I have performed an analysis on the differences between two relatively newer metrics that are being used to measure player performance and success in the NHL: Expected Goals (xG) and Game Score Value Added (GSVA). Even though both of these metrics are so new, I wanted to answer the question of "what players are over- or under-valued by these metrics and why?" While the recent development of GSVA makes it semi-difficult to form generalizations about its practical usage, I think both of these metrics fall victim to over- and under-valuing players in different ways. However, both of these metrics, especially GSVA, are very advanced and in-depth, in terms of how they are calculated, which should lead to more precise insights that will be obtained as these metrics become more widely used.

Starting with xG, which has existed for longer than GSVA and is a bit easier to calculate and discuss, there are 15 elements/variables typically taken into account for xG models. In terms of the importance of each variable, the creators of one of the main hockey xG models, Josh & Luke Younggren and @EvolvingWild (2021), performed analysis to address that very inquiry. Shot Distance From Net ('shot_distance') was found to be *by far* the most important factor/variable, and the three next most important are Time Since Last Game Event ('seconds_since_last'), Shot Angle ('shot_angle') and Distance From Previous Event ('distance_from_last'). I was also able to find a 'Simple xG Model', which displays relative probabilities that unblocked shots from certain areas of the ice result in goals. A few notable probabilities are 30% from right in front/to the side of the net (crease/'low slot' area), 12% from the slot, 9% from just inside the blue line, and 5% from just outside the blue line. Based on data from the 2021-22 NHL Regular Season, I came upon a graphic, showing players who either exceeded expectations or were "untalented/unlucky", with regards to xG (predicted goals scored) vs. G (actual goals scored). Auston Matthews, with 38.29 xG vs. 60 G, BC's own Chris Kreider,

with 34.65 xG vs. 52 G, Brendan Gallagher, with 18.53 xG vs. 7, and Joonas Donskoi, with 10.19 xG vs. 2 G, are great examples of four players during this ‘21-’22 season. These qualifiers are better representative of the performance of each Matthews and Gallagher that season; however, Kreider and Donskoi were outliers, which indicates potential inaccuracies and inefficiencies of xG. Kreider had a career-best year in goals that season with 52, but he only averages 25.33 throughout the course of his 12-year career, so this occurrence was somewhat of an anomaly. Donskoi, on the other hand, averaged 11.4 G throughout his seven-year career, so his lackluster ‘21-’22 season performance of only 2 goals is mostly explained by it being the last year of his career.

I would like to quickly note another version of xG, Relative Expected Goals For % (xGF %). Again, based on 2021-22 data, there are forwards and defensemen whose excellence in this metric is representative of their play, and others make me question the effectiveness of this metric: Patrice Bergeron with 16.4 xGF%, Jesse Puljujarvi with 12.16% xGF%, Charlie McAvoy with 9.71% xGF%, and Alexander Edler with 8.49 xGF%. My happiness from two Bruins, both accurately and highly rated by this metric, was overshadowed by my confusion surrounding Puljujarvi and Edler. Puljujarvi is currently with the Penguins and only scored three goals this year in 22 games. While these statistics may not seem too underwhelming, I should add that he was drafted fourth OVERALL by the Oilers only eight years ago! Also, 2021-22 was technically his “prime”, compared to his statistics from other seasons, so I can partially understand why he was rated so high in xGF%. However, with only 14 goals, after having just one more for his career-high the year before, it is evident that both his quality of play and point production have not lived up to expectations. Somehow, Puljujarvi wasn’t even the most surprising observation I made from this xGF% metric! Alexander Edler, a great defenseman for the Canucks in his prime,

was playing for the Kings at this point, and this season was his penultimate before retiring. He only scored 3 goals in 2021-22, compared to his 17-year career average of 6.1. I simply do not understand him being second in xGF% among defenseman for that season, above Cale Makar and Devon Toews, with 28 and 13 goals, respectively (career-highs for both of them!), who literally helped lead their Avalanche to a Stanley Cup win that year. It should be transparent now that xG, at the very least xGF%, is not extremely indicative of player performance and is probably not the best metric to use in predicting and representing a player's contribution to their teams.

