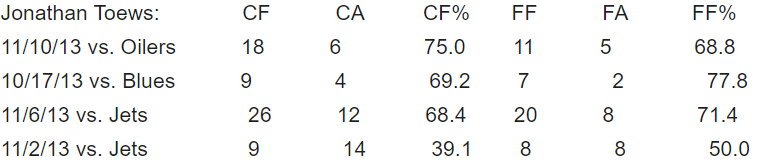
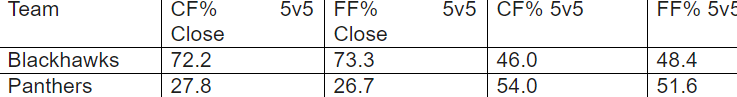
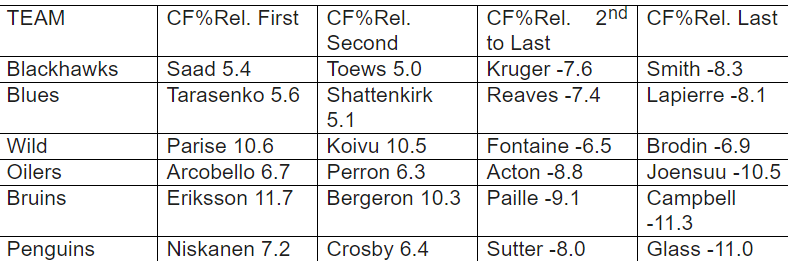
## Stats Made Simple Part 1: Corsi & Fenwick

* Advanced stats/metrics/analytics = initial stages of a movement to bring hockey analysis into modern era.
* Antiquated measures hockey has relied upon since Dark Ages (Plus/Minus (+/-)) = outdated + coming under heavy fire via a realization that there’s a lot more to hockey than simply being on the ice when a goal is scored.
* Better name = “**expanded metrics**” b/c most data being used has been available for a long time.
* \*\**The way* data (like shots + time on ice (TOI) are employed = where growth/expansion comes in\*\*\*
* So, while @ face value, expanded metrics may seem intimidating/too complicated, ***they really are not***
* Don’t have to be an expert in “fancy stats” to grasp their meaning, as many are as simple as BA or OBP in baseball, but b/c they’re relatively new, fans just need a little education.
* Many sports fans = familiar w/ football + at least some elementary stats used to keep track of a team’s performance.
* Time of possession (TOP) = 1 more commonly used simple metric = how long team’s offense controlled ball during a game.
* Obviously, team has a better chance of scoring if controlling the ball.
* In football, rigid structure of the game w/ offense on the field vs. opponent’s defense makes this stat easy to track.
* **In hockey, this is not so easy to do ==** more fluid w/ offensive + defensive players on the ice @ the same time, **but like football, a team = more likely to score when they have the puck (possession) than when stuck in the defensive zone.**
* Apart from teams of people watching skaters w/ timers to determine how long each has the puck, a way to track TOP in hockey = **Corsi** and **Fenwick**.
* **\*\*\*Corsi = shots on goal + missed shots + blocked shots\*\*\***
* basically uses every shot toward the goal throughout the game
* **\*\*\*Fenwick = shots on goal + missed shots\*\*\***
* measures the same thing as Corsi *but excludes blocked shots*.
* Essentially, in order **to shoot the puck**, you **must possess the puck**.
* Since we do not have the tech or another practical way to measure TOP in hockey, must employ a proxy.
* Expanding stats we use to understand a player’s/team’s performance in the past, present, + future opens doors to analyzing the game in all new ways.
* If we can ID trends in #’s, we can predict w/ *some degree of confidence* what’ll happen in the future
* We can determine progress made by teams/players in different areas of the game, figure out if a team’s early season success is built to last for duration of a season or just riding coattails of some hot goal tending.
* **Possibilities = as many + varied as the user wants them to be**.
* Metrics != first + last line of analyzing hockey 🡺 cannot stop watching games + rely solely upon stats
* *but they do enhance our hockey experience.*
* Both Corsi + Fenwick = counted as *“For” or “Against”.*
* “For” = a shot or event that happens while player is on the ice that is *on behalf of his team*
* “Against” = same but for opposing team.
* Both can be applied *team-wide* or *by player*.
* In general, **Fenwick = usually regarded as better indicator over a longer period of time vs. Corsi = better indicator over a shorter period of time.**
* Example: Patrick Kane is on ice for 10 shots on behalf of his team + opposing team takes 3 shots while Kane is on the ice during the game.
* **Corsi For (CF) = 10 Corsi Against (CA) = 3 Kane = a +7 Corsi (10 – 3 = 7) on the night.**
* Let’s say of the 10 shots Kane was on the ice for, *2 were blocked* by players on opposing team.
* Opposing team had 3 shots while Kane was on the ice but *1 was blocked.*
* B/c *Fenwick excludes blocked shots*, Kane’s numbers would look like this:
* **Fenwick For (FF) = 8 Fenwick Against (FA) = 2 Kane = +6 Fenwick (8 – 2 = 6) on the night**
* To make this data easier to use, statisticians express a player or team’s #’s as a %.
* **CF% (Corsi For Percentage) + FF% (Fenwick For Percentage)** can be easily compared among players, teams, + games.
* Example:([www.extraskater.com](http://www.extraskater.com))
* Remembering **Corsi event = any shot toward the goal** (SOG – Shots on Goal, Missed Shots, Blocked Shots), we see Toews’ Corsi For (CF) varies greatly over these games, as does his Corsi Against (CA)
* **Focusing on these #’s *alone* could be misleading for sake of comparing his performance w/ other players throughout the league, teammates, or even own play from game to game.**
* **\*\*\*Using Corsi For Percentage (CF%) allows us to see how the #’s work together + remove game-to-game variables that would otherwise be misleading or confusing.\*\*\***
* Performance against the Blues (10/17/13) + Jets (11/2/13) = both a CF = 9, but when CA is factored in + translated into a %, see just how different those performances really were.
* **Posted very good #’s (i.e. had a good possession game) @ 69.2% against Blues but had a disappointing 39.1% against Jets.**
* When we remove blocked shots, Fenwick #’s take over.
* Toews’ best Corsi game = 3rd in Fenwick.
* Even the “bad game” in Corsi terms (Jets 11/2/13) was a decent showing @ 50.0% when viewed from perspective of FF%.
* CA = 14 becomes FA = 8 due to Blackhawks blocking 6 shots while Toews was on the ice.
* Using Corsi and Fenwick, particularly CF% and FF%, is just the beginning of the expanded metrics possibilities available to us
* Many fans like to see #’s just to confirm what was observed of a certain player/line during a game, others dive deep for more detailed analysis.
* However you choose to use them, if expanded stats enhance experience as a fan of the game, it sounds like a positive outcome/
* Hockey fans = going through a learning process b/c expanded metrics = relatively new to the game.

## Stats Made Simple Part 2: Score Close & Score Effects

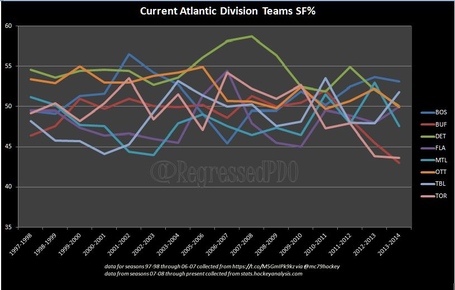
* Game = normally played w/ 5 skaters + 1 goalie == **5v5** or some other similar variation.
* When team takes a penalty + goes on Penalty Kill (PK) may see **4v5**/**Shorthanded** + occasionally **3v5**
* When opponent takes a penalty, team who drew the penalty = awarded a **Power Play (PP)** = **5v4, Man Advantage,** etc.
* **Even strength = any situation when both teams have the same number of players on the ice.**
* **\*\*\*For purposes of advanced stats, best of the above situations to use is 5v5\*\*\***
* **\*\*\*PK, PP, 4v4 = *NOT* considered to be truly representative of a team’s strengths/weaknesses over time\*\*\***
* Point of these metrics = judge a team’s/player’s performance over time + get an idea of what to expect in the future.
* Cannot happen w/out being able to filter out noise + focus on game situations that give clearest results
* To filter out **Score Effects**, statisticians focus on 5v5 performance when score is close.
* **Score Close** = defined as a score that’s tied (*including 0-0*) or w/in 1 goal in the 1st or 2nd period.
* \*\*\*In the 3rd period, score is only considered close when tied\*\*\*
* For those familiar w/ science/research, consider **5v5 Close** (**5 on 5 Score Close**) to be the "control" in this study
* All other situations that arise during the game (PK, PP, etc.) should be considered **experimental variants**.
* In any statistical discussion, \*\*\*sample size is always a concern\*\*\*, so why make the already limited (5v5) pool of data even smaller? 🡺 b/c "**Score Effects**".
* **Score Effects** take over when a team has a lead > 1 goal, *particularly late in the game*.
* Often, team w/ the sizeable lead goes into defensive mode instead of continuing to press offensive attack (think "prevent" defense)
* *Defensively-minded style of play often allows trailing team to make a push offensively = leads to more shots + thus higher possession + offensive zone time for attacking (trailing) team.*
* Further, teams trailing as game gets closer to end tend to throw caution to the wind in efforts to score, **contributing further to disparity in shot attempts** (like to onside kicks, trick plays, Hail Mary)
* *When Score Effects are @ work, tend to see leading team taking defensive zone penalties*.
* Ex: 3rd period of Blackhawks game vs. Stars on December 10, 2013
* Blackhawks had a 5 – 0 lead in the 2nd period, Stars scored + suddenly shot attempts quickly escalated until end of period, bringing 5v5 possession #’s up dramatically.
* In the 3rd, Stars spent a substantial amount of time in the offensive zone = led to 3 penalties taken by Blackhawks forwards, including 1 delay of game penalty (puck over glass) + 2 hooking penalties.
* Stars then enjoyed 3 PP in the 3rd alone, *furthering driving up shot attempts.*
* Practical example of Score Effects: Blackhawks vs. Panthers on December 8, 2013.
* Blackhawks dominated play early in 1st, leading to 2 goals.
* Early goal for Blackhawks in 2nd led to Panthers playing more aggressive offensively
* Panthers scored 2 in the 2nd, **bringing** **the score back to being “close”**.
* Blackhawks scored again [4-2] for remainder of the 2nd
* In the 3rd, Blackhawks scored a PP goal early, making the score 5-2.
* Following that goal, Panthers had 31 shot attempts to Blackhawks 8, + 11 Panthers shots came on 2 PP’s from penalties against the Blackhawks (interference + holding).
* Still leaves 20 shot attempts @ 5v5 = far more than the leading team attempted, a standard example of Score Effects.



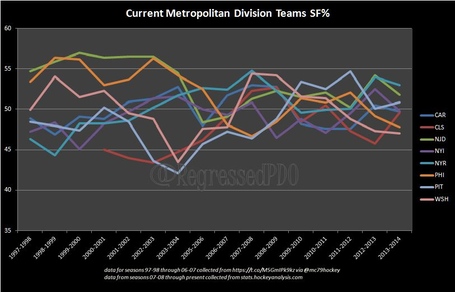
* As you can see from the table above, when score was close (*sans Score Effects*) Blackhawks dominated possession.
* W/ the score filter removed, the Panthers had better possession #’s than the Blackhawks, thus demonstrating the effect of Score Effects on shot attempts + style of play.
* **Once variants are removed, Corsi + Fenwick = much more reliable over time as analytical tools.**
* **CF% + FF% = useful in comparing teams + players across the league, + even game by game.**
* Many fans get an idea from watching the game as to which forward line or defensive pairing had the best performance of the night.
* Comparing players + line combos on a team = aided by adjusting CF% + FF% values to make them **Relative**
* \*\*\***CF% Relative and FF% Relative**\*\*\* allow us to see how a player stacks up against teammates.
* **Relative values** tell us how a team performs when a player is on the ice.
* If positive, team performed better (more shot attempts/higher possession #’s) w/ player on the ice than off.
* If negative, team performed better when player was off ice
* **Relative *Percentages*** do NOT mean certain players are good + others are not good.
* many factors affect these #’s, such as **Quality of Competition** + **Zone Starts**
* What we’re really looking = **strength of performance** 🡪 use this info to determine where strengths + weaknesses of a team are located.
* If team’s checking line consistently has better Relative #’s than the offensively gifted 2nd line, perhaps the usage + deployment of the line needs to be revisited.
* *Further, large disparities between a team’s lines may indicate a team w/ less forward depth or heavily front loaded lines.*
* Some teams in terms of CF% Rel (5v5):
* Distribution such as that seen from the Blackhawks + Blues = representative of many teams, in that Relative #’s = fairly evenly spread out
* Bruins = much wider distribution, as do the Penguins, + Wild = similar to these 2 as well.
* Distribution of a team's Relative possession #’s = heavily dependent upon *not only depth of talent* but *also* ***Usage*** *+* ***Deployment*** *of players*.
* \*All statistical data gathered via [www.extraskater.com](http://www.extraskater.com)

## Using Shots For Percentage

* **Possession statistics** + the data that allows us to use them only reach back to the 2007-2008 season.
* Prior, total shot attempts were not tracked + cataloged into a usable format, thus making the task of taking a statistical look @ team's past performances very difficult.
* 1 method used to get a *general* idea of team's overall possession game = **Shots For Percentage (SF%)**
* **Shots for + Shots against** in a game = 100%, + a team's Shots For are then turned into a % of shots taken in a game.
* A team has to have the puck to shoot it, so w/out more expansive data prior to 2007-2008, *must make what we can of the data we have.*
* **SF% can be used to *gauge* puck possession**.
* More a team possesses puck = more chances to score + thus win.
* **SF% does NOT tell the whole story b/c obviously, a hot goaltender can steal a playoff series, but it is a useful tool**
* Recently, Tyler Dellow (@mc79hockey) publicly shared a [spreadsheet](https://docs.google.com/spreadsheet/ccc?key=0AuFrjZE8ZySpdDZpclc4TG5qX3RjczhpbUtDNHFpX1E#gid=0) w/ SF% for all NHL teams back to 1997-1998 season (further than any other info we have previously had convenient access to + thus can give some insight into history of a team's puck possession game)
* Using that data:

