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Canadian Hockey Leagues Game-to-Game Performance

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Abstract

This study examines game-to-game performance of players across the three Canadian Hockey Leagues (Western Hockey League, Ontario Hockey League, and Quebec Major Junior Hockey League) for the 2017-2018 season. It tests the importance of factors such as rest, travel, weather conditions, and more. Data for this study were collected from each of the three CHL websites and from www.weatherunderground.com. The null hypotheses of different factors affecting performance were tested through regression models using Ordinary Least Squares. The dependent variables, used across different specifications, were on-ice performance variables such as points, goals, and penalty minutes on a per-game basis.

Introduction

The Canadian Hockey League (CHL) consists of three major junior hockey leagues for 16 to 20 year old players. The Western Hockey League (WHL), Ontario Hockey League (OHL), and Quebec Major Junior Hockey League (QMJHL) serve as platforms for players hoping to reach the major leagues. As is the case for all professional-level sports leagues, the players in these leagues have a number of outside factors that may impact their performance, yet they have no control over. For players who are trying to prove themselves to National Hockey League Executives, some factors can significantly affect their performance on the ice.

Some of these outside factors that can have an impact on performance include home ice advantage, the amount of days between games, the distance they must travel for each game, and weather effects that can affect ice conditions. These factors can have both positive and negative effects on performance, and can also affect different players in different ways. Considering the differences between the WHL, OHL and QMJHL, these factors can also have different effects on player performance within each league compared to each other. For example, the Western Hockey League covers far more land than the other two leagues, so factors like days of rest and travel distance will most likely affect players differently. In fact, George Johnson describes life as a WHL player with the childhood song "The Wheels on the Bus" and emphasizes that sometimes teams will be on the bus for 15 hours at a time (Johnson, 2010).

The most pronounced outside factor in terms of its impact on performance is playing games at home. In all sports, to some degree there is an advantage of playing in one's home facility rather than playing on the road. The advantage is the greatest in hockey, as per 100 games played at home, the home team on average wins 53 games, loses 30, and ties 17. Excluding ties this would mean home teams win 64 percent of their games (Schwartz & Barsky, 1977). Furthermore, the National Basketball Association (NBA) offers a clear assessment of the advantage of playing at home, due to crowd effect, because the Los Angeles Lakers and Los Angeles Clippers share a stadium. When the two teams play each other, the "home" team has their win likelihood raised by an estimated 21-22.8 percentage points (Boudreaux, Sanders, & Walia, 2017).

In order to run a profitable business, the CHL schedules games to produce the highest attendance possible, which often results in three games in four days. Playing night after night does not necessarily bode well for players trying to perform at their highest level. Inversely, having long stretches of days without playing can also negatively affect performance, as players often go on hot streaks throughout the season or can get "rusty" through lack of actual game action. Prior research conducted on the NBA on rest and travel effects have shown that players perform worse when they only have one day between games, while having more than one day in between games improves performance. Additionally, peak performance comes with three days in between games, while performance begins to tail off with four or more days. Travel was also seen to have an effect on performance, as visiting teams were affected by days of rest more than home teams (Steenland & Deddens, 1997).

The goal of this research is to identify which outside factors significantly affect player performance for major junior ice hockey players and in which way. Furthermore, an attempt is made to consider these leagues in the scope of a labor market and how workers are affected by the scheduling of their work. Through a method of ordinary least squares regression, an analysis of these factors' effects on performance is conducted for not only the CHL as a whole, but also each league individually.

Empirical Model

I hypothesize that playing at home, the amount of days between games, travel, and ice conditions caused by weather effects have an impact on player performance. Therefore, points, goals, assists, and even penalty minutes can be affected by

these outside factors. In order to test the significance and the effect that these factors have on performance, I ran four regressions with these factors as independent variables, and each of the four performance variables as the dependent variables. The points and penalty minutes models will be shown in the body of the paper as Table I and Table II, while the goals and assists models did not have as conclusive results. The data consists of the game logs from the top three hundred scorers from each of the three CHL leagues. Weather data from www.weatherunderground.com was matched with these game logs.

In the models, "playerhome" represents whether the player was playing at home or on the road, where the value "0" is for a road game, and "1" is for home. The "daysbetween" variable is for how many days between the current game and the last game they played. Given the offseason, holiday breaks, and players coming off of injuries, the maximum for this variable was restricted to 10 days. The distance measured in miles from a player's home city to the road city in which they are playing in is represented by the "travel" variable. Lastly, "temp," "hum," "precip," and "pres" are used as weather variables, and are temperature, humidity, precipitation, and pressure, respectively. These models also included squared variables for both "daysbetween" and "travel" to test for a nonlinear relationship between performance and the aforementioned variables. All models are fixed for both player and opponent effects.

The main focus will be on the model which uses points as a dependent variable, as this is the best all-encompassing variable for player performance. The results of this model are in the table below. Coefficients on the independent variable and the p-value associated with that coefficient is presented for each league and for the pooled sample (including all three leagues).

