Does Player Size Affect Productivity in the "New NHL"?

Gregory J. Miller, West Chester University

After the 2003-2004 hockey season, the players' union and NHL team owners failed to reach common ground on a new collective bargaining agreement resulting in the cancellation of the 2004-2005 hockey season. The cancellation brought fear among team franchises that a year-long lockout would cause a decline in ticket sales, television ratings, and merchandising. During this time, the popularity of hockey was extremely low and with ESPN's refusal to renew its television contract, the league was in a tough position. The NHL needed a solution to reclaim its fan base and stimulate enthusiasm for the sport of hockey. To make the game more exciting, league officials and team franchises agreed to implement new rules to increase the penalty stringency.

The stricter penalty calling eliminated player obstruction, aggressive stick work, and holding, which resulted in a faster European-style play. Players who once used their large size as an advantage soon found themselves admonished by fans and management for their lackluster performance. Teams that built themselves around large, bulky defensemen, like the Philadelphia Flyers, saw some players unable to transition to the new style of play. The rule changes were widely criticized for assisting smaller players, while at the same time substantially hindering the performance of larger players. Has the stricter penalty calling for player obstruction, aggressive stick work, and holding affected the way hockey is played? The purpose of this study is to determine if larger players experienced a drop in productivity following the rule changes, as measured by points-per-hour.

I. Literature Review

The purpose of this review is to identify variables that have been shown in past studies to influence player's productivity. Early hockey studies examine whether a player's productivity can explain his salary. The most notable study, by Jones and Walsh (1988), examines the impact of skill differences on player salaries. Jones and Walsh regress player salary on a comprehensive list of independent variables assessing a player's skill level. They predict that penalty minutes will have a positive effect on the productivity of players, insisting that penalty minutes are a measurement of intensity and intimidation. Jones and Walsh also expect a positive correlation between salaries and height and weight because they feel size enables a player to accomplish more on the ice.

The authors conclude that the impact of skill differences on players' salaries is significant. Coulombe, Grenier, and Lavoie (1992) criticize Jones and Walsh's analysis, arguing that their measurements of productivity are vague. Jones and Walsh emphasize how the "plus-minus" statistic is an invalid measurement of a defenseman's productivity and omit the variable from their study. The "plus-minus" statistic is recorded when a player is on the ice during an even-strength goal. A plus is awarded to the individuals on the ice when their team scores and a minus is given when their team is scored against. Jones and Walsh reason that defensive players are positioned to cover the opposing superstars and those opposing superstars tend to score many points. As a result, the "plus-minus" statistic may not accurately reflect the productivity of defensive players.

Coulombe et al. contradict Jones and Walsh by using a more in depth analysis of the "plus-minus" statistic that includes the statistics on short-handed participation. Short-handed participation refers to a situation where a team has taken a penalty and must play with fewer men

on the ice for a set amount of time. Coulombe et al. argue that short-handed participation by a defensive player demonstrates the importance of his role on the team when the number of power play goals scored against is considered.

The study conducted by Longley (1995) also analyzes the factors that affect a player's salary. To capture player productivity, Longley only uses a few variables to measure the effectiveness of players and omits defensemen from his data. He argues that few measurements of defensive performance exist since it is the job of the defense to prevent the opposition from scoring. The variables Longley uses to capture player productivity include regular season games played and regular season points-per-game. Longley criticizes Jones and Walsh for utilizing too many variables in their regression. However, the limited number of independent variables regarding player productivity used by Longley ignores fundamental details that determine a player's worth.

Kahane (2005) uses a different approach when attempting to identify discriminatory hiring practices and production inefficiency. Kahane's article differs from previous studies because he uses team payroll as a measure of inputs. He asserts that this choice for the dependent variable reduces the number of problems associated with immeasurable inputs and provides a relatively easy way for testing the effects of discriminatory hiring practices on production efficiency. Kahane uses the maximum likelihood estimation method to simultaneously estimate the parameters of the stochastic production function and to test the model for errors. The results indicate there are production inefficiencies in the NHL, and they may be connected to the level of inputs at the team level including coaching ability, franchise age, and franchise relocation. These results are a contribution to the literature because they identify new factors beyond the individual player that may affect the productivity of players.

