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On the Evaluation of the "Most Important" Position in Professional Sports

David J. Berri[1] and Stacey L. Brook[2]

Abstract

This article investigates whether general managers in the National Hockey League (NHL) evaluate the playing talent of goalies efficiently. The authors examine both the voting record for the Vezina Award (Best Goalie) and salary data from free agent goalies to ascertain how the goalie position is evaluated by general managers in the NHL. The authors find that general managers evaluate past performance of goalies efficiently. However, the authors also find observed differences in goalie performance are quite small. Furthermore, NHL goalies are quite inconsistent across time. These aspects of goalie performance are not taken into account by decision makers in the NHL, leading us to conclude that inefficiencies in this labor market exist.

Keywords

NHL, Goalies, rationality, decision making

A fundamental assumption in economics is that decision makers are rational, or more precisely, "people choose efficiently the means that advance their goals."[1] Such an assumption presumes that people are open to—and willing to adopt—new information. In addition, the process by which people adopt information—as described below by Douglass North—leads people to the "correct" model.

[1] Department of Economics & Finance, Southern Utah University, Cedar City, USA
[2] Department of Economics, Tippie School of Business, University of Iowa, USA

Corresponding Author:
David J. Berri, Department of Economics & Finance, Southern Utah University, 351 West University Boulevard, Cedar City, UT 84720, USA.
Email: berri@suu.edu

> Players must not only have objectives but know the correct way to achieve them. But how do the players know the correct way to achieve their objectives? The instrumental rationality answer is that, even though the actors may initially have diverse and erroneous models, the informational feedback process and arbitraging actors will correct initially incorrect models, punish deviant behavior, and lead surviving players to correct models (North, 1994, 360):[2]

The idea that decision makers essentially have the "correct" model has become fundamental to how theoretical models are built within economics. In addition, at first glance, one would expect to find empirical support for the rationality assumption in the sports industry. Decision makers in the sports industry have an abundance of worker productivity data to evaluate their employees. Furthermore, teams cannot easily hide failure (i.e., everyone sees when you lose) and failure comes with very clear consequences (i.e., loss of job and/or public derision). In such an environment, decision makers should use the "correct" models.

The Moneyball story, though, casts doubt on this perspective. As Michael Lewis (2003) detailed, in the latter 1990s, the Oakland Athletics managed to consistently rank among Major League Baseball's leaders in wins despite one of the lowest payrolls in the game. Lewis contended this disconnect between wins and payroll was achieved because Billy Beane—the general manager of the Athletics—was able to exploit an inefficiency in baseball's labor market. Specifically, on-base percentage was undervalued. Jahn Hakes and Raymond Sauer (2006, 2007), via a study of wins and salary in baseball, confirmed the story that baseball's labor market was inefficient. On-base percentage was found to have a bigger impact than slugging percentage on wins; but historically, the labor market rewarded the latter more than the former.

The labor market for hitters in baseball is not the only place researchers have uncovered inefficiencies. In the National Basketball Association (NBA), Berri, Schmidt, and Brook (2006) and Berri, Brook, and Schmidt (2007) presented evidence that scoring totals are overvalued. With respect to the National Football League (NFL), Massey and Thaler (2005) have shown that first-round draft picks in the NFL have been overvalued, and Romer (2006) has presented evidence that coaches are not maximizing when it comes to decision making on fourth down.

The purpose of this article is to examine decision making in the National Hockey League (NHL). Our focus will be on the goalie position. According to Martin Brodeur, "the goaltender position is arguably the most important in team sports."[3] We wonder whether the market for this "most important" position is working efficiently.

