World of Tanks – Top Players & Top Tanks

Game Overview

World of Tanks is a popular massive multiplayer "freemium" game, developed by Wargaming. As the name suggests, the players control a tank or similar armored vehicle and engage in team-based combat. The player controls a single tank, including movement, firing and communication with team members. All players start in Tier 1 and chose a beginning tank. The most common gameplay option assigns players randomly to 15-person teams and places each player in a random area on the combat arena/map. The primary goal is to destroy all the tanks on the other team or capture the other team's base. Each player accumulates experience points and credits through their gameplay which allows them to progress in the game. The extensive individual component of the game has players improving their equipment, advancing through 10 tiers, each with different tanks and choosing to purchase premium tanks. Players choose which tanks to keep, which to sell and what tank lines, by country, to advance through. There are five different types of vehicles (light tanks, medium tanks, heavy tanks, tank destroyers and self-propelled artillery) and each vehicle comes from one of 11 countries (Britain, China, Czechoslovakia, France, Germany, Italy, Japan, Poland, the Soviet Union, Sweden, and the United States). In total there are over 600 vehicles, which all represent actual real-life vehicles from pre-World War I to the Cold War eras. each country and vehicle have strengths and weaknesses that the player must manage. Each vehicle has a cost, hit points, weight limit, mobility features, armor, armament and more. The most salient features of the vehicles that can be upgraded are guns, engines, suspension and radio. World of Tanks was released in 2010 and is available on all major computer platforms and consoles. The game is played worldwide, with particular popularity in Russia. The number of players has grown from 700,000 in 2010 (500,000 in Russian servers, where it was first released) to over 20 million active players and 400,000 daily players in April 2023. [1,2]

Game Analytics

To conduct an analysis of top players and tanks I am using a dataset compiled through nobometer.com by an economist Juan-Manuel Sanchez-Cartas and made freely available on the Mendeley Data website (which I found through the Google Dataset Search engine.[3] The economist intended to use it for research into the economics of "freemium" games, but the research has not yet been published. The dataset is encompassing the entire career history of the top 50 players on each server (North America, Europe, Southeast Asia and Russia) through January 2019 and raw data on 586 tanks in over 400 million battles. Note that the Russia servers were closed in 2022, due to the Ukraine hostilities. In total the dataset has information on over 20 million battles over 500 tanks, from the top 200 players, plus an additional 100 million battles using the tanks. To conduct my analyses, I significantly change the Excel file to allow for detailed analyses by player and tank across all servers. The analyses for players and tanks were ultimately conducted on two worksheets that combined all players and all tanks. The player worksheet included the following fields - player number by server, name, WN8 rating, performance rating, battles, win rate, average damage, average experience overall, average kills, average base capture, average base defense, vehicles spotted and average tier. Most are self-explanatory while

others need clarification. WN8 rating is a third-party player rating system supported by Wargaming. The rating is a proprietary algorithm that includes wins, kills, damage, defense, and other factors. WN8 ranges from 0 to over 2,000. Performance rating is a more basic rating algorithm provided by Wargaming. Average experience is the average experience earned per battle. Average base defense is a base defense score given by Wargaming for each battle. Vehicles spotted is numbers of enemy vehicles actively spotted by the player, which highlights that enemy's position for the rest of the player's team. The tank worksheet includes the following fields: Tank number, tank name, nation, battles, win rate, Premium status, Tier, type, and price. Most fields are again self-explanatory. Premium tanks are tanks that must be purchased with real-world money. It is important to note that the player dataset is unique in that it is the top-200 players worldwide. It would not be appropriate to consider this a random sample, since it is not random. Moreover, it is reasonable to assume that the top players are different in many ways than typical players, for instance these players each have over 90,000 battles of experience. Therefore, results of the analyses are not generalizable to the player community, at large, and possibly only to other top players.

Research Analytics

The goal of this project is to understand the top players, tanks, and what leads to the ultimate goal of the game-winning. At the outset, I wanted to first determine whether player characteristics or tank characteristics had more impact on the win rate, especially whether premium tanks confer significant advantage. The cost of premium tanks ranges from approximately $4 to up to $80, and thus could understandably have a substantial effect on win rate. I expected the premium tanks to outperform the free tanks and thus affect win rate overall, so I began my analysis there.

