The hypothesis has been analyzed by many over the past decades because of the gambling market’s ability to provide a pricing benchmark to economic research that is hard to find in other markets (Sauer, The Ecomonics of Wagering Markets, 1998).

The expected return of the gambler should be zero or less, since market prices should generate an overall profit for the bookie and not the gambler (Sauer, 1998). Sauer found this to be mostly true, and that when betting strategies were profitable to gamblers, the gambling markets corrected to become more efficient. However, in a study on the National Hockey League for seasons 1990-1991 through 1995-1996, it was found that a profit could have been made from placing bets on the underdog, especially the lower the odds were of the underdog winning (Gandar & Zuber, 2004). Woodland & Woodland (2001) also found that in the NHL, betting on underdogs (especially with low odds) was profitable although they did comment that the betting markets were diminishing such opportunities and that future wagers of that kind may not be as profitable.

The NHL operates on a point system to determine performance of teams throughout the season. When there is a winner after three twenty-minute periods, the winning team receives two points and the losing team receives zero points (NHL, 2015). If the teams are tied at this point, each receives one point and the game proceeds to overtime (NHL, 2015). Overtime is five minutes and whichever team scores first wins and earns and additional point, but if there is still no winner the game goes to a shootout (NHL, 2015). A shootout is comprised of three rounds and the team scoring the most goals wins; if there is still no winner at this point the game goes into sudden death where all players on a team must participate before any player shoots twice (NHL, 2015). The winner of the overtime or shootout receives an additional point, giving the winner of the game two points and the loser one point in total, bringing the total points given to three instead of two in a regular game.

Labor disputes in the NHL have caused a few lockouts during which no games were played, the most recent one being a four month lockout at the end of 2012 that cut the number of regular season games per team from 82 to 48 (Treber, Mulcahy, & Sharma, 2016). The NHL has had two other substantial lockouts in the 1994-1995 and 2004-2005 seasons that caused fan upset in the short term but did not hurt attendance and revenue in the long run (Treber, Mulcahy, & Sharma, 2016).

METHODOLOGY

I analyzed data on final scores, money lines, and game details from 12,789 regular season NHL games from the 2005-2006 through the 2015-2016 seasons. Data on final score and money lines is from Sports Insights, a company that collects gambling market data from different leagues in order to provide sports betting analytics. Overtime and shootout information comes from hockey-reference.com, a website that keeps records of past NHL games.

The money lines were converted into predicted win probabilities for each team using the method introduced by Sauer (2005). Games in which the home win odds and visitor win odds were equal were removed from the data set, leaving only games where one team was favored to win. Dummy variables are created for each of the four scenarios: expected home win (E[HW]), expected home loss (E[HL]), unexpected home win (UE[HW]), and unexpected home loss (UE[HL]). From the dummy variables, an outcome variable is created (outcome = 1* E[HW]+2* E[HL]+3* UE[HW]+4* UE[HL]).

Table 2 summarizes the frequency and percentage of each game outcome. The most frequent outcome was expected home win, with 43.48% of games falling in this category. Expected home win and expected home loss totaled 58.65% of game outcomes, leaving 41.35% of games having unexpected outcomes (11.36% unexpected home win and 29.99% unexpected home loss). As Table 3 shows, if the overtime and shootout games are omitted, the percentages remain roughly the same. Overtime and shootout games happened on average 21% of the time in expected outcomes and 27% of the time in unexpected outcomes.

TABLE 2

Frequency of Game Outcomes

Outcome	Frequency	Percent
Expected home win	5,561	43.48
Expected home loss	1,940	15.17
Unexpected home win	1,453	11.36
Unexpected home loss	3,835	29.99
Total	12,789	100.00

TABLE 3

Frequency of Game Outcomes (dropping OT/SO)

Outcome	Frequency	Percent
Expected home win	4,434	45.35
Expected home loss	1,511	15.45
Unexpected home win	1,063	10.87
Unexpected home loss	2,770	28.33
Total	9,778	100.00

NHL playoff participation is determined by the point system; each team's accumulated points throughout the season determine when each team clinches a playoff berth or is eliminated from the playoffs. For each game played, a team's worst case scenario (current points with no more wins) and best case scenario (current points + 2*games left) are tracked in order to calculate if one team has either clinched a playoff berth or has been eliminated from the playoffs.