Table 1: Regression Results CHL Player Performance

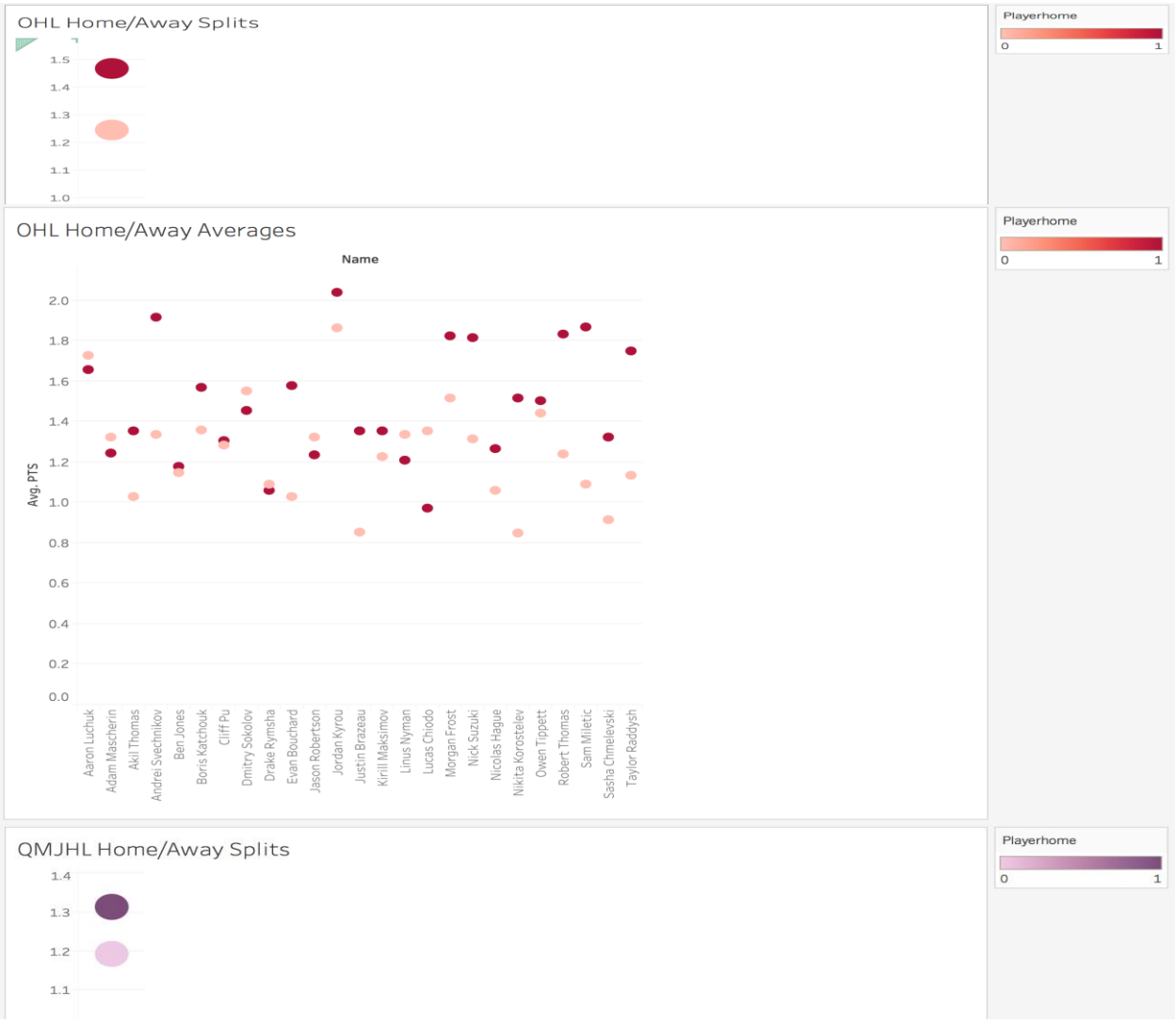
	OHL	***OHL***	***QMJHL***	***QMJHL***	***WHL***	***WHL***	***CHL***	***CHL***
Variable	***Coefficient***	***Prob.***	***Coefficient***	***Prob.***	***Coefficient***	***Prob.***	***Coefficient***	***Prob.***
Intercept	2.836	*0.013*	-0.031	*0.957*	-0.919	*0.242*	0.216	*0.584*
Player Home	0.090	*0.032*	0.128	*0.000*	0.103	*0.000*	0.114	*0.000*
Days Between	0.036	*0.002*	0.033	*0.000*	-0.006	*0.492*	0.022	*0.000*
Days Between^2	-0.004	*0.001*	-0.003	*0.000*	0.001	*0.301*	-0.003	*0.000*
Travel	-0.000	*0.383*	0.000	*0.060*	0.000	*0.699*	0.000	*0.046*
Travel^2	0.000	*0.228*	0.000	*0.158*	0.000	*0.885*	0.000	*0.125*
Temperature	0.000	*0.410*	-0.000	*0.246*	0.001	*0.070*	0.000	*0.473*
Humidity	-0.001	*0.069*	-0.000	*0.638*	0.001	*0.063*	-0.000	*0.576*
Precip.	-0.064	*0.323*	0.058	*0.016*	0.051	*0.343*	0.036	*0.035*
Baro. Pressure	-0.039	*0.294*	0.017	*0.351*	0.046	*0.071*	0.011	*0.403*
QMJHL							-0.128	*0.000*
WHL							0.050	*0.000*
Player Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Opponent Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