Tanks

The dataset used for the tank analysis includes both the top player dataset and the tank dataset for a total of 467.6 million battles, but note that each battle includes 30 tanks. There were 586 unique tanks used - a vast majority of the over 600 tanks available in the game today, both free and premium. Since the dataset ends in January 2019, it is likely that all pre-2019 tanks are included, given the size of the dataset. The following are the descriptive statistics for win rate across all tanks in the dataset:

Count	586
Mean	0.53018771
Median	0.52
Mode	0.52
Standard Deviation	0.02915562
Coefficient of Variation	0.055
Range	0.21
Minimum	0.46
Maximum	0.67

Table 1. Descriptive Statistics, Win Rate by Tanks

I will start with what will quickly become a theme in this analysis: Wargaming has created an incredibly well-balanced game. Across 586 unique tanks, the average win rate is very close to 50%, and though the range is somewhat large, most of the tanks have a win rate similar to the mean as shown by the coefficient of variation. This is further demonstrated in the following histogram as well:

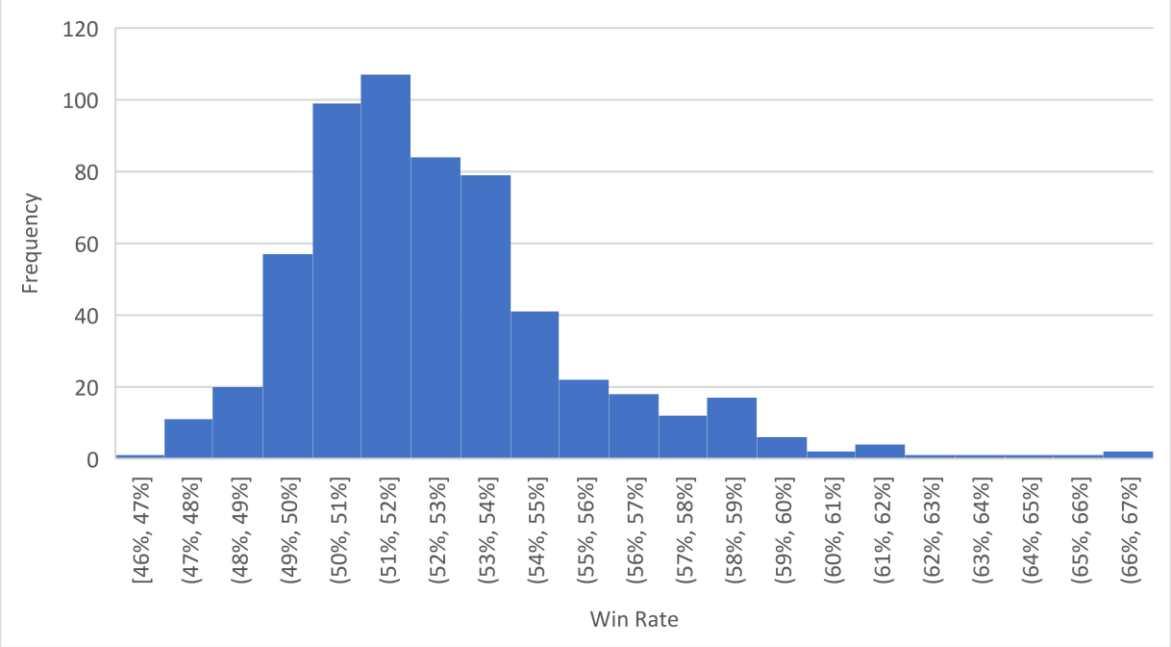

Fig. 1. Frequency of win rate by tanks

As shown here in Figure 1, with even a histogram with a very small bin size of 1%, the data is still tightly clustered near the mean win rate. The vast majority of the tanks are within 5% of the average win rate of 53%.