To determine clinching, each team's worst case scenario is included in an array with the best case scenarios of its division, as well as an array with the best case scenarios of its conference. In the 2005-06 through 2012-13 seasons, a team clinches if their worst case is first in their division array or top eight in their conference array. In the 2013-2014 through 2015-2016 seasons, a team clinches if their worst case is top three in their division array or top eight in their conference array.

To determine elimination, each team's best case scenario is included in an array with the worst case scenarios of its conference. For all seasons analyzed in this paper, a team is eliminated from the playoffs if their best case is less than the eighth largest in their conference array. Division arrays are not created for elimination determination because even if a team does not make first or top three in its division, that team can still enter the playoffs as a conference wildcard, therefore conference placement determines elimination and not division placement. If the team has not met either the clinching or the elimination requirement, the status of that team at that time remains undecided. Table 4 provides a summary of NHL playoff clinching requirements.

TABLE 4

Playoff Clinching Requirements

Seasons	# Divisions	Division placement	# Division clinchers	# Conf-erences	Conference placement	# Wildcards	# Teams in playoffs
2005-06 - 2012-13	6	1st	6	2	top 8	10	16
2013-14 - 2015-16	4	top 3	12	2	top 8	4	16

At the time of each game, the home team and the visiting team will have a status of either undecided, clinched, or eliminated. Table 5 summarizes the frequency of the home team and visiting team having each status in the 12,789 games analyzed; roughly 93% of the time each team remains undecided and the last 3.5% of games during the season are games in which the home and visiting team have a status of either clinched or eliminated.

TABLE 5

Home Team Status			Visitor Team Status		
Status	Frequency	Percent	Status	Frequency	Percent
Undecided	11,902	93.06	Undecided	11,892	92.99
Clinched	442	3.46	Clinched	440	3.44
Eliminated	445	3.48	Eliminated	457	3.57
Total	12,789	100.00	Total	12,789	100.00

The games in which a team has a status of clinched or eliminated are analyzed against gambling market predictions to examine if tanking might be taking place; if a team is tanking, that team could possibly be winning fewer games than anticipated when eliminated from the playoffs in order to secure a better draft position in the following season. For example, if the home team has been eliminated from the playoffs, the probability of an expected home win may be lower relative to other outcomes or the probability of an unexpected home loss may be higher than other outcomes.

The NHL announced new draft lottery changes on March 4, 2013 that went into effect for the 2013 draft that took place in June 2013 (NHL Announces New Draft Lottery, 2013); the data before and after the announcement date are examined separately to determine if there was any change in behavior after the draft lottery changes went into effect. The regular season was still progressing on March 4, 2013 and at the time no teams had clinched a playoff berth or been mathematically eliminated from the playoffs.

ANALYSIS

A multinomial logit model is estimated in Stata using outcome as the dependent variable and game characteristics as independent variables. This estimator is used because the dependent variable (outcome) is categorical and is not ordered. The model estimates the relative probabilities of different outcomes based on independent variables included, which can be either dummy variables or quantitative values. The most frequent outcome is used as a reference outcome and all other outcomes are compared against it. The model must have independent variables that are distinct for each occurrence; in this case game characteristics are distinct for each outcome in each game. A linear predictor function is created from a set of coefficients and independent variables to predict the occurrence of the dependent variable. There are four unordered outcomes analyzed using the multinomial logit model 1, 2, 3, and 4, and independent variables X. The model estimates a set of coefficients that relate to each outcome, β(1), β(1), β(1), β(4) which relate to each outcome:

$$\text{Probability } (y=1) = \frac{e^{X\beta(1)}}{e^{X\beta(1)} + e^{X\beta(2)} + e^{X\beta(3)} + e^{X\beta(4)}}$$

$$\text{Probability } (y=2) = \frac{e^{X\beta(2)}}{e^{X\beta(1)} + e^{X\beta(2)} + e^{X\beta(3)} + e^{X\beta(4)}}$$

$$\text{Probability } (y=3) = \frac{e^{X\beta(3)}}{e^{X\beta(1)} + e^{X\beta(2)} + e^{X\beta(3)} + e^{X\beta(4)}}$$

$$\text{Probability } (y=4) = \frac{e^{X\beta(4)}}{e^{X\beta(1)} + e^{X\beta(2)} + e^{X\beta(3)} + e^{X\beta(4)}}$$