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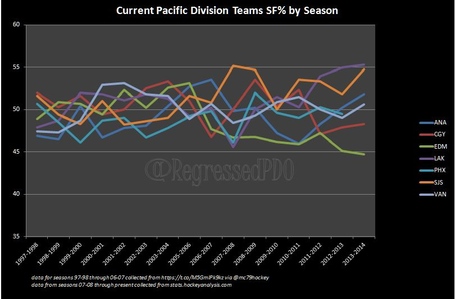
* Dominance of [Detroit Red Wings](http://www.sbnation.com/nhl/teams/detroit-red-wings) = obvious for over a decade, + *no surprise that other teams, such as* [*Blackhawks*](http://www.sbnation.com/nhl/teams/chicago-blackhawks)*, have patterned their game after this team.*
* Rather precipitous drop of possession game for the [Maple Leafs](http://www.sbnation.com/nhl/teams/toronto-maple-leafs) is astounding.
* For years, they hovered ~50%, but since 2009-2010 season, possession game indicators have dropped like a stone.
* Dramatic spike for [Tampa Bay Lightning](http://www.sbnation.com/nhl/teams/tampa-bay-lightning) coincides w/ their [Stanley Cup](http://www.sbnation.com/nhl-playoffs) winning season in 2003-2004

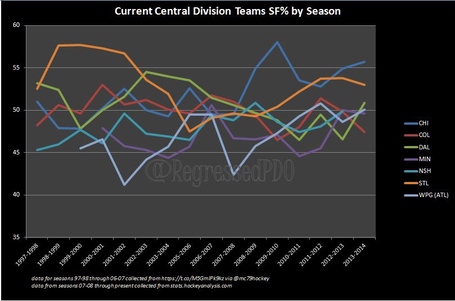
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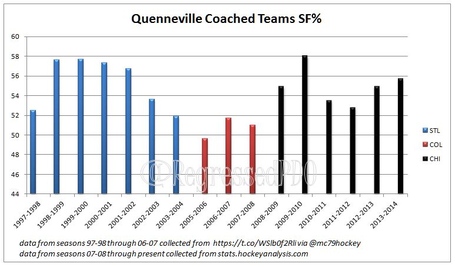
* Both [Capitals](http://www.sbnation.com/nhl/teams/washington-capitals) + [Penguins](http://www.sbnation.com/nhl/teams/pittsburgh-penguins) bottomed out in 2003-2004 + spiked up quickly thereafter = [Ovechkin](http://www.sbnation.com/nhl/players/54337/alex-ovechkin)

drafted in 2004 + [Crosby](http://www.sbnation.com/nhl/players/55428/sidney-crosby) the following season.

* [Devils](http://www.sbnation.com/nhl/teams/new-jersey-devils) early dominance, drop, + slow resurgence in SF% is also notable here.
* This division now seems to be getting more tightly grouped on the possession spectrum (2013)

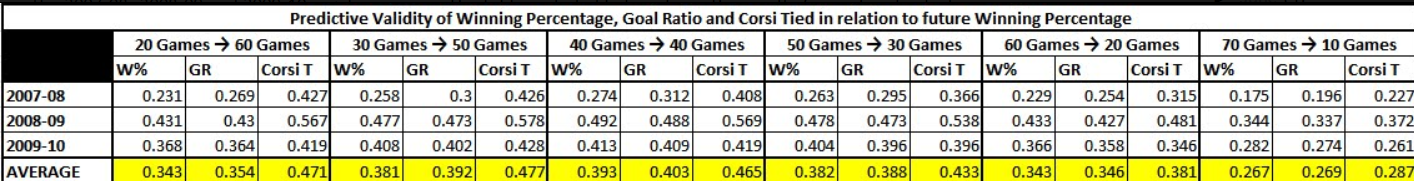
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* [Oilers](http://www.sbnation.com/nhl/teams/edmonton-oilers) continue on long road toward a rebuild of former powerhouse position.
* [Kings](http://www.sbnation.com/nhl/teams/los-angeles-kings) have really shot skyward in terms of SF% + currently lead the NHL in this metric, as well as FF%
* [Sharks](http://www.sbnation.com/nhl/teams/san-jose-sharks) are also sustaining their offensive dominance.
* Pacific teams seem to be spreading out to reveal a serious lack of parity in the division (should come as no shock to anyone)
* [](http://cdn3.vox-cdn.com/assets/4227607/central_season_sf_.JPG)
* Central = bit more spread out over time than other divisions.
* Obviously, these teams have not been playing each other as divisional foes for all of this time, but dominance of the [Blues](http://www.sbnation.com/nhl/teams/st-louis-blues) + Blackhawks for past several seasons is striking.
* This also leads to another point of interest 🡺 early years on this chart (in which Blues were dominant, middle years wherein [Avalanche](http://www.sbnation.com/nhl/teams/colorado-avalanche) were near the top, + last several years where Blackhawks dominate possession), all have 1 thing in common: ***the coach of each of those teams***

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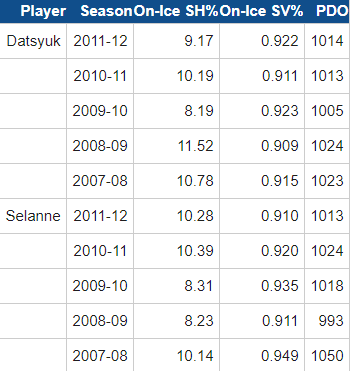
* Joel Quenneville has coached the Blues, Avalanche, + Blackhawks
* SF% for each season of his coaching career are above.
* Only 1 team (2005-2006 Avalanche) finished season w/ < 50% SF%.
* This track record = very impressive + it’s obvious Quenneville has good grasp on coaching puck possession + using both star + depth players in such a way as to maximize effectiveness in this regard
* Links to helpful articles regarding SF% and it's uses:
* Dellow's original article on this topic: <http://www.mc79hockey.com/?p=6451>
* <http://www.extraskater.com/>
* <http://stats.hockeyanalysis.com/>
* <http://www.arcticicehockey.com/2013/10/23/4862840/the-importance-and-misconceptions-of-advance-hockey-analytics>

## Loose Ends - Part I: Predicting Future Success

* Various shot metrics (all calculated @ even strength w/ tied score) can predict future success @ the team level
* How well do these shot metrics predict future success when compared to more conventional measures of team strength (winning % + goal ratio?
* **Split-half reliability of goal ratio** (0.417) was lower than predictive validity coefficients for both Corsi Tied (0.444) + Fenwick Tied (0.429).
* Implication = 2 latter variables are better able to predict goal ratio from ½ of the schedule to the other than goal ratio is itself.
* ***If shot metrics like Fenwick + Corsi fail to predict future success better than conventional measures, that would render them considerably less useful.***
* Method employed = developed and first used by Vic Ferrari
* B/c of relative complexity of the process, including a step-by-step description may be helpful.
* 1) Randomly selected a certain # of games from each team's schedule, w/ each team having an equal # of home + road games selected.
* 2) Calculate how each team performed over those games w/ respect to certain variables = **even strength Corsi w/ the score tied**, **overall goal ratio** (empty net + shootout goals excluded), + **winning %** (defined as WINS/(WINS+LOSSES))
* Games that ended in a shootout = considered ties + therefore not included in calculation.
* 3) Random selected a 2nd, *independent* group of games
* if a game was included in 1st grouping, it was NOT eligible for selection in the 2nd
* Again, equal # of home + road games were selected for each team.
* 4) Determine how each team did in terms of winning % over 2nd group of games + looked @ how each of the 3 variables calculated in relation to 1st group correlated w/ winning % in the 2nd
* Relationship between the size of the 2 groups can be expressed as **y=(80-x),** where x = # of games in 1st group + y = # of games in 2nd group.
* Ex: 20 games selected for 1st group, 2nd group would consist of 60 games.
* Ultimately, x values used = {20, 30, 40, 50, 60. 70}
* Raw data used = from 2007-08, 2008-09, + 2009-10 regular seasons.
* Table below shows results for each individual season, as well as average results, + values represent the average correlation over 1000 calculations
* **Corsi Tied = best predictor of** how a team will perform over remainder of its schedule, regardless of the point in the schedule @ which calculation occurs.
* **Corsi Tied** = only ***marginally* more predictive of future success than goal ratio or winning %** *when looking at samples of 60+ games or more*.
* In other words, as sample size increases 🡺 diminishing returns w/ respect to predictive advantage of Corsi
* **By end of season, all 3 variables seem to predict future success equally well**
* Above fact has implications in terms of determining playoff probabilities @ team level, w/ results suggesting **a composite metric would work best**
* Aggregate values for Goal Ratio + Winning % are remarkably similar w/ implication = once shootout results are controlled for, winning % = as good of a measure of a team as goal ratio

# Intro To Advanced Statistics – PDO

* **PDO (SPSV%) = On-Ice Shooting % + On-Ice Save % +** can be measured for individuals or teams
* = very telling way of exploring a team's "**puck luck**" = which way bounces have been going, *though skill does heavily influence the result.*
* Named after regular Oiler Fans commenter PDO, originally devised by statistical guru **Vic Ferrari.**
* PDO = On-Ice SV% + On-Ice SH%. typically quoted as **10X the actual %**
* **PDO = 10\*(On-Ice SV% + On-Ice SH%)**
* Usually look @ **Even Strength PDO** b/c vast majority of ice time is spent in this game state
* Usually it regresses towards NHL average = 1000 over course of a season, though for some teams their sustainable PDO = higher due to excellent goaltending or consistently good shooters.
* Ex: 2011 Leafs shot 8.6% @ 5v5, ranking 10th, + 5v5 SV% = .906, which ranked 27th.
* Combined PDO score = 10\*(90.6 + 8.6) = **992** = 26th in NHL in ‘11
* Thus, can be argued “bounces went against them”, though Leaf’s atrocious goaltending obviously contributed to such a result.
* Boston + Vancouver consistently (as of 20120) outperform PDO as a result of excellent team goaltending + shooting
* Canucks = top team from a PDO perspective over the past 5 years (2007-2012), w/ Boston = 2nd
* Median SH% over past 5 years in NHL = 8.3% at 5v5, while SV% = .917, which makes median PDO exactly = 1000
* **Teams consistently above/below this level = proving that their results = likely *more than just luck,* particularly if they outperform by a wide margin.**
* Meanwhile, Toronto + Islanders = worst *under*-performers over 2007-2012, w/ Toronto's problems almost solely result from horrid goaltending 🡪 .906 5v5 SV% over 2007-2012 ranks only slightly ahead of Tampa Bay's .905 SV%.
* NYI on the other hand = below average goaltending *AND* shooting for 2007-2012
* **At team level, PDO allows us to quickly spot teams unlikely to sustain performance mid-season.**
* Minnesota = near dead-on-average team over 2007-2012, producing average PDO = 1001.4, largely due to excellent team defense + goaltending combined w/ mediocre offensive results.
* Early 2011, this stretched to extremes 🡺 led NHL through 1st 40 games despite having absurdly low **Team Fenwick = of 44.2**.
* Wild had a team PDO = 1007*, thanks to a very favorable .938 SV%,* due to **regress**.
* By end of season, it went pretty far the other way (as expected given atrocious team Fenwick %), + Wild finished season w/ a team PDO = 989.
* Compared to Kings 🡺 1st 37 games = out of playoffs despite favorable Fenwick % = 51.5.
* After 37 games, Kings had team PDO = 981 🡺 unsustainably low for a team dominating possession as they were.
* Despite having a solid team SV% = .923, *virtually no luck* went their way @ offensive end, as the team was firing home only 5.8% of Even Strength shots.
* As year progressed, goaltending improved even further to .927 SV% + shooting bounced back to a poor, but more respectable 6.0%.
* Thus, Kings closed out season w/ a PDO = 987
* Still less lucky than Minnesota, but trending in right direction + more reflective of quality of play.
* In playoffs, Kings had a dominating PDO = 1038
* Lowest playoff PDO in 20120 = Red Wings = paltry 904, who despite playing reasonably well, got no bounces @ either end of the ice
* Actually, *outshot* playoff opposition by an average of 10 shots/game @ Even Strength, but were *outscored* by almost 2 goals/game at Even Strength.
* In a similar fashion, can explore PDO scores of *individual players* during course of season + reads for who is benefiting from fortuitous bounces while on the ice.
* Perhaps guy padding the score sheet regularly has been seeing benefits of sieve-like goaltending from opposition, or maybe he who looks like worst player ever seen = actually being victimized by atrocious PDO as a result of *teammates* not scoring + *goalie* not doing their job
* Again, can make excellent use of the data provided by TimeOnIce.com to examine "luck" seen by players over a stretch of games.
* Conversely, can also pull data from BehindTheNet.ca
* Leaf-related examples: Darryl Boyce + Philippe Dupuis.
* Following the end of 2011, Boyce looked like lock to be checking forward for Leaf’s entering 2011-12 season.
* Then Leaf’s signed Dupuis to a 1-year contract + a battle ensued in training camp that saw Dupuis get nod for opening night roster.
* What people remember about Boyce = production in limited opportunity (5 goals + 13 points in only 524 minutes of ice time + ended the season a +8 player despite facing tough competition, usually starting shifts in own zone + not being a flashy offensive player)
* *So why should we have been cautious about his results?*
* 2010-11 season 🡺Boyce posted a Fenwick % of .438, Corsi % of .430, + yet somehow... against all odds, Boyce enjoyed .923 goaltending, + the team shot 14.2% w/ him on the ice.
* Goaltending isn't alarmingly good: @ Even Strength, .923 goaltending = pretty close to NHL average, + in fact 19 Leafs had better **ES SV%** while on the ice
* So, his impact on the defense wasn't the reason for his stellar +/- #’s.
* But 14.2% On-Ice shooting? Was Boyce really responsible for that type of offensive production from his line mates? ***NO***
* In fact, his **On-Ice SH%** = highest in NHL amongst forwards to play 30 games in 2010-11, by a margin > 2%
* **PDO** = 1069 resulted from combo of average SV% + ridiculously high SH% + ranked 2nd in NHL
* Just say, either he's 1 of the most skilled forwards in the NHL, or his **PDO from 2010-11 was unsustainably high + he wasn't going to repeat.**
* After losing job to Dupuis, Boyce was placed on waivers + picked up by Columbus where his On-Ice SV% was .923, *again*, so that wasn't something he was ruining.
* But his On-Ice SH% dropped to 5.08%, and his PDO fell to 974, indicating he's pretty far from stellar @ offensive end + ***Luck can make a big difference.***
* Dupuis in Colorado in 2010-11 season worked a lot on the PK + in 674 minutes of ice time produced 6 goals + 17 points
* Looked like a *comparable* defensive player, but *an offensive upgrade on Boyce*, particularly when factoring in likely drop off in Boyce's luck entering 2011-12.
* For sake of discussion, Dupuis = below average PDO = 984 in ’10-11 season w/ Avalanche, mainly stemming from seeing .900 goaltending behind him @ Even Strength.
* On-Ice SH% = 8.4 = just under NHL average 🡺 implied he should be fine @ helping put puck in the net
* Logically expect at least a *slight* improvement in On-Ice SV% Dupuis would play in front of, + if he could replicate his On-Ice SH% = might get at least a comparable 4th line Center
* Unfortunately, that isn't quite how things worked out 🡺 On-Ice SV% = stellar (Even-Strength Leafs goaltenders = .966 SV% w/ Dupuis on ice)
* He probably wasn't driving force behind stellar netminding, but wasn't ruining Leafs w/ defensive miscues apparently either.
* So, what was the problem? 🡺 *Offense* - or a lack thereof.
* Dupuis' On-Ice SH% in 30 GP = 0.00% 🡺 *NO goals were scored with him on the ice.*
* Only 2 players in 2011-12 season played 30+ games w/ On-Ice SH% = 0.00% (Dupuis + Eric Boulton of the Devils = only forwards w/ 30+ GP in a season in past 5 years not on ice for a goal)
* Bad luck 🡺 Dupuis has a legitimate claim
* Typically, guys w/ #’s *that low* = cement fisted enforcers/checkers who see virtually no offensive zone time.
* This would be a case where Dupuis' bad luck prevented him from playing in the NHL.
* So unsustainably bad or unsustainably good
* There’re often guys on every roster = unlikely to repeat stellar or horrid #’s from prior year
* Then there’re players = consistently outperform or underperform expectations.
* **Enforcers** = often horribly low PDO, largely due to a complete lack of offensive contribution.
* Comparably, extremely skilled players = often above average PDO thanks to positive influence on shooting, while top-end goalies can sustain high PDO for the entire team, thanks to high Even Strength SV% values.
* The following chart effectively illustrates **the skill factor of PDO for skaters:**