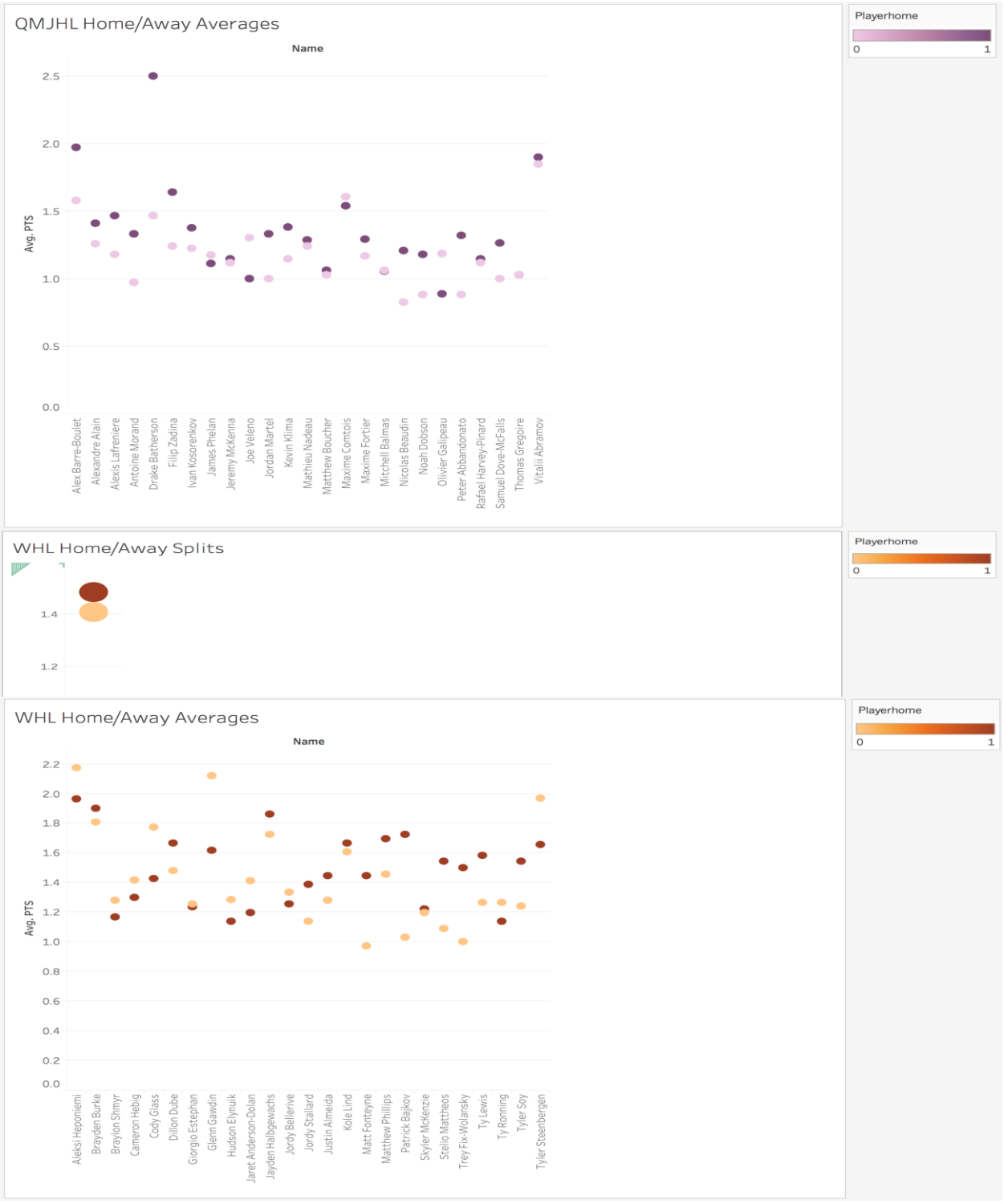
The table is constructed to show how each of the variables affect each league and the CHL as a whole. Taking a broad look at all three leagues together, there are several variables that are significant. First, and most obvious, is that playing at home is significant at the 1% level with a positive coefficient of .114. Furthermore, both "daysbetween" variables are significant at the 1% level, which signifies that the relationship between points and the amount of days between games is nonlinear. Understanding the true coefficient for "daysbetween" will be discussed later. The travel variable was also significant, at the 5% level, but with such a small coefficient, nothing can be said about its effect on performance without looking at it visually. Lastly, precipitation was significant at the 5% level as well, with a small but positive coefficient. For the CHL, the OHL was used as a dummy variable to look for a difference between leagues, which was found for both of the other leagues at the 1% level. Players in the WHL scored more points than the OHL, while players in the QMJHL scored less.

Before moving on, a quick look at the OHL, QMJHL, and WHL models show differences between some variables. First, unlike the other two, the WHL didn't have significance for either of the "daysbetween" variables, while the QMJHL was the only league with significance for travel. As far as the weather variables go, the OHL found significance at the 10% level for humidity, with a negative effect, while the QMJHL saw significance at the 5% level for precipitation with a positive effect. The WHL had significance at the 10% level and positive coefficients for all four weather variables besides precipitation.

Impact of Playing at Home

It comes as no surprise that the biggest effect out of the variables tested came from a home ice advantage. All three leagues saw significance with a positive effect. A look at how home ice advantage contributes to scoring points can be seen in the graphs below that include the top 25 scorers from each of the three leagues. The choice to use the top 25 scorers rather than the entire sample size was decided by the fact that the data has too many players to look at as a whole, and the top scorers in theory should perform at a high level regardless of where they are playing.