Our study proceeds as follows. First, we will discuss the various measures available to assess a goalie's contribution. We will then turn to two evaluations of goalies. The first is the Vezina Trophy that is awarded by general managers to the best goalie in each season. The second evaluation will be the salaries awarded by general managers. The evaluation of how goalies are evaluated will be followed by a discussion of performance similarities and inconsistency. The article concludes with an evaluation of Martin Brodeur, which illustrates the essential findings of the article.[4]

Measuring a Goalie's Performance

One can debate whether the goalie is the "most important" position in professional team sports. What is more difficult to question is the ease by which this position is evaluated. Goalies have essentially one task on the ice; keep the puck from entering the goal net. Consequently, evaluating this position simply requires that we estimate the value of completing this task and how often the task is successfully completed.

Although goalies have only one task, there is more than one measure used to evaluate the position. The standard list includes shots on goal (SOG), goals against (GA), saves (or the difference between SOG and GA), save percentage (saves/SOG), and goals against average (GAA). This latter factor is calculated as GA/(minutes played/60).

To this list, we add team wins that are credited to the goalie. Like pitchers in baseball, goalies are often credited with wins and losses. If a goalie plays and his team wins, the goalie is credited with the win. Of course, a goalie could allow six goals and get a win if his team scores seven times. Likewise, a goalie can allow only one goal and lose because his teammates fail to score. Consequently, a goalie's won–loss record captures more than just a goalie's contribution to team success.

In looking over our list of performance measures, it appears that save percentage comes closest to capturing the value of the actions the goalie takes on the ice. In contrast, GAA and a goalie's won–loss record are both influenced by the goalie's teammates. Our next task is to determine which of these measures decision makers focus on in evaluating this position.

GM Goalie Evaluation: Vezina Trophy Voting

Berri and Schmidt (2002) offered a study of voting for the All-Rookie award in the NBA. Such a study was used to evaluate the decision making of voters for this award (i.e., NBA coaches). Following the lead of this article, we decided to examine the Vezina voting record in an effort to uncover how goalies were evaluated by general managers in the NHL.

The Vezina Trophy is the only award voted by NHL general managers and is voted on at the conclusion of the regular season each year. The voting procedure is that each general manager votes for one first-team, one second-team, and one third-team goalie. The votes then have the following values: 5 points for a first-team vote, 3 points for a second-team vote, and 1 point for a third-team vote.[5] Once all the votes are received, then voting points are tabulated and the goalie with the highest number of voting points is awarded the Vezina Trophy.[6]

Our study of voting for this award begins with a sample that included NHL goalies from the 1999-2000 season to the 2008-2009 season. We only included NHL goalies who played at least 1,000 minutes (min) in the current season (with a sample

Table 1. Summary Statistics

	Mean	Median	Maximum	Minimum	*SD*	*n*
Voting regression						
Log voting points	0.555	0	4.94876	0	1.200	363
Save percentage	0.907	0.908	0.933	0.860	0.012	363
Goals against average (GAA)	2.643	2.59	3.98	1.69	0.417	363
Wins	21.375	20	48	2	10.789	363
Age	29.094	29	43	19	4.266	363
Minutes	2,672.077	2,663	4,697	1,003	1,032.334	363
Salary regression						
Log salary	14.386	14.219	15.725	13.122	0.738	40
Save percentage	0.906	0.907	0.929	0.883	0.012	40
GAA	2.674	2.672	3.723	1.876	0.397	40
Wins	20.250	20.500	38	4	8.972	40
Age	31.85	31	42	24	3.991	40
Minutes	2,520.65	2,524.5	3,910	1,079	798.611	40
Population	4,917,672	4,319,663	18,323,002	1,034,945	4,423,062	40

Note: The model also considers three dummy variable for goalies that signed after the 2002-2003 (D03), 2003-2004 (D04) and 2005-2006 (D06) seasons. These dummy variables are included to control for the impact of the 2004-2005 lockout.

size of 363) and those that played at least 1,000 min in both the current and previous season (sample size of 279).

