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Revenue generating in the NHL

Multiple regression analysis on generating revenue in the National Hockey League

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Abstract

This thesis aims to explain the differences between different National Hockey League teams generated revenues. This is done by analyzing the previous researches on different major sports leagues in the Northern America and comparing them with the findings from the NHL. By the data available, different regression models are constructed and further evaluated to analyze the different factors affecting revenue generating in the NHL. Scope of this research is from season 2005/2006 to season 2014/2015. From recent seasons, only a relatively small amount of data was available, thus the season 2014/2015 is the latest season of interest in this research. The data used to build the regression models was first collected in Excel, and then imported to Stata, which was used to build the models.

After testing and analysis, a fixed effects model proved out to be the preferred model. Further analysis of the results pointed out the importance of competitive balance in the league to maximize the profitability between teams. In addition, the geographical features of a team, such as population in the area a team is located, proved out to be important when analyzing the generated revenues.

Compared with the previous researches, the results had similarities, but as expected, some differences appeared as well. The most noticeable difference from the previous researches was that the regular season success of a team did not appear as a significant factor in any of the models presented. In addition, some earlier studies suggested that pricing of the tickets would be a significant factor in generating revenue, but surprisingly models used in this research did not provoke similar results.

Overall, the results indicate that modeling the revenue generating of a NHL team is complicated, but definitely achievable. Further research on the topic should be done, as the financial side of the NHL still remains underexplored.

Keywords Revenue generating, National Hockey League, Panel data, Regression model

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1. Introduction

The National Hockey League is one of the four major professional sports leagues in the North America. The league consists of 31 teams, of which seven are located in Canada and the rest in the United States. During the season from October to April each team plays 82 regular season games, divided into 41 home games and 41 away games. After the regular season, 16 teams qualify for the Stanley Cup playoffs, which are played as an elimination tournament consisting of best of seven series to determine the Stanley Cup champion.

In recent years, the popularity of the National hockey league, NHL has grown massively. From the season 2005/2006 to 2014/2015, the total revenue of NHL teams has grown from 2.267 billion US dollars to 3.979 billion. This indicates an average growth rate of 5.79% per year. Compared with the average economic growth rate of the United States (1.93%), we can see that the industry has grown more than the economy during this period. Following this growth of popularity, there has been a lot of discussion regarding the financial side of the NHL. Differences between teams' revenues are significant, and for example, the difference between the highest and lowest revenue for the season 2014/2015 was 92 million US dollars.

There is a significant amount of differences between NHL teams, some of which the league itself cannot regulate or rule of, such as performance in the games and the loyalty of the fan base. However, the league can regulate e.g. the labor contracts and revenue sharing with the objective of achieving competitive balance within the teams in the league. The NHL is also aiming to achieve a better competitive balance by implementing a draft lottery system, similar to the ones in National Basketball Association (NBA) and National Football League (NFL). With this drafting system, the teams with least points at the end of the season have the highest probability of receiving the number one pick in the draft following the season.

Competitive balance in the NHL is under regulation in the form of labor contracts and institutional arrangements, such as the CBA. CBA stands for Collective Bargaining Agreement and is negotiated between the NHL team owners and NHL Players' Association (NHLPA). At the end of the 2003/2004 season, NHL faced financial trouble, as player salaries were consuming over 65% of generated revenues (Büschemann and Deutscher, 2011). This led to a lockout season, and the whole season 2004/2005 was canceled, as the owners and the NHLPA could not find an agreement on the new CBA negotiations. NHL introduced a new CBA for

the season 2005/2006, which included player salary regulations and regulations in revenue sharing. After the introduction of the new CBA, NHLs' competitive balance has improved (Büschemann and Deutscher, 2011). This research will focus on the time period after the CBA that was put in use for the season 2005/2006.

For the clarity of the research, the team Winnipeg Jets is excluded from this research due to moving from the United States to Canada for the season 2011/2012. Figure 1 shows the total revenue generated in the NHL from season 2005/2006 to season 2014/2015.

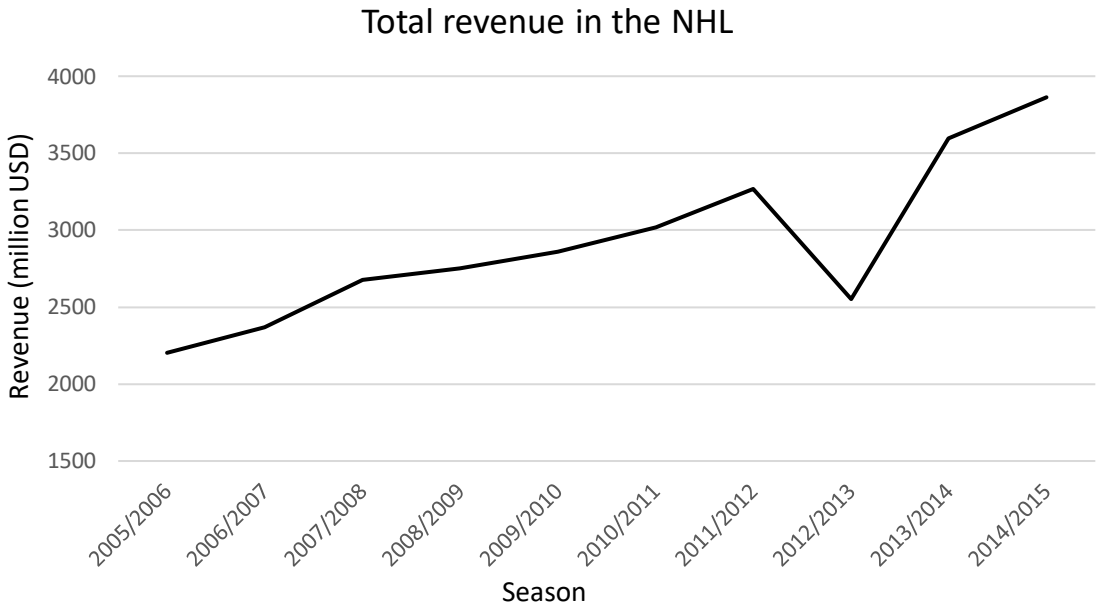

Figure 1. Total revenue in the NHL

The total revenue in the NHL has increased every season, with the exception of the season 2012/2013. During that season, nearly 60 percent of the regular season were canceled due to a lockout, which explains the lower total revenue in the NHL.

