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25 January 2009

The Journal of Private Enterprise 24(2), 2009, 165-174

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Abstract

As private enterprises in the U.S. and Canada, franchises in the National Hockey League (NHL) can be presumed to be firms pursuing maximum profits. Part of this pursuit involves the negotiation between NHL players and management of player salaries, which (among other things) must be consistent with the productivity level of each player. This educational note endeavors to empirically identify key, quantifiable factors that reflect individual NHL player productivity and as a result help to determine the regular season salary structure for individual NHL players, whether they be goalies, centers, wingmen, or defense-men. Ideally, such information can be useful for the student of private enterprise insofar as it provides insights relevant to free market decisions and outcomes involving marginal revenue product. Thus, this educational note demonstrates to the student of private enterprise how systematic measures of player productivity help to explain NHL player salaries.

JEL Codes: A11, J31, L22
Keywords: Salary determination; Marginal revenue product; Productivity measures

I. Introduction

In the free enterprise system, profit maximization for the firm involves a complex set of considerations. Some of these are rather easily obtained (for example, demographic information on one's potential customer base), whereas other considerations (such as the complex nature of market demand and its shifts over time and space) are more elusive. Furthermore, from the production/cost side of the profit-maximization endeavor, issues such as labor productivity measurement are not always immediately obvious and easily quantifiable. Yet, efficient operation of firms in a private enterprise system requires some form of systematic measure of productivity to

compensate employees in a manner consistent with their marginal revenue products.

This educational note demonstrates for the student how owners of National Hockey League (NHL) teams (of which there are 30) use quantifiable information about players' individual performances to help them systematically compensate each individual player according to his own specific productivity level and, in effect, because of the inclusion of a variable reflecting home team attendance, according to his own specific marginal revenue product. It is assumed that NHL team owners seek to maximize profits within the private enterprise system of professional sports. This assumption is consistent with the empirical study by Ferguson, Stewart, Jones, and Le Dressay (1991, p.297), who find that "The results in large measure support the hypothesis that hockey teams are profit maximizers." The case of the NHL is adopted simply because its economic and market characteristics have been less extensively studied than most other major professional sports enterprises in the U.S., e.g., the NBA, MLB, and the NFL (Cebula and Belton, 1996).

This study identifies four categories of NHL player: centers, wingmen, goalies, and defense-men. In addition, it includes several measures of player productivity, a variable for home team attendance (to indirectly reflect team revenues), and a variable to reflect whether there may be wage discrimination. The next section of this note provides the definition of each of the variables in the analysis and the empirical results, as well as background relevant to the structure of this study. Since this is an educational note, a separate table of descriptive statistics is not provided; however, certain pertinent descriptive statistics are provided in either the text or in Table 2. In addition, it is noted that estimating the model in semi-log form generally resulted in the same conclusions as those shown in Equation (1) and Table 2. Although not presented here, these results may be obtained from the author.

II. The Framework and Empirical Results

A hockey team consists of six players. Three are classified as offensive players or "forwards" (the center, the right wing, and the left wing), and three are classified as defensive players (two defense-men and a goalie). An interesting trait of modern hockey is that all but one of the players must be aware of and involved in whatever is transpiring all over the ice rink. For example, forwards are

responsible not only for offensive play but also are involved in defense; similarly, defense-men must play not only defense but also a role in the offense. Whereas forwards and defense-men theoretically can generally play any of these positions if needed, goalies by contrast are very specialized. In effect, they must stand in front of the net and stop hockey pucks. They do not generally play other positions, and other players almost never play as the goalie. Given this backdrop, this pedagogical study now shows how individual player productivity can be measured and how that measurement helps to determine (in large part) the player's salary.