The model will set β(1) equal to 0 so that the remaining coefficients β(2), β(3) and β(4) will calculate the adjustment relative to the y=1 outcome. This changes the probability equations to:

$$\text{Probability (y=1)} = \frac{1}{1 + e^{X\beta(2)} + e^{X\beta(3)} + e^{X\beta(4)}}$$

$$\text{Probability (y=2)} = \frac{e^{X\beta(2)}}{1 + e^{X\beta(2)} + e^{X\beta(3)} + e^{X\beta(4)}}$$

$$\text{Probability (y=3)} = \frac{e^{X\beta(3)}}{1 + e^{X\beta(2)} + e^{X\beta(3)} + e^{X\beta(4)}}$$

$$\text{Probability (y=4)} = \frac{e^{X\beta(4)}}{1 + e^{X\beta(2)} + e^{X\beta(3)} + e^{X\beta(4)}}$$

Thus the relative probability of outcome 2 to the reference outcome 1 is and also the relative risk ratio is:

$$\frac{\text{Probability (y=2)}}{\text{Probability (y=1)}} = \frac{e^{X\beta(2)}}{1 + e^{X\beta(2)} + e^{X\beta(3)} + e^{X\beta(4)}} * \frac{1 + e^{X\beta(2)} + e^{X\beta(3)} + e^{X\beta(4)}}{1}$$

$$\frac{\text{Probability (y=2)}}{\text{Probability (y=1)}} = e^{X\beta(2)}$$

X and each $\beta_k(2)$ are vectors and are equal to:

$$X = (x_1, x_2, \ldots, x_k)$$

$$\beta_k(2) = (\beta_1(2), \beta_2(2), \ldots, \beta_k(2))'$$

When there is a one unit change in an independent variable, the ratio of the relative risk is e^(β_i(2)) thus when the exponent is taken of the coefficient, it gives the relative risk ratio for a one unit change in the independent variable (for example, a dummy variable changing from zero to one).

The independent variables are home clinched, home eliminated, visitor clinched, visitor eliminated, overtime and shootout (OT/SO), home games left, and visitor games left. Each game has an outcome of E[HW], E[HL], UE[HW], or UE[HL]. The model will help illustrate the connection between the game characteristics and the outcome of the game, as well as showing the relative effect of those characteristics on outcome. Some independent variables are dummy variables with value one if the condition is met and zero otherwise; home clinched equals one if the home team had clinched the playoffs, home eliminated equals one if the home team had been eliminated from the playoffs, visitor clinched equals one if the visiting team had clinched the playoffs, visitor eliminated equals one if the visiting team has been eliminated from the playoffs, and OT/SO equals one if the game went into overtime or ended in a shootout (both cause the losing team to receive one point instead of zero).

The multinomial logit model choses the most frequent outcome (in this case expected home win (E[HW]) which is the most common outcome at 43.48%) as the reference category and all the probability ratios for each independent variable in each outcome are relative to the reference category. The exponential beta coefficient represents the change in probability of that outcome relative to the reference outcome when the independent variable has a one unit change. Table 6 shows the results of the multinomial logit model's coefficients as well as p-values (the coefficient is statistically significant with a level of 95% confidence if the p-value is less than .05).

