Hockey I

Produced by Dr. Mario | UNC STOR 390

Hockey Explained

PLAYER PERFORMANCE

- Unique to Hockey = Rapid Substitutions
  - Median Time for Unique Configuration is 8 Seconds
  - Most Shifts Are Between 30 and 50 Seconds
  - Constant Substitutions Make it Difficult to Value Players for Events Such as Goals

- Plus-Minus (+/-)
  - Difference Between Goals Scored and Goals Allowed Player is on Ice
  - Example of a Marginal Effect

- Marginal Effect = Difference in Variable Between 2 Groups

PLAYER PERFORMANCE

- Problems With +/-

- Variables Effecting +/- Other Than Player Skill
  - Ability of Player's Teammates
  - Opponent Quality
  - Amount of Playing Time

- Partial Effects = Difference in Variable Between 2 Groups After Controlling for Other Variables

PLAYER PERFORMANCE

- Experiments = Optimal for Estimating Marginal Effects
  - Pick a Player
  - Randomly Sample from Pool of Other Players
  - Do This When Player is Playing and on Bench
  - Impractical and Need to Rely on Observational Data

- Estimated Using Regression
  - Predict Number of Goals
  - Include All Covariates
  - Massive Set of Covariates
    - Requires a Ton of Data
    - Standard Linear Regression Fails
  - Over-Fit or Fail to Converge

PLAYER PERFORMANCE

- Proportional Hazards Model
  - Studied by Thomas, Ventura, Jensen, Ma (2013)
  - Goals are Rare and Time is Almost Continuous

- Introduction of Binary Goals
  - Purpose = Simplicity
  - +1 = Goal Scored by Home Team
  - -1 = Goal Scored by Away Team

$$p_i = P(Y_i = 1) = P(Home\ Team\ Scored\ Goal\ i)$$

PLAYER PERFORMANCE

- Logistic Regression Model

$$\log\left[\frac{q_i}{1-q_i}\right] = \alpha + \mathbf{u}_i'\boldsymbol{\gamma} + \mathbf{v}_i'\boldsymbol{\varphi} + \mathbf{x}_i'\boldsymbol{\beta}_0 + (\mathbf{x}_i \circ \mathbf{s}_i)'(\boldsymbol{\beta}_s + p_i\boldsymbol{\beta}_p).$$

Team/Season

Special Teams:
Penalty Scenarios
Pulled Goalies

Player-Presence
Indicator Variables

Player/Season

Post-Season
Indicator

PLAYER PERFORMANCE

- **Partial Effect of Specific Player**

$\beta_{0j} + \beta_{sj}$ → Regular Season Effect of Player *j*

$\beta_{0j} + \beta_{sj} + \beta_{pj}$ → Post-Season Effect of Player *j*

- **Player-Only Version of Model**

$$\log\left[\frac{q_i}{1-q_i}\right] = \alpha + \underbrace{\beta_{h_{i_1}} + \cdots + \beta_{h_{i_6}}}_{\text{Home Players}} - \underbrace{\beta_{a_{i_1}} - \cdots - \beta_{a_{i_6}}}_{\text{Away Players}}$$

PLAYER PERFORMANCE

- **Player-Only Version of Model**

Y: scoring team — $y_i \in \{-1, 1\}$

X: players — $x_{ij} \in \{-1, 0, 1\}$

	1 ⋯ n
1	01−110−10−11−1−100⋯01011
⋮	⋮
−1	1−11−10101−1110⋯0−10−1−1

Massive Model Matrix
(All Hockey Players)

PLAYER PERFORMANCE

- Regularized Approach
  - Representation of Log Odds

$$\eta_i = \log[q_i/(1-q_i)]$$

  - Negative Log Likelihood Objective Function

$$l(\eta; \mathbf{y}) = \sum_{i=1}^{n} \log\left(1 + \exp[-y_i \eta_i]\right)$$

Bernouilli Distribution in Exponential Family

  - Penalization of Generalized Linear Model

$$l(\eta; \mathbf{y}) + n\lambda \sum_{j=1}^{p} \left[c\left(|\beta_{0j}|\right) + c\left(|\beta_{sj}|\right)\right]$$

Cost Function of Coefficients

PLAYER PERFORMANCE

- **Lasso Penalization**

$$l(\eta; y) + n\lambda \sum_{j=1}^{p} (|\beta_{0j}| + |\beta_{sj}| + |\beta_{pj}|)$$

Penalizing Only Player Effects

- **Regularization Path**
  - Each Lambda Leads to Different Estimates
  - Larger Lambda = Effects Pushed Towards 0
  - Cross-Validation Used to Choose Lambda
  - Alternative: Corrected Akaike Information Criterion

$$AICc = 2l(\hat{\eta}_\lambda; y) + \frac{2kn}{n-k-1}$$

PLAYER PERFORMANCE

- Goal-based Effects
  - Utilized Play-by-Play Data from 2002-2014
  - Based on 2,439 Unique Players
  - Involved 69,449 Goals
  - Link Function Makes Coefficients Difficult to Interpret
  - Partial Probabilities for Individual Players

$$\mathrm{PFP}_{sj} = \left(1 + \exp[-\beta_{0j} - \beta_{sj}]\right)^{-1}$$

Given Goal Scored by Team,
What is the Probability Player *j* Scored?