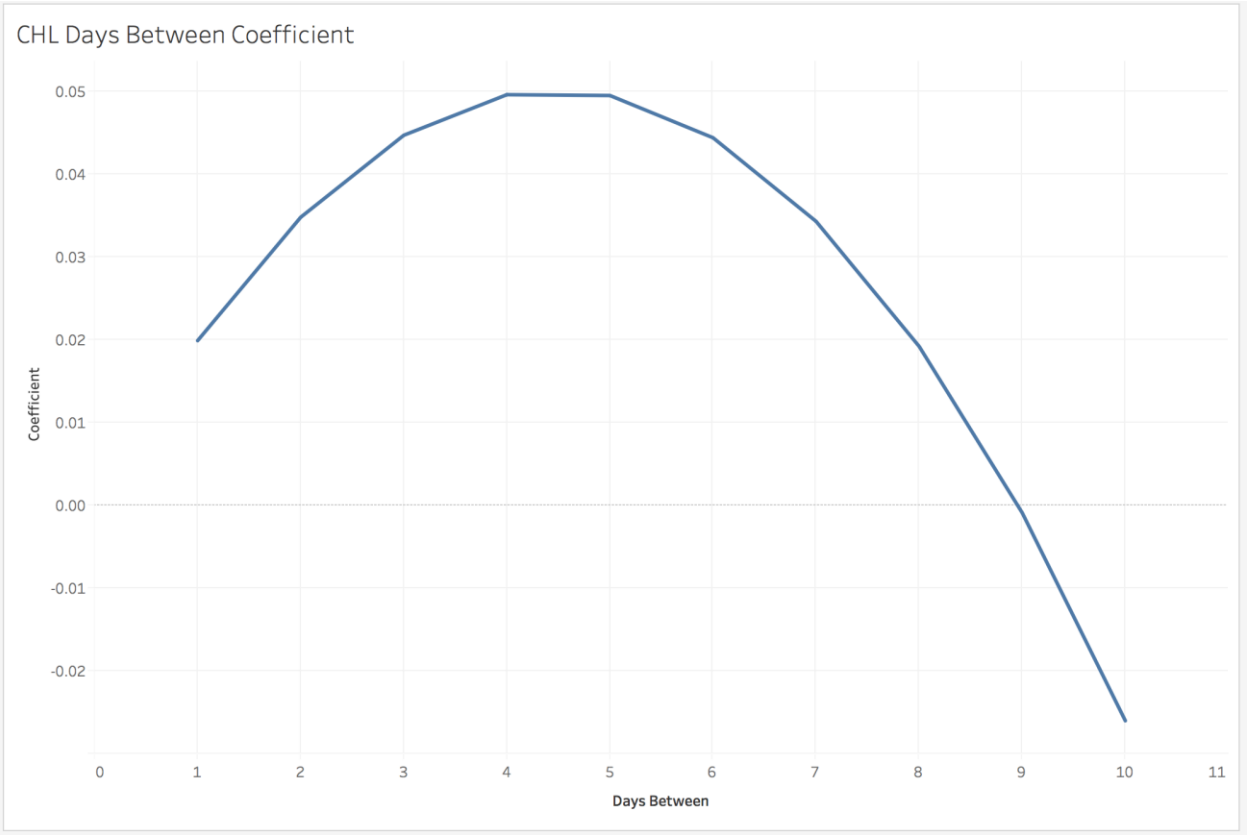


The first graph for each league shows the combined home and away point averages for the top 25 scorers. The darker circle in each graph represents the home average while the lighter circle is for on the road. In all three leagues, averages at home were higher than on the road. For the second graph for each league, the top 25 scorers are labeled on the x-axis with average points on the y-axis. The two circles for each player represent their averages at home and on the road, with the darker circles representing being at home and the lighter on the road. The OHL and QMJHL show that out of their top 25 scorers, 18 and 19 of them, respectively, score better at home. The difference between playing at home and on the road is less noticeable

for the WHL, as only 14 of the top 25 scorers produce more at home. Overall, there is a clear advantage to playing at home rather than playing on the road when it comes to performance.