* Obviously, goaltending = varies wildly for both players, + it should be noted = extremely difficult for a forward to influence On-Ice SV% (completely logical).
* So, when we examine player PDO, it is NOT assumed PDO should regress towards 1000 (as is often suggested)
* *Should* expect depends on **context in which player is used** (**usage metrics**), who they’re playing with, + their own natural talent.
* As Tom Awad of Hockey Prospectus said 🡺 ***PDO is not JUST a measurement of luck.***
* "Even after > 200 games, almost ½ of shooting % + save % = luck
* At the team level, slightly over ½ of team talent exhibits itself as puck possession, + slightly under ½ exhibits itself as finishing (+ preventing finishing).
* **Just so happens the possession talent is much, much easier to measure**"
* Similarly, David Johnson of HockeyAnalysis.com 🡺 **luck is not the *sole* component of PDO**
* To put it simply, need to look @ players *long term* patterns before assessing what's likely to happen in the future.
* @ individual level, player's quality of teammates + offensive opportunities will likely influence PDO 1 way or another*, so when looking for future trends be sure to take this into consideration.*

# Colorado Avalanche are not a test case

* 2014: “Avs aren't good enough to outplay their possession problems” 🡺 spurred by spurious claims made in Denver Post + Yahoo as to team's ability to continue racking up seasons of 100+ pts. in perpetuity, despite the fact they “absolutely + positively cannot”
* LV 🡺 many go thinking they have the formula to crack whatever code casinos have created to build up massive monuments to excess, opulence, + human misery.
* While a few *do* leave a couple $K richer, most head short on money + long on regret.
* Inevitably so will the Avalanche
* Math all checks out: *Teams simply cannot sustain score-close possession % south of 50% + PDOs north of 102.*
* To claim otherwise is to say math compiled over nearly a decade is wrong, + *you* are right.
* Crux of argument for Avalanche success = Patrick Roy has figured out something which literally hundreds of NHL coaches have not in past several years: *How to sustain play which has otherwise been found to be wholly unsustainable.*
* In 1st year under new coach 🡺 were able to generate quality chances in relatively few shots (keeps own shooting % high) + to suppress opponent chances effectively so that, even though they're get more, a smaller % are *actually* troubling netminder (keeps team save % high as well).
* But how many times have hockey fans since, let's say, 2010 or so, heard a team assert that “yes, we know we give up a ton of shots etc., but *we* have the ability to do those 2 things reliably enough that we’re going to be able to do it forever”
* 2009-10 Avalanche started out very well 🡺 40-23-6 in 1st 69 games, 5th in West.
* Getting 86 points from 1st 69 games = pace for a little more than 102 points for the season
* But b/c luck runs out + their Fenwick through 69 = 45.5% (26th in NHL): lost 10/final 13 games + went from a playoff lock to barely making it + then getting demolished by San Jose in the 1st round.
* Prior to year-end correction, Colorado's **score-close PDO** for the year = 102.4, 2nd-highest in league
* Time passed + it became increasingly unlikely they'd be able to keep juddering ship from breaking apart
* 1 year later, Dallas Stars were in much the same boat: began season 29-13-5 (63 points in 47 games, pace for ~110 points) w/ PDO at the time = 102.9, top in NHL, while Fenwick = 25th at 46.5%
* Were also 5th in the league standings, 3rd in the West, then lost 2 straight, then 4, then 5, then 6 straight + finished year w/ just 95 points, winning just 13/final 35 (PDO during collapse = 99.4)
* Peaked very early, indeed, + season ended up out of playoffs + in ruins + everyone wondered what happened to them *except nerds who said Stars were cruising for this all season.*
* Very next season, 2011-12 Wild started 20-7-3 atop Western Conference w/ PDO = 3rd in league = 102.1 w/ Fenwick = 42.%.
* Immediately lost 8 in a row + never recovered 🡺 finished @ just 81 points w/ more regulation losses than total wins.
* Blamed injuries, but might’ve also considered **team's worst-in-the-league 97.2 PDO** from the start of 8-game losing streak to end of season 🡺 **That, too, was long predicted.**
* Leafs in lockout-shortened 2013 season got into playoffs despite season-long PDO = 103 (No. 1 in NHL) + possession #’s = 44% (30th in NHL) + also claimed this was all part of their “system.”
* Had season been a full 82 instead of 48, they, too, probably would’ve suffered inevitable collapse *that came next season instead.*
* Now Avalanche = trying to distract selves from the fact they got bounced + significantly out-possessed by deeply mediocre Minnesota team in last year's playoffs + clearly learned nothing from the latest “test case” in Toronto that sent assistant coaches + GMs alike scurrying to unemployment office + brought in all the thinkpieces about nerds having definitively won once and for all.
* Might just believe they're a team like the Bruins
* PDOs posted by Claude Julien's clubs last few years (1st, 3rd, 14th, 1st again from 2010-11 to ’14, , + never < 100)
* Whatever Julien seized upon, it's leading to high save %’s + shooting %’s overall.
* Can attribute this to world-class goaltending from Tim Thomas + Tuukka Rask, minutes-eating of Chara, + the fact that Patrice Bergeron = world-class center.
* But with *that high PDO* (can't call unsustainable, based on what evidence here suggests) comes w/ **the fact the Bruins' possession #’s have been sky-high as well** (16th, 5th, 4th, 6th)
* Are also literally the only team that does this consistently over last few years.
* Even teams like Chicago + LA, other definitive elites over that time, can't really keep up shot-quality efforts as routinely as Boston, even as possession #’s are almost invariably better.
* Can almost see where Patrick Roy + Co. are coming from 🡺 have a very high-quality top-6
* can say has moved laterally at very best in replacing Paul Stastny at center w/ improving Nathan MacKinnon, then slotting Jarome Iginla into wing slot MacKinnon previously occupied
* Stastny drove play consistently in a way haven't seen MacKinnon accomplish yet, especially on road, or against tougher competition.
* If being asked to play the middle, instead of Ryan O'Reilly for instance, that could lead to more questions than answers at the other end of the ice.
* *But bottom 6 is awful, + was made it actively worse in summer by acquiring Danny Briere for no reason at all*
* Avs are, therefore, counting on a lot of development from MacKinnon + continued dominance from Duchene, despite the fact = guy who ate all of Colorado's toughest minutes last year = now playing for a different team in same division.
* And Chicago, Dallas, Nashville, Minnesota, + so on got better
* Conference will be a knife fight from beginning to end + Avs saw fit to actually make sure their switchblade was a little bit smaller than last year, when it absolutely didn't have to.
* To that end, when considering Avs' blue line, must really wonder who's going to do what to improve
* # of even-strength shot attempts conceded by Avalanche last year = 26th in league, ahead of only really awful teams
* Didn't add anyone to help, + in fact brought in someone who's going to hurt (Brad Stuart = awful)
* D corps = going to get run over once again, + it's tough to be sure they can keep suppressing shot quality, 🡺 last year = got lucky
* **Shot-quality reduction** isn't really a big factor for any team (save, again, for Boston, but Bruins have top-shelf goaltending) + that's if teams have a strong collection of defensemen from Nos. 1-6
* If Keith, Seabrook, Oduya, + Hjalmarsson can't keep opponents from getting quality chances (unlucky in this regard last year, for sure), how can you say Erik Johnson, Brad Stuart, Hejda, + Barrie can?
* Examine **goaltending** = **ultimate determiner of save % at any rate**.
* Colorado's even-strength save % last season = ~.931, 5th in league = about 3/4 pts. higher than what Semyon Varlamov (.935 all by himself) has done past few years = potentially huge difference given the gargantuan # of shots he faces per 60 minutes of even-strength ice time (32.5)
* If he plays 3,200+ ES minutes again this season + faces even a *similar* # of shots to the 1,772 from last season, a 6-point drop in save % does major damage = extra 13 goals against, or > 4 pts. in the standings just from him alone.
* If Varlamov plays fewer minutes (ex: gets hurt) + backup Reto Berra has to take a heavier workload, that = even greater # of minutes in which Avs' goaltending will be worse.
* JS Giguere's ES save percentage last season = .924 in nearly 975 minutes.
* Give that much time to Berra (abysmal .905 ES) == another 9 G conceded/3 pts. in standings conceded
* So, from a goaltending standpoint *alone*, regression to historical norms cuts Avs' point total by 7.
* Even before you factor in D's so-called “ability to inhibit shot-quality”
* Also consider Colorado's health last year 🡺 only lost 204 man-games to various ailments, 19th in league
* Can probably expect that # to go up as well, + that's where team's depth kicks in 🡺 they have none
* In reality, the #’s guys say this team could lose as many as 20+ points from last season's total by the time it has played 82
* Even being more conservative, @ a drop of 12 or 15, that presents big problems.
* Given league's new divisional playoff format, dropping into high 90s = move from “comfortable in division” to “oh my god we have to play the Blackhawks/Blues/Stars in the 1st round.”
* This is NOT a team equipped to stand up to what Chicago or St. Louis or (potentially) Dallas will be able to do for 7 straight games 🡺 couldn't take Minnesota last year.
* *They'd probably call that bad luck, which is funny.*
* **Analytics have proven time + again, year after year, this can't happen over, say, 50 (or in outside cases 100) games. Over 164, forget about it.**
* People will say all year Colorado is a “test case” for analytics.
* Hockey world outside greater Denver area largely accepts as gospel that this kind of play simply cannot be kept up.