Just to confirm my theory, I looked at 2023-24 NHL Regular Season statistics. For instance, a player like Anders Lee, who scored 20 goals this season as a solid, top-six forward for the Islanders, seems to be a bit overvalued compared to Connor McDavid, the widely-regarded best current NHL player. McDavid did not have his best goal-scoring season this year, yet he still finished with 12 more goals than Lee, plus a mere 100 assists! However, in the xG rankings, Lee was #16 in the league (xG of 35.8), while McDavid was all the way at #30 (xG of 30.6). McDavid ended up exceeding this expectation with 32 goals, while Lee fell way short with only 20 goals. A similar phenomenon occurred, again with a 12 goal disparity, between Vincent Trocheck and J.T. Miller. Trocheck, who scored 25 goals this season, appears to be a bit overvalued compared to Miller, who scored 37, and Trocheck was #20 in xG ranking, while Miller was #42.

The other metric I analyzed is Game Score Value Added (GSVA), similar to WAR in baseball. The most up-to-date GSVA models partition overall/net ratings into offensive and defensive ratings for each player. Since this statistic is so new, not many calculations and formulas are easily accessible. So, I adapted my GSVA model from a model I found online,

which itself was adapted from The Athletic's GSVA model, largely created by Dom Luszczyszyn. In my first model adaptation, GSVA v.1, I calculated the Net Ratings for the top 10 skaters (excluding goalies) on The Athletic's 2022-23 Regular Season GSVA Leaderboard. I reordered the 10 names from highest to lowest GSVA, and my first takeaway was that my adapted model did not value defensemen as highly as they should be. I then repeated the above calculations with the same players, but this time I used data from this past 2023-24 NHL Regular Season. I also added in a "random" Boston Bruin player, Matt Grzelcyk, to better put my rating calculations into perspective. At this point in my analysis, I realized that he had the highest Defensive Rating. A fourth-line defenseman who is in and out of the active lineup, Grzelcyk is currently my least favorite Bruin, as he is not offensive enough to make up for his incompetencies on defense. His Net Rating conveys his relative mediocrity, at least compared to some of the game's All Stars; however, I realized I still needed to incorporate more defensive factors, in order to make my Defensive Ratings more accurate. I looked again at how The Athletic calculated their GSVA, and they factored in Penalty Kill +/-. This statistic was not readily available to me on Hockey Reference or Money Puck, from where I have retrieved these other statistics. So at this point, I decided to add Power Play Corsi For (PPCF) and Penalty Kill Corsi Against (PKCA) to my model, to somehow account for Special Teams efficiency. I believed that this addition should result in Defensive Ratings that are more representative of these player's defensive abilities.

In this next model, GSVA v.2, I removed regular CF & CA when I added PPCF & PKCA, in order to avoid collinearity, but I used the same weights. Some player's Net Ratings were impacted significantly after Special Team factors were added: Tkachuk +~2.5, Draisaitl +~2 and

Fox +~1.5, for example. However, Grzelcyk still had a higher defensive rating than both Fox and Lindholm, and I refused to accept my model as accurate until this occurrence was not the case.

In my GSVA v.3 Model, I adjusted the weights of many variables. I also added the variable Defensive Point Share (DPS). These Point Shares in hockey are similar to Bill James' Win Shares (see "Calculating Win Shares" in Works Cited). Finally, at this point in my analysis and calculations, I achieved much more accurate Defensive Ratings. Fox surpassed Pettersson and Roberston in Net Rating for this past regular season, an occurrence which, as an avid hockey fan, I would say is accurate. To gauge the accuracy of my v.3 model, I returned to statistics from the 2022-23 NHL Regular Season. I, again, reordered the 10 top players from that season based on my adapted version of a GSVA model. In looking at these results, my v.3 model improved vastly from v.1, with regards to giving more credit to defensemen. I then used Data Analysis in Excel to calculate the correlation between my two metrics of interest, xG and GSVA Net Ratings. My v.3 model statistics possessed a relatively strong correlation with xG for these 10 players for the 2023-24 NHL Regular Season. I figured that the correlation would probably be higher, with a larger sample size of forwards, and if it weren't for the two defensemen I included, since xG obviously prioritizes goals more than GSVA models do.