The minimum number of votes any goalie could receive is 0, and the maximum number of votes any goalie could receive is 150. No goalie received the maximum number of votes, but of the goalies in our sample, 282 of the 363 (78%) goalie observations received 0 votes. To explain the variation in NHL GM voting, we considered the variables listed—along with corresponding summary statistics—in Table 1. This list begins with a measure of player performance (PROD), which could be current save percentage, GAA, or the number of team wins credited to the goalie; as well as performance lagged (LAGPROD). In addition, we considered the goalies age (AGE), age squared (SQAGE),[7] and the minutes the goalie played (MP). Each of these variables is used in our voting points model, illustrated by Equation 1.

$$\mathrm{Log}(\mathrm{Votes}_{ij}) = \beta_0 + \beta_1\mathrm{PROD}_{\mathrm{ij}} + \beta_3\mathrm{LAGPROD}_{\mathrm{ij}} + \beta_4\mathrm{AGE}_{\mathrm{ij}} + \beta_5\mathrm{SQAGE}_{\mathrm{ij}} + \beta_6\mathrm{MP}_{\mathrm{ij}} + e_{ij} \quad (1)$$

Because the dependent variable is constrained at the lower end, we used a Maximum Likelihood TOBIT (Censored) regression. We had at most 363 observations, of which 282 were left censored. Table 2 reports three estimations of Equation 1, with each estimation using a different measure of player performance.

Let us first discuss the nonperformance results. With respect to age, we see the familiar shape; age and voting points initially have a positive relationship but after a certain point the relationship reverses. In addition, with respect to save percentage and GAA, more minutes also leads to more votes.[8]

Table 2. Estimation Results for Equation 1. Dependent Variable: Log of Voting Points Maximum Likelihood—Censored (TOBIT; z Statistics Reported Beneath Each Coefficient)

Independent Variable	Eq. 1a	Eq. 1b	Eq. 1c
Save percentage	218.217*	–	–
	8.668	–	–
Save percentage, lagged	19.911	–	–
	1.125	–	–
Goals against average (GAA)	–	−6.105*	–
	–	−7.896	–
GAA, lagged	–	−0.079	–
	–	−0.138	–
Wins	–	–	0.289*
	–	–	5.849
Wins, lagged	–	–	−0.014
	–	–	−0.548
Age	1.032***	0.692	1.151***
	1.952	1.334	1.872
Age, squared	−0.014***	−0.010	−0.017***
	−1.692	−1.209	−1.757
Minutes played	0.003*	0.003*	0.000
	8.659	7.977	0.732
Constant	−245.11577*	−3.48188	−28.88323*
	−8.55616	−0.66137	−2.95329
Adjusted R^2	0.68	0.64	0.51
Included observations	279	279	279

* Statistically significant at 1%.
*** Statistically significant at the 10% level.

Turning to the performance measures, we see that last year's performance is never significant. When we look at this year's productivity, it appears the model based on save percentage does the best job of explaining voting points. Team wins assigned to the goalie does a particularly poor job. This suggests that general managers are not fooled by measures that are influenced by the goalie's teammates.

GM Goalie Evaluation: Salary Determination

Awards may capture the media's attention, but it is dollars that matter most to the goalie and his team. To study salaries, we follow the lead of Jenkins (1996). Jenkins argued that including players in the midst of a long-term contract results in measurement error in a salary regression. To overcome this potential measurement error, we restrict our sample of NHL goalies to those goalies who became free agents at the end of the season during the 2002/2003 to 2006/2007 seasons. The data cover the

2 years before and after the lockout cancelled season of 2004/2005. Furthermore, we restrict the data set to NHL goalies that played at least 1,000 min in the two seasons before they became a free agent and played at least 1,000 min in the subsequent season after they signed a new contract.