1.1 Research objectives and research question

The motivation for this research is driven by the fact that earlier studies and literature have not studied the financial side of the NHL in the same manner as the other major sports leagues. Therefore, a knowledge gap in the subject is present. To further motivate the purpose of this

research, the practical significance needs to be discussed. By analyzing the factors behind revenue generating in the NHL, this research aims to give perspective on why certain teams are financially succeeding in the NHL, and thus evaluate how to maximize the revenue of a NHL team.

The objective of this research is to determine and evaluate the different factors behind the differences of generated revenue between NHL teams. As the financial side of the NHL is the least studied of major sports leagues in North America, this research aims to test whether there are similarities or major differences in generating revenue in the NHL and the other major sports leagues in the North America. With this objective in mind, this thesis is determined to find an answer to the following research question:

What kind of a regression model is the most capable of explaining the differences between NHL teams generated revenue?

By finding the preferred model to regress the generated revenues in the NHL, the earlier stated objectives of this research can be taken into closer investigation. This is done by comparing the results with the previous researches conducted on the other major sports leagues and identifying the key differences and similarities to the NHL.

1.2 Structure of the research

The rest of this thesis is structured as follows. Chapter 2 reviews previous research and literature on the financial side of the NHL and North American major league sports in general and provides a theoretical framework for this research. Chapter 3 goes through the methodology and theory applied in this research. In this chapter, hypotheses are stated for further analysis in this research. In Chapter 4, the data sources will be presented, followed by the results and further analysis of these results. Chapter 5 consists of conclusions and limitations. In this part, the suggestions for future research will also be presented.

2. Literature review

As prior discussed, the amount of previous research on the topic is limited, which naturally affects the review of literature. The earlier literature is reviewed by the previously identified determinants of revenue in professional sports, focusing on the North American sports leagues. Whether these previous findings are applicable to the NHL or not is also discussed in this review of literature. To ensure the relevance and significance of the earlier researches, the literature discussed is based on the popularity of the authors and their recognition over the respected topic.

2.1 Effects of performance on generating revenue

The common assumption when economically analyzing professional sports leagues in general is that profit maximizing owners seek to increase revenue through on field success, winning (Bradbury, 2018). Acknowledging this assumption, researchers have assumed that revenue returns to winning are positive ($\frac{\partial Revenue}{\partial Winning} > 0$), while additional wins have positive returns, but at a diminishing rate. It is noted that success has a positive impact on the revenue returns of a sports team, but the diminishing returns on winning should be highlighted due to the lack of competitive balance within the league (Rottenberg, 1956). From the revenue generating point of view, Quirk and Fort (1992) point out that in team sports, the demand by fans is positively affected by the uncertainty of the outcome in the games. Thus, Rottenberg (1956) further argues that wealthy teams prefer winning by close margins to winning by large margins to keep the games interesting. This will lead to more equally distributed player talent across the teams. In this instance, this is referred to as competitive balance. For the purpose of this research, it is assumed that winning is the main goal of any team in the league and winning by a close margin is not any of the teams' objective.

One way to measure competitive balance is to compare standard deviations in winning percentages. Low standard deviation in winning percentages across the teams in the league indicates a good competitive balance. This means that the teams in the league are competitively performing close to another, leading to a close race for the championship. (Balfour, Porter, 1991; Fort, Maxcy, 2003; Zimbalist, 2002, as cited in York and Miree, 2018). NHL has had a

lower standard deviation in winning percentages across teams in 11 seasons after the Lockout Season than the 11 seasons before (York, Miree, 2018). This claim is supported with evidence from the research done by York and Miree (2018), but the differences in the standard deviation of winning percentages before and after the 2003/2004 lockout season are relatively small. The mean of standard deviation in winning percentages before the lockout season was 0.10 and after the lockout 0.09. Acknowledging such a small difference, the competitive balance of the NHL needs to be taken into occasion when analyzing the team revenues. Challenging the assumption of diminishing returns on winning is thus done in this research. El-Hodiri and Quirk (1971) point out in their research that even when the leagues are constraining the movement of single players between the teams and implementing a draft system to equalize strengths in the league, there is still inequality within the league as long as teams are located in cities with different revenue generating potential.

In his study, Bradbury (2018) discusses all of the major sports leagues in North America, and points out that qualifying for the post season is associated to a greater revenue in all the major sports leagues except the NFL. This finding is well reasoned by the fact that participating in the postseason equals more games played and by that increases revenue from ticket sales. The other reason why qualifying for the post season is important for increasing generated revenue are the so-called "bandwagon" fans (Burger and Walters, 2003). In sport terms a bandwagon fan stands for a fan whose interest for a team is positively associated with winning. The bandwagon effect can also be linked to Fourth Estate Benefit (Neale, 1964). By Fourth Estate Benefit Neal refers to the monetary benefits gained from the free advertisement due to newspaper articles written about the teams. In today's professional sports industry, this is also seen as online articles and news. Being successful in the league leads to more attention by the press and for example social media and thus generates new fans and additional revenue. In their research of this bandwagon effect in the MLB, Brown and Link (2008) pointed out that regular season success is not a significant determinant to a team's revenue, unless this success qualifies the team for the post season. In addition, Brown and Link (2008) state that success during the post season has more effect on the following season's revenue than in the current season. This is justified by the fact that post season success typically attracts new fans for the season to follow. As pointed out by Bradbury (2018), this bandwagon effect has not been studied outside of baseball and is in need of further investigation.