# Analytics, not statistics, driving NHL evolution (2014)

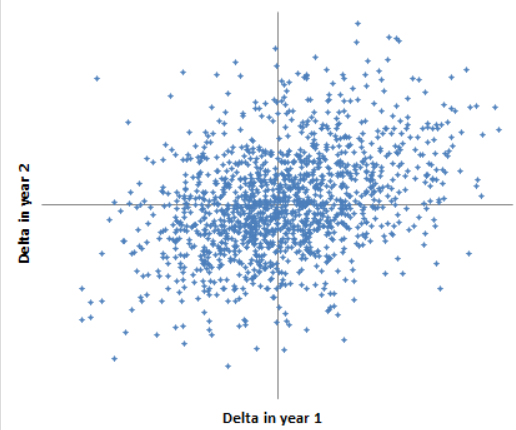
* Every June, executives + columnists wax poetic about traditions that make hockey; handshake line, passion + pain threshold of players, Stanley Cup.
* What has truly made hockey into the exhilarating sport + thriving industry it is today = its ability to adapt, fusing playmaking concepts from European soccer w/ rugged athleticism of rugby + structure + tactical teachings of lacrosse.
* Evolution continues w/ addition of analytical specialists in hockey operations departments of several teams (highlighted by Kyle Dubas named assistant GM of Maple Leafs)
* Such developments suggest hockey may be in process of learning its most important lesson, 1 baseball has only recently come to terms with itself: *"If we weren't already doing it this way, is this the way we would start?"*
* That = the question Paul DePodesta asked Billy Beane when they met: *Was Beane's process guided by principles of accuracy + efficiency or by convention and tradition*?
* For Beane, who soon faced the loss of 3 big-time free agents, the question made an impression.
* < 3 years after he + DePodesta joined forces, 2002 A's won 20 games in a row, an AL record.
* Despite having lowest payroll in baseball, Oakland tied for best record in MLB
* Beane + DePodesta revolutionized baseball w/ those accomplishments. Now, more than a decade later, hockey is facing a similar tipping point.
* There has been an attempt to distance the sport from the "Moneyball philosophy," laid out in "Moneyball: The Art of Winning an Unfair Game," by Michael Lewis.
* *Hockey insiders suggest statistics only lend themselves to slower games which stop + start following every play*
* **But "Moneyball" wasn't about advanced statistics or $**; **it was about thinking differently, asking questions, + never being satisfied w/ doing things the way they’ve always been done**
* "In such a tight market for talent, needed to look beyond conventional means of thinking," hockey executive Mike Gillis told Bruce Dowbiggin in "Ice Storm: The Rise and fall of the Greatest Vancouver Canucks Team Ever."
* Gillis = GM of the Cancuks in run to 2011 Stanley Cup Final.
* "In hockey, people have not wanted to go beyond their experience to find new solutions," he said. "Some hockey people dismissed 'Moneyball' b/c Oakland never won using it. But A's = small-market, + when they taught big guys how it works, advantage was gone. Red Sox *did* adopt those principles + won 2 World Series"
* **Principles of "Moneyball" apply to hockey as much as any other sport, + in order to claim an understanding of the game, executives must be willing to look at it from every angle**
* *This is where analytics come into play 🡺* **willingness to discard preconceived notions that don't stand up to strict scrutiny = already playing a role in separating successful teams from the rest**
* 1st step in embracing analytics = **to understand them**.
* Only w/ that base can misconceptions + biases that skew hockey decision-making @ the highest level be appreciated.
* Last season during a "Hockey Night in Canada" broadcast, when the Oilers lost to Vancouver 6-2, analyst Glenn Healy commented on Oilers' performance in a manner which echoes how many sports fans feel about the analytics movement.
* "When you look @ the stats, every stat was in Edmonton's favor. They were better in faceoffs. They were better in hits. They had more blocked shots. But they weren't even in the game."
* Seems to be an idea among those who oppose analytics that Healy's words present a flaw in the practice, that those who believe in analytics think adding up #’s in a box score should produce game's winner

In this instance, Healy was arguing against a caricature 🡺 ***\*\*\*There is a crucial difference between statistics and analytics\*\*\****

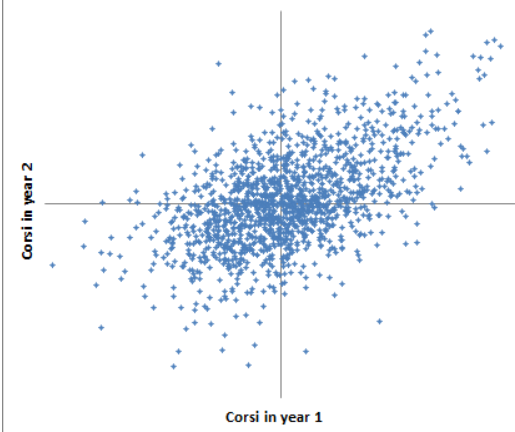
* A **statistic** = simply a piece of data (Sharks defeating Kings 2-1 = a statistic, Tyler Seguin scoring 20th G to put the Stars up 4-3 = a statistic)
* **Anything can be a statistic, + that is why they say statistics can be manipulated to fit any narrative**
* **\*\*\*Analytics** = **distinct study of statistics to find meaning**\*\*\* 🡺 analysts look for **reproducible patterns** in **large samples** which **illuminate** important **lessons** about the game.
* "If a metric is consistent over time, it's a reliable gauge of skill”: A.C. Thomas, co-founder of popular advanced-stats website War-On-Ice.
* Any analyst would say player's performance on Thursdays in March or team's home/road power-play splits = largely meaningless.
* Misuse of statistics = poor analytics (just as taking player's quote out of context = poor journalism)
* "For an analyst to suggest a metric has value, **need to be able to explain how or why it relates to outcomes we desire**, **most generally goals for or goals against**": Stephen Burtch
* "Once we can ID how it relates to winning, **need to be able to show it describes something meaningful + that it relates relatively strongly to goals/wins**."
* Hits = prominent example of a dividing-line statistic.
* Purists cite it as a difference-maker + analysts dispute its importance.
* To evaluate their claims, **analysts test every # under a high degree of scrutiny**.
* *What is a “hit”? How is it tracked? Have more hits historically = more wins?* ***Are there problems w/ the statistic?***
* *Turns out hits = unreliable metric 🡺 Team w/ puck the most = fewest opportunities to record hits*
* Ultimately, there’s very little correlation between hitting + winning.
* Hit = example of a play that *can* make an impact but *also of a statistic analysts have shown to be misleading*
* Analysts + non-analysts = on same side in struggle to counteract abuse of statistics.
* There’re a lot of #’s out there, but **if a statistic isn't a true indicator of performance or in large samples tends to predict future success, it can lead to misinformation**.
* **W/out thinking analytically: nearly impossible to determine which #’s = important + which = noise**
* **Trusting analytics is difficult w/out a fundamental understanding of metaphysics involved in sport.**
* Most conventional analysis treats hockey as a solely **deterministic entity 🡺** conditions which lead to every occurrence in a game, **deterministic theory** dictates*, couldn't have resulted in any other outcome.*
* i.e. Game's result = product of physical manifestations independent of past or future games.
* *Under a strictly deterministic lens*, winning = only metric that matters b/c every game is a clean slate +, *under fresh conditions*, anybody can defeat anybody + anything is possible.
* As commentators often state @ beginning of an important PP, "Throw the %’s out the window here"
* **Deterministic logic** *does* hold up in a hockey game 🡺 **Hockey = deterministic; every game is a fresh opportunity for success in an ever-changing environment.**
* **But the sport is NOT *exclusively* deterministic** 🡺 that = the key behind much of the disagreement between analysts + purists, between those who played @ a high level + those whose expertise rests in quantitative fields.
* Consider Texas Hold 'em, a form of poker where players combine privately held + publicly shared cards to form best possible hand, placing bets along the way.
* On the surface, seems like a very different game from hockey b/c it's all about **odds**.
* Player estimates chance of winning a particular hand based on available info + bets accordingly
* Game = **probabilistic in nature** = in long term, probabilities bear out.
* *Even if a player sees his full house defeated by a straight flush in 1 instance, he should bet on a full house winning the next time around.*
* It would seem as though hockey + poker are metaphysically opposed: 1 = deterministic, the other = probabilistic -- *but there is a problem with that view.*
* *Poker = an example of a game that is deterministic AND probabilistic.*
* Result of each hand comes from the physical process of shuffling, but b/c no players know the result of that process *beforehand*, the game = one of probabilities.
* *Hockey is very much the same way.*
* When Ovechkin decides to wind up for his patented one-timer from the left circle on the PP or to pass to the slot, he must take into account a # of factors: timing of windup, direction of swing, weight of the pass, + texture of the ice all decide, *in absolute terms*, where a shot would end up.
* If the puck doesn't go in, critics argue it was b/c *he* did something wrong.
* If he opts to pass + the play doesn't connect, they’d ask why didn't he take the shot?
* But whether the effort went bar-down + in or struck the wrong side of the post would **largely be a result of variance**, or as it's called in metaphysics, **chaos**.
* Because Ovechkin doesn't know how variance will impact his shot (how a deck will be shuffled), he must trust in probabilities + must to go w/ the play he thinks gives the Caps the best chance to score
* **During the course of thousands of repetitions, those probabilities will remain constant**.
* It is why best scorers during long periods tend to stay constant, but why in *individual* games/seasons there may be inexplicable hot + cold streaks.
* Players will make the right decision a certain % of the time based on their hockey IQ, + their physical makeup will allow them to deke, pass, check, clear, deflect, + score a certain % of the time.
* But the determination of when they’re able to do those things successfully = largely out of their control
* So, yes, each PP = a fresh chance to do the little things right + score a critical goal, but **through *enough* of those chances, the *true* talent of the group will be revealed, whatever it may be.**
* So, no, someone CAN'T throw the %’s entirely out the window.
* Fans generally think of luck in most blatant form: strange bounce, bad call, broken stick.
* **Variance**, though, affects results of games in *more critical ways*, and *THAT is why winning is NOT the only metric that matters*.
* **A good process, across a large #’s of games, will lead to the most wins.**
* Though winning a game in the present is nice, having *sustainable* success (making the playoffs, winning 4 playoff series in a row, or ascending to dynasty status) is what every team + player seeks.
* **Those successes = dictated by an accumulation of probabilities**; teams most likely to win the most games will *eventually* win the most games.
* **The aspect of variance that’s most difficult to understand = outcomes are NOT evenly distributed**
* Ex: Senators forward Bobby Ryan was left off U.S. Olympic team, + a story from ESPN's Scott Burnside revealed Ryan was disparaged in the process, w/ Calgary Flames executive Brian Burke metaphorically painting him as someone who "can't spell intense."
* In the 5 weeks following the decision, leading up to the 2014 Sochi Olympics, Ryan had 7 points in 17 games, causing commenters to opine Burke was right + Ryan missed an opportunity to prove the executive wrong
* It certainly wasn't the 1st time a player was criticized for a scoring drought, but it echoed a failure by many, from fans to executives, to understand variance + how it manifests itself in hockey + more broadly.
* When Apple's iPod came out w/ shuffle option, customers complained software must be broken b/c they kept getting 2 songs by the same artist back to back, or several in a row of the same genre.
* *Didn't think built-in randomness was "random" enough.*
* In reality, **randomness** "creates ***counterintuitively dense clusters***," + the **mind is programmed to read patterns even when none exist**
* According to Nobel Prize-winning psychologist Daniel Kahneman, we "understand sentences by *trying to make them true*."
* **If there’s the potential for a causal connection, we naturally cling to that explanation.**
* In an experiment done at a university in Barcelona, students were asked to predict a sequence of 5 coin tosses.
* In the aftermath, 1 student was IDed as having predicted the most tosses correctly, + 1 the least.
* Audience members were told they’d either be betting on the student who had been *least* successful for a 2nd round of flipping, or could pay to switch to the student who had done the best.
* Anonymously, 82% of audience paid to switch.
* *In a simple game that was so clearly decided by chance, the audience was fooled by randomness.*
* In the end, Barcelona students lost money betting on randomness disguised as reproducible success.
* Steve Jobs had to change the iPod shuffle feature to manufacture false randomness in a way that would appease customers.
* Bobby Ryan had to address the media to make excuses for a sudden inability to score that was more likely the result of variance than of criticism or skill level.
* **Hockey = fast, fluid game of small margins**.
* Even across samples as large as a season or 2, bounces can go 1 team's way more than another's.
* 1 player may see his shots tip in off of a stick or post, or may benefit from fortunate screens, + another may not.
* Variance = difficult to catch w/ naked eye, b/c a shot off the crossbar + in looks like something a player could repeat every time if focused.
* **Analytics have a ways to go in differentiating variance from talent, but an inability to recognize clustered randomness in extreme cases has led to some of the biggest management mistakes in hockey history.**
* Being wary of chaotic concepts can give a team numerous wins a season but falling prey to them can waste millions.
* From the time Bill James published his 1st "Baseball Abstract" in 1977, purists have accused analysts of not watching games, suggesting they treat a spreadsheet as manuscript + pleasure derived from sports is drawn only from calculations. *This, by and large, couldn't be further from the truth.*
* Massive amounts of most cutting-edge analysis in hockey have been recorded by watching game film repeatedly + tracking metrics in an attempt to make sense of what goes on at ice level.
* But there are also reasons *only* watching games isn't sufficient, + why conventional scouting alone is flawed
* 1st problem = *nobody can watch every game*.
* Even w/ an implausibly packed schedule, a scout could see ~300 games a year, split between teams and leagues.
* A GM or coach will watch mostly his team's games, seeing snippets of other players as a result.
* **Analytics allow the ability to attain a level of insight into a team or player that can't be gleaned from sporadic viewings.**
* #’s *can* see *every* game + provide a better idea of how a certain team/player is doing than by going off past viewings, hearsay, the odd shift, or, worst of all, reputation.
* **More statistics available, + the better those statistics are at measuring value = better the insight**
* That's why some advanced stats are better than goals, assists, +/-, etc. 🡺 They get you closer to an all-encompassing understanding of a game in a sport that tends to be dictated by selective viewing.
* **Advanced statistics provide a more precise understanding of the broader game.**
* Beane was asked a question about trusting the eye test + responded, "The idea that I trust my eyes more than the stats, I don't buy that b/c I've seen magicians pull rabbits out of hats + I just know that rabbit's not in there."
* Sports = obviously different from magic tricks, b/c players aren't intending to fool the viewer at every turn, but there is so much happening during any play that a similar effect is present.
* "The eye test isn't sufficient for analyzing a fast-moving game like hockey," Burtch said. "There's just far too much going on at far too fast a pace for any 1 individual to easily track + store the info they're seeing via memory."
* Hockey's pace makes numerical analysis + eyeball scouting more difficult when compared to baseball, but doesn't make either method less valid.
* Just means each needs to be handled with more scrutiny.
* Watching games can give us info but *can't get us all the way there*.
* Preconceived notions, biases, + inability to capture everything that happens make the eye test imperfect as a means of evaluating performance.
* There needs to be an objective layer 🡺 That is what analytics provide.
* Around the time Beane's Oakland team was becoming a contender, hockey's wave of analytics was beginning to take shape in the comments section of blogs like Irreverent Oiler Fans.
* Impassioned fans who understood analytic principles searched for areas of the game that most strongly correlated to winning, attempting to syphon the variance/chaos that clouded decision-making + analysis at the highest levels.
* They found that **shot-attempt differentials, w/ a sample size that accumulated far quicker than a +/- of goals or regular shots, were able to do that** 🡺 led to the creation of **Corsi** = a metric that has infiltrated the mainstream media + front offices, + on NHL.com = called Shot Attempts
* They discovered that **uncharacteristically high or low shooting + save %’s**, even during a full season, **aren't sustainable** for players or teams.
* Therefore, **adding them together + comparing to past team performance or league averages can work as a decent proxy for variance** 🡺 became known as **PDO** (called **SPSV%** on NHL.com)
* Several pioneers (Tim Barnes (Caps), Tyler Dellow (Oilers), + Sunny Mehta (Devils)) now work for teams + find ways to account for parts of the game that puck-possession metrics like Shot Attempts miss, + to reconcile newfound importance of controlled-zone entries + deployment optimization w/ challenges including imperfect data recording, changing environments, and noise.
* For some teams, that’s meant sweeping systematic changes.
* Wild have gone from a neutral-zone-trapping, dump-and-chase behemoth to promoting controlled entries + faster play, leading to vastly improved even-strength #’s recently undone by disappointing goaltending + special teams.
* For others it has meant an evolving lineup structure 🡺 Leafs waived physical players Colton Orr + Frazier McLaren + signed undervalued targets Daniel Winnik + Mike Santorelli
* Ultimately, **judging analytics on short-term results of recent converts = an affront to the analytic process itself**.
* \*\*\***Analytics aren't any more of a magic bullet than a new GM or a first-round pick \*\*\***
* "B/c #’s are involved, there’s the perception that statistical predictions have to achieve perfect accuracy": Rob Vollman. "But results only need to be compared w/ *traditional* analysis."
* In other words, **analysts aren't trying to take unpredictability out of sport but are attempting to improve on evaluative practices.**
* Adopting an analytical mindset in a salary-cap world can't overcome challenges created by fielding a bad team, but **by extracting a fraction more out of every player + situation through optimal deployment + then working to improve by acquiring undervalued assets + avoiding costly mistakes, are the ways a team can pave the way for a successful future.**
* "Analytics = about effective decision-making w/ a high reward," said Thomas, War-On-Ice founder.
* "If hiring someone for $100k right now can get you a free-agent-value savings of $1M + more flexibility under the cap, they've paid for themselves right there."
* Stars GM Jim Nill told Travis Yost: "We’re all trying to get 3-5% better. It's a cap world + we’re limited. We are always looking for the next thing."
* A team can win w/out analytics, + many will lose employing them, but the additional info + a scrutinized process provide a greater chance at success.
* As metrics improve + attitudes shift, this will become more apparent.
* Analytics have led hockey execs, journalists, + fans to pose the same question DePodesta asked Beane prior to joining him in Oakland, + have precipitated a massive shift in ways teams do business.
* Rather than exclusively trusting the eye test, condemning players for misfortune in small samples, or labeling players as lazy/enigmatic based on reputation or hearsay, **analytics has provided the opportunity to scrutinize decision-making and avoid those characterizations.**
* **Dismissing analytics = settling for an obsolete method of evaluation + using an inefficient business practice.**
* "Hockey analytics = simply the objective analysis of hockey," Vollman said. "Teams are bringing in outsiders to challenge conventional wisdom, + there's an opportunity to gain an edge."
* NHL has experimented w/ SportVision to work on advanced player tracking w/ microchips placed in pucks + jerseys, + that could lead to an entire new world of data to be analyzed.
* The so-called "Summer of Analytics" doesn't represent the beginning of analytical adoption in hockey; analytics have been in use for some time.
* It proves, in no uncertain terms, that Beane's progressive thinking is flowing into hockey.
* Inclusion of enhanced stats on NHL.com + a partnership w/ SAP that’ll continue to expand + is expected to produce further innovations could help.
* If a 28-year old former sports-management major, a university statistics professor, + a practicing lawyer (none having played professional hockey) can successfully replace longtime execs, the door is open for other innovative thinkers to follow them into positions of influence.
* Execs, journalists + fans will continue to revere the tradition behind the Cup, but the future will bring new challenges to teams hoping to win it, + *that's good.*
* The spirit of evolution that has crafted the hockey we enjoy remains alive, well and back on track
* **PUCK POSSESSION**
* **\*\*\*Shot attempts = best proxy for puck possession\*\*\***
* Not all shots = created equal, but **good teams create more shots + chances than opponents**, a process = far less subject to variance than *actually* scoring
* *Teams w/ best even-strength shot-attempt differentials tend to perform best in regular season + Playoffs*
* **ZONE ENTRIES**
* Manual tracking games = uncovered evidence opposing use of **dump-and-chase** as a primary strategy
* **Controlled entries** of offensive zone lead to, ***on average***, 2X as many shot attempts as dump-ins
* Contrary to popular belief, *forcing other team to move the puck 200 feet doesn't appear to significantly decrease opposition chances.*
* **SCORE EFFECTS**
* *Trailing Teams = tend to shoot more, + for a lower %, than leading teams or when score is* tied
* **Any useful statistic needs to be adjusted for the score @ time in it is recorded; otherwise oft-trailing teams will appear better than they are by shot metrics.**
* **BACK-TO-BACKS**
* Goaltenders who start on back-to-back nights have save % on average 11% points *lower* (.901 vs. .912) on *the 2nd night*
* So, teams w/ a good backup should split back-to-back starts as much as possible to avoid such drop-offs
* **PLAYER DEPLOYMENT**
* Analyzing where players begin shifts after stoppages of play (**zone starts**) can help determine how much they’re driving puck possession + offer some insight into coaching strategy.