Our sample yielded 33 observations. Each goalie was an unrestricted free agent, which minimizes the amount of monopsony power teams have in setting salaries for restricted free agents.[9] In addition to considering such issues as age, minutes played (to capture injury), market size,[10] and dummy variables to account for the time period before and after the lockout,[11] we also looked at the same list of performance statistics considered in our study of the Vezina voting. Our list of independent variable is reported—with summary statistics—in Table 1. In addition to considering performance and minutes played the season before the contract was signed, we also considered—as Equation 2 notes—performance and minutes played from 2 years before the goalie became a free agent.

$$\begin{aligned}\mathrm{Log}\left(\mathrm{Salary}_{ij}\right) = {} & \gamma_0 + \gamma_1 \mathrm{PROD_{ij}} + \gamma_3 \mathrm{LAGPROD_{ij}} + \gamma_4 \mathrm{AGE_{ij}} + \gamma_5 \mathrm{SQAGE_{ij}} + \gamma_6 \mathrm{MP_{ij}} \\ & + \gamma_7 \mathrm{LAGMP_{ij}} + \gamma_8 \mathrm{POP_{ij}} + \gamma_9 \mathrm{D03_{ij}} + \gamma_{10} \mathrm{D04_{ij}} + \gamma_{11} \mathrm{D06_{ij}} + e_{ij}\end{aligned} \tag{2}$$

The results—reported in Table 3—indicate that age, age squared, and minutes played have the expected sign, although these factors are not always statistically significant. We also found that market size and the year dummies were unrelated to salary.

Turning to the performance measures, the results again suggest that general managers separate a goalie from his teammates. Both GAA and team wins are statistically insignificant. In contrast, both save percentage last season and from 2 years ago are statistically connected to a goalie's salary. So, general managers ignore GAA and goalie wins and focus on the one metric that captures a goalie's contribution to team success.

At this point, the market appears quite efficient. Our model, though, only considered past performance. Our story changes when we regress current salary on current performance and characteristics of the goalie. Such an approach—reported in Table 4—reveals that none of the performance measures we considered are statistically related to current salary.[12]

Although salaries are often a function of past performance, the salary decision is a statement about the future. Teams are not paying what a goalie did last year, but what they hope that goalie will do after he signs the contract. Our study of salaries, though, suggests that predicting the future is quite difficult. When we further examine performance data for goalies, we can see why making predictions in this labor market is so difficult.

Predicting the Future

Let us consider a sample of all goalies that played at least 1,000 min from 2000-2001 to 2007-2008 (a sample of 368 goalies). The preferred measure for goalie

Table 3. Estimation Results for Equation 2. Dependent Variable: Log of Salary. Ordinary Least Squares (White Heteroskedasticity-Consistent Standard Errors and Covariance; *t* statistics reported beneath each coefficient)

Independent Variables	Eq. 2a	Eq. 2b	Eq. 2c
Save percentage, last season	17.320**		
	2.219		
Save percentage, 2 years ago	27.577**		
	2.365		
Goals against average (GAA), last season		−0.189	
		−0.657	
GAA, 2 years ago		−0.188	
		−0.475	
Wins, last season			0.009
			0.344
Wins, 2 years ago			−0.023
			−0.781
Age	0.836	0.791	0.780
	1.455	1.343	1.480
Age, squared	−0.013***	−0.012	−0.011
	−1.539	−1.371	−1.487
Minutes played, last season	0.00042*	0.00053*	0.00049
	2.901	2.982	1.471
Minutes played, two seasons ago	0.00022**	0.00017	0.00036
	2.159	1.426	1.336
Population	−9.501E-09	−4.984E-09	−9.478E-09
	−0.518	−0.206	−0.388
D2006	−0.242	−0.240	−0.307
	−0.640	−0.539	−0.738
D2004	−0.512	−0.579	−0.610
	−1.327	−1.289	−1.352
D2003	−0.308	−0.563	−0.568
	−0.830	−1.257	−1.426
Constant	−41.413**	−0.581	−0.486
	−2.386	−0.061	−0.054
Adjusted R^2	0.48	0.29	0.29
Observations	33	33	33

* Statistically significant at the 1%.
** Statistically significant at the 5%.
*** Statistically significant at the 10% level.

performance is save percentage. For this population, the average save percentage is 0.906. The standard deviation (*SD*) is 0.012, giving us a coefficient of variation of .013. This result suggests that there is very little difference between goalies.