After reading even more about how The Athletic calculated their GSVA, I decided to change my model, yet again, to include Per Game stats for each player, instead of entire season stats. By doing so, I sought to achieve Net Ratings that should be more similar to The Athletic's. I also believed that this implementation should result in more representable metrics (better conveying players' consistency throughout a season, or lack thereof). I added the variables Offensive Point Share (OPS) and Goals Created/Game (GC) in my v.4 model as well. Additionally, I decided to use regression with statistics from Money Puck, in which they

calculate their own ‘gameScore’ (GSVA), in order to obtain a better idea for my coefficient values/weights. However, I manually made some of my defensive coefficients more negative, in order to better reflect below average defense (Defense Rating < 0). At this point, I had calculated a Net Rating for a player from each NHL team. Overall, these Net Ratings in v.4 are almost identical in scale to The Athletic’s, even though we used slightly different variables and weights. I think that my final model does an exceptional job, in general, of representing a player’s overall contribution to their team through Net Ratings. There is one small flaw to my metric that I could/would try to address if I had more time. I noticed that some players on really good (bad) teams can be over(under)valued by this metric, at the very least regarding Defensive Rating, like Matt Grzelcyk and Cam Fowler, respectively. This occurrence may be due to both the inclusion of DPS, which obviously favors teams with more points (i.e. better teams at the top of the standings), and the heavy weights I applied to PKCA and Goals Against (GA), in order to obtain some negative Defensive Ratings in my scale.

Finally, I used Correlation in Excel again between xG statistics for players from the 2023-24 NHL Regular Season and my v.4 GSVA Net Ratings, now with a much larger sample size of players. As I had expected and hoped, the correlation increased from about 0.6, from before, to about 0.72, meaning that approximately 72% of the variation in my v.4 GSVA Ratings can be explained by xG. While GSVA factors in many more components than xG, especially on the defensive side of the puck, there is still clearly a strong relationship between these two metrics, both quite effective in analyzing player performance. Although, for reasons already covered, I, personally, will be using GSVA in my future more often than xG, as I feel GSVA encompasses more of players’ contribution to their teams and is simultaneously more representative and less likely to over- or under-value.

| Original Model from SimulationHockey.com | |
|---|---|
| Player Game Score | = (0.75 * G) + (0.7 * PA) + (0.55 * SA) + (0.075 * SOG) + (0.05 *BLK) + (0.05 * CF) - (0.05 *CA) +(0.5 *AMG) + (0.005 *Steals) - (0.005 * Takeways) + (0.025 * HIT) - (0.05 * PIM) |

| My GSVA v.4 Model | |
|---|---|
| Offensive Rating | = (0.55 * G) + (0.5 * A1) + (0.375 * A2) + (0.2 * SOG) + (1.5 * PPCF) + (1.25 * GF) + (1.25 * GC) + (1.5 * OPS) |
| Defensive Rating | = (0.25 * BLK) - (1.95 * PKCA) + (0.15 * Steals) - (0.15 * Takeaways) + (0.2 * HIT) - (1.85 * GA) + (1.25 * DPS) |
| Miscellaneous Rating | = (10 * AMG) - (10 * PIM) |