Idson and Kahane (2000) study whether individual attributes are rewarded differently on different teams. Idson and Kahane use regression analysis to examine the effects of co-worker attributes on individual pay as well as coaching effects on productivity. Following Jones and Walsh, height, size, and penalty minutes are viewed as positive attributes of players when determining their productivity. Idson and Kahane also hypothesize that teams place greater value on larger, more physical players, arguing that larger players are more effective both offensively and defensively because they can use their size to gain a competitive edge and increase the team's potential scoring opportunities. However, their results indicate that height and penalties have negative and significant effects on salaries. Idson and Kahane rationalize this result by proposing a scenario of diminishing returns for height and physicality, suggesting that teams who already have these attributes view them as less significant and will pay less for them. Idson and Kahane's regression results do show a strong correlation between player productivity and coaching quality, suggesting that coaching strategy can increase the productivity of players.

Jones, Nadeau, and Walsh (1997), in their study on violent play and its effect on salary, consider violence as a positive attribute for a player and argue that this determinant must also be positively correlated with player salary. The model is a variation of Jones and Walsh (1988). They rationalize that the same categories used to classify and analyze players are insufficient when examining the violence-salary relationship. Jones et al. classify players into two groups, "grunts" and "non-grunts" through a clustering procedure, giving each category different coefficients. Using a probit model, player statistics and characteristics are used to determine a player's probability of being a "grunt". A regression model is used to compare the significance of variables used in determining player salaries of the "grunts" and "non-grunts". Jones et al. conclude that physical and violent play does not provide players with a salary advantage.

However, Jones et al. also conclude there are two distinguishable categories "grunts" and "non-grunts" that determine player salaries.

Kahane (2001) uses a hierarchical linear model approach to examine the performance of players using individual level attributes and team level attributes. Kahane states that a player is nested within a team and that an individual's effort as well as the team's effort affects the way players are paid. The results are that teams with more revenue tend to reward players with greater salary increases for performance increases and that the variation in player salaries in the NHL is due to both player-specific and team-specific attributes. The major blemish of the study is that it contains a limited amount of data and number of variables. Only average career points per game, average career points per game for all players on the team, and the revenues for each individual team are considered in the analysis. Other strong determinants of productivity such as age, size, and coach quality are omitted.

The most recent study by Idson and Kahane (2004) concentrate on the relationships between teammate productivity and pay in a team setting by comparing the effects of teammate performance on pay. The study focuses on players who switch teams from one year to the next. The results indicate that teammate attributes have an impact on an individual's compensation. Idson and Kahane found that players in the NHL have a tendency to stay on one team for a long period of time, which enables the players to develop and allow for complementarities to mature.

Previous literature primarily examines whether a player's salary can be explained by their productivity, and the results generally support this hypothesis. The major differences between these studies include different variables, models, and time periods. This paper is unique in the literature because no prior study has attempted to examine player productivity in the NHL as measured by their points per hour. Since the amount of ice-time and games played during a season differs for each player, the points per hour variable allows for an accurate comparison of player productivity over the span of an NHL season. The time period under consideration for this study, before and after the new rules were initiated, offers a natural experiment to test if size affects scoring.

II. Research Questions / Hypothesis

The hypothesis to be investigated is whether large players have seen a decrease in productivity as a result of several rule changes. The new rule changes that increase the speed of the game are: the allowing of two line passes, zero tolerance on interference, hooking and holding/obstruction, bigger offensive zone, and no more tied games. Many hockey fans believe that the new rules decreased the physical play of the game, therefore decreasing the advantage possessed by larger players. Taking away the physical element of the game requires larger players to adjust their technique and may hinder their ability to perform. While larger players may be losing their competitive advantage, opening the ice as a result of the reduction of physical play allows small "finesse" players the ability to skate freely and utilize their superior skill.

If large players have seen a decrease in their level of productivity, teams will need to reevaluate how they assemble their line ups, draft prospects, and condition their players. On the other hand, if large players have not seen a decrease in productivity, fans, coaches, and players can dispel the rumor that the rule changes have negatively affected the productivity of large players. No prior study attempts to examine whether a player's productivity can be explained by his size or how rule changes can affect a player's productivity. Have smaller players seen an increase in their productivity in the "New NHL" because the physical aspect of the "Old NHL"

hindered their ability to compete as effectively as larger players? The goal of this paper is to settle this question.