Small differences, though, might be important if they are consistent. Unfortunately, this does not appear to be the case. Looking at our population of goalies from

Table 4. Estimation Results for Equation 2. Dependent Variable: Log of Salary. Ordinary Least Squares (White Heteroskedasticity-Consistent Standard Errors and Covariance; *t* Statistics Reported Beneath Each Coefficient)

Independent Variables	Eq. 2d	Eq. 2e	Eq. 2f
Save percentage, current season	8.018		
	0.734		
Goals against average (GAA), current season		−0.265	
		−0.842	
Wins, current season			−0.005
			−0.195
Age	0.578	0.660	0.587
	1.396	1.610	1.542
Age, squared	−0.009	−0.010	−0.009
	−1.376	−1.606	−1.540
Minutes played	0.00049*	0.00049*	0.00056**
	3.737	4.013	2.095
Market size	1.02E-08	1.15E-08	8.12E-09
	0.507	0.598	0.384
Constant term	−3.866	2.691	3.246
	−0.385	0.391	0.509
Adjusted R^2	0.27	0.28	0.27
Observations	33	33	33

* Statistically significant at 1%.
** Statistically significant at 5%.

2000-2001 to 2007-2008, we regressed current save percentage on what the goalie did in the prior season. This analysis revealed an R^2 of .06, which tells us that 94% of a goalie's performance cannot be explained by what the goalie did last season.[13]

Such analysis, though, only focuses on the regular season. The ultimate objective in hockey is to win the Stanley Cup, and it is widely believed that this objective can be achieved if a team simply employs a "hot" goalie. With this belief in mind, we looked to see whether performance in the postseason could be predicted. Specifically, we looked at 125 goalies who logged at least 1,000 min in the regular season and 100 min in the corresponding playoffs from 2000/2001 to 2007/2008. Once again, inconsistency was the story. A regression of postseason save percentage on regular season save percentage revealed an R^2 of .07. In other words, about 93% of what a goalie did in the postseason could not be explained by his corresponding performance in the regular season.

We also considered the idea that some goalies were just better in the postseason. To test this hypothesis, we looked at 42 goalies from 2000-2001 to 2007-2008, who managed to accumulate 100 min in two consecutive postseasons. Our analysis revealed that there was no statistical relationship between these consecutive

playoff runs.[14] This suggests that whether a goalie is "hot" is not about skill but rather about luck.

Differentiating skill from luck is an issue addressed by Bradbury (2008). Bradbury argued that decision makers have to do more than connecting the statistics tracked for players to team outcomes (i.e., wins). Decision makers also need to know whether the statistics tracked for players are capturing the skills of the players.

Bradbury goes on to explain how this is done:[15]

> "One method researchers can use for separating skill from luck is to look at repeat performance of players. If performance is a product of skill, then the athlete in question ought to be able to replicate that skill. If other factors, such as random chance or teammate spillovers are responsible for the performance, then we ought not observe players performing consistently in these areas over time. A common way to gauge the degree of skill contained in a performance metric is to observe its correlation year to year. If metrics for individual players do not vary much from year to year, then it is likely that players have a skill in that area. If there is no correlation, then it is likely that other factors are heavily influencing the metric. In the latter case, even if a particular metric appears to have a powerful influence on the overall performance of the team, its utility as a measure of quality is quite limited." (Bradbury, 2008, 48)

Decision makers in hockey have correctly identified save percentage as the appropriate measure of performance. However, it does not appear that decision makers understand the inconsistency of this measure. To see this, the salaries from the sample of free agent goalies we previously examined had a coefficient of variation of .74. The coefficient of variation for save percentage in this sample was .011.[16] In sum, decision makers pay goalies as if they are very different and as if these differences are predictable. It does not appear, though, that the empirical evidence is consistent with either perspective.[17]

Evaluating the Best Player at the Most Important Position

To illustrate our research, let us discuss the performance of Martin Brodeur. During the 2008-2009 season, Martin Brodeur set the record for most career wins by a goalie. Brodeur's mark led some to argue that Brodeur is the greatest NHL goalie ever (Cox, 2009). Our study of general managers suggests that many decision makers in hockey would not concur with this statement. After all, Brodeur only ranks 6th all time in career save percentage.