PLAYER PERFORMANCE

- **Goal-based Effects**
  - **Translate Player Effects Into Scale of Goals**
  - **Partial Plus-Minus**

$$\mathrm{PPM}_{sj} = g_{sj}\mathrm{PFP}_{sj} - g_{sj}(1 - \mathrm{PFP}_{sj}) = g_{sj}(2\mathrm{PFP}_{sj} - 1)$$

Number of Goals Player *j* Was on the Ice For

PLAYER PERFORMANCE

- Goal-based Effects
  - Results

Top 25 and Bottom 20 Player-Seasons When Ranked by Their Regular-Season PPM

Goal-Based Performance Analysis								
Rank	Player	Season	Team	PFP	FP	PPM		PM
1	Peter forsberg	2002–2003	COL	0.68	0.77	55.52		85
2	Sidney crosby	2009–2010	PIT	0.60	0.64	43.47		60
3	Dominik hasek	2005–2006	OTT	0.59	0.67	42.45		80
4	Sidney crosby	2008–2009	PIT	0.60	0.61	42.26		48
5	Sidney crosby	2005–2006	PIT	0.60	0.62	41.86		52

Completely Different Ranking

PLAYER PERFORMANCE

- Problem With Previous Analysis
  - Focused on Goals
  - Other Important Events
    - Shots on Goals
    - Missed Shots
    - Blocked Shots

- Corsi and Fenwick Statistics

Corsi = shots on goal + missed shots + blocked shots

Fenwick = shots on goal + missed shots

PLAYER PERFORMANCE

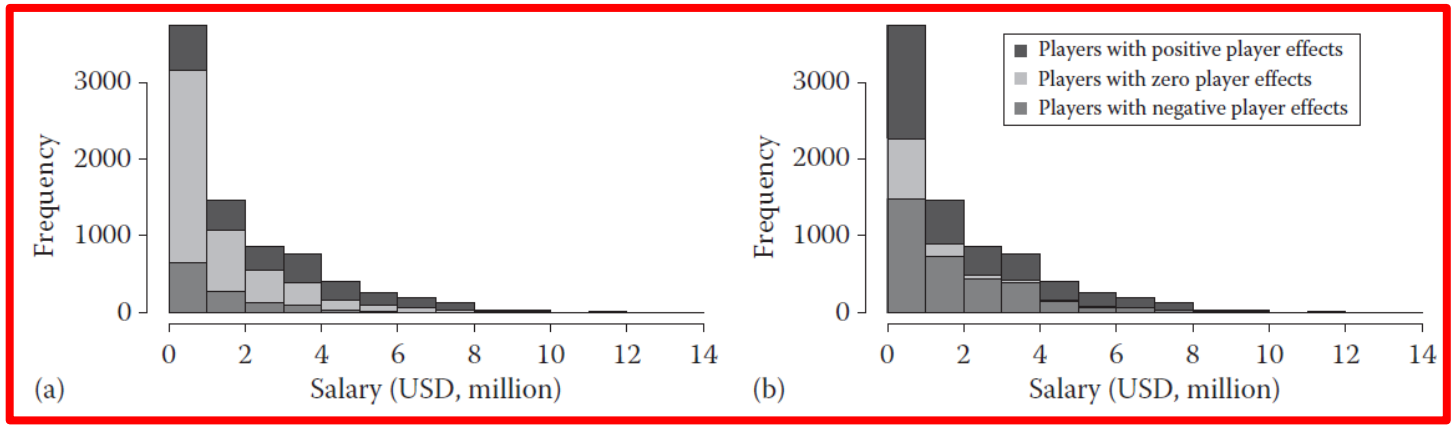
- Results for Corsi-Based Partial +/-

Top 25 and Bottom 20 Players by Corsi-Based PPM

Corsi-Based Performance Analysis							
Rank	**Player**	**Season**	**Team**	**PFP**	**FP**	**PPM**	**PM**
1	Daniel sedin	2010–2011	VAN	0.60	0.65	615.14	876
2	Eric staal	2008–2009	CAR	0.58	0.59	605.41	619
3	Mikhail grabovski	2010–2011	TOR	0.60	0.57	597.05	465
4	Joe thornton	2011–2012	SJS	0.59	0.61	596.37	742
5	Alex ovechkin	2009–2010	WAS	0.59	0.66	575.72	1047

PLAYER PERFORMANCE

- Salary and Performance



Goals-Based

Corsi-Based

PLAYER PERFORMANCE

- **Salary and Performance**

Top 20 Value Players as Ranked by PPM/Salary

Rank	Player	Team	Goals per million
1	Ondrej palat	TAM	58.27
2	Ryan nugent-hopkins	EDM	19.81
3	Gabriel landeskog	COL	16.74
4	Tyler toffoli	LOS	16.72
5	Gustav nyquist	DET	9.08
6	Jaden schwartz	STL	8.43
7	Eric fehr	WAS	7.51
8	Andrew macdonald	NYI	7.48
9	Benoit pouliot	NYR	6.43
10	Brad boyes	FLA	6.01

← 2013-2014 Season

Final Inspiration

I will personally challenge anyone who wants to get rid of fighting to a fight.

-Brian Burke