2.2 Spectator demand

There is a common finding in the analysis of spectator demand that a new stadium will have a short-term positive effect on the attendance. This is referred to as the "honeymoon effect" (Bradbury, 2018). Leadley and Zygmont (2005) have also identified this effect in the NHL. However, when discussing the generated revenue by a NHL team, this does not appear to be such a significant determinant due to the old and historical stadiums of financially successful teams, such as the Madison Square Garden of the New York Rangers. The effect will be under consideration and analyzed in this research as well, but due to the heritage of historical teams, the interpretation of the results is done with caution to avoid misinterpretations and overstatements.

2.3 Pricing strategies

Pricing strategies are commonly known to be one of the most important strategic decisions that firms have to make. In professional sports industry and the NHL, this is not different. As each team plays every season 41 games at their home stadium, the pricing strategies become inevitable and have a significant impact on the generated revenue.

The pricing strategy includes two parts. First one is to set a level of price on which the tickets are sold. Second decision to be made is the level of price discrimination. Price discrimination is defined as setting different prices for different customers on the same product/service. Price discrimination is a heavily studied area, and it has been found that companies that offered single prices for their events had reduced revenue compared with the ones that offered multiple prices (Leslie, 2004). In the professional sports industry, this becomes problematic, as the seller has a fixed capacity of seats, there is a lot of demand uncertainty, and stadiums have different seating categories when selling tickets (Jane, Sasaki, Wang, 2019). It has been shown that the level of price discrimination has a positive effect on the generated revenue by an NHL team, which is also considered in this research.

NHL tickets are also considered as inelastic goods (Jane, Sasaki, Wang, 2019) and this has been justified by their research. This inelasticity of ticket prices has also been found in NFL (Brook, 2006). As Miller (2012) points out in his research, this inelasticity of ticket prices indicates that teams are setting their ticket prices below the profit maximization level. This suggests that more revenue could be generated in the professional sports industry if the teams

set their ticket prices higher. Porter and Thomas (2010) justify these nonprofit maximizing ticket prices by arguing that teams desire to obtain public subsidies and to improve their political support. The inelasticity of ticket prices will be analyzed in this research with the objective of finding out whether higher prices lead to more generated revenue or not. When it comes to ticket pricing in any of the four major sports leagues in the North America, the four leagues are relatively similar. All of the leagues are competing on the same market of professional sports, which makes the pricing of NFL, NBA and MLB tickets relevant for this study as well.

2.4 Summary of the literature

To summarize the literature reviewed in this chapter, it is noticeable how much attention competitive performance has gained when discussing the financial performances in professional sports. It is relatable that in-game success should increase the financial performance in professional sports, but the extent of additional revenues appears as slightly overstated in the existing literature. The effects of spectator demand and pricing strategies are applicable to any other business-related topics, and thus need to be taken into occasion when discussing professional sports as well. However, what can be found surprising in the existing literature is the insufficient attention for the market size in professional sports. The effects of population and wealth of the market are underexplored but will be examined in this research.

3. Methodology

This chapter presents and discusses the methodological framework applied in this research. The variables used in the regression models are divided into four topics followed by further discussion and justification. At the end of the chapter, three hypotheses are presented based on the earlier literature and its' analysis. The purpose of these hypotheses is to clarify the interpretation of the results discussed in the following chapter.

3.1 General methodology

Due to the form of data set, the function is analyzed as panel data, where *i* represents the different teams in the NHL and *t* represents the different seasons under observation. The dependent variable in this occasion is the natural logarithmic amount of revenue generated per season. This data is collected from the Statista database, which uses Forbes annual business reports as the source for their data. The regressions are generated with the STATA software.

The variables and their descriptions are presented in table 1.

Table 1. Variable Descriptions

Variable	Measure
LnRevenue	Logarithmic revenue generated in the season
CB	Measurement for competitive balance in the league
Point%	Points gathered from the max amount of points
FirstPick	1 = First pick in the draft, 0 = no first pick
StadiumAge^2	Squared age of the home stadium
AvgTicketprice	Average price for a standard ticket, US dollars
Difference	Difference between standard and premium ticket prices
LnPopulation	Natural logarithm of the population in the metropolitan area
LnIncome	Natural logarithm of average income per capita in the metropolitan area
AvgAttendace	Average attendance of home games, thousands
TeamAge^2	Squared age of the team
MadePlayoffs	Team made the playoffs, 1 = yes, 0 = no
$MadePlayoffs_{t-1}$*$PlayoffWins_{t-1}$	Number of wins during the previous post season

StanleyCupChampion	Team won the Stanley cup, 1 = yes, 0 = no
GoogleSearches	Index value on the amount of Google searches by Google trends
AllStars	Number of all-stars players in the team during the season

3.2 Team performance

Competitive balance within the league is taken into consideration, as variable CB is introduced. This variable demonstrates the variance of teams point percentages within a season. Smaller values of the variable indicate a more balanced league. As Quirk and Fort (1992) pointed out in their research, it is expected that all teams will generate more revenue when the league is competitively balanced. To highlight the differences between each season's competitive balances, the values are variances instead of standard deviations. The point percentage of a team is calculated as the points gathered during a season divided by the maximum amount of points. This is a way to measure a team's in-game success during the season, as more points equal higher rank within the league.

Variable to measure the goal difference of a team is excluded from this research after some analysis on goal scoring in the NHL. As in ice hockey, often in the final minutes of a close game, the losing team will pull their goalie to the bench in order to get a sixth attacker on the ice. By the data from MoreHockeyStats website, during seasons 2005/2006 to 2014/15, on average a team scored 3.8 empty net goals and conceded 7.1 empty net goals per season. As scoring a goal to the empty net is considered easier relative to when a goalie is in the goal, the goal difference of a team can result in biased estimates for the real performance during the season. Thus, differing from many of the other researches on the NHL, this research does not further analyze goal differences in the NHL.