## How to bring shot quality into player evaluation: Can we improve on Corsi by factoring in shot location and type?

* **Not all shots are equal**
* Stats community relies heavily on **shot differential measures** (**Corsi**, **Fenwick**) that *don't make any effort to account for quality of shots*.
* Shot quality must matter 🡺 try to factor it in
* Michael Parkatti created **Expected Goals** = instead of treating all shots equal, put a *weight* on each shot *based on how often shots of that type + location go in* = Makes a lot of intuitive sense
* 2006: Ken Krzywicki published detailed regression analysis of the likelihood any given shot would go in = <http://www.hockeyanalytics.com/Research_files/Shot_Quality_2006_Krzywicki.pdf>
* Tom Awad built on that + produced a stat = **Delta** = almost identical to Michael's expected goals but also added **corrections** *for situation, opponents, + teammates in* ***DeltaSOT***.
* Later, Sports Analytics Institute was selling something very similar to Delta to the Penguins.
* Michael Schuckers added in plays *other* than shots + also accounted for quality of teammate + competition in **Total Hockey Rating (THoR)**
* \*\*\*So why haven't any of these stats really caught on?\*\*\*
* Easy to dream up a new stat, **but how do you decide whether it's meaningful?**
* Simple intuition = not enough + many stats are not really important (think about popularity of hits, plus/minus, goalie wins)
* There's a certain standard of proof required for a new stat to catch on widely
* <https://www.sbnation.com/nhl/2013/11/21/5096220/nhl-stats-advanced-idiots-criticism>
* 1 basic expectation = advocates look at whether it is a **repeatable talent** = important b/c it tells us *how to interpret strong results.*
* Think about the 2 possible scenarios:
* If stat is highly repeatable (ex: Corsi), a player posting good #’s for a stretch = good news + it means they're probably genuinely good at it + we should expect them to continue to do well.
* **If stat is poorly repeatable (ex: on-ice save %), a player posting good #’s for a stretch is likely bad news = means we should bet on them fading as performance regresses toward the mean.**
* Pretty important difference 🡺 hard to be enthusiastic about a new stat before we even know whether to be excited or concerned if a player top-ranked
* Another important question for analysts to answer: \*\*\***if the stat is repeatable, does it correlate with future results?\*\*\***
* # of hits = highly repeatable stat, but its’ clear it doesn't bear much relation to success.
* **\*\*\*Be skeptical of any stat that doesn't come w/ an assessment of correlation to future results.**
* Until recently, that's never really been done for any of these stats.
* Evaluating shot quality measures
* Parkatti found that, in 1 season, expected goals @ the team level became more predictive than Corsi after ~35 games
* *Be aware: Corsi significantly outperformed shot quality measures in other years*
* <https://www.sbnation.com/nhl/2013/12/3/5153828/nhl-stats-close-range-shots-predictions>
* Schuckers looked more closely at THoR + showed it had a higher YOY repeatability @ player level than Corsi + subsequently observed that, w/in a game, a team's total THoR = better predictor of the outcome than shots on goal (*though not as good as Corsi)*
* <http://statsportsconsulting.com/2013/11/13/an-evaluation-of-the-total-hockey-rating-thor-part-i/>
* <http://statsportsconsulting.com/2013/11/26/an-evaluation-of-the-total-hockey-rating-thor-part-ii/>
* Analysts testing new statistics = a significant step forward that allows us to assess utility of metricc, but *there's still a hole in the analysis*
* **Key question = "Should we expect a team that does well by a metric over 1 period of time to outscore opponents in the future?"**
* And, relatedly, **"If a team does well by this metric w/ a certain player on the ice over 1 period of time, should we expect them to outscore opponents in his future minutes?”**
* The 1st one but not the 2nd was answered for Expected Goals.
* Schuckers published info from which you can infer implications about the 2nd, but didn't directly answer either
* A closer look at Delta
* Few metrics have been published for public scrutiny, Awad did w/ 4 years worth of tabulated **Delta** (<https://drive.google.com/drive/folders/0B8D4onnbcAAUMjhlNTc0NjYtNjQ1NS00NGZmLTkzNGYtZTYxOTAzNTVkNTU3?hl=en&tid=0B8D4onnbcAAUNDJjNmRkNjMtNzEyYi00YmY2LTg4YjUtZGZiOTNhNmUwMzcz>) which allows us to do the legwork to assess its utility.
* By comparing it to Corsi, we can look at how much value **shot location + type** data has added.
* Correlation between a player's Delta 1 year + Delta in the next year = 0.35, a modest figure + enough that a player's Delta in 1 year tells us something about what to expect next year
* But, players obviously bounce up and down a fair bit from year to year.



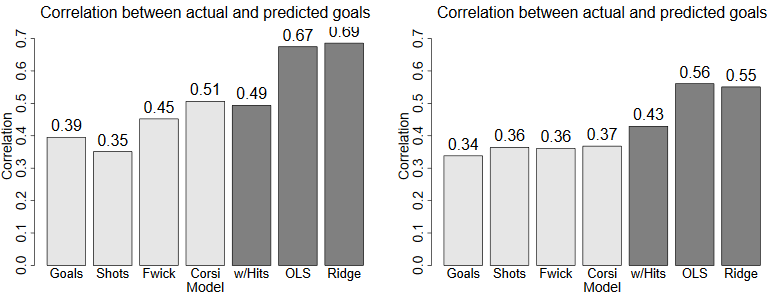
* If repeatability were really high, dots on plot would = straight line (if we know how a player did in year 1, can predict very accurately how they’d do in year 2)
* Here, result isn't completely random 🡺 definitely a bit of a slope from bottom-left to top-right.
* But it's NOT a *strong* relationship 🡺 players near bottom of league in year 1 = all over in year 2, so points scatter into more of a blob than a line.
* *Is Corsi more repeatable?* 🡺 Yes 🡺 repeatability = 0.56 + points are clustered more towards a line:



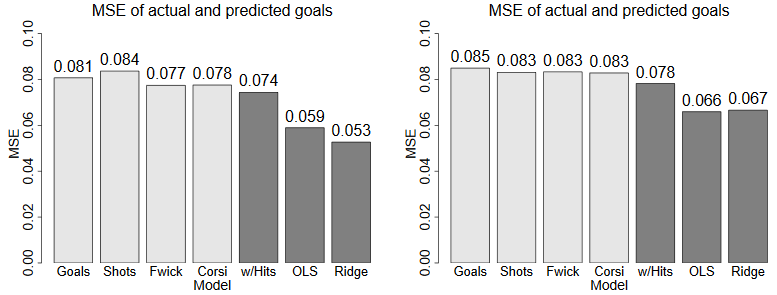
* Still a fair bit of spread in the data, but dots = more tightly grouped + blob is elongated into a shape w/ a distinct slope to it = how a more **repeatable** stat looks
* range of possible year 2 outcomes = smaller, so blob = compressed more closely like a line
* **Repeatability isn't everything** (hit totals) 🡪 can still not predict future outcomes.
* Question is really **whether factoring in shot quality leads to a stronger correlation to future scoring**
* ***Is the added info more important than the added noise?***
* There’re lots of different ways to use data for this assessment.
* Do we express Delta + Corsi as **cumulative** (counting) statistics or as **rate** statistics?
* Do we include all players or just ones w/ significant playing time?
* It turns out that it doesn't matter in this case:
* 
* No matter what form data is in, Corsi = better job of predicting next year's goal differential w/ the player on the ice than Delta does.
* **This is b/c the “shot quality” factor in Delta has a lot of randomness in it**.
* variability = so bad that not only is Delta a *worse* predictor than Corsi of future goal differential but is *even a slightly worse predictor of future Delta.*
* Remember: Only difference between Delta v. Corsi = Delta accounts for location + type of each shot.
* *So, doing significantly worse @ predicting future implies including shot quality factor = not helping*
* THoR = more repeatable than Corsi or Delta, but unless Schuckers has markedly improved on Krzywicki's shot quality assessment, it’s likely that this arises from inclusion of plays like penalties + faceoffs + NOT from inclusion of shot location data.
* **“Shot quality” factor appears to add more noise than value over sample sizes of ~82 games** = why these metrics have never really caught on.
* Extracting value from shot quality
* **\*\*\*Added info should NEVER make analysis worse\*\*\***
* When people try to incorporate shot quality 🡪 often makes things worse b/c they **fail to account for variance.**
* **Shot quality measures have a lot of random fluctuations**, but CAN add value in some instances as Parkatti + others have shown.
* However, ***to get the most out of them*, they must be regressed *properly* 🡺 must pull estimates in towards the average so random fluctuations don't have a large influence on our assessments.**
* **As long as sample sizes = large enough that shot quality factors aren't *completely* dominated by randomness, including them w/ a proper regression will improve quality of the analysis a bit.**
* Ex: for putting together very best evaluations they can:
* **Step 1: Include shooting talent too**
* Shot type + location = easier to pull from scoresheet than shooting skill, so it's what most people focus on.
* But **shooting talent** = nearly as large a factor in shooting % as shot location is
* Might expect shot location to be an even smaller factor for on-ice shooting %.
* Guy who plays in front of net = many shots from in close
* But if every line has 1 of those guys, won't necessarily see a difference *between lines* in average shot distance the way we do for individuals
* So, *do the extra work* to figure out not just *what type* of shots a player takes, but also *whether he scores on more of those shots than the average player.*
* **Step 2: Account for scorer bias**.
* Rinks don't record shot location very accurately + some rinks tend to record shots as being closer than others 🡺 can have a disastrous impact on results
* Over the 4 years Tom tabulated Delta, Colorado = middling 8.18% 5v5 shooting % + 99.8 PDO, yet had 16 players among top 10% in the league in Delta's shot quality factor.
* W/out even looking, can bet they had a huge home/road split indicative of a biased scorer.
* **Step 3: Separate shot quality For + shot quality Against, + separate forwards from defensemen**
* We know forwards drive shooting % a lot more than defensemen + that save % differences = more heavily driven by variance than shooting % differences.
* So, don't want to lump everything together 🡺 some shot quality factors will need to be regressed more heavily than others.
* **Step 4: Regress the data**.
* For each shot quality factor, **calculate variance across the league + variance contributed by simple random chance.**
* Difference between the 2 = amount of variance due to some factor of skill or usage
* the smaller that is = the more you should pull each player's observed results in towards the mean to account for the role of chance.
* **Step 5: Show that your data is better**.
* Now that you've gone through these steps to calculate something that should be better, don't stop here 🡺 ***prove it to the reader***.
* Dot the i's by calculating correlation between your measure + future results + show you've actually produced a better estimate of value.
* Good = simplicity of just using shot differential 🡺 very nearly as precise + much simpler to explain.
* Still, there’re occasions where we want the *very best accuracy* we can get.
* In those cases, including all available info makes sense, **but it needs to be done carefully, + readers should expect to see the result tested**