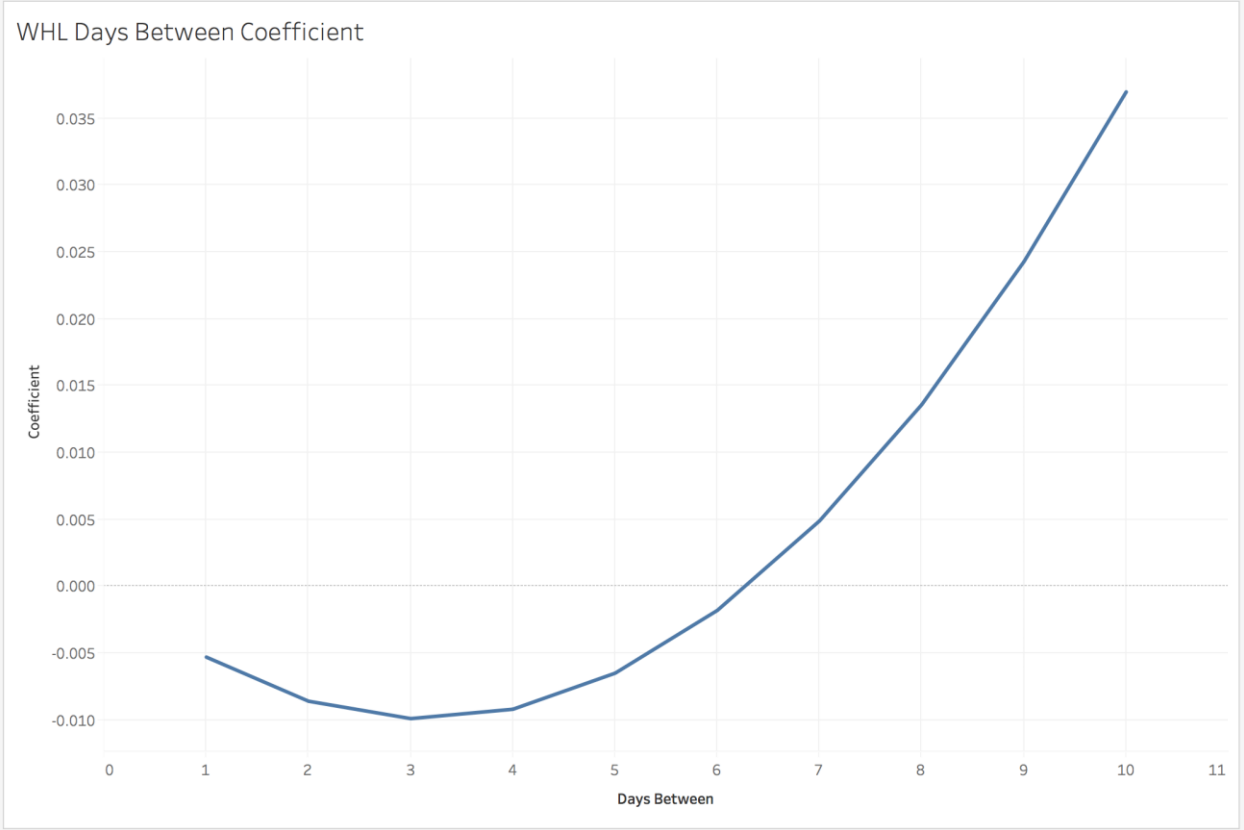
Days in Between Games

In order to assess the impact that the amount of days between games has on performance, based on the regression results, we must first adjust the overall coefficient. We do this by first multiplying the coefficient for "daysbetween" by the actual amount of days between and then adding it to the product of the "daysbetween" squared coefficient and the actual amount of days between. After doing this, we get the true coefficient for each amount of days between, which is represented in the graph below which shows the coefficient for the CHL as a whole.