TABLE 6

Multinomial Logistic Regression

Outcome		Coefficient	P> |z|
E[HW]		(base outcome)	
E[HL]	Home Clinched	-2.153	0.000
	Home Eliminated	2.792	0.000
	Visitor Clinched	1.006	0.000
	Visitor Eliminated	-3.517	0.000
	OT / SO	0.123	0.063
	Home Games Left	-0.061	0.001
	Visitor Games Left	0.061	0.001
UE[HW]	Home Clinched	-1.701	0.000
	Home Eliminated	2.419	0.000
	Visitor Clinched	0.829	0.000
	Visitor Eliminated	-3.194	0.000
	OT / SO	0.376	0.000
	Home Games Left	-0.071	0.000
	Visitor Games Left	0.068	0.001
UE[HL]	Home Clinched	-0.110	0.386
	Home Eliminated	0.379	0.053
	Visitor Clinched	0.432	0.006
	Visitor Eliminated	-0.632	0.000
	OT / SO	0.415	0.000
	Home Games Left	-0.023	0.116
	Visitor Games Left	0.023	0.106

The gambling market predicts home winning in both E[HW] and UE[HL] outcomes although the winner is home in E[HW] and visitor in UE[HL]. Table 6 shows that the coefficient for home eliminated in outcome UE[HL] is 0.379, which means if home is eliminated, the multinomial log-odds for UE[HL] relative to E[HW] are estimated to increase by 0.379, all other variables held constant. The exponential of the coefficient will give the relative risk ratio (probability ratio); for example, the exponential of 0.379 ($e^{0.379}$) is 1.46, which means the relative probability of an unexpected home loss outcome to an expected home win outcome is 46% higher when home has been eliminated. Table 4 shows that the beta coefficient for home eliminated in outcome E[HL] is 2.79, which means if home is eliminated, the multinomial log-odds for E[HL] relative to E[HW] are estimated to increase by 2.79 while all other independent variables are held constant. The exponential of the coefficient will give the relative risk ratio, $e^{2.79}$, equal to 16.28 which means the relative probability of an expected home loss outcome to an expected home win outcome is 1628% higher when the home team has been eliminated. It is more intuitive to compare unexpected home loss to expected home win when analyzing the issue of the home team being eliminated from the playoffs, although each coefficient relays information compared to the base outcome of expected home win.

Because the log-odds and relative risk ratios can be cumbersome to analyze for this reason, marginal effects are computed for each outcome to show how game characteristics change the probability of a game outcome relative to other outcomes.

Table 7 summarizes the estimated marginal impact of game characteristics on the four game outcomes. The marginal impact for each game characteristic sums to zero across the four outcomes, as required by the model. For example, for the independent variable home eliminated, the probability it is in category 1, 2, 3, and 4 is -34.5%, 37.6%, 17.3%, and -20.4%, respectively, which sums to zero. Dy/dx shows the change in probability of outcome when each game characteristic increases by one, holding all other independent variables constant.

TABLE 7

Marginal Impact of Game Characteristics on Outcome

Games included: 2005-06 - 2015-16 Regular Season Games [12,789 observations]

Dependent Variable: Outcome

Game Characteristic	E[HW]		E[HL]		UE[HW]		UE[HL]	
	dy/dx	P> |z|	dy/dx	P> |z|	dy/dx	P> |z|	dy/dx	P> |z|
Home Clinched	0.148	0.000	-0.124	0.000	-0.086	0.000	0.062	0.030
Home Eliminated	-0.345	0.000	0.376	0.000	0.173	0.000	-0.204	0.000
Visitor Clinched	-0.157	0.000	0.106	0.000	0.052	0.015	0.000	0.992
Visitor Eliminated	0.287	0.000	-0.144	0.000	-0.109	0.000	-0.034	0.191
OT / SO	-0.082	0.000	-0.010	0.156	0.020	0.002	0.072	0.000
Home Games Left	0.010	0.001	-0.005	0.010	-0.005	0.005	0.000	0.941
Visitor Games Left	-0.012	0.001	0.005	0.011	0.005	0.007	0.000	0.990

Expected home win and expected home loss are both outcomes in which the outcome of the game was predicted correctly by gambling markets. Compared to other game outcomes, the probability of an expected home win is on average 34.5 percent lower if the home team had been eliminated from the playoffs and the p-value shows that to be statistically significant at the 5% level. In addition, the probability of an expected home loss is on average 37.6% higher if the home team had been eliminated from the playoffs compared to other outcomes. The probability of an expected home win, compared to other outcomes, is 28.7% higher when the visiting team had been eliminated from the playoffs. The probability of an expected home loss, compared to other outcomes, is 14.4% lower when the visiting team had been eliminated. In the two outcomes where results met gambling market expectations and the team (whether home or visiting) had been eliminated from playoff contention, there was an increased probability of a loss and a decreased probability of a win.

