"Examination of efficient NHL roster design"

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1. Introduction

Roster design can be defined as the efficient assembling of forward line combinations and defensive pairings that maximizes the win probability of a team. This study examines the impact each roster position has on team performance in the National Hockey League (NHL). The NHL was chosen for two reasons. First, in-game success is accomplished by team effort as the nature of the game (physical, accelerated and fluid) makes it impossible to be monopolized by an individual. Second, general managers try to compose a high-performing, well-balanced roster with the existence of a strict salary cap.

Recent studies on roster design examined the consequences of racial discrimination on roster assembly (Duru, 2006); the correlation between newly teammates' global experience and contribution to team performance (Engeler, Georgakakis & Ruigrok, 2013); the relationship between diagnosed player types and their effect on team efficiency (Chan, Cho & Novati, 2012); the effects from hiring cultural diversified coworkers (Kahane, Longley & Simmons, 2013; Mongeon & Boyle, 2015); the importance of roster flexibility (Chan & Fearing, 2015) and the significance of physical diversity of players on winning (Mongeon, 2015).

The motivations for this research were initially to identify the key components of in-game team success, recognize which roster positions have greater contribution to team performance and establish the significance of roster depth. The objective of this study is to establish the value of each NHL roster position on team success.

2. Data

Play-by-play data from every regular game of six seasons (2010-15) is used for the analysis. On-ice even strength events materialized in regulation time only, were enlisted in the dataset. All on-ice events must be listed and verified by the NHL. The on-ice events are: faceoff, hit, giveaway, takeaway, shot on goal, missed shot, blocked shot, goal and penalty. A value is appointed to an event determined by the probability that event generated a goal. Each play encompasses a total of twelve observations, six for the home team and six for the visitor team, along with information related to the outcome of each event. Values are assigned to all on-ice players and is dependent on the volume of influence an individual had on the result of a given play. The estimation of the overall performance of a given player, for every observation from every on-ice event he participated in, is conducted by the player evaluation model. The first five seasons will be applied for the appraisal of player overall performance, player allocation to their respectful roster position and to generate the variables for the roster model. Upon completion of skater interpretation, the 2015-16 regular season will service as a validation dataset to test the roster design model and to correlate it with all NHL team rosters.

3. Methodology

3.1. Player Evaluation

The intention of player evaluation is the assessment of specific hockey skills of an individual that improves the in-game performance of his team. The utmost contribution of a player is illustrated by his capability to improve the goal differential of his team, which increases the win probability. Player evaluation will be administered prior to roster design, as it weighs the overall performance of each player throughout the course of a season.

Total Hockey Rating (THoR) by Shuckers and Curro (2013) is an all-inclusive statistic rating of all NHL defensemen and forwards incidental to all on-ice events. The objective is to generate a ranking system for all skaters that examines in-game information at twenty second increments to estimate the marginal probability in terms of a goal scored and allowed of the occurrence of obtained events. To help simplify with correlation, THoR is measured in wins above average for a season.

A ridge regression from a Bayesian perspective is applied to measure the impact each player has on a given event in terms of the probability of a goal. Ridge Regression was selected for two reasons. First, it reduces the ratings of skaters with smaller sample size. Second, it minimizes multicollinearity, as the effect each player has on every play is isolated from the performance of their teammates and opponents. Bayesian estimation procedures are used to estimate the model parameters and measure the probabilistic differences in the value of various roster positions.

The model used with the values for every play individually is the following:

$$NP20 = \mu + \sum_{j=1}^{p} 1_{ij}^{H}\,\theta_j + \sum_{j=1}^{p} 1_{ij}^{A}\,\theta_j + \gamma ZS$$

where $NP20$ is the net probability that a goal will be scored within the following twenty seconds of an on-ice event. The value is the probability that a goal will be scored for the home team minus the probability that a goal will be scored for the away team. The effect home ice advantage has on every play is represented by μ, θ_j is the impact of each skater, P is the total number of players who have participated at least in one on-ice event and γ represents the influence of a zone start on the $NP20$ of every event. Both 1_{ij}^{H} and 1_{ij}^{A} variables are interpreted to be

$$1_{ij}^{H} = \begin{cases} 1 & if\ skater\ j\ is\ on\ the\ ice\ for\ the\ home\ team, \\ 0 & if\ skater\ j\ is\ not\ on\ the\ ice. \end{cases}$$

and

$$1_{ij}^{A} = \begin{cases} 1 & if\ skater\ j\ is\ on\ the\ ice\ for\ the\ away\ team, \\ 0 & if\ skater\ j\ is\ not\ o\square\ the\ ice. \end{cases}$$

Three values are assigned for zone start (ZS), depending on the location of initiation of each shift. For turnovers, a takeaway has a positive impact on the team that stole the puck, whereas a giveaway has a negative implication on the team that had the puck stolen. Likewise, penalties have a negative effect on the team committing the penalty and a positive effect on the team drawing the penalty.