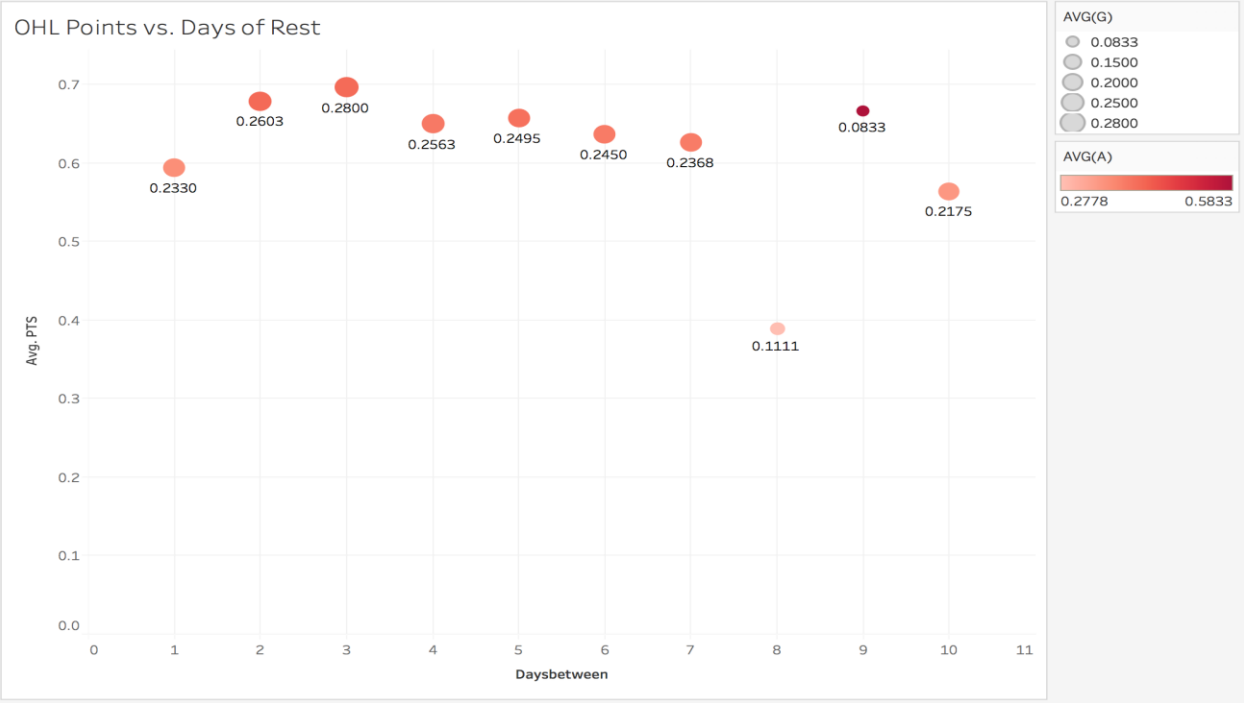


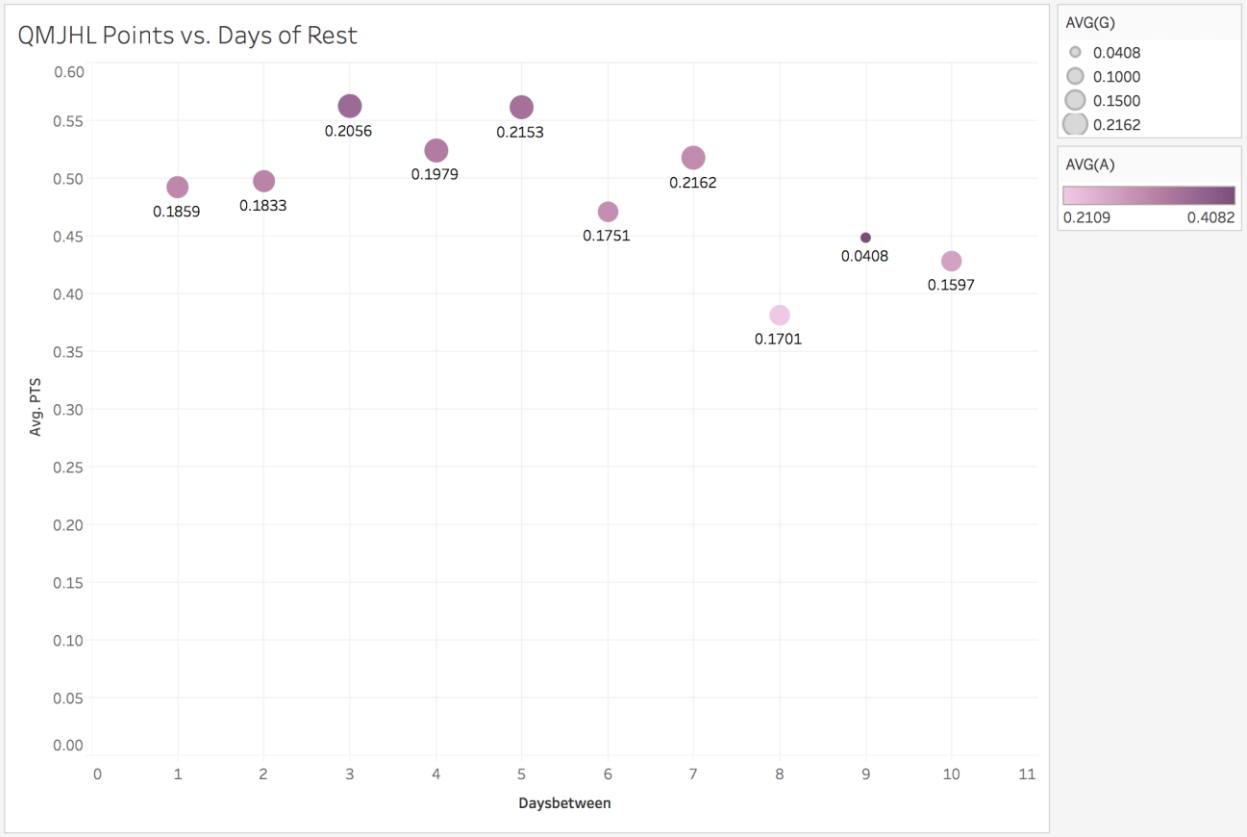
The downwards concavity of this graph shows us that peak performance comes around four to five days between games. If we did not include the "daysbetween" squared coefficient and then find the true coefficient, we would have been left believing that as the amount of days in between games is increased, performance increases. This is clearly not the case, as the coefficient decreases after five days between games.

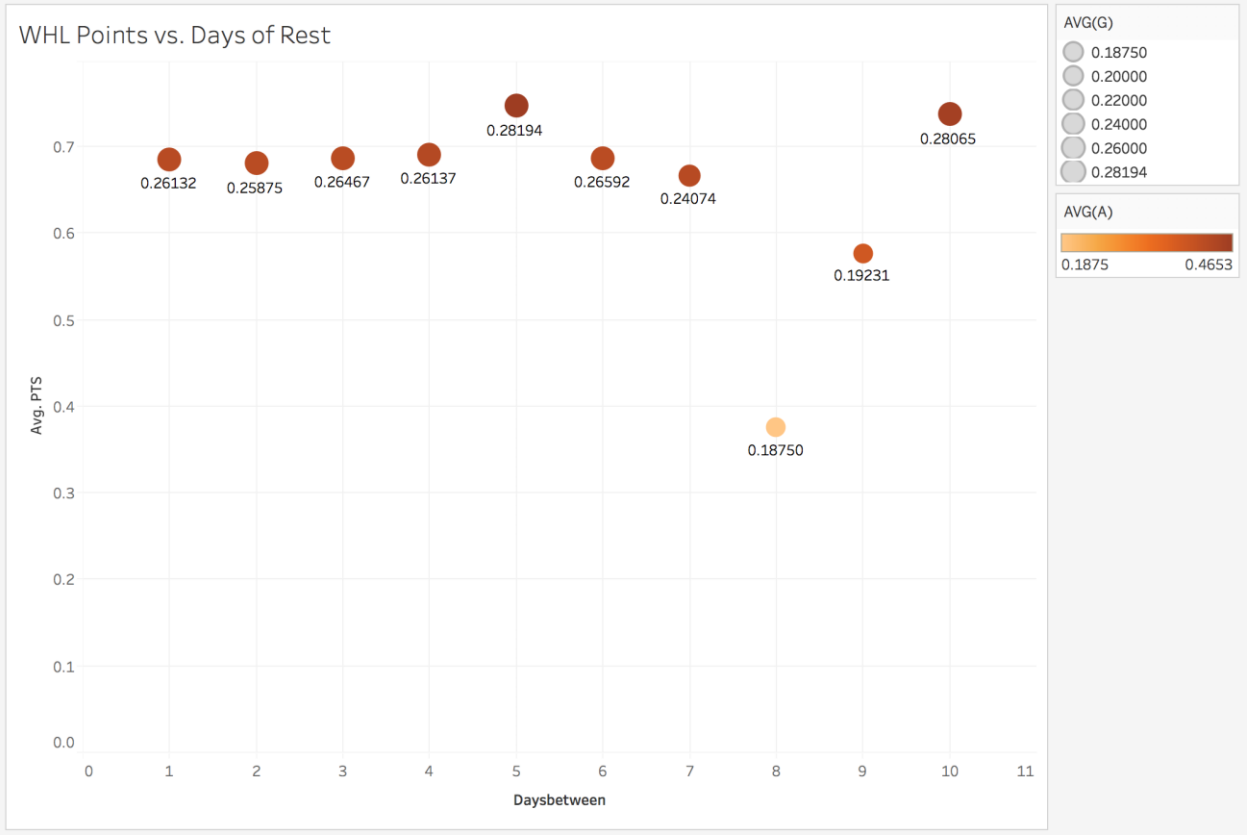
It is important to point out that the OHL and QMJHL coefficients produced graphs similar to the one above, but the WHL, which, individually, did not have significance for the "daysbetween" variables, showed a different relationship. However, because the variables were not significant, the relationship is not necessarily a perfect picture of how these variables affect performance. The graph for the true coefficient of the WHL is show below.