At the end of the season, 16 teams proceed to the playoffs. Qualifying for the so-called post season equals more games played during the campaign, which directly shows as more revenue from ticket sales. Therefore, a binary variable is introduced to describe whether a team qualified for the playoffs or not. To evaluate the effect of success even more thoroughly, the variable $MadePlayoffs_{t-1}$*$PlayoffWins_{t-1}$ is included. This variable indicates the number of wins during the previous season's playoff campaign. As pointed out before, Brown and Link (2008) state that this is a significant factor in the MLB, and thus it is taken into consideration in this research as well. Another binary variable is introduced to represent the Stanley cup

champion, in order to investigate whether the bandwagon effect is present in the NHL as well. In addition, a binary variable for the first draft pick is added to the model. This variable is justified, as the team with the number one draft pick gains more attention from the audience, as the first pick in the draft is considered as the player with the most potential in their age. To conclude, successful teams tend to attract more fan base, and thus the in-game performance of a team needs to be acknowledged when analyzing the revenue of an NHL team.

3.3 Market size

The market size of a NHL team is in this research represented by two variables. The first obvious variable to describe market size is the population of the metropolitan area a team is located in. The choice of metropolitan area instead of city population was made to include the people from nearby cities to the size of the market. To make the evaluation of the market size complete, a second variable is introduced. This variable represents the average income per capita in the metropolitan area. Average income per capita demonstrates the wealth of the potential market. Naturally, when the potential customers are wealthier, the prices are more inelastic, and the service provider can charge a higher price for the same service or product.

3.4 Ticket price

In the NHL, regular season ticket prices are determined before the beginning of a season. Acknowledging this, the teams are determined to find the highest possible prices possible, still managing to fill the stadium to the maximum capacity. In this research, there are two different variables related to the pricing of the tickets. Firstly, the average ticket price demonstrates the average price charged for a normal seating ticket, excluding any premium seats, which usually include beverages and other goods besides the ticket. The difference between the average ticket price and the premium ticket price demonstrates the level of previously discussed price discrimination.

3.5 Team specific attributes

The team specific attributes are captured by four different variables. Firstly, as suggested by the previous studies, the traditional teams with most heritage tend to attract a bigger fan base.

This effect is captured by the variable age of a team. The variable stadium age refers to the age of the home stadium of a team. This variable is included to capture the previously mentioned honeymoon effect (Bradbury, 2018). Both of the previously introduced variables will be included as raised to the power of two to make the differences more noticeable. Variable for the average attendance of a team's home games is included as the number of audience is a significant factor in the revenue generated by a team. To evaluate the number of high-status players within a team, variable All-Stars is included. This variable describes the number of players that participated in the All-Star game during the respective season. Finally, a variable to demonstrate the popularity of a team is introduced. The variable GoogleSearches describes the popularity of a team based on the Google Trend Index, provided by Google.

3.6 Hypotheses

Most of the past studies on the financial side of professional sports in North America focus on the NFL, NBA and MLB. Even though the leagues have a significant number of common characteristics with NHL, it is inevitable that differences between the sports lead to differences in the economic features between the leagues. The following three hypotheses are stated to evaluate the similarities and differences with the previous researches. The objective of the chosen statements is to address the most common assumptions made on the financial side of the NHL and major sports leagues in general.

As previously discussed in the literature review, the success of a team is proven to have a positive impact on the generated revenue. The difference between being successful during the regular season and the post season in the NHL has not been previously examined, which leads to the first hypotheses in this research:

Hypothesis 1: Success during the post season has a significant positive impact on the generated revenue. Regular season success is not a significant factor.

When discussing the teams with the largest and most enthusiastic fan bases, the common assumption is that being a traditional team with a long history is seen as an advantage. There are teams with various different establishment dates in the NHL, some established in the 21st century and some in the early 20th century. As Jane et al. (2019) suggested in their research,

the age of a team does not only indicate the history and heritage, but also the business operating experience of a team. Thus, the following hypothesis is presented:

Hypothesis 2: Age of a team in the NHL has a significant positive impact on the generated revenue.

The previous research by Jane et al. (2019) suggests that bigger differences in the pricing of NHL tickets lead to more generated revenue. However, as Miller (2012) and Brook (2006) argued in their studies, there is inelasticity in the pricing of tickets in the professional sport industry. From the point of this research, it is expected that higher ticket prices have a more significant impact on the generated revenue than the price discrimination pointed out by Jane, Sasaki and Wang (2019).

Hypothesis 3: Average ticket price is a more significant factor in revenue generating than level of price discrimination.

4. Data and Results

4.1 Data sources

The data for the revenues generated by each team is collected from the Statista database, which collects the data from the Forbes annual business reports of the NHL. Other data sources are presented in table 2. Some of the sources require further explanation: Firstly, the population data for US metropolitan areas was available only for years 2010-2015, so the earlier population values are estimates based on the annual average population growth rates gathered from the United States Census Bureau as well. Secondly, the average annual incomes from Canadian metropolitan areas are converted from Canadian dollars to US dollars using the annual exchange rates. Finally, the source for ticket prices in the NHL, Rodney Fort's Business data, is also used in other researches, such as the one by Jane et al. (2019), giving credibility for the legitimacy of the source.

Table 2. Data sources

Data	Source	Based on
Point percentages	NHL.com	-
Playoff success	NHL.com	-
League results	NHL.com	-
Draft picks	NHL.com	-
Ticket prices	Rodney Fort's sports business data	Team Marketing Report of NHL
Attendances	Statista database	ESPN.com
Team & Stadium age	NHL.com	-
US populations	United States Census Bureau	-
Canadian populations	Statistics Canada	-
US incomes	Bureau of Economic Analysis	-
Canadian incomes	Statistics Canada	-
Google searches	Google trends	-

4.2 Descriptive statistics

The descriptive statistics for each variable are presented in table 3.