# [Expected goals & ridge regression](http://www.hockeyanalytics.com/Research_files/NHL-Expected-Goals-Brian-Macdonald.pdf)

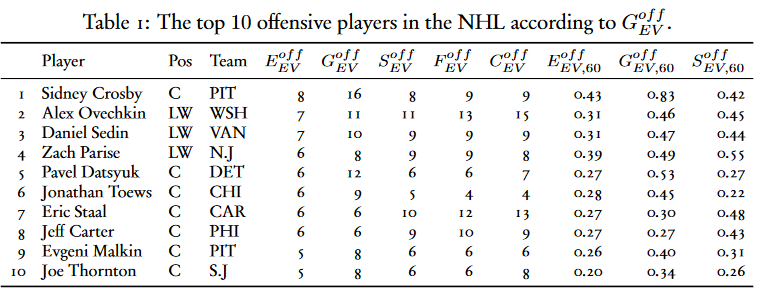
* <http://www.hockeyanalytics.com/Research_files/NHL-Expected-Goals-Brian-Macdonald.pdf>
* 1 difficulty w/ analyzing performance in hockey = relatively low scoring rates vs. to other sports
* **Fenwick rating** (shots + missed shots) + **Corsi** rating (shots, missed shots, blocked shots) have been used to analyze players + teams b/c they’ve been shown to be better than goals as a predictor of future goals
* “missed shots” = an attempted shot that went wide of net, over net, or hit post
* Can use variables like faceoffs, hits, + other stats as predictor variables *in addition to* goals, shots, missed shots, + blocked shots, to predict goals.
* These models outperform previous models w/ regard to **mean squared error** of actual and predicted goals.
* Results can be interpreted as **expected goals** + can be used in adjusted +/- models *instead of goals*
* Used **Ridge regression** to estimate player’s contribution to team’s expected goals per 60 minutes, *independent of his teammates, opponents, and the zone in which his shifts begin*.
* Also give **adjusted +/- estimates** based on goals, shots, Fenwick rating, + Corsi rating alongside results for expected goals to provide an *additional* means by which NHL analysts, decision-makers, + fans can measure how valuable a player is to his team.
* 1 Introduction
* Low scoring rates = source of difficulty when analyzing team + player performance in hockey, particularly when using < a season’s worth of data.
* Randomness + scarcity of goals limit the ability to properly judge current performance + predict future performance of teams + players using goals *alone*.
* Shot differential, Fenwick rating differential, + Corsi rating differential = popular in hockey analysis community for analyzing performance of teams + players.
* 1 reason hockey analysts use these statistics = one can obtain better predictions of a team’s future performance by using shots, Fenwick or Corsi rating *instead of goals*.
* Specifically, **team’s current shot, Fenwick, + Corsi differentials = each better than current *goal* differential at predicting goal differential when a ½ season’s worth of data is used [1].**
* These statistics = less scarce + less random than goals, + are good indicators of **territorial advantage + possession advantage** @ the team level.
* 1 benefit of using these statistics to evaluate a player’s performance = for the most part, **goalies will not have a big impact on a player’s defensive ratings**.
* Further details about benefits of using Fenwick + Corsis rating are discussed in [1], [2], [3], [4], [5]
* 1st goal of paper = to answer following question: **Can the above predictive performance be improved further if including additional stast = hits, faceoffs, etc., as predictor variables, along w/ some combo of goals, shots, missed shots, + blocked shots?**
* Form new models using these stats + show they perform better than previous models *in terms of mean squared error* of predicted goals + actual goals.
* **Focus** strictly on **team offense**, + we **restrict** attention to 5v5 situations in which both goalies are on ice.
* *Unless otherwise specified*, all stats throughout paper = given as “per 60 min" **rate stat** during *even strength* situations.
* \*\*\*Ex: “Goals” or “GF” = “Goals For per 60 minutes of playing time at even strength."
* Results of models = interpreted as “**expected goals**” based on various stats mentioned above.
* Many uses for an expected goals statistic
* to evaluate team offensive + defensive performance over a ½ season’s worth of games.
* to evaluate players
* 2nd focus of paper = **use of expected goals in an adjusted +/- model to evaluate players.**
* Adjusted +/- models were introduced in basketball ([6], [7], [8], [9]) to estimate player’s contribution to team, independent of strength of teammates + opponents.
* 1 main downside of adjusted +/- = large error bounds on estimates of player performance obtained from the model.
* 1 reason for large errors = **tendency of some teammates to play together often = causes collinearity to be present in the data.**
* Ex: Daniel Sedin is on ice w/ twin brother Henrik 93% of the time, + their adjusted +/- estimates have very large error bounds as a result.
* Another source of large errors in hockey = low goal scoring rates.
* In light of these issues, used an adjusted +/- model similar to those described in [10], [11], [5], using ***expected* goals per 60 minutes as dependent variable instead of goals per 60 minutes.**
* Results give an estimate of player’s contribution to team’s expected goals, independent of strength of teammates, opponents, + zone in which his shifts begin.
* 1 main benefit of using expected goals = much more data compared to just using goals = helps produce lower error bounds.
* Also use **ridge regression** (1st first used by Joe Sill in basketball [12] to estimate each player’s adjusted +/-)
* **Ridge regression = statistical technique commonly used when collinearity is present in data +** helps reduce error bounds in estimates + typically improves model’s predictive performance
* Also use ridge regression to estimate adjusted +/- stats based on goals, shots, + Fenwick + Corsi ratings.
* Combo of ridge regression + expected goals, along w/ adjusted +/- results based on other stats provides useful means w/ which to analyze performance of players.
* 2. Two new models
* Used both **ordinary least squares regression** + **ridge regression** w/ goals, shots, missed shots, + blocked shots, along w/ several additional stats from ½ a season to predict **goals scoring rate** in the *other ½* of a season
* Team statistics considered:
* Goals Goals scored Shots Shots on goal
* Missed Shots = Attempted shots that missed the net wide/high, or hit goalpost
* Blocked Shots = Attempted shots blocked by opposing team’s forward/defenseman,
* Fenwick rating = Shots + missed shots
* Corsi rating = Shots + missed shots + blocked shots
* Zone starts = # of shifts that begin w/ a faceoff in the offensive, defensive, neutral zone.
* Turnovers = Giveaways and takeaways.
* Faceoffs = Faceoff wins, losses, faceoff winning %, net faceoff wins (faceoff wins - losses), + total faceoffs
* Hits = Player on team hit a player on other team
* Hits against = player on team hit by player on other team
* Shooting % = Team shooting % (= goals/shots)
* Used data from last 4 full NHL seasons + for each team, season was split into 2 halves.
* Midseason trades + injures can have impact on team’s performance, we did not use statistics from 1st ½ of season to predict *goals* in 2nd half
* **Instead, split season into odd + even games**, + used stats from odd games to predict goals in even games
* Data from 2007-08, 2008-09, + 2009-10 = used as **training** data to estimate parameters in the model, + data from entire 2010-11 = set aside for **validating** the model via 10-fold CV
* **Mean squared error (MSE)** of **actual goals** and **predicted goals** = choice for measuring performance of models.
* Chose subset of above predictor variables that yielded best fit, according to **adjusted R2**, in an **ordinary least squares (OLS) model**.
* Then removed 2 more variables which were not statistically significant.
* Predictor variables remained + used in OLS +ridge regression models 🡺 goals, shots, hits, hits against, faceoffs.
* Also tested Corsi rating w/ hits (Corsi rating + Hits Against - Hits)

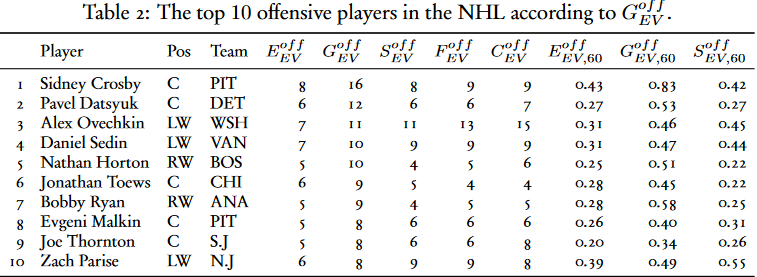
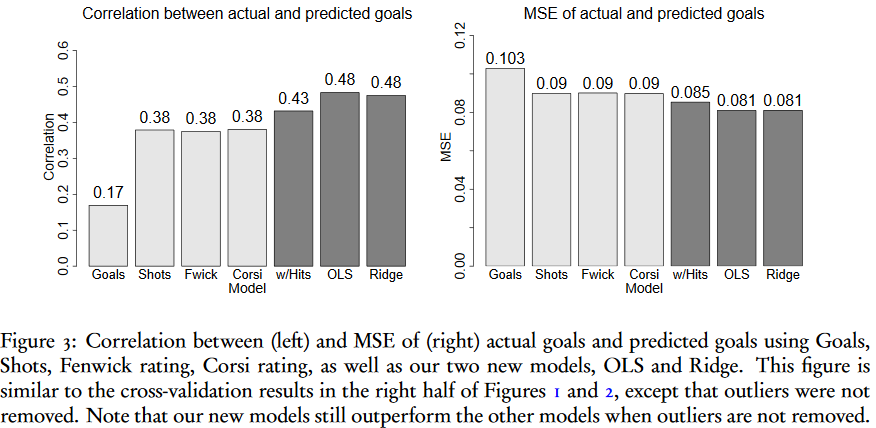


* Correlation between actual goals + predicted goals using Goals, Shots, Fenwick rating, Corsi rating, as well as our new models, Corsi w/ Hits, OLS + Ridge.
* Left = correlation of entire 2010-11 season (validation data)
* Right = cross-validated correlation
* In both cases, OLS + Ridge have the highest correlation.
* Results for new models = given in dark grey.
* In order to compare results to those in [1], look @ correlation between actual vs. predicted goals using various models in Figure 1.
* Note correlations for goals, shots, Fenwick + Corsi ratings = fairly similar to those given in [1].
* Differences = likely b/c we’ve restricted to offense, while in [1], author considered both offense + defense.
* **Note**: Shots, Fenwick + Corsi ratings tend to have a slightly higher correlation than goals.
* Correlation between actual goals + predicted goals = highest w/ OLS + Ridge models.