Although one can debate whether Brodeur is the very best player at the most important position in professional sports, few would question the idea that Brodeur is one of the greatest goalies in league history. Our study of goalies, though, suggests that "one of the greatest ever" and "just average" is not that different.

To see this point, let us first connect what a goalie does to outcomes. This requires that we estimate a simple production function. Specifically, to determine the value of

Table 5. OLS Regression Results for Equation 3: Standings Points 1983/1984–2007/2008

Variable	Coefficient	*t* Statistic
C***	80.367	23.283
Goals for***	0.314	46.728
Goals against***	−0.308	−46.992
D08***	9.548	6.026
D07***	9.780	6.253
D06***	9.723	5.990
D04***	5.403	3.100
D03***	5.701	3.557
D02***	4.582	2.703
D01***	4.558	2.742
D00***	4.568	2.905
D99	0.543	0.316
D98	0.541	0.328
D97	0.426	0.286
D96	0.332	0.223
D95	0.397	0.215
D94	0.291	0.164
D93	0.132	0.091
D92	0.193	0.137
D91	0.203	0.127
D90	0.108	0.076
D89	0.084	0.060
D88	0.096	0.065
D87	0.114	0.075
D86	−0.010	−0.006
D85	0.024	0.015
R^2	.926	
Adjusted R^2	.923	
F statistic	293.801	
Prob(*F* statistic)	.000	

$n = 609$. White heteroskedasticity-consistent standard errors and covariance.
*** Statistically significant at 1% level.

allowing a goal to score, we simply regress—as illustrated by Equation 3—standing points[18] on goals scored and goals allowed.

$$\text{Standing Points}_{\text{it}} = a_0 + a_1\text{GS}_{\text{it}} + a_2\text{GA}_{\text{it}} + e_{it}. \tag{3}$$

This model was estimated with team data, beginning with the 1983-1984 season and ending in the 2007/2008 campaign.[19] The model explained 92% of the variation in standing points. The estimated results reveals that each goal scored is worth 0.31 standing points, and a goal allowed is worth −0.31 standing points. With the

value of allowing a goal ascertained, we can now evaluate Brodeur and an average goalie.

After the 2008-2009 season, Brodeur had faced 25,126 shots and stopped 22,954; giving him a save percentage of 91.4%. An average goalie, though, would have posted a save percentage of 90.4%. In other words, an average goalie that faced 25,126 shots would have prevented 22,737.1 goals. Given the impact goals have on standing points, this 216.9 increase in goals allowed would have cost Brodeur's employer (the New Jersey Devils) 66.9 standing points. In addition, because a win is worth two standing points, an average goalie facing Brodeur's shots would have won 33.5 fewer games.[20] After the 2008-2009 season, Brodeur had played 16 seasons in the NHL. So, an average goalie would have only produced about two fewer wins per season across Brodeur's career.

To put that mark in perspective, at the conclusion of the 2008-2009 season, Brodeur had 557 career wins; a mark that led all goalies in the history of the NHL. An average goalie, though, would have won 523.5 games. Such a mark would currently rank second on the all-time win list.

This analysis illustrates the point we are making about the difference in goalies. One of the very best goalies in NHL history is simply not very different from an average goalie.[21] When we couple this finding with the inconsistencies of goalies, we wonder then there are such large differences in the salaries goalies received. In other words, if there is very little difference in the performance of goalies, why would any team pay much more than the minimum salary to acquire a goalie?