Table 3. Descriptive Statistics

Variable	Obs	Mean	Std.Dev.	Min	Max
LnRevenue	290	18.383	.284	17.841	19.249
Point%	290	56.033	8.724	31.7	80.2
CB	290	75.772	21.607	37.386	101.382
Firstpick	290	.034	.183	0	1
StadiumAge^2	290	379.434	498.523	0	2304
AvgTicketprice	290	52.801	16.477	25.41	124.69
Difference	290	70.836	40.625	0	254.62
LnPopulation	290	15.202	.875	13.857	16.809
LnIncome	290	11.03	.251	10.568	11.63
AvgAttendance	290	17.398	2.214	11.059	22.623
TeamAge^2	290	2573.948	2867.547	25	11025
MadePlayoffs	290	.545	.499	0	1
StanleyCupChampion	290	.034	.183	0	1
MadePlayoffs * PlayoffWins	290	2.993	4.367	0	16
GoogleSearches	290	164.017	89.992	23	534
AllStars	290	.845	.984	0	5

Based on the descriptive statistics presented in Table 3, we can conclude that the competitive balance in the NHL cannot be considered as satisfactory. A balanced league would mean that the variance in point percentages would be close to zero, but as it stands, the variance is noticeable. It is also noticeable that the differences in pricing strategies are significant in the NHL. Average ticket prices are ranging from 25.41 US dollars to 125.69 US dollars, indicating that the customer bases differ significantly between different teams. This claim is further supported by the differences in populations and average incomes of the different metropolitan areas.

Figure 2 presents the Kernel density estimate for logarithmic revenues in the NHL.

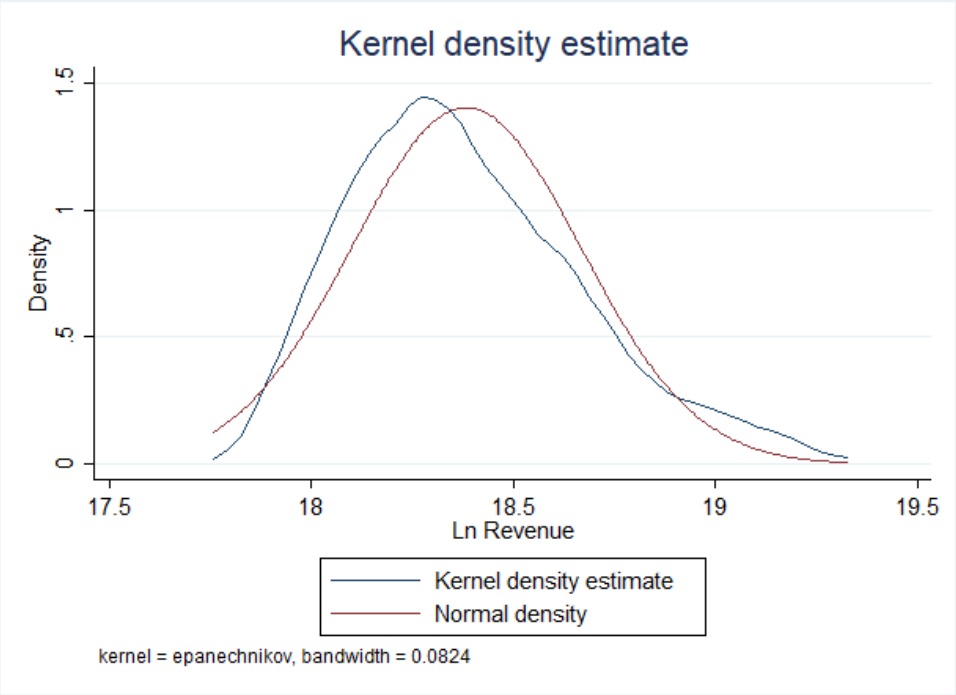

Figure 2. Kernel density estimate

As can be seen from Figure 2, the revenues in the NHL are distributed on the left side of the normal density distribution. Most of the teams are generating a yearly revenue between 50 and 100 million US dollars, with a few exceptions generating more than 150-million-dollar revenue per year.

4.3 Regression results

The regression is completed with three different models. The first model is a fixed effects model, named as FE1. The FE1 model equation is presented below.

$$LnRevenue_{it} = \beta_1 TeamPerformance_{it} + \beta_2 MarketSize_{it} + \beta_3 TicketPrices_{it} + \beta_4 TeamSpecificAttributes_{it} + u_i + v_{it}$$

The second model is also a fixed effects model, but with a deterministic trend, in other words, a variable is included for each season in this model to capture the yearly trends. This model is named FE2. This model equation can be presented as following:

$$\boldsymbol{LnRevenue_{it} = \beta_1 TeamPerformance_{it} + \beta_2 MarketSize_{it} + \beta_3 TicketPrices_{it} + \beta_4 TeamSpecificAttributes_{it} + Season_t + u_i + v_{it}}$$

The third model introduced is the random effects model, named RE. The choice of the best model from these three is firstly done by performing the Hausman test to determine whether a fixed effects model or a random effects model is preferred. The Hausman test is a test for model misspecification. The Hausman test tests if there is correlation between the unique errors and the regressors in the model. The null hypothesis of the Hausman test is that the preferred model is random effects. Figure 3 presents the results of the Hausman test between FE1 and RE. In Figure 4, the Hausman test is done between FE2 and RE.

```
Test:  Ho:  difference in coefficients not systematic

             chi2(13) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                      =      132.65
            Prob>chi2 =      0.0000
            (V_b-V_B is not positive definite)
```

Figure 3. Hausman test for FE1 and RE

```
Test:  Ho:  difference in coefficients not systematic

             chi2(13) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                      =      200.52
            Prob>chi2 =      0.0000
            (V_b-V_B is not positive definite)
```

Figure 4. Hausman test for FE2 and RE

Both Hausman tests performed lead to the same result. As in both tests, the Prob>chi2 ≤ 0.05, the null-hypothesis of random effects being the recommended model is rejected. By this result, the choice of the preferred model is done between FE1 and FE2. Fixed effects models control for all time-invariant differences between the teams, so the estimated coefficients of the fixed effects models cannot be biased due to omitted time-invariant characteristics.