In this study, four categories of individual player salaries are considered, one for each category of player (center, wingman, goalie, and defense-man). This is similar to Richardson (2000) in that his study also breaks down NHL players into multiple categories; in particular, Richardson (2000) identifies three categories of NHL players, forwards, defense-men, and goalies. Other empirical studies of NHL salaries, such as Kahane (2001), do not distinguish among categories of players. In the present study, eight measures of individual NHL player productivity are considered: Assists05, Timeice05, NHLexp, Goals05, Goals05sq, Saves05, Saveperc05, and Penmin05. There is also a variable (binary) indicating whether a given individual player is French-Canadian (FRCAN), to test (albeit crudely) for possible discrimination against French-Canadian hockey players (Lavoie, 2000). Finally, a variable indicating each team's home attendance for the 2005-2006 season (Attend05) is included in the model. Since marginal revenue product matters in pay determination, equally skilled players might well have different salaries if one plays in a large market with many fans whereas another plays in a smaller market with fewer fans. In other words, while acknowledging the very important role of productivity *per se* in salary determination, some of the previous research on earlier time periods suggests that team revenue also affects NHL salaries (Idson and Kahane, 2000; Jones and Walsh, 1988; Richardson, 2000). Including Attend05 in the model is an effort to control for this issue. Table 1 provides precise definitions of the independent (explanatory) variables, along with precise definitions of the dependent (salary) variables, in the analysis.

Table 2 provides the results of estimating regressions of the 2006-2007 regular season salaries for individual NHL centers, wingmen, goalies, and defense-men on the explanatory variables in the analysis. The estimates in Table 2 are linear OLS regressions.

However, before addressing the results for these position-specific positions, we first provide an aggregate OLS estimate of individual NHL salaries (SAL) for *all* players in the NHL, regardless of position, included in the same regression. In the estimate, the White (1980) heteroskedasticity correction has been adopted:

$$\begin{aligned} SAL = {} & -52{,}460 + 36{,}979\ Assists05 + 91{,}411\ Timeice05 \\ & \qquad\qquad (+3.90) \qquad\qquad (+2.88) \\ & + 67{,}107\ NHLexp + 29.953\ Goals05 + 4{,}212\ Goals05sq \\ & \quad (+2.68) \qquad (+2.40) \qquad\qquad (+1.29) \\ & + 37{,}059\ Saves05 + 5{,}912\ Saveperc05 + 4{,}857\ Penmin05 \\ & \quad (+2.02) \qquad (+1.67) \qquad\qquad (+2.22) \\ & - 87{,}171\ FRCAN + 0.083\ Attend05, \\ & \quad (-0.69) \qquad (+2.40) \\ & R^2 = 0.56,\ adjR^2 = 0.55,\ F = 31.94 \end{aligned} \tag{1}$$

Terms in parentheses are t-values. For the interested reader, the mean season salary among the 668 NHL players was $1,703,705, with a standard deviation of $1,509,482. Furthermore, the mean home team season attendance was 695,139, with a standard deviation of 93,285.

In Equation (1), three of the estimated coefficients exhibit the expected signs and are significant at the one percent level. Thus, SAL is positively impacted by assists, time on the ice, and years of experience in the NHL. Four other variables exhibit positive signs and are statistically significant at the five percent level. Therefore, SAL is also positively impacted by goals scored, penalty minutes (a surrogate for violence on the ice, which might well enhance fan interest), saves, and Attend05, the total regular season home attendance level for each team. By contrast, there is evidence that the variables Saveperc05, Goals05sq, and FRCAN played no serious role in determining NHL player salaries. Nevertheless, the overall estimate implies that both player productivity and team revenues positively affect SAL, i.e., evidence that players are paid something on the order of their marginal revenue products within the private enterprise system of the NHL.