Notes

1. This is the definition of "instrumental rationality" and it comes from Etzioni (1988, 136). Etzioni notes that there are at least 60 definitions of rationality, but it is this definition that most writers appear to use.
2. North's purpose in explaining the concept of instrumental rationality was to highlight how difficult it was for this ideal to be achieved.
3. See "*Hockey Goaltending: Skills for Ice and In-Line Hockey*" by Brian Diaccord, Publisher: Human Kinetics, 1998, p. vi.
4. We are not the first to study goalies in the National Hockey League (NHL). Previous research by Lavoie and Grenier (1992) modeled NHL goalie salary for the 1977 and 1989 NHL seasons as a function of starting age, experience, experience squared, goal average, games played per season, and whether the goalie was French Canadian. For the 1989 season, they also included deferred compensation and whether the goalie was American or European. The authors find for the 1977 season at the 5% level of significance, that experience, experience squared, goal average, and games played per season were statistically significant; while for the 1989 season, only deferred compensation and games played per season were statistically significant at the 5% level. Our study will examine more years of salary data and also consider voting for the Vezina award and the nature of goalie performance over time.

5. An anonymous referee has noted that a change in the numerical values for first, second, and third place votes can change the end ranking for the Vezina award and thus may change the results of the model. Although we agree with this point, we would note that save percentage, goals against average, and wins are statistically significant at the 1% level. This result indicates that each of these are measures are used by NHL GMs to evaluate NHL goalie talent.
6. The Vezina Award winner is also awarded $10,000, with lesser monetary awards going to the second and third place winners.
7. We included both age and age squared. At the onset of a goalies' career, additional experience should lead to improvements in performance. Therefore, initially age and salary should be positively related. At some point, though, age reduces the ability of a goalie to play. So, age squared should be negative. The estimated coefficients often indicated this relationship (although the coefficients were not always statistically significant). At the suggestion of an anonymous referee, we also considered experience and experience squared. Experience and its square were never statistically significant in our study of the Vezina Award or the study of free agents salaries. We thank the referee for suggesting we look at this.
8. The lone exception to this finding is seen when we measure performance with wins. This is the only performance metric that is a function of time on the ice in a regular season.
9. To qualify for our sample you had to have played at last two seasons prior to signing the contract (if we only focused on a single lag our sample would have increased to 40).
10. For market size, we considered the size of the metropolitan area where the team is located. For cities in the United States, we used data from the U.S. Census Bureau (2000 census). Data for Canadian cities were taken from Statistics Canada (www.statcan.gc.ca) and this was from their 2006 census. We also considered a separate dummy variable for cities located in Canada and this was insignificant.
11. We thank an anonymous referee for suggesting we control for the impact the lockout had on salaries. These dummy variables, though, were not statistically significant.
12. We also went away from the Jenkins approach and considered a much larger data set. Salary data were collected from USA Today on goalies that played at least 2,500 min in a single season from 2000-2001 to 2007-2008. We then looked at the relationship between the pay a goalie received and his current save percentage. Across 181 goalie observations, we found no statistical relationship between current pay and current save percentage. This larger data set did not consider when the goalie signed his contract or his free agent status when he signed the contract. Results are available on request.
13. An anonymous referee noted that as a team's defenseman change, the quality of shots a goalie sees may also change. Hence, the goalies inconsistency may be about the quality of his teammates. Essentially, this is the point of our story. The statistics tracked for a goalie do not separate him from his teammates or the random elements of the game. Hence, these statistics—which decision makers do consider in evaluating talent—do not help decision makers ascertain who is a better or worse goalie.
14. Our sample only considered goalies who logged at least 100 min in successive postseasons. We also considered looking at the link between a goalie's performance in

a postseason and what he did in his most recent appearance. The results, though, were identical. There was no statistical link between save percentage in a current postseason and what the goalie did in his most recent appearance.