Figure 5 shows the results of the unit root test for the dependent variable LnRevenue. The test is done to ensure the stationarity of the dependent variable. Time trend is included in the test, as the revenue has an upward deterministic trend. The result of the test shows that the null hypothesis of the series containing unit root is rejected, as the bias-adjusted t statistic is -9.4235, which is significant at all the usual testing levels. Due to the null hypothesis being rejected, we can conclude that the series is trend stationary. The result of the test suggests that the time effect should be considered in the model, indicating that FE2 is the preferred model.

```
Levin-Lin-Chu unit-root test for LnRevenue
---------------------------------------------

Ho: Panels contain unit roots               Number of panels  =     29
Ha: Panels are stationary                   Number of periods =     10

AR parameter: Common                        Asymptotics: N/T -> 0
Panel means:  Included
Time trend:   Included

ADF regressions: 1 lag
LR variance:     Bartlett kernel, 6.00 lags average (chosen by LLC)
------------------------------------------------------------------------------
                     Statistic      p-value
------------------------------------------------------------------------------
 Unadjusted t       -20.2356
 Adjusted t*         -9.4235        0.0000
------------------------------------------------------------------------------
```

Figure 5. Dependent variable unit root test

Table 4 presents the significant coefficient values for each of three models. The standard error for each coefficient is reported in parentheses. R^2 values are presented in the bottom of the

table. The complete results of the regressions and the coefficient values are reported in Table 5 in appendices.

Table 4. Regression results

	(FE1) LnRevenue	(FE2) LnRevenue	(RE) LnRevenue
CB	-0.00201***	-0.00207***	-0.00152***
	(0.000299)	(0.000281)	(0.000360)
Stadiumage^2	-0.0000921**	-0.0000650*	-0.0000244
	(0.0000303)	(0.0000288)	(0.0000282)
AvgTicketprice	0.00120	0.00128	0.00749***
	(0.000992)	(0.000931)	(0.000851)
Difference	0.000553	0.000434	0.00165***
	(0.000316)	(0.000298)	(0.000314)
LnPopulation	1.915***	-0.182	0.0187
	(0.304)	(0.458)	(0.0224)
LnIncome	0.138	0.446**	0.0561
	(0.155)	(0.155)	(0.0725)
AvgAttendance	0.0219***	0.0194**	0.0214**
	(0.00639)	(0.00602)	(0.00682)
Teamage^2	0.000226***	0.0000733	0.0000357***
	(0.0000409)	(0.0000464)	(0.00000743)
StanleyCupChampion	0.0804*	0.0851*	0.0920*
	(0.0388)	(0.0365)	(0.0467)
GoogleSearches	0.000151*	0.000151*	0.000112
	(0.0000748)	(0.0000702)	(0.0000901)
Season		0.0388***	
		(0.00664)	
_cons	-13.25**	-62.32***	16.48***
	(4.456)	(9.374)	(0.880)
N	290	290	290
R^2	0.710	0.746	

4.4 Analysis

As stated in the previous chapter, the results of the Hausman tests lead to excluding the random effects model from further analysis. Going back to the hypotheses made in chapter three, we can see the following:

Hypothesis 1: Success during the post season has a significant positive impact on the generated revenue. Regular season success is not a significant factor.

Based on the results of the regressions, success during the regular season does not appear as a significant variable in any of the models presented. None of the models considers the amount of playoff wins as a significant variable either, but in both of the fixed effects models, the variable StanleyCupChampion is a significant variable with a positive coefficient value. This indicates that winning the championship can lead to more generated revenues.

Hypothesis 2: Age of a team in the NHL has a significant positive impact on the generated revenue.

In the FE1 model, the age of a team is a significant factor on the 0.1-percentage confidence level. The coefficient value for this variable is also positive, which supports the earlier statements made. Based on the FE1 model, it is noticeable that older teams with more history and heritage indeed seem to generate higher revenues in the NHL. As the values for team age are squared, it is mandatory to note the U-shape effect on the revenue. This U-shape effect is demonstrated in Figure 6. This effect is not further interpreted due to FE2 being the preferred model.

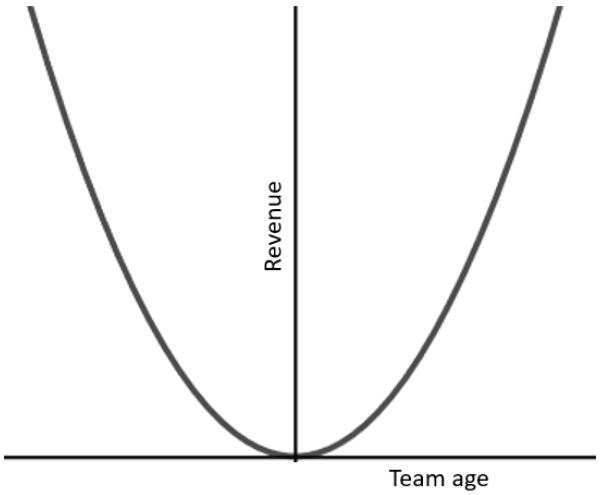

Figure 6. Demonstration of the U-shape effect

However, when analyzing the FE2 model, which includes the seasonal deterministic trends, the team age variable is not significant. This is because when the seasonal deterministic trends are included, the aging of a team is explained by the Season variable. Hence, based on the FE1 model, the second hypotheses could be accepted, but acknowledging the previously mentioned limitation on the U-shaped effect and deterministic trends, this cannot be done. FE2 model being the preferred model further justifies the rejection of the second hypotheses.