Where G = Goals/Game*, A1 = Primary Assists/Game, A2 = Secondary Assists/Game**, SOG = Shots on Goal/Game, BLK = Shots Blocked/Game,
PPCF & PKCA are Power Play Corsi For/60 min./Game & Penalty Kill Corsi Against/60 min./Game***, GF & GA are Total Goals For & Against/Game (while On-Ice),
GC is Goals Created/Game, OPS and DPS are Defensive Point Shares (expected number of points generated by a player due to their defense)
AMG = Average Minutes/Game % (i.e. what % of a typical 60-minute hockey game for which a player is on the ice), and PIM = Penalty Minutes/Game
*All stats per games played ( /Game) (if not already calculated by Hockey Reference) are the raw per season stats divided by # of games played (GP) for each player
**If no data for A2, use (0.425 * A) instead
***If no data for PKCA, use CA/60 min./Game instead

| GSVA v.4 Model | | | | Offensive Rating | Defensive Rating | Miscellaneous Rating | Net Rating |
|---|---|---|---|---|---|---|---|
| F | TBL | Nikita | Kucherov | 26.9965 | -0.514481 | 3.58642 | 30.068439 |
| F | TOR | Auston | Matthews | 25.98 | -0.561 | 1.0255 | 26.4445 |
| F | COL | Nathan | MacKinnon | 27.1835 | 0.278 | -1.3 | 26.1615 |
| F | NYR | Artemi | Panarin | 24.48175 | 0.6162 | 0.45 | 25.54795 |
| F | EDM | Connor | McDavid | 24.276 | 0.356 | -0.3 | 24.332 |
| D | VAN | Quinn | Hughes | 17.8675 | 4.36635 | -0.57 | 21.66385 |
| D | COL | Cale | Makar | 18.596 | 0.268215 | 2.033 | 20.897215 |
| F | BOS | David | Pastrnak | 21.6485 | 0.6925 | -2.4 | 19.941 |
| F | MIN | Kirill | Kaprizov | 20.9515 | -0.237645 | -1.203 | 19.510855 |
| F | EDM | Leon | Draisaitl | 25.98 | -0.7004 | -5.98 | 19.2996 |
| D | NSH | Roman | Josi | 18.0045 | 2.2755 | -1.395 | 18.885 |
| D | NYR | Adam | Fox | 15.899 | 3.388 | -1.1 | 18.187 |
| F | VAN | Elias | Pettersson | 16.7525 | -0.77775 | 1.807 | 17.78175 |
| F | CAR | Sebastian | Aho | 17.50675 | 1.2225 | -1.33 | 17.39925 |
| D | WPG | Josh | Morrissey | 12.93025 | 5.7709 | -1.4 | 17.30115 |
| F | NJD | Jesper | Bratt | 15.4975 | -1.851627 | 1.74 | 15.385873 |
| F | PIT | Sidney | Crosby | 19.209275 | -2.35675 | -1.528 | 15.324525 |
| F | DAL | Jason | Robertson | 14.8655 | -0.085275 | 0.37 | 15.150225 |
| F | WPG | Kyle | Connor | 13.970125 | -2.661535 | 2.386 | 13.69459 |
| D | FLA | Gustav | Forsling | 8.63025 | 6.737 | -1.71 | 13.65725 |
| D | LAK | Drew | Doughty | 10.006375 | 3.957 | -1.1 | 12.863375 |
| F | STL | Jordan | Kyrou | 12.784875 | -0.7833 | 0.375 | 12.376575 |
| F | WSH | Alex | Ovechkin | 12.69825 | -1.15385 | 0.7 | 12.2444 |
| D | TBL | Victor | Hedman | 15.3075 | 2.232 | -5.567 | 11.9725 |
| F | ARI | Clayton | Keller | 14.58125 | -1.948765 | -0.9 | 11.732485 |
| D | EDM | Mattias | Ekholm | 9.32705 | 4.551 | -2.4 | 11.47805 |
| F | NYI | Mat | Barzal | 13.669125 | -1.5893125 | -0.895 | 11.1848125 |
| F | VGK | Jack | Eichel | 15.2075 | -3.1828 | -0.9857 | 11.039 |
| F | PHI | Owen | Tippett | 11.4155 | -1.765005 | 1.26 | 10.910495 |
| F | FLA | Matthew | Tkachuk | 16.442875 | 1.145375 | -7.4 | 10.18825 |
| F | MTL | Nick | Suzuki | 13.8309825 | -2.76695 | -0.89 | 10.1740325 |
| F | CGY | Yegor | Sharangovich | 11.6125 | -3.69262 | 1.9104 | 9.83028 |
| F | DET | Dylan | Larkin | 15.2439 | -3.356725 | -2.34 | 9.547175 |
| F | SEA | Jared | McCann | 12.156375 | -1.81775 | -1.08 | 9.258625 |
| F | CHI | Connor | Bedard | 11.698125 | -3.31095 | -0.803 | 7.584175 |
| F | ANA | Troy | Terry | 9.0535 | -1.310835 | -0.2 | 7.542665 |
| F | BUF | Tage | Thompson | 12.82325 | -2.71107 | -3.037 | 7.07518 |
| F | LAK | Adrian | Kempe | 14.0425 | -0.7755 | -6.195 | 7.072 |
| F | OTT | Claude | Giroux | 10.20035 | -3.4426275 | 0.18 | 6.9377225 |
| F | CBJ | Johnny | Gaudreau | 8.848125 | -2.7864125 | 0.436 | 6.4977125 |
| D | ANA | Cam | Fowler | 6.3885 | -4.02 | 1.109 | 3.4775 |
| F | SJS | William | Eklund | 6.574 | -3.5965625 | -0.65 | 2.3274375 |
| D | BOS | Hampus | Lindholm | 4.84705 | 1.856 | -4.747 | 1.95605 |
| D | BOS | Matt | Grzelcyk | 2.858 | 0.6585 | -3.57 | -0.0535 |