Table 1: Definitions of Variables

SAL = salary for each individual player in the entire NHL, regardless of position
CentSAL = salary for each individual Center in the NHL during the 2006-2007 regular playing season
WingSAL = salary for each individual Wingman in the NHL during the 2006-2007 regular season
GoalSAL = salary for each individual Goalie in the NHL during the 2006-2007 regular season
DefSAL = salary for each individual Defense-man in the NHL during the 2006-2007 regular season
Assists05 = total assists for each individual player during the 2005-2006 season
Timeice05 = the total amount of actual playing time on the ice for each individual player during the 2005-2006 season
NHLexp = years of NHL playing experience for each individual player prior to the start of the 2006-2007 season
Goals05 = number of goals scored by each individual player over the 2005-2006 season
Goals05sq = the square of variable Goals05
Saves05 = number of saves credited to each individual player during the 2005-2006 season
Savesperc05 = percent of shots that each individual goalie was able to convert to a save during the 2005-2006 season
Penmin05 = the total number of penalty minutes for each NHL players during the 2005-2006 season
FRCAN = a binary variable = 1 if an individual NHL player was of French-Canadian origin
Attend05 = total home attendance over the 2005-2006 season for each individual player's team
N = number of players in category during the 2006-2007 season
Mean salary06-07 = the mean salary of the individuals in each NHL player category during the 2006-2007 season

Sources: National Hockey League, Player Statistics at http://www.nhl.com/nhlstats/app; *USA Today* at http://asp.usatoday.com/sports/hockey/nhl/salaries/default.aspx; and ESPN at http://sports.espn.go.com/nhl/attendance?year=2006.

The student can refer to Table 2 to observe how the identified forms of NHL player productivity and team revenues concretely influenced the salaries paid to NHL players according to position during the 2006-2007 regular playing season. Consider first the case of NHL centers. The results from Table 2 reveal that for NHL centers the estimated coefficients on variables Assist05, Timeice05, and NHLexp are positive and statistically significant at the one percent level and that the coefficients for Goals05 and Attend05 are positive and statistically significant at the five percent level. In

addition, there is very modest evidence of a reward for penalty minutes (statistical significance at the 7.5 percent level). Neither the Goals05sq nor the FRCAN variables is significant at the ten percent level, however. In practical terms, this means that the market for NHL centers for the 2006-2007 season operated in such a fashion as to reward centers (i.e., pay them more) the greater the number of assists with which they were credited in the previous (2005-2006) regular season, the greater the amount of playing time (time on

Table 2: Factors Influencing NHL Player Salaries, 2006-2007

Independent Variables	CentSAL	WingSAL	GoalSAL	*DefSAL*
Constant	-21,453	-19,852	-31,429	*-18,179*
Assists05	37,413*** (3.94)	37,054*** (3.92)		*47,817*** (4.26)*
Timeice05	91,867*** (3.52)	69,617** (2.14)	144,443** (2.12)	*111,712*** (5.29)*
NHLexp	53,286*** (2.95)	45,908*** (2.82)	63,894** (2.40)	*61,426*** (5.94)*
Goals05	50,168** (2.42)	46,048** (2.43)		*9,836** (2.41)*
Goals05sq	3,794 (1.32)	5,028 (0.17)		*-1,140 (-0.41)*
Penmin05	1,895* (1.80)	4,232** (2.32)	5,825 (1.63)	*7,687*** (3.21)*
Saves05			60,562** (2.22)	
Saveperc05			41,774** (2.09)	
FRCAN	-262,243 (-1.64)	-54,742 (-0.42)	25,380 (0.68)	*-81,179 (-0.60)*
Attend05	0.084** (2.02)	0.083** (2.18)	0.082** (2.21)	*0.08*** (4.28)*
R^2	0.61	0.66	0.40	*0.59*
Adjusted R^2	0.59	0.65	0.37	*0.58*
F	34.04***	48.4***	16.03***	*43.3****
N	181	207	62	*218*
Mean Salary	$1,787,386	$1,577,362	$1,882,680	*$1,703,292*
Std. Deviation Salary	*$1,591,200*	*$1,471,559*	*$1,668,605*	*$1,427,016*