Unexpected home win and unexpected home loss are both outcomes in which the outcome of the game did not match what the gambling markets predicted. Compared to other game outcomes, the probability of an unexpected home win is on average 17.3%

higher if the home team had been eliminated from the playoffs. The probability of an unexpected home loss is on average 20.4% lower if the home team had been eliminated compared to other outcomes. The probability of an unexpected home loss, compared to other outcomes, is 3.4% lower when the visiting team had been eliminated but the p-value shows this value is not statistically significant at the 5% level. The probability of an unexpected home win is 10.9% lower when the visiting team had been eliminated. In both outcomes where results were different than market expectations and the team (whether home or visiting) had been eliminated from the playoffs, there was a decreased probability of a loss outcome and an increased probability of a win outcome.

Independent variables also include if the home team clinched the playoffs and if the visiting team clinched the playoffs. Compared to other game outcomes, the probability of an expected home win outcome is on average 14.8 percent higher if the home team had clinched a playoff berth and the p-value shows that to be statistically significant at the 5% level. In addition, the probability of an expected home loss is on average 12.4% lower if the home team had clinched compared to other outcomes. The probability of an expected home win, compared to other outcomes, is 15.7% lower when the visiting team had clinched. The probability of an expected home loss, compared to other outcomes, is 10.6% higher when the visiting team had clinched. In the two outcomes where results met gambling market expectations and the team (whether home or visiting) had clinched a playoff berth, there was an increased probability of a win outcome and a decreased probability of a loss outcome. The marginal impact of home and visiting teams having clinched a playoff berth were not statistically significant at the

5% level in scenarios where actual game outcomes did not match gambling market predictions.

The probability of an expected home win decreased 8.2% and the probability of an unexpected home loss increased 7.2%, relative to other outcomes, if the game went into an overtime and shootout. The marginal effect of home games left and visitor games left were negligible on probability of outcome, meaning that as remaining games increased there was not a significant change in the chance the game outcome would change.

Table 8 shows the marginal impacts of game characteristics on game outcome for games played on or before the March 4, 2013 NHL announcement of draft lottery changes which decreased the odds of the teams with the fewest points from winning the top draft pick (and also included all fourteen non-playoff teams in the chance to win top pick instead of just the ten with the fewest points).

TABLE 8

Marginal Impact of Game Characteristics on Outcome Before 2013 Draft Lottery Changes

Games Included: Through March 4, 2013 [8,779 observations]

Dependent Variable: Outcome

Game Characteristic	E[HW]		E[HL]		UE[HW]		UE[HL]	
	dy/dx	P> |z|	dy/dx	P> |z|	dy/dx	P> |z|	dy/dx	P> |z|
Home Clinched	0.161	0.000	-0.114	0.000	-0.096	0.000	0.049	0.167
Home Eliminated	-0.355	0.000	0.402	0.000	0.164	0.000	-0.211	0.000
Visitor Clinched	-0.163	0.000	0.105	0.001	0.057	0.036	0.001	0.986
Visitor Eliminated	0.308	0.000	-0.137	0.000	-0.106	0.000	-0.065	0.040
OT / SO	-0.083	0.000	-0.016	0.049	0.015	0.058	0.084	0.000
Home Games Left	0.007	0.063	-0.001	0.580	0.005	0.018	0.000	0.951
Visitor Games Left	-0.007	0.060	0.001	0.635	-0.005	0.015	0.001	0.844

Table 9 shows the same analysis for games played after the announcement. Of the total 12,789 total regular season games between the 2005-2006 season and the 2015-2016 season, 8,779 were on or before March 4, 2013 and 4,010 were after.