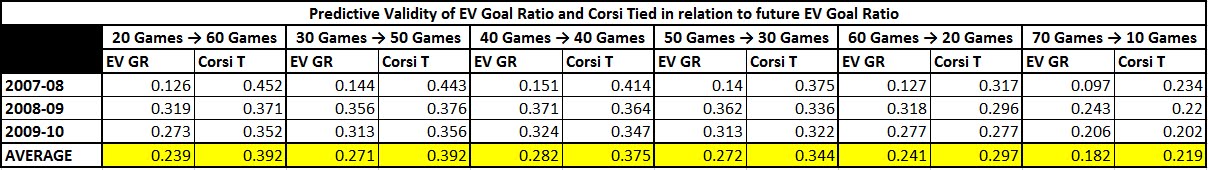
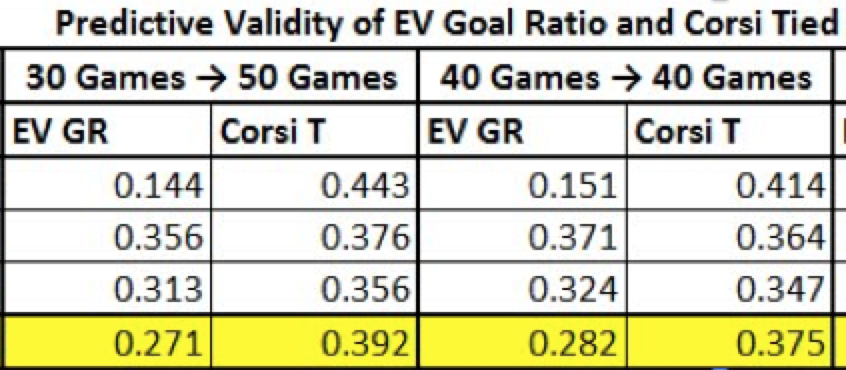
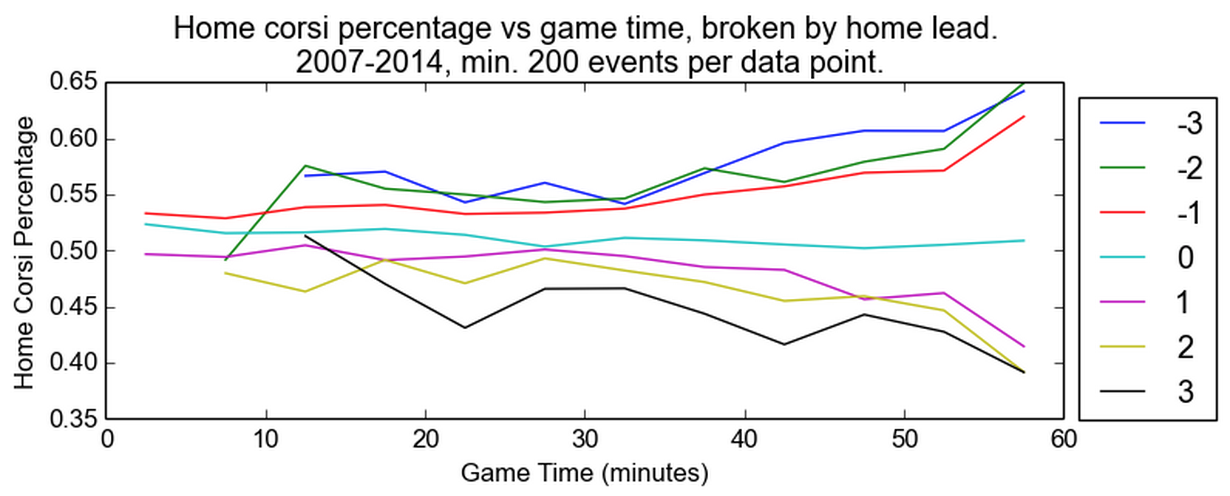
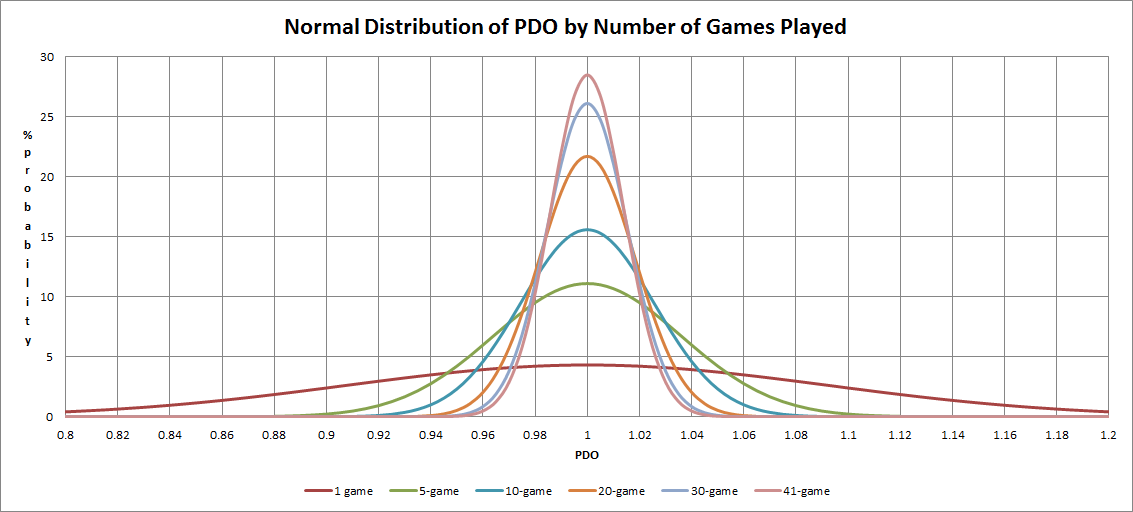


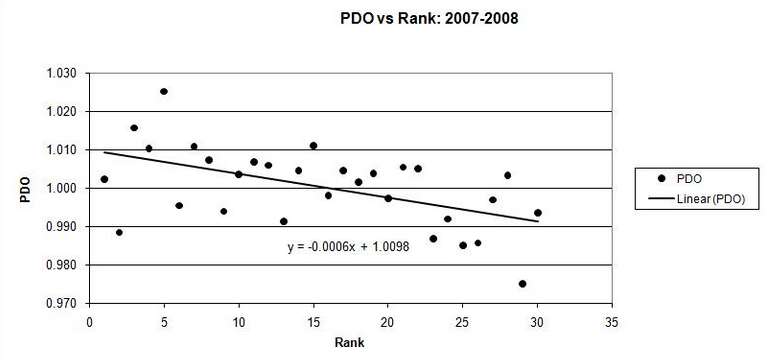
* MSE of actual + predicted goals using Goals, Shots, Fenwick rating, Corsi rating, as well as new models, Corsi w/ Hits, OLS, + Ridge.
* Left = MSE for entire 2010-11 season as validation data set
* Right, CV MSE
* In both cases, OLS + Ridge have the lowest MSE.
* New models = lower MSE, indicating difference between actual vs. predicted goals = lower, on average
* Ridge estimates perform slightly better than OLS regression for 2010-11 season as validation data, while OLS performs slightly better when using CV.
* Since ridge regression typically performs better than OLS regression when predictor variables = correlated, use ridge regression results for computing expected goals in Section 3.
* ***Note***: In forming final model, removed 4 outliers: Ottawa + Carolina in 07-08 + Wild + Islanders in 2010-11, + also fit model w/out removing outliers, + results for correlation + MSE = similar (see Figure 3 the Appendix).
* 3: Using Expected Goals in Adjusted Plus-Minus
* **Expected goals** can be used to analyze *team* performance, but here we focus on *player* performance, +specifically on using **adjusted +/-** w/ expected goals to evaluate players.
* Recall we use an adjusted +/- model similar to those described in [10], [11], [5], using expected goals per 60 min. as dependent variable instead of goals per 60 min.
* Also, recall we use **ridge regression** as in [12] + [5] *instead of OLS regression*.
* In Table 1: top players in  = **the offensive component of adjusted +/- during even strength situations based on expected goals**

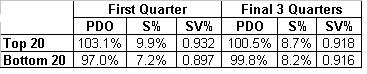


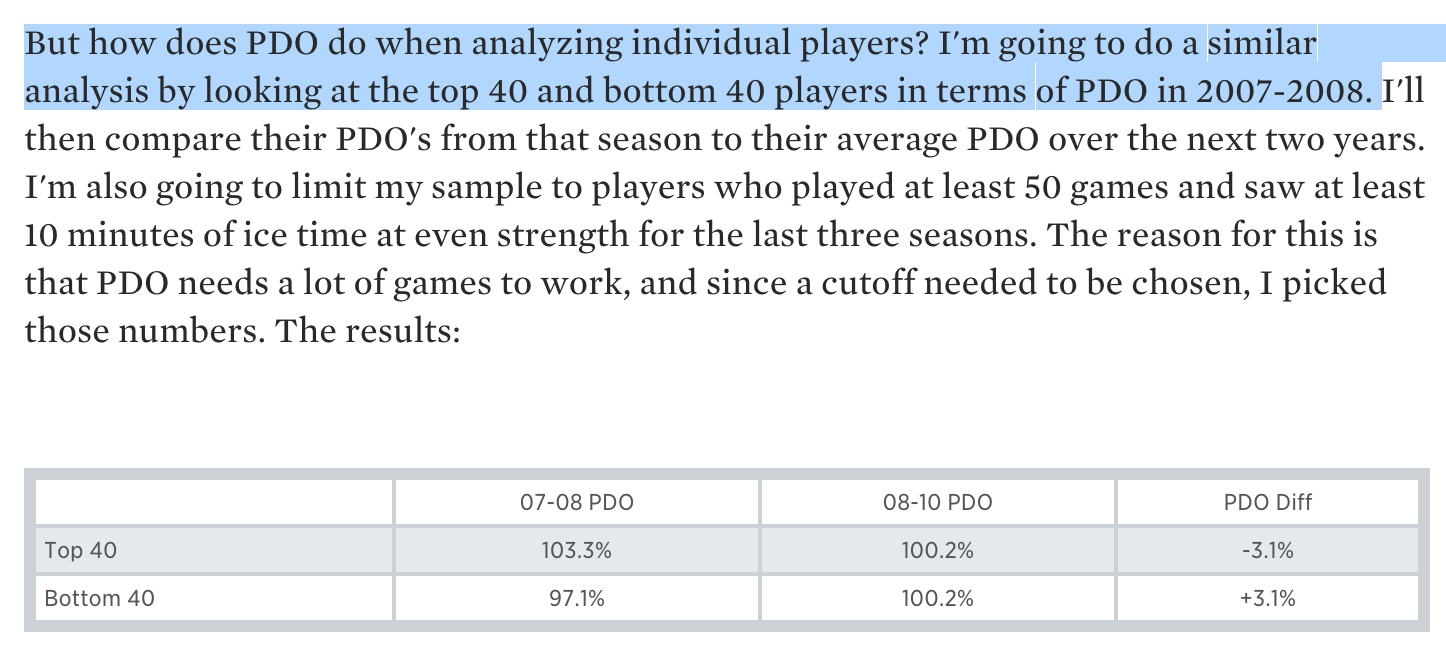
* Also listed each player’s  = **the offensive components of adjusted +/- at even strength based on goals, shots, Fenwick + Corsi ratings**, respectively
* Also give some per 60 minute versions of these statistics in last 3 columns.
* For comparison, top 10 players in  are given in Table 2
* 
* Not surprisingly, Crosby = best offensive player @ even strength according to both  + , despite the fact he missed significant amounts of time during the last 4 full seasons.
* The 2 lists contain many of the same players, + 2 = Eric Staal + Jeff Carter, are in Table 1 but not Table 2, probably b/c of the # of shots they generate (recall **shots** = 1of the variables used in expected goals models).
* Nathan Horton may be a surprise as 5th player in Table 2 🡺 typically not regarded as 1 of the league’s best offensive players.
* One might prefer to consider a player w/ significantly better  or , like Zach Parise, among the top 5 offensive players @ even strength, instead of Horton.
* However, we note the strength of Horton’s teammates (2.43 goals per 60 minutes) is fairly low, + when Horton is on ice, his team scores 3.20 goals per 60 minutes = a difference of 0.77 goals per 60 minutes == 3rd best total in the league, among players w/ 600 minutes played
* *Incidentally, Crosby = 1st in this measure also, w/ 1. 03 goals per 60 minutes*
* In light of this ranking, Horton’s  seems reasonable + he should be considered 1 of the best offensive players in the league @ even strength.
* 4 Discussion
* Results of our model can also be used to analyze **relative value of different box score statistics.**
* Ex: In every model tried during model building process, **hits** = significant predictor, but not in the way you might think
* **Hits** = 1 thing that stood out from model building process = hits + hits against were significant statistics.
* Not terribly unexpected perhaps, but the sign of estimates for hits + hits against may be a bit surprising.
* Coefficients of hits + hits against = negative + positive, respectively 🡺 means low hits + high hits against = good predictors of goals.
* **In other words, teams w/ more hits against than hits = teams w/ higher goals.**
* 2 possible explanations.
* Doing hitting = doesn’t have puck 🡪 hits + hits against contain info about possession
* Hits against indicate possession of puck, + hits indicate opposition had possession
* **Good puck possession teams = more hits against than hits simply b/c they have the puck more often than opponents**.
* Player who applies a hit often takes himself out of the play temporarily, along w/ the player he hit.
* hit typically means other team has puck, + after a hit, the play can momentarily be 4-on-4 instead of 5-on-5
* This is even more true on the PP 🡺 If a PK players hits someone on the other team, play is temporarily 4-on-3 instead of 5-on-4, even if only for a ½ a second.
* Fractions of a second can matter, especially @ NHL level, + especially in defensive zone
* These results don’t necessarily indicate hits = bad, or that players should stop finishing checks, but does provide some evidence that hits, hits against, + puck possession = related, + that poorly timed hits can impact goal scoring.
* **Total faceoffs** = Interestingly, total faceoffs =significant variable.
* Intuitively, *offensive zone* faceoffs should be a significant predictor of goals, but importance of total faceoffs is not as obvious.
* 1 reason = total faceoffs contain some info about goals, since every goal results in a neutral zone faceoff.
* But even when excluding neutral zone faceoffs that followed a goal, total faceoffs were still significant.
* Another possible reason = flow of a game is more structured after a faceoff, since a team that wins a faceoff can run an organized play.
* 3rd possible reason = typically after a faceoff, there is not a lot of dead time in the play when both teams are changing players “on the fly”.
* 1 team may hold the puck behind their net for 5-10 seconds while substitutions occur, + this break in activity reduces goals scoring rate (for both teams).
* On the other hand, after a faceoff, there is typically NOT a break in activity like this as often.
* Tried the model w/out total faceoffs + performance of both OLS + ridge model was reduced w/out the total faceoffs, however both models still performed better than shots, Fenwick rating, or Corsi rating alone.
* 
* In the end, we included faceoffs b/c performance increased w/ this variable, + while they may be not an obvious explanation for why they should matter, it appears that they do indicate an increase in goal scoring rate.
* **Faceoffs Wins** = note, if a predictor variable, such as FO wins or net FO wins, for example, was removed from our model, it does not necessarily mean the statistic is not important.
* **may just mean the statistic does not provide any info that is not already provided by other predictor variables.**
* In the case of FO wins, one would think they are important b/c possession is important.
* But several other statistics (namely shots, missed shots, hits against) are all indicators of possession
* FO wins, net FO wins, or FO % may not be adding much additional info about possession
* 5 Future work and Conclusions
* Natural idea for future work would be to develop similar models for goals against or net goals.
* One added complication = *goalies are involved*, but one could take steps to account for the strength of a team’s goalies.
* Could also do similar studies for special teams situations.
* Significance of some statistics could be different for special teams situations as opposed to even strength situations.
* 1 problem w/ studying special teams = lack of data compared to even strength.
* Another approach = split season in half using a random sample of 41 games, instead of using odd + even games, fit a model, + repeat process many times.
* This approach may yield more robust results.
* A statistic like total FO may have come up as significant in our model by chance, but may not be significant if data were split randomly + models were fit several times.
* Drawing any firm conclusions about a statistic like FO could be deferred until after this approach is taken.
* One could also partition each season into smaller chunks of games + be interested in finding variables that’re best predictors of performance in 10-game chunks, for example.
* significant variables would likely change when using smaller chunks of data.
* Ex: shots would likely become a stronger indicator than goals using a smaller chunks
* Different sized partitions are studied in [13].
* Noted that many predictor variables were correlated, which is 1 reason we chose **ridge regression** as our final model.
* Other methods, such as **principal component regression** or **partial least squares regression**, are commonly used when predictors are correlated, + those models might improve performance.
* These methods are used in a forthcoming article [14].
* In both those methods, new uncorrelated predictor variables that are combos of original predictor variables are formed.
* It is typically harder to interpret results for specific predictor variables (like we did for hits) w/ these models, which is 1 reason we chose to use OLS + ridge regression 1st.
* But if the main goal = to predict goal scoring, then these models, + others like them, could prove useful.
* Bayesian techniques, non-parametric techniques, or time-series techniques, for example, could give better predictions.
* Results of any of these models could be interpreted as expected goals.
* We believe the use of expected goals in a ridge regression to estimate adjusted plus-minus, coupled w/ results based on goals, shots, Fenwick rating and Corsi rating, can be useful to NHL teams, analysts, + fans as they evaluate the performance of teams and players.
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* [13] B. Macdonald, “Predicting Goals Scoring Rates in the NHL,” In progress, 2012.
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# LECTURE