Terms in parentheses are t-values. All t-values reflect the White (1980) heteroskedasticity correction. *** indicates statistical significance at the one percent level; ** indicates statistical significance at the five percent level; and * indicates statistical significance at the ten percent level.

the ice) they accumulated during the previous (2005-2006) regular season, the greater the number of years of NHL playing experience they brought with them as they were about to begin the 2006-2007 regular playing season, the greater the number of goals they scored during the 2005-2006 regular season, and the higher the home team attendance during the 2005-2006 season, with a possible very modest premium also being paid for penalty minutes accumulated during the 2005-2006 season (the violence/excitement proxy). Thus, salaries for NHL centers appear to have been influenced by productivity measures and a measure of team revenues and thus appear to have reflected marginal revenue products.

In the case of NHL wingmen, Table 2 reveals the productivity and team revenue measures that helped to determine the salary that each one of them was paid by NHL team owners during the regular 2006-2007 playing season. In particular, NHL wingmen received higher salaries during the 2006-2007 regular playing season for being credited with more assists in the 2005-2006 season, the greater the amount of playing time they accumulated during the previous (2005-2006) regular season, for a greater number of years of NHL playing experience prior to the 2006-2007 season, for being credited with scoring more goals during the 2005-2006 regular playing season, and for accumulating more penalty minutes during the 2005-2006 regular season. In addition, higher home team attendance during the 2005-2006 season elevated their salaries. Neither Goals05sq nor FRCAN influenced wingmen salaries. Thus, there once again is evidence that individual NHL players (wingmen in this case) are paid roughly according to productivity measures and team revenue, and hence their salaries appear to have reflected their marginal revenue products.

Goalies play a small role moving across the ice in terms of mobility, whereas they contribute to the team effort principally by defending their team's goal from opposing teams' shots. Hence, it is not surprising that their productivity measures are rather different from those of their teammates. In particular, the results found in Table 2 strongly imply that an NHL goalie received a higher 2006-2007 regular season salary for accumulating more playing time on the ice during the 2005-2006 season, for having more years of NHL experience prior to the 2006-2007 regular season, for having a higher *number* of saves with which he was credited during the 2005-2006 regular season, for having a greater *percentage* of shots turned into

saves during the 2005-2006 season, and for being on a team with higher home attendance numbers. Although the penalty minutes and FRCAN variables were not statistically significant, the overall conclusion nevertheless is that NHL Goalies were paid salaries that reflected productivity and revenues and hence resembled their marginal revenue products.

Finally, there are the defense-men. From Table 2, the student can readily observe that during the 2006-2007 regular season, NHL defense-men were being paid higher salaries for being credited with more assists during the 2005-2006 regular season, for accumulating more time on the ice during the 2005-2006 season, for bringing more years of NHL experience with them as the 2006-2007 regular season began, for scoring more goals during the 2005-2006 season, and for accumulating more penalty minutes during that season. In addition, they were paid higher salaries if on the roster of a team with higher season home attendance. As with the other hockey positions, then, NHL defense-men were paid a salaries that reflected productivity and team revenues and hence resembled their marginal revenue product.

III. Concluding Observations

In conclusion, it is important that the student of private enterprise be cognizant of the fact that the free market system does endeavor to reward labor according to its marginal revenue product. This entrepreneurial dimension of the private enterprise system is critical to its efficiency and success, if not its ultimate survival. The examples provided in this educational note involving NHL salaries constitute a potentially engaging and informative manner in which to demonstrate in concrete, quantifiable terms the fact that the free market does in fact tend to work in the very fashion that classroom lectures suggest.