15. Bradbury (2008) illustrates the importance of consistency in a study of earned run average (ERA) in baseball. Bradbury notes that ERA does connect to outcomes in baseball. The inconsistency of the measure, though, suggests that ERA is not measuring the contribution of pitchers exclusively. Consequently, a better measure is needed if decision makers wish to properly evaluate pitchers.
16. If we look at all 181 goalies that played 2,500 min from 2000-2001 to 2007-2008, our results are similar. The coefficient of variation for player salary was .672. For save percentage, the coefficient of variation was .011.
17. An issue one could raise is that a goalie can affect a team's bottom line beyond his ability to influence wins. If fans want to see the expensive goalie play—because they believe the goalie is far above average (even if that is not true)—a team will benefit by hiring the expensive goalie. Research by Berri, Schmidt, and Brook (2004) argues that star power has very little power in the NBA. Such research suggests that fans will not pay much more to see a player that does not generate wins. Again, though, this research was on the NBA. Whether this story holds true in the NHL is a subject for future research.
18. Since 1999-2000, a team gets 2 points for a win and 1 point for losing in overtime. In the past, it was 2 points for a win and 1 point for a tie.
19. We had 609 team observations in our data set and our model was estimated with White Heteroskedasticity-Consistent Standard Errors & Covariance. Additionally, year dummies were used. These were only statistically significant after the 1999/2000 season, possibly due to the change in how standing points were tabulated at this time. In an effort to have fewer ties during the regular season, if a game ended in regulation play tied each team would one standings point. The team that won in overtime - or during a subsequent shootout (if necessary) - would then get one additional standings point. Table 5 presents the empirical results from the estimation of equation (3).
20. We find that Brodeur produced 33.5 wins above average (WAA). Calculating WAA for a specific goalie (i.e., goalie$_{ij}$ or the *i*th goalie in year *j*) involves three steps.

    1. First, we subtract the save percentage of an average goalie from the save percentage of goalie$_{ij.}$
    2. The outcome of step one is then multiplied by the number of shots goalie$_{ij}$ faced. This step provides the number of saves goalie$_{ij}$ accumulated above, or below, average.
    3. In terms of standing points, a save is worth the same—in absolute terms—as a goal allowed. Consequently, to measure a goalies value in terms of standing points, we multiply the outcome of Step 2 by 0.31. In addition, because each win is worth two standing points, the standing points value is then divided by two.

All of this is summarized by the following equation:

$$\text{WAA} = \left(\text{Save\%}_{\text{ij}} - \text{Ave.Save\%}_{\text{j}}\right) \times \text{Shots}_{\text{ij}} \times |\text{marginal value of goals against}|/2$$

21. An anonymous referee noted that the difference between Brodeur and an average goalie might seem more significant than our discussion suggests. Specifically, the referee noted that in at least five of his seasons with the New Jersey Devils, two additional wins were necessary for the team to make the playoffs. Thus, although two wins may not seem to matter much on average, they can be extremely valuable at the margin. The difficulty with this approach, though, is that teams cannot value wins in this fashion. Although the Devils may have only made the playoffs by one or two wins in a single season, it seems unreasonable to argue that the one or two wins produced by the goalie (or any other player) were the specific wins that launched a team into the postseason. Such an argument would mean a team would have to pay each player who produced two wins an amount equivalent to the revenue generated by postseason play. This would make each win a very expensive purchase for a team. For us, a more reasonable approach is to treat each win as a win. So, for example, if a team won 40 games, and the goalie produced only two wins, then the goalie is only responsible for 5% of the team's wins.

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Bios

David J. Berri is an associate professor of economics in the Department of Economics and Finance at Southern Utah University. His current research focuses on the economics of sport, specifically the topics of consumer demand, competitive balance, and worker productivity.

Stacey L. Brook is a lecturer in the Tippie College of Business. His research interests revolve around the behavior of sports leagues and decision making in professional sports.