Players who were traded throughout the duration of a regular season, are treated as two diverse individuals; one for their initial team and one for their second team. For evaluation to achieve utility maximization and to genuinely isolate individual performance, the following measure was developed:

$$\Gamma = \frac{\frac{1}{N_T}\sum_{k=1}^{T} n_k(\hat{\theta}_{k1} - \hat{\theta}_{k2})^2}{\frac{1}{N}\sum_{j=1}^{P} n_j(\hat{\theta}_j - \bar{\theta})^2}$$

T shows the sum of skaters who got traded during the regular season. The mean number of on-ice plays in which k^{th} skater was implicated, is described by n_k. Accordingly, $\hat{\theta}_{k1}$ and $\hat{\theta}_{k2}$ are the evaluations of the k^{th} skater for their initial and second team. n_j is the number of on-ice events in which skater j participated in. $\hat{\theta}_j$ is the projected evaluation of skater j, $\bar{\theta}$ is the mean evaluation of all skaters, n_j. NT is the total of all $n_k{'s}$, whereas N is the total of all $n_j{'s}$. Γ is preferred to be minimal, for the estimation method to be trustworthy.

3.2. Player Allocation

Upon completion of evaluation of overall performance for all skaters, each player will be categorized and assigned to their respectful position within the roster of their team. To determine which skaters are considered top and which bottom, position and additional specific statistics throughout the course of a regular season are used. Those statistics are: zone starts, total ice time, power play minutes and penalty kill minutes.

Top six forwards and top four pairing defensemen will start much of their shifts in the zone of their opponent whereas bottom six forwards and bottom pairing defensemen in their own zone. For total ice time, the two players who have logged the most minutes per position, are regarded as top forwards and defensemen. The most offensively gifted players will be assigned the majority amount of power play minutes whereas the less skillful skaters will be given minimal to zero minutes. Differently, bottom six forwards and bottom defensive pairing tend to be defensively minded and are on the ice for the bulk quantity of penalty kill minutes.

3.3. Roster Design

The formation of every NHL team roster will be finalized with the distribution of all players to their respectful position. The linear model consisting the minimum quantity of additional wins each roster position needs to contribute to team success, for a team to qualify for the postseason, is the following:

$$
\begin{aligned}
P_{(t=1)} = \beta_0 &+ \beta_1 LW_1 + \beta_2 C_1 + \beta_3 RW_1 + \beta_4 LW_2 + \beta_5 C_2 + \beta_6 RW_2 + \beta_7 LW_3 + \beta_8 C_3 + \beta_9 RW_3 \\
&+ \beta_{10} LW_4 + \beta_{11} C_4 + \beta_{12} RW_4 + \beta_{13} LD_1 + \beta_{14} RD_1 + \beta_{15} LD_2 + \beta_{16} RD_2 \\
&+ \beta_{17} LD_3 + \beta_{18} RD_3 + \beta_{19} G + \varepsilon_{s,g,t,l}
\end{aligned}
$$

where P is the projection roster of a given team, LW is left wing, C is centre, RW is right wing, LD is left defence, RD is right defence, G is goaltender, s represents season, g is game, t is team and l is goal. The autonomous contribution of each roster position to the prediction of the dependent variable P is symbolized by the β coefficients.

Once the optimal roster is constructed, it will cross examine all NHL rosters with the intention of estimating the marginal probability of an additional top and bottom center, winger, defenseman and diagnosing the positions of "weakness" of each team, in the form of player underperformance.

4. Results

Preliminary results from estimating the linear roster model imply that low performing teams have less roster depth than high performing teams, as the contribution of each roster position to team success is relatively lower. The roster positions with the greatest marginal differential, in terms of additional wins, is the positions of top four defensemen. THoR of players for high performing teams, in those four roster spots, are noticeably greater in relation to THoR of players on low performing teams. In even strength situations, top forwards generated more additional wins than top defensemen. This indicates that the value of a forward is greater than the value of a defenceman, regarding five-on-five play. Finally, findings showed that the player evaluation model is influenced more by the zone start of a shift rather than home ice advantage. The effect of zone start is more substantial than the impact of home ice advantage on a per event basis.

Hockey operations may possibly profit from the linear roster model, as it could assist on decision making related to current skaters of a team (resign, trade, release) and obtaining new players, based on their roster needs. Additionally, it will provide general managers with the ability to detect efficient incompetence in contemporary roster construction methods and facilitate in manufacturing more adequate roster design approaches.

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