# Works Cited


**"A New Expected Goals Model for Predicting Goals in the NHL."** ***EvolvingHockey A New Expected Goals Model for Predicting Goals in the NHL Comments*****, 1 Jan. 1967, evolving-hockey.com/blog/a-new-expected-goals-model-for-predicting-goals-in-the-nhl/. Accessed 1 May 2024.**

**"Calculating Point Shares."** ***Hockey*****, www.hockey-reference.com/about/point_shares.html. Accessed 1 May 2024.**

**"Expected Goals (XG) Models Explained."** ***JetsNation*****, jetsnation.ca/news/amp/expected-goals-xg-models-explained. Accessed 1 May 2024.**

**Garrethohl. "By the Numbers: Is Corsi or Goals a Better Evaluator of Defensive Success?"** ***Arctic Ice Hockey*****, 13 Aug. 2023, www.arcticicehockey.com/corsi-analysis-defensive-defensemen-mark-stuart-1551123576/. Accessed 1 May 2024.**

***GSVA*****, simulationhockey.com/showthread.php?tid=99600. Accessed 1 May 2024.**

**Luszczyszyn, Dom. "2022-23 NHL GSVA Leaderboard."** ***The Athletic*****, 5 Apr. 2023, theathletic.com/3894138/2023/02/09/2022-23-nhl-gsva-leaderboard/. Accessed 1 May 2024.**

**Luszczyszyn, Dom. "Introducing the 'new' NHL Stats Fans Should Know: Offensive and Defensive Rating."** ***The Athletic*****, theathletic.com/4396412/2023/04/12/nhl-advanced-stats-offensive-defensive-rating/. Accessed 1 May 2024.**

**"NHL Scoring Leaders."** ***NHL Player Statistics -Advanced Stats 2023-2024*****, moneypuck.com/stats.htm. Accessed 1 May 2024.**

**"NHL Stats, History, Scores, Standings, Playoffs, Schedule & Records."** ***Hockey*****, www.hockey-reference.com/. Accessed 1 May 2024.**

**Piccolo, Nick. "Inside the Stats: Expected Goals."** ***Inside The Rink*****, 16 Aug. 2022, insidetherink.com/inside-the-stats-expected-goals/. Accessed 1 May 2024.**