TABLE 9

Marginal Impact of Game Characteristics on Outcome After 2013 Draft Lottery Changes

Games Included: After March 4, 2013 [4,010 observations]

Dependent Variable: Outcome

Game Characteristic	E[HW]		E[HL]		UE[HW]		UE[HL]	
	dy/dx	P> |z|	dy/dx	P> |z|	dy/dx	P> |z|	dy/dx	P> |z|
Home Clinched	0.124	0.013	-0.146	0.000	-0.066	0.002	0.088	0.067
Home Eliminated	-0.330	0.000	0.333	0.000	0.189	0.000	-0.193	0.000
Visitor Clinched	-0.146	0.003	0.112	0.027	0.040	0.242	-0.007	0.891
Visitor Eliminated	0.255	0.000	-0.158	0.000	-0.114	0.000	0.018	0.678
OT / SO	-0.082	0.000	0.000	0.971	0.034	0.008	0.048	0.006
Home Games Left	0.020	0.001	-0.015	0.000	-0.005	0.159	0.001	0.918
Visitor Games Left	-0.019	0.001	0.016	0.000	0.005	0.192	-0.001	0.887

The probability of an expected home win outcome decreased 35.5% compared to other outcomes before the 2013 draft lottery changes if the home team was eliminated and changed to 33.0% compared to other outcomes after the changes. The probability of an expected home loss outcome increased 40.2% compared to other outcomes if the home team was eliminated and changed to 33.3% compared to other outcomes after the changes.

The probability of an expected home win outcome increased 30.8% compared to other outcomes before the 2013 draft lottery changes if the visiting team was eliminated and changed to 25.5% compared to other outcomes after the changes. The probability of an expected home loss outcome decreased 13.7% compared to other outcomes if the visiting team was eliminated and changed to 15.8% compared to other outcomes after the changes.

DISCUSSION

Tanking takes place when a team loses on purpose in order to gain a better draft position; if a team had been eliminated from the playoffs, there could be an incentive to lose since playoffs are not an option and more losses mean a better chance of winning in the next season because of a potential star player added to the roster. The marginal effects on outcome can possibly be a way to see if teams are more likely to lose when they have been eliminated from playoff contention.

When the home team had been eliminated from the playoffs, they are 34.5% less likely to have an expected home win and 17.3% more likely to have an unexpected home win relative to other outcomes. The 34.5% less likely marginal effect of winning is in line with tanking behavior but the 17.3% more likely marginal effect of winning is not, although compared to one another it is still less likely that an eliminated home team will fall into an outcome of winning. When the home team had been eliminated from the playoffs and the losing games are analyzed, they are 37.6% more likely to have an expected home loss and 20.4% less likely to have an unexpected home loss, relative to other outcomes. Similar to above, when the marginal effects are compared, an eliminated home team will be more likely to have an outcome of losing which could be indicative of tanking behavior.

When the visiting team had been eliminated from the playoffs, they are 14.4% less likely to have an expected home loss and the marginal effect for an unexpected home loss is not statistically significant; therefore, the eliminated visiting team is less likely to fall into an outcome of winning. When the visiting team had been eliminated from the playoffs and the losing games are analyzed, the eliminated visiting teams are 28.7% more likely to have an expected home win and 10.9% less likely to have an unexpected home win, relative to other outcomes. The marginal effects of visitor teams that are eliminated show that those teams are more likely to have an outcome of losing which could, like the eliminated home teams, show tanking behavior.

When looking at the marginal effects of the two game outcomes that matched market predictions, expected home win (E[HW]) and expected home loss (E[HL]), teams that had clinched a playoff berth were more likely to be in winning game outcomes relative to other outcomes. Teams that a clinched a playoff berth were also less likely to be in losing game outcomes relative to other outcomes. This makes sense when taken into account that the effort of teams that had clinched a playoff berth were competing for better playoff positions at the end of the season and were slightly more likely to win more (14.8% for home teams and 10.6% for visiting teams) and lose less (12.4% for home teams and 15.7% for visiting teams).