III. Data

Data on player productivity is gathered from the NHL.com website covering the 2003-04 and 2005-06 hockey season. The rookie eligibility criterion is applied to all forward and defensive skaters, requiring them to participate in at least 25 games to be included in the data set. Many of these players played less than one hour per season and are not "impact players." The data set does not include goalies in order to focus the study on the productivity of skaters. Additionally, data from the Hockeydb.com website regarding NHL head coaches of the 2003-04 and 2005-06 season are included. A more qualified coach is thought to increase the productivity of players which is consistent with the findings of Idson and Kahane (2000) whose regression results show a strong correlation between player productivity and coaching quality.

Table 1. Linear Regression Dependent and Independent Variables

Abbreviation	Variable Definition
PTS/HR	The amount of points scored per hour (Dependent Variable)
HT0304	Player height in inches interacted with 2003-04 dummy variable
HT0506	Player height in inches interacted with 2005-06 dummy variable
POS	Forward = 1; Defense = 0
AGE	Age of the player
COACHEXPER	The number of years as head coach
COACH	Head Coach's career winning percentage
TEAMMATE	Current team's winning percentage

The dependent variable is a measure of a player's level of productivity throughout an individual season and is represented by the amount of points he scores per hour. The independent variables for individual attributes are height, age, and position. The height variables are interacted with dummy variables designating the 2003-04 and 2005-06 seasons. If the rules changes decreased larger players' productivity, then it is predicted that the 2003-04 height variable (HT0304) will have a larger regression coefficient than the 2005-06 height variable (HT0506). The age variable controls for a player's veteran status. More experienced players are expected to register more points, so the age variable (AGE) is expected to have a positive impact on scoring. A position dummy variable (POS) is used to distinguish between forwards and defensemen, with forwards receiving a one and defensemen a zero. The coefficient for POS is expected to be positive, given that forwards score more than defensemen.

The independent variables that control for team level determinants of productivity include coaching and teammate data. The coach's winning percentage (COACH) and the number of years the coach has held a head coaching position (COACHEXPER) are used as a proxy for his coaching ability and experience. Idson and Kahane (2000) identify coaches as having "to make numerous decisions that can affect team and player performance, including composing player lines, special team assignments, and match ups with opposing team's player lines (350)." The coaching variables are expected to have positive effects on productivity. The variable for the contributing productivity of teammates is the team's winning percentage in the given year (TEAMMATE), which is expected to have a positive effect on scoring. Variables regarding the

age of the team franchise and the previous season's winning percentage are used for a Hausman endogeneity test, discussed in the methods section.

Table 2. Descriptive Statistics

Variable	Minimum	Maximum	Mean	Std. Deviation
PTS/HR	0.039	4.405	1.488	0.830
HEIGHT	67	81	73.21	2.061
AGE	19	44	27.8	4.559
COACHEXPER	1	20	6.12	4.798
COACH	0.325	0.668	0.520	0.075
TEAMMATE	0.348	0.756	0.544	0.097

Table 3. Frequencies: Position and Height Variables

Position Variable	Frequency	Percent
Defense (0)	458	35.1
Forwards (1)	845	64.9
Total	1303	100
Height Variable	Frequency	Percent
HT0506	649	49.8
HT0304	654	50.2
Total	1303	100

The descriptive statistics listed in Table 2 summarize the 1303 observations and the expected signs for the coefficients of each variable. Table 3 documents the frequency of the position variable, as well as the height dummy variables. 654 players played in the 2003-04 season and 649 played during 2005-06. The player height ranges from 6'9" to 5'7", with a league average of 6'1". The majority of the players in the NHL are forwards which is expected since there are three forwards and two defensemen on the ice during play.

V. Methodology and Results

A linear regression is used to test whether taller players experienced a decrease in productivity after the 2003-04 season. The regression equation is:

(1) $PTS/HR = \alpha + \beta_1 HT0304 + \beta_2 HT0506 + \beta_3 POS + \beta_4 AGE + \beta_5 COACHEXPER + \beta_6 COACH + \beta_7 TEAMMATE + e,$

where e is the error term. A problem with this model is that the TEAMMATE variable may be endogenous. One would expect that higher quality teammates would result in an increase in a player's PTS/HR, but it also is possible that players who score more points per hour would increase the team's winning percentage. To test for endogeneity, a separate linear regression, Equation 2 below, is estimated for the TEAMMATE variable. This analysis employs a Hausman test.