A look at actual point averages for each amount of days between games supports the curves for the OHL and QMJHL, while the WHL somewhat reflects the same pattern. Individual looks at each league are shown below.



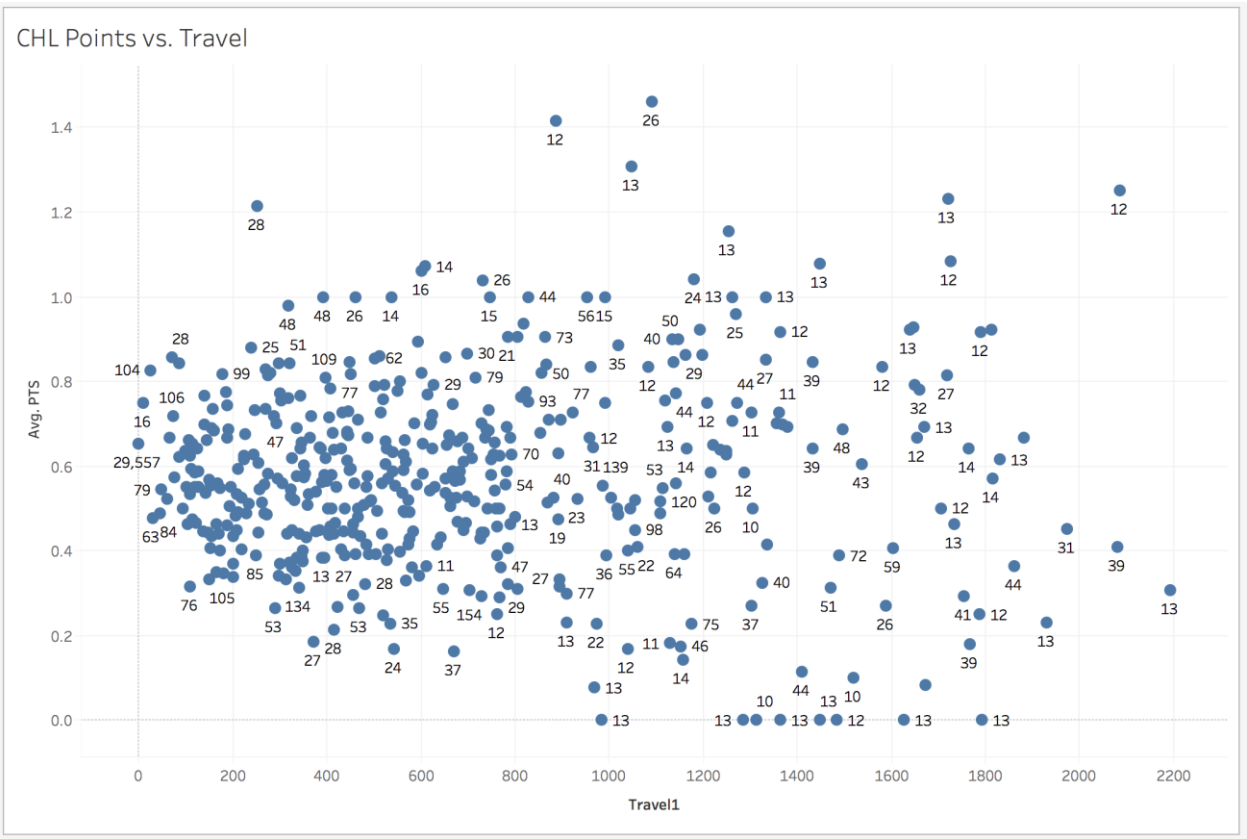

QMJHL Points vs. Days of Rest
Avg. PTS
Daysbetween
0.2056
0.2153
0.1979
0.2162
0.1859
0.1833
0.1751
0.0408
0.1597
0.1701
AVG(G)
0.0408
0.1000
0.1500
0.2162
AVG(A)
0.2109
0.4082


WHL Points vs. Days of Rest
Avg. PTS
Daysbetween
0.28194
0.28065
0.26132
0.25875
0.26467
0.26137
0.26592
0.24074
0.19231
0.18750
AVG(G)
0.18750
0.20000
0.22000
0.24000
0.26000
0.28194
AVG(A)
0.1875
0.4653

Each of these graphs show the amount of days in between on the x-axis with average points on the y-axis. The size of each data point and the corresponding number under them represents the average number of goals scored, while the color range represents the average number of assists, with the darker the color representing a higher average. Each league shows similar trends but with different peaks. OHL players perform best with three days in between, having their highest average of both points and assists with this amount. QMJHL players have almost identical peak average points with three or five days in between, with slightly higher assists with three days and slightly higher goals with five days. Lastly, the WHL has peaks at both five and 10 days in between games. Points, goals, and assists are all slightly higher with five days than 10. Interestingly, both the OHL and QMJHL see their smallest, darkest circles with nine days in between games.

Inconsistencies from Traveling

In the model, travel was significant at the 5% level, but with such a small coefficient, the effects of travel were hard to interpret. Graphing miles traveled against average points tells the story of how travel affects performance. The relationship is show below.