Hypothesis 3: Average ticket price is a more significant factor in revenue generating than level of price discrimination.

The variable for the average ticket price does not appear as a significant variable in neither of the fixed effects models. The same applies to the level of price discrimination, as measured in difference between regular ticket prices and premium ticket prices. These results differ from the earlier studies, as the average ticket price is considered as a significant determinant of revenue in most of the studies on professional sports.

Besides these previously stated hypotheses, there are some interesting results in the regressions. Firstly, the age of a team's home stadium appears as a significant variable in both of the fixed effects models. The coefficient value is negative, indicating that an older stadium will lead to less revenue generated. In fact, this is supported by the earlier statements made on the honeymoon effect, but as older teams such as the New York Rangers still have older stadiums with more heritage, it is not reasonable to assume that introducing a new stadium would generate even more revenue for the older teams. When investigating the honeymoon effect, it is important to keep in mind that some model misspecification can be detected, for the same reason as for the variable describing team age. As in this case, the coefficient value is negative and the effect on revenue is thus an inversed U-shape. This means that the positive effect of a new stadium on the generated revenue will wear off as the stadium has reached a certain point of age. This finding is supported by previous researches, as the honeymoon effect is argued to diminish before leveling off (Bradbury, 2018). This effect is further demonstrated in Figure 7.

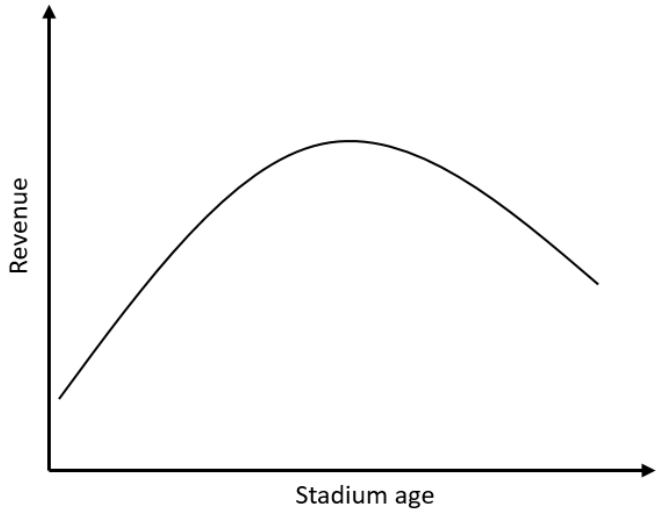

Figure 7. Demonstration of the Honeymoon effect

Secondly, it is surprising that in both of the fixed effects model's, success during regular season or in playoffs is not a significant variable. Previous researches suggest that being successful can lead to more fans, the bandwagon effect, but by the results of these regressions, only winning the championship can be linked to this effect.

Thirdly, the significance of variables describing the market size can be detected in the models. The variable LnPopulation appears as a significant variable in the FE1 model, and LnIncome in the FE2 model respectively. The coefficient values for both of these variables are positive, suggesting that teams located in highly populated and wealthy areas could generate more revenue.

It is also noticeable, that in the FE2 model the Season variable is highly significant with a positive coefficient value. This is due the fact that as economic growth rate in the United States is approximately 2 % per year, when proceeding for the next season, it is expected that a teams' generated revenue will grow as well. In both FE1 and FE2 models, average attendance is a significant variable having a positive effect on the generated revenue. This is reasonable, as approximately 40 percent of the revenue generated in the NHL come from ticket sales. Higher average attendance leads to more tickets sold and thus has a significant effect on the revenue as well.

The most noticeable variable in this analysis proves out to be the variable measuring competitive balance in the league. This variable appears to be a significant variable at 0.1% significance level in all of the models presented. The negative coefficient value can be interpreted in two ways. Firstly, the values measuring the competitive balance increase as the balance in the league decreases. Thus, when the league is balanced, teams are likely to generate more revenue compared with a situation where the league is highly unbalanced. Secondly, this negative coefficient value indicates that one unit increase in the value for competitive balance will lead to roughly 0.2% decrease in the generated revenues (coefficient values between -0.00201 and -0.00207).

4.5 Comparison

Compared with the previous researches, the presented results have some similarities. Firstly, as El-Hodiri and Quirk (1971) pointed out in their research, there is inequality in the league as the teams are located in cities with different revenue generating potential. In both of the fixed effects models, this is supported by the variables for population and average income per capita in the metropolitan areas. In other words, both fixed effects models recognize the value of revenue generating potential in the form of potential markets.

Compared with Bradbury's (2018) study where he argues that qualifying for the post season is a significant factor on generating revenue, the results from this research differ. None of the models presented suggest that qualifying for the post season is a significant factor in generating revenue. However, as Burger and Walters (2003) suggested, succeeding in the post season has a positive impact on the revenue, as winning the Stanley Cup is a significant positive factor on generating revenue. This can be linked to the bandwagon effect, also stated by Burger and Walters (2003).

As pointed out previously, the age of a NHL team's home stadium appears as a significant factor with a negative coefficient value. This suggests that newer stadiums have a less negative effect on the revenue. The results of the regression support the statements made by Bradbury (2018) on the honeymoon effect and are in line with the findings of Leadley and Zygmont (2006) on the honeymoon effect being present in the NHL. Still, because of possible model misspecifications regarding the interpretation of the honeymoon effect due to omitted

variables, it cannot be stated that newer stadiums will certainly lead to more generated revenue. However, this could be a possibility in the NHL and is definitely in need of further research.