* *“In order to shoot the puck, you have to possess the puck”* -[JenLC](http://www.secondcityhockey.com/2013/12/4/5167404/nhl-stats-made-simple-part-1-corsi-fenwick)
* **Corsi** = shots on goal + missed shots + blocked shots
* **Fenwick** = shots on goal + missed shots (*i.e. Corsi – blocked)*
* Ex: Patrice Bergeron
* On ice for 15 Boston SAs (CF = 15) + for 8 Washington SAs (CA = 8) = +7 for the game (*Corsi)* w/ a 15/23 = **65% *CF%***
* **How to interpret +7? How to interpret 65%?**
* Why Corsi?
* Strong correlation with future success
* 
*  🡺 Corsi = more “predictive” than Goals for future Expected Goals
* Repeatable
* Certain standard of proof required for a new stat to catch on widely
* <https://www.sbnation.com/nhl/2013/11/21/5096220/nhl-stats-advanced-idiots-criticism>
* 1 basic expectation = advocates will look @ whether stat = a **repeatable talent** = important b/c it tells us *how to interpret strong results.*
* 2 possible scenarios:
* Highly repeatable stat (ex: Corsi) = player posting good #’s for stretch = good + means they're probably genuinely good @ it + should expect them to continue doing well
* **Poorly repeatable stat (ex: on-ice save %) = player posting good #’s for a stretch = likely bad = means should bet on them fading as performance regresses toward mean**
* *Why not Corsi?*
* **CF60** = Corsi x 60 / Time-on-ice
* **CorsiOff** *=* Teammates # when player is off ice
* **CorsiRel** = **CF60 - CorsiOff**
* Bergeron’s 2016 **CorsiRel =** *7.97* 🡺 ~8 more shots per 60 even strength minutes were directed at opponents net while Bergeron was on ice vs. when off ice
* Additional tweak: *Score adjustments*
* Only look at tied or close games? (no longer “en vogue”)
* Adjust for relative score differential (-1, 0, etc.) + shot differential during each game (*weighted by time*)
* 
* <https://hockey-graphs.com/2014/11/13/adjusted-possession-measures/>
* Game is broken down the into 5-min. bins+ w/in each, plot **share of Corsi events generated by the home team, broken out by home-team lead.**
* Bins w/ < 750 events over the course of the last 7 years are not shown.
* As expected, not very many teams were down 3 in the 1st 5 min. of P1, even over several years
* Plot repays close inspection for many reasons 🡺 **1st Note**: home-team share of shots when tied drifts down slowly from ~53% at first to barely over 50% @ the end of the game.
* **2nd Note**: **Score effects** = stronger when home team is losing.
* In the last 5 min., for instance, home team generates between 62%-65% of the events when losing, where road team generates between 58%-61% when losing.
* **Home-ice advantage, it seems, applies in all score situations, although not evenly at all times.**
* **PDO 🡺 5v5 On-Ice Shooting % + 5v5 On-Ice Save % 🡺 5v5 shooting % + 5v5 save %**
* 
* Strong ties to team performance

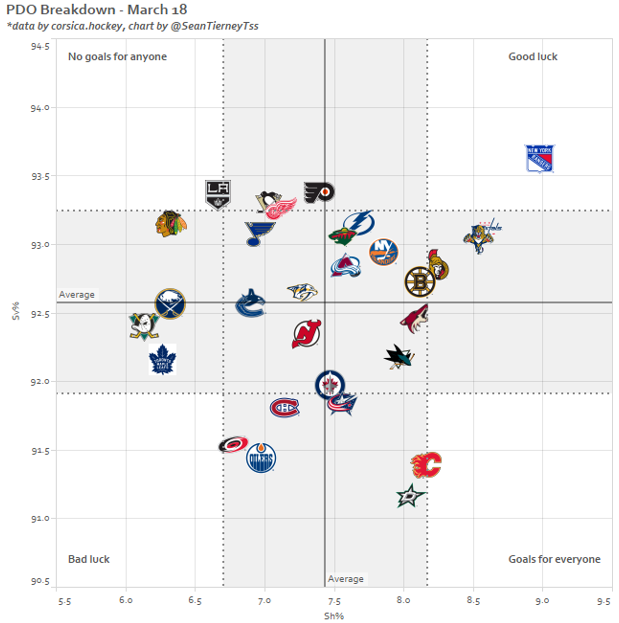


* *But less repeatable?*
* Quarterly PDO #’s for 20 best + 20 worst 1st quarter PDO teams since 2003-2004 season + how PDO for each team changed from quarter 1 to quarters 2-4.
* Results are pretty startling: **[](http://assets.sbnation.com/assets/382987/PDO___s.jpg)**
* Top 20 teams saw average PDO decrease of 2.6% over following 3 quarters of hockey, while bottom 20 teams saw a 2.8% increase in PDO over same time period.
* More specifically, 19/20 top teams saw a *drop* in PDO + all but 2/20 teams saw a *rise* in PDO
* Correlation wouldn't be as strong if you added the rest of the teams, b/c it adds randomness when looking @ average teams.
* 2 points to take away:
* PDO = great predictor of future performance
* PDO *works even better for those at the extremes.*
* But how does PDO do when analyzing *individual* players?
* Look @ the top + bottom 40 players in terms of PDO in 2007-2008 + compare their PDO's from that season to average PDO over the next 2 years, limiting my sample to players who played at least 50 games + saw at least 10 minutes of ice time at even strength for the last 3 seasons.
* *Reason for this = PDO needs a lot of games to work, + since a cutoff needed to be chosen, I picked those numbers.*

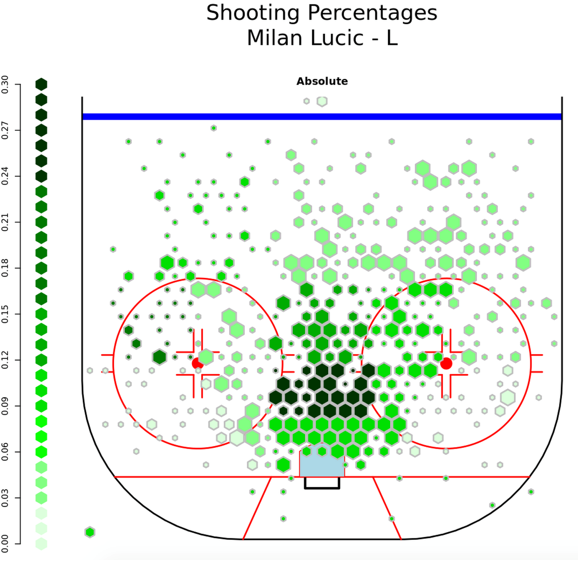


* Change in PDO for the top + bottom players = *even greater than change in team PDO above.*
* **Makes sense**, given the **wider variation** of talent **among individual players** as opposed to whole teams.
* **Correlation is also stronger**, as only 2/80 players surveyed failed to move in PDO-predicted direction.
* **1 cautionary point** = When dealing w/ individual PDO's, one needs to take the **context of the player into account.**
* If Eric Godard finishes w/ a 99% PDO + Crosby has a 101%, does that mean Godard will get only get better + Crosby will get worse?
* **NO**, b/c talent differential between these 2 players means they have different *average* PDO's.
* Since Crosby = 1 of the best players in the world, he'll have an above average PDO, which should be the benchmark by which you judge him, not the general 100% average.
* Yet discovering each player's "true" average PDO = very difficult, + sample sizes only become big enough once a player is about 30 years old
* How can PDO predict the future?
* *[2] Teams simply cannot sustain score-close possession % south of 50% + PDOs north of 102.*
* To claim otherwise is to say math compiled over nearly a decade is wrong, + *you* are right.
* 2011-12 Wild started 20-7-3 atop Western Conference w/ PDO = 3rd in league = 102.1 w/ Fenwick = 42.%
* Immediately lost 8 in a row + never recovered 🡺 finished @ just 81 points w/ more regulation losses than total wins.
* Blamed injuries, but might’ve also considered **team's worst-in-the-league 97.2 PDO** from the start of 8-game losing streak to end of season 🡺 **That, too, was long predicted.**
* 2010-2011 Dallas Stars began season 29-13-5 (63 points in 47 games, pace for ~110 points) w/ PDO at the time = 102.9, top in NHL, while Fenwick = 25th at 46.5%
* Were also 5th in the league standings, 3rd in the West, then lost 2 straight, then 4, 5, 6 straight + finished year w/ just 95 points, winning just 13/final 35 (PDO during collapse = 99.4)
* Peaked very early + season ended up out of playoffs + in ruins + everyone wondered what happened to them *except nerds who said Stars were cruising for this all season*
* Leafs in lockout-shortened 2013 season got into playoffs despite season-long PDO = 103 (No. 1 in NHL) + possession #’s = 44% (30th in NHL) + also claimed this was all part of their “system.”
* Had season been a full 82 instead of 48, they, too, probably would’ve suffered inevitable collapse *that came next season instead.*
* Now Avalanche = trying to distract selves from the fact they got bounced + significantly out-possessed by deeply mediocre Minnesota team in last year's playoffs
* Clearly learned nothing from the latest “test case” in Toronto that sent assistant coaches + GMs alike scurrying to unemployment office + brought in all the thinkpieces about nerds having definitively won once and for all.

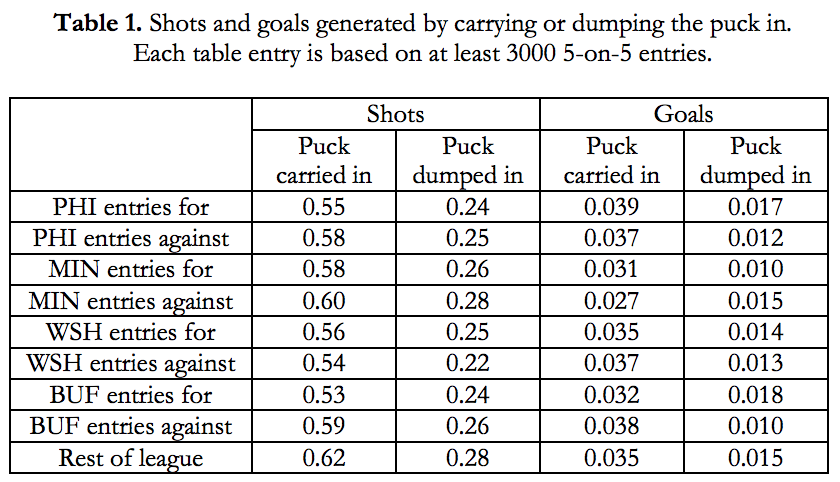




* <https://public.tableau.com/profile/sean.tierney#!/>
* **Heatmaps**



* (WAR on ice)
* **Zone entry**



* <http://www.sloansportsconference.com/?p=10561>
* <http://www.sloansportsconference.com/wp-content/uploads/2013/Using%20Zone%20Entry%20Data%20To%20Separate%20Offensive,%20Neutral,%20And%20Defensive%20Zone%20Performance.pdf>
* Would be a mistake to simply use **shots per entry** as the measure of **offensive zone success**, b/c there is an aspect of **neutral zone performance** that can impact offensive zone results.
* **A team that moves the puck through the neutral zone most effectively will be able to enter the offensive zone w/ possession, carrying the puck across the blue line.**
* This *might be expected to result in more shots + goals* than a play = dumping the puck into the corner hoping to retrieve it, so must 1st assess the **impact of this neutral zone outcome** BEFORE judging offensive zone performance.
* Indeed, difference between a zone entry *w/ possession* vs. dump-in = quite substantial.
* Every data set collected showed **entries w/ possession** = more than 2X as effective as dump-ins at 5v5.
* **The neutral zone play that sets a team up to enter the offensive zone w/ possession = a critical driver of success.**
* It is clear: **Any assessment of offensive zone performance must account for the influence of the neutral zone play that initiates the offensive zone possession.**
* **Adjusting for Score Effects To Improve Predictions** <http://www.broadstreethockey.com/2012/1/23/2722089/score-adjusted-fenwick>
* **How important is Nuetral Zone Play?** [**http://nhlnumbers.com/2012/7/9/how-important-is-neutral-zone-play**](http://nhlnumbers.com/2012/7/9/how-important-is-neutral-zone-play)
* **NHL Expected Goals Model** <http://donttellmeaboutheart.blogspot.com/2015/05/nhl-expected-goals-model.html>