With distance (in miles) traveled on the x-axis, average points scored when traveling those distances on the y-axis, and the count of how many times that distance is traveled (the numbers under the data points), a clear relationship develops. Distance traveled doesn't necessarily provide a positive or negative effect on performance, but rather brings about inconsistency. As the data points move to the right in the graph above, they become more spread apart than they once were. Not only are there far worse performances the farther teams travel, but there are also far better ones. Although not a perfect analogy, this phenomenon might be explained by the Alchian-Allen Theorem which states that as transportation costs increase, consumption shifts toward higher-grade products (Potts, 2014.) In this case, as a possible explanation of improved performance, the further a player has to travel for a game, the more effort they may put into this game, possibly due to being exposed to different professional scouts in that region, compared to their own.

Penalty Minutes

Considering points can be used to evaluate performance and how it can be affected by outside factors, we will use penalty minutes to evaluate aggressiveness in the sport. Using the same independent variables and penalty minutes as the dependent variable, we get the following results for our model.

Table 2: Penalty Minutes Regression Results

	OHL	***OHL***	***QMJHL***	***QMJHL***	***WHL***	***WHL***	***CHL***	***CHL***
Variable	***Coefficient***	***Prob.***	***Coefficient***	***Prob.***	***Coefficient***	***Prob.***	***Coefficient***	***Prob.***
Intercept	-0.859	*0.493*	2.177	*0.058*	-0.572	*0.751*	1.486	*0.042*
Player Home	-0.043	*0.320*	-0.006	*0.893*	-0.262	*0.000*	-0.081	*0.001*
Days Between	-0.020	*0.115*	0.012	*0.470*	-0.073	*0.001*	-0.025	*0.008*
Days Between^2	0.002	*0.206*	-0.000	*0.827*	0.009	*0.000*	0.003	*0.001*
Travel	-0.000	*0.635*	0.000	*0.737*	-0.001	*0.001*	-0.000	*0.012*
Travel^2	0.000	*0.725*	0.000	*0.519*	0.000	*0.001*	0.000	*0.010*
Temperature	0.002	*0.005*	-0.001	*0.144*	0.003	*0.001*	0.001	*0.000*
Humidity	-0.001	*0.472*	0.001	*0.195*	-0.002	*0.064*	-0.000	*0.575*
Precip.	0.043	*0.507*	-0.006	*0.852*	0.409	*0.001*	0.003	*0.930*
Baro. Pressure	0.036	*0.377*	-0.047	*0.212*	0.059	*0.319*	-0.028	*0.247*
QMJHL							0.153	*0.000*
WHL							0.244	*0.000*
Player Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Opponent Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

These results show that playing at home is significant at the 1% level with a negative effect on penalty minutes. Furthermore, both "daysbetween" and travel variables are significant, with all but travel being significant at the 1%. Lastly, temperature positively affects penalty minutes at the 1% level. Perhaps higher temperatures lead to more aggressive behavior resulting in more penalties.

Considering that "daysbetween" squared is significant, the effects are nonlinear. After finding the true coefficient for the amount of days in between games, it shows the opposite effect than it does with performance. Having three to five days in between games shows lowest numbers in penalty minutes, while not having much rest increases penalty minutes, and having extended days off greatly increases aggressiveness. This is most likely due to having an "itch" to get back out and play.

Conclusions

Junior hockey players in the Canadian Hockey League are constantly trying to prove themselves to National Hockey League teams in hopes they can make it into the league. By not making it to the NHL, players are either tasked with playing in minor leagues or overseas, which both have significant pay drop-offs in comparison to the NHL, or giving up hockey all together. With this in consideration, it is vitally important for players to perform at their peak ability in order to show what they can bring to a team. However, there are many outside factors that are out of their control that can affect their performance.

For most players, playing at home is usually beneficial. Not having to travel means players most likely feel fresher, and playing in front of one's home crowd most likely motivates most players. Playing at home has a significant positive effect in the OHL, QMJHL and WHL for points, goals and assists. Although playing at home seems to have less of an impact in the WHL than the other two CHL leagues, it is still regarded as a positive.

In addition to having home ice advantage, another factor that affects player performance is the amount of days in between games. As a whole, peak performance throughout the CHL comes with somewhere between three and five days between games. Only having one or two days between games can lead to players not having enough rest for games. Inversely, having six or more days between games can lead to poorer performance due to rust and the streaky nature of the game of hockey.

With not a lot of rest and too much rest causing a decrease in production, performance as it relates to days in between games has an umbrella-like relationship.

Travel also plays a role in how players perform. Although traveling far distances doesn't really have a positive or negative effect, there is still an impact on performance. As travel distance increases, player performance tends to become less consistent. Average point totals tend to be either very high or very low, and it might just be that some players benefit and others play worse when having to travel.

As far as weather effects go, my research did not find anything that had that great of an impact on performance. However, other work conducted on the matter has. Northern cities tend to have higher quality ice conditions due to the colder temperatures and less humidity. This results in "fast" game conditions. On the other hand, warmer, more humid cities produce "slow" ice. These differences can have positive and negatives effects on players with different playstyles and can also lead to teams taking different strategies depending on where they are playing (Conetta, Weinberg, & Paul, 2016). In terms of my research, I did find temperature to have a positive effect on penalty minutes, which means that players tend to be more aggressive when temperatures are higher.

Overall, players playing at the major junior level of hockey have a lot to prove to NHL teams. The opportunity cost of not making it to the majors is substantial. There are many outside factors that can contribute to their performance on the ice and therefore affect their chances of being able to compete against the best players in the world.

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