The inelasticity of NHL ticket prices can be seen in the models, as the models suggest that higher ticket prices can have a positive effect on the generated revenue. This finding supports the statements made by Jane et al. (2019), even though the variable for the ticket prices is not significant. However, when comparing the results of the regression to the statement made by Jane et al. (2019), we can see that the level of price discrimination does not appear as a significant factor on generating revenue. The level of price discrimination appears as a significant variable only in the random effects model, but as shown previously by the Hausman tests, the random effects model is not the preferred model when considering the data in use.

As pointed out by Jane (2014) in their research, the competitive balance of a league is an important factor when considering the attendance in professional sports, and thus affects the generated revenues as well. The results of the research conducted by Jane et al. (2019) did not consider the competitive balance of a league as a significant factor affecting revenues in the NHL. However, the results of this research suggest that competitive balance is indeed a significant factor when considering the revenues generated in the NHL.

5. Conclusions and limitations

5.1 Conclusions

The research question presented in the first chapter for this thesis was:

What kind of a regression model is the most capable of explaining the differences between NHL teams generated revenue?

After collecting the data used and performing the Hausman tests, the preferred model proved out to be the fixed effects model. The results for the regressions were certainly interesting, as discussed in the analysis section of the thesis. Especially the variable to measure competitive balance in the league appeared to be a highly significant factor in all of the models and the effects of balance within the league on generating revenue on a team level are engaging. Secondly, the average income of the metropolitan area a team is located in proved out to be a significant factor in the FE2 model and population of the metropolitan area in the FE1 model. It is noticeable that as argued in Chapter 2, the location of a NHL team has not been studied to enough of extent and these results indicate that further research on the topic should be conducted.

The results of the models can be considered as satisfactory, as the R^2 –values for the fixed effects models are 0.710 and 0.746. These values indicate that the models are capable of explaining 71.0 and 74.6 percent of the observed variation in the values of the logarithmic revenues in the NHL.

5.2 Limitations and future research

When discussing the conclusions presented in the previous part, it is paramount to address the limitations to this research in order to avoid the possible misinterpretations of the models presented in this thesis.

Firstly, as mentioned before, some model misspecification may occur when analyzing the impacts of a single independent variable on the generated revenue of a NHL team. Some biasedness can be expected, as not all data regarding the financial side of the NHL is publicly accessible, and for example, the ownerships and strategic decisions between different teams

naturally vary. Much more data would have been available by paying different fees, but for this research, this was not a possibility.

Secondly, it is noticeable that the timeframe for this research is limited to only ten seasons, due to the accessible data. For more convincing and trustworthy results, the time-span for a research like this should be further expanded.

Finally, as mentioned before, the level terms of age variables are excluded from the models, as otherwise the Season variable would be omitted because of collinearity. Thus, the interpretation of the age variables was done with caution to avoid biased statements.

There are some limitations in the data used as well. Firstly, the team Winnipeg Jets is excluded from this research due to the team moving from the United States to Canada in 2011. In order to include this team in this research, the data collection would have been significantly more complicated and time consuming.

Secondly, the data source for the ticket prices (Rodney Fort's Sports Business Data) had some limitations. Average premium ticket prices, which were used to calculate the level of price discrimination, were absent for the season 2006/2007. Thus, the values for season 2006/2007 are estimates based on the premium ticket prices of season 2005/2006.

For the future researches on the financial side of the NHL, it can be expected that as the amount of advanced statistics constantly increases, the possibilities of conducting an even more excessive research on this topic increase. In addition, by including more different models than the three presented in this thesis, a larger set of comparable results could be achieved. By having more different types of results to discuss, an even deeper understanding of the revenue generating mechanisms in the NHL could be achievable. Still, as discussed earlier, the geographical factors in the NHL are in need of more research, accompanied by the need for further investigation on the honeymoon effect and team aging.

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Appendices

Table 5. Full regression results

	(FE1) LnRevenue	(FE2) LnRevenue	(RE) LnRevenue
Point%	0.00144 (0.00132)	0.00114 (0.00124)	0.00204 (0.00158)
CB	-0.00201*** (0.000299)	-0.00207*** (0.000281)	-0.00152*** (0.000360)
Firstpick	-0.00827 (0.0389)	0.00141 (0.0365)	0.0251 (0.0467)
Stadiumage^2	-0.0000921** (0.0000303)	-0.0000650* (0.0000288)	-0.0000244 (0.0000282)
AvgTicketprice	0.00120 (0.000992)	0.00128 (0.000931)	0.00749*** (0.000851)
Difference	0.000553 (0.000316)	0.000434 (0.000298)	0.00165*** (0.000314)
LnPopulation	1.915*** (0.304)	-0.182 (0.458)	0.0187 (0.0224)
LnIncome	0.138 (0.155)	0.446** (0.155)	0.0561 (0.0725)
AvgAttendance	0.0219*** (0.00639)	0.0194** (0.00602)	0.0214** (0.00682)
Teamage^2	0.000226*** (0.0000409)	0.0000733 (0.0000464)	0.0000357*** (0.00000743)
MadePlayoffs	0.0142 (0.0223)	0.0209 (0.0210)	0.0109 (0.0268)
StanleyCupChampion	0.0804* (0.0388)	0.0851* (0.0365)	0.0920* (0.0467)
MadePlayoffs * PlayoffWins	0.00194 (0.00174)	0.00214 (0.00163)	0.000383 (0.00205)
Googlesearches	0.000151* (0.0000748)	0.000151* (0.0000702)	0.000112 (0.0000901)

AllStars	-0.000723	-0.00283	0.00128
	(0.00702)	(0.00660)	(0.00844)
Season		0.0388***	
		(0.00664)	
_cons	-13.25**	-62.32***	16.48***
	(4.456)	(9.374)	(0.880)
N	290	290	290
R^2	0.710	0.746	