The marginal impacts of game characteristics on outcome shown in Table 8 (before the 2013 draft lottery changes) and Table 9 (after 2013 draft lottery changes) show that the lottery changes possibly changed behavior of teams that had been eliminated from the playoffs. If the home team was eliminated from the playoffs, there was a decreased probability of 35.5% of an expected home win outcome (relative to other outcomes) before the March 4, 2013 changes compared to 33.0% after the changes. Likewise, if the home team was eliminated from the playoffs there was an increased probability of 40.2% of an expected home loss outcome (relative to other outcomes) before the draft lottery changes compared to 33.3% after. The home teams that were eliminated from the playoffs were more likely to be in game outcomes of losing for games that met gambling market expectations, but were less drastic after draft lottery changes that decreased the odds of the worst performing teams winning the top pick.

Behavior of visiting teams that had been eliminated from the playoffs was similar in some ways but different in others to home teams that had been eliminated from the playoffs in expected outcomes. If the visiting team was eliminated from the playoffs, there was an increased probability of 30.8% of an expected home win outcome (relative to other outcomes) before the March 4, 2013 changes compared to 25.5% after the changes. There was a decreased probability of 13.7% of an expected home loss outcome (relative to other outcomes) before the draft lottery changes if the visiting team was eliminated compared to 15.8% after, so the expected home loss outcome saw a slight increase after draft lottery changes in what could be tanking behavior of visiting teams that were eliminated. Other than this instance in expected outcomes, all eliminated teams showed less tanking behavior after the 2013 changes which is in line with what officials wanted to see from the updated policy.

The unexpected outcomes (both unexpected home win and unexpected home loss) had less disparate outcome probabilities because of game characteristics than expected outcomes, both before and after the 2013 draft lottery changes. If the home team was eliminated, there was a 16.4% higher probability of being in the unexpected home win category (relative to other categories) compared to 18.9% after the changes. There was a 21.1% lower probability of an unexpected home loss outcome (compared to other outcomes) if the home team was eliminated before the 2013 changes compared to 19.3% after. This result does not support tanking, but in comparison to the much higher 40.2%

and 33.3% higher probabilities eliminated home teams are in the expected home loss outcome, tanking is still suspect.

CONCLUSION

The multinomial logit model used in this research shows that NHL teams that have been eliminated from the playoffs exhibit tanking behavior at the end of the season. Money lines from gambling markets for 12,789 regular season games from the 2005-2006 through 2015-2016 seasons are converted to four distinct outcomes: expected home win, expected home loss, unexpected home win and unexpected home loss. For each game played, each team is identified as undecided, eliminated from the playoffs, or clinched a playoff berth. I find that home teams and visiting teams that have been eliminated from the playoffs have a higher probability of a loss outcome and a lower probability of a win outcome which suggests tanking behavior.

The results of this paper, especially the differences shown before and after the 2013 draft lottery changes, can be significant to the NHL and other sports leagues that use draft lotteries in the determination of how to lessen the incentive to lose games for a better draft position. The combination of rumors, fan discontent, and possible decreased revenue was a catalyst in implementing a draft lottery (Elliott, 1994) and it is in the NHL’s best interest to create a system that works well.

The draft lottery continues to change for the NHL that further decrease the odds of the teams with the fewest points from winning the top pick and continued data collection and examination using econometric modeling would be material going into the future. Gambling market data dated before 1995, when the first draft lottery was implemented, is not easy to obtain and would probably be unmatched to the type of gambling market data available today; therefore, if using gambling market data as a benchmark the best time to study playoff-eliminated team behavior would be in the future, especially with the significant changes that the NHL is currently making to the draft lottery. Alternate research methods that do not rely on gambling market data would allow comparisons between games before 1995, between 1995 and 2013 and after subsequent draft lottery changes. The international implications of the research done on North American sports leagues, including the NHL, can be applied to sports leagues in different countries and give league officials around the world information to improve league integrity, preserve fan devotion and maximize revenue.

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