Finally, although the results in estimate (1) no doubt reflect this salary-marginal revenue-product association, it can be argued that the (dis-aggregated according to position) results shown in Table 2 can potentially provide additional insights into the salary/marginal-revenue-product linkage. This is in part because different positions serve different functions, and as a consequence, the measurement of "productivity" varies somewhat (if not greatly) from one position to the next. To demonstrate, consider first centers and wingmen. They both play fundamentally *offensive* roles. In this capacity, they are remarkably evenly paid for assists and rather evenly paid for goals

and experience. They appear to be very differently paid for time on ice, however, with centers receiving much higher compensation for such activity. As for penalty minutes, the coefficient for the case of centers (which is only 44.8 percent the size of that for wingmen) is statistically significant at only the 7.5 percent level, in contrast to the statistical significance of 2.5 percent for wingmen. That is, penalty minutes may not even be rewarded for centers (and, *if* so, it is rewarded much less than for wingmen). Thus, unlike the case of wingmen, it is likely there is at best questionable evidence of any reward for centers to accumulate penalty time. Interestingly, as shown in Table 2, centers are paid on average about 13 to 14 percent more than wingmen overall.

Goalies and defense-men serve principally *defensive* roles. Therefore, it is not surprising that their productivity measures are rather different than for centers and wingmen. The results in Table 2 reveal this clearly. Moreover, given the very different roles of defense-men and goalies on defense, their productivity measures also are a bit different as well. For example, both of these positions receive rather similar rewards for NHL experience, but goalies appear to receive a higher premium for time on the ice. Defense-men do occasionally score a goal, for which they receive a modest reward; by contrast, all NHL goalies combined scored only one goal in the 2005-2006 season—thus this variable was omitted altogether from the goalie equation. Defense-men receive a reward for penalty minutes, whereas there is no statistically significant evidence that goalies receive any such reward. The latter result may well reflect the need to always have someone proficient at the role of protecting a team's goal.

The above are but a few examples of the advantages of providing salary estimates by position. That is not to say the aggregate estimate is not useful; quite the opposite is true. Nevertheless, estimates by position can potentially be useful in providing more detailed information, if that is pertinent. Perhaps, like this brief note, salary studies should provide aggregate estimates *and* estimates by position. In any case, it appears that the NHL clearly provides a good example of salaries being approximations of marginal revenue product in our private enterprise system.

References

Cebula, R.J., and W.J. Belton. 1996. *Economics of the Sports Industry*. New York: McGraw Hill.

ESPN. 2008. National Hockey League Attendance, by Season. http://sports.espn.go.com/nhl/attendance?year=2006 (accessed December 12, 2008).

Ferguson, D.G., K.G. Stewart, J.C.H. Jones, and P. Le Dressay. 1991. "The Pricing of Sports Events: Do Teams Maximize Profit?" *Journal of Industrial Economics*, 39(1): 297–310.

Idson, T.L., and L.H. Kahane. 2000. "Team Effects on Compensation: An Application to Salary Determination in the NHL." *Economic Inquiry*, 38 (2): 345–57.

Jones, J.C.H., and W.D. Walsh. 1988. ""Salary Determination in the NHL: The Effects ofSkills, Franchise Characteristics, and Discrimination." *Industrial and Labor Relations Review*, 41(4): 594–604.

Kahane, L.H. 2001. "Team and Player Effects on NHL Player Salaries: A Hierarchical Linear Model Approach." *Applied Economics Letters*, 8(5): 629–32.

Lavoie, M. 2000. "The Location of Pay Discrimination in the National Hockey League." *Journal of Sports Economics*, 1(4): 401–11.

National Hockey League. 2008. National Hockey League Player Statistics. http://www.nhl.com/nhlstats/app (accessed December 12, 2008).

Richardson, D.H. 2000. "Pay, Performance, and Competitive Balance in the National Hockey League." *Eastern Economic Journal*, 26(4): 393–417.

USA Today. 2008. USA Sports: The National Hockey League. http://asp.usatoday.com/sports/hockey/nhl/salaries/default.aspx (accessed December 12, 2008).

White, H. 1980. "A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity." *Econometrica,* 48(5): 817–38.