(2) $TEAMMATE = \alpha + \gamma_1 HT0304 + \gamma_2 HT0506 + \gamma_3 POS + \gamma_4 AGE + \gamma_5 COACHEXPER + \gamma_6 COACH + \gamma_7 LASTYRWINPER + \gamma_8 TEAMHISTORY + y.$

The residuals from Equation 2 *(ŷ)* are then inserted in the initial regression, to yield Equation 3.

(3) $POINTS/HR = \alpha + \delta_1 HT0304 + \delta_2 HT0506 + \delta_3 POS + \delta_4 AGE + \delta_5 COACHEXPER + \delta_6 COACH + \delta_7 TEAMMATE + \delta \hat{y} + e.$

If the residuals have a significant effect on PTS/HR, then endogeneity exists. The results of the Hausman test are reported in Tables 5 and 6. As indicated below, the TEAMMATE variable is not endogenous since the T-statistic of the coefficient estimate for ŷ in Equation 3 is insignificant at 0.741. Therefore, Equation 1 can be estimated with no endogeneity correction.

Table: 5 Hausman Test Equation 2 Coefficients

Variable	Coefficient	T-stat
(Constant)	0.099	1.429
Ht0304	-0.001	-0.846
Ht0506	0	-0.497
Pos	-0.001	-0.295
Age	-0.001	-1.468
Coachexper	0.003	7.108
Coach	0.76	25.914
Lastyrwinper	0.169	6.736
Teamhistory	9.16E-05	1.291

Table: 6 Hausman Test Equation 3 Coefficients

Variable	Coefficient	T-stat
(Constant)	3.046	4.168
Ht0304	-0.041	-4.481
Ht0506	-0.038	-4.084
Pos	0.919	23.146
Age	0.005	1.098
Coachexper	0.01	1.451
Coach	0.813	0.635
Teammate	0.258	0.179
Residuals	1.086	0.741

The results for Equation 1 are reported in Table 7. The POS dummy variable is positive and significant. This result is expected because offensive men score more than defense. The TEAMMATE variable is also positive and significant, consistent with the view that the productivity of teammates has a positive impact on a player's ability to score. The COACH and COACHEXPER variables are both insignificant. One would assume coaching would have a positive impact on a player so these results are somewhat at odds with the findings of Idson and Kahanes' (2000), whose study shows a strong correlation between player productivity and coaching quality. The AGE variable has a positive but insignificant effect on scoring, so a player's age does not seem to affect his ability to score.

The coefficients for the height variables are negative and significant which is consistent with the results of Idson and Kahane (2000). Every additional inch of height reduces a player's

PTS/HR by 0.041 for the 03-04 season and 0.038 in 05-06. The coefficients of the two height variables are almost identical, signifying that the affect of a player's height on his PTS/HR has not changed significantly after the 2003-04 season. These results imply that the rule changes did not decrease the productivity of larger players and contradict popular belief among fans, franchises and players.

Table: 7 Equation: 1 Coefficient Estimates

Variable	Coefficient	T-stat	Significance
(Constant)	2.919	4.109	0
Ht0304	-0.041	-4.431	0
Ht0506	-0.037	-4.052	0
Pos	0.921	23.215	0
Age	0.005	1.285	0.199
Coachexper	0.006	1.423	0.155
Coach	-0.1	-0.29	0.772
Teammate	1.303	4.676	0
Adjusted R	0.368		
F-statistic	109.224		

VI. Conclusion

This study investigates whether large players have seen a decrease in productivity as a result of several rule changes which increased the speed of the game, seeming to give advantage to smaller, less physical players. Unlike previous papers that use salary as a dependent variable, this paper employs points-per-hour as a more accurate measure of player productivity since the amount of ice-time differs for each player as well as the number of games played during a season. The points per hour variable allows for a precise calculation of a player's productivity over the span of a NHL season.

The findings contradict popular belief that the rule changes have hindered the productivity of taller players. This study indicates that taller players are just as likely to score as they were before the rule change. Future studies that focus on examining productivity of hockey players may build on this model to identify if advances in the technology of hockey equipment have increased productivity over the last several years. These advances have enabled players to shoot harder, skate faster, and allow for greater protection from injury. The most notable of these advances is the transition from the traditional wooden stick to the lighter composite design.

VII. References

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