One would expect that in a “freemium” game such as World of Tanks, there would be a substantial advantage to spending real-world money to buy better tanks rather than earning free tanks with experience. A scattergram of the free and premium tanks would demonstrate this easily, as follows:

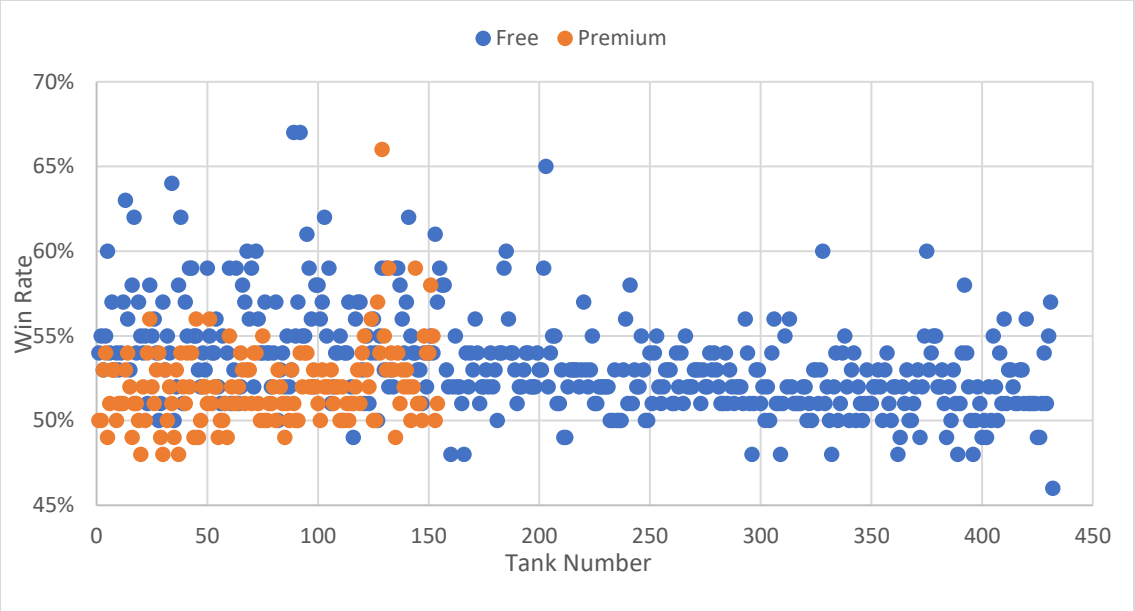

Fig. 2. Scattergram of win rate, of both free and premium tanks.

Surprisingly, the scattergram reveals that premium tanks confer little advantage. In fact, all but one of the best tanks, defined by having a win rate of over 60%, are free tanks, and even the best premium tank is outperformed by two free tanks. This equivalence is further demonstrated in the descriptive statistics for both free and premium tanks:

	Overall	Free	Premium
Count	586	432	154
Mean	0.53018771	0.52712963	0.53876623
Median	0.52	0.52	0.53
Mode	0.52	0.52	0.53
Standard Deviation	0.02915562	0.027419604	0.03212166
Coefficient of Variation	0.055	0.52	0.60
Range	0.21	0.21	0.18
Minimum	0.46	0.46	0.48
Maximum	0.67	0.67	0.66

Table 2. Descriptive Statistics separated by free and premium.

The descriptive statistics shows that premium tanks have only a very slight advantage, conferring a single percentage point worth of extra wins and with a slightly smaller range between the worst and best tank. Overall, it is clear that tanks are not the decisive factor for winning the game, even considering the expensive premium tanks against free tanks earned with experience. One of the reasons this is likely the case, beyond Wargaming's strategy of creating balance, is that there is an active community of players who discuss and analyze tanks. There are many websites where a player can find out which is the best tank for each tier, so although there are clearly differences in win rate by tank, as demonstrated by the ranges above, this is well-known to players. For instance, the Leichttraktor, a German light tank, is

generally considered the best for Tier 1. Not only is this proven in the dataset, with a Tier 1 leading win rate of 60%, but it is also the most often used tank of 11 tanks, used in 44% of Tier 1 battles. The same pattern is seen in Tiers with far more tanks, such as Tier 2 with 49 tanks. Numerous websites claim that the U.S. M2 light tank is the best, which the dataset demonstrates it is and it is also the most used tank. Therefore, the rest of this analysis will focus on players.

Players

The goal of analyzing players is to both understand the players, yield insight into their differences and determine what effects win rate. The first step is to understand these 200 top players by focusing on the major categories of Win Rate, Average Damage, Average Kills, Average Base Defense, Average Experience, and WN8 rating. These categories are important because the objective of the game is to win, the primary interaction players have with the game is dealing damage, kills lead directly to the winning objective, defending your base prevents a loss, experience is eared by playing better and in higher tiers as well as moving players up in tiers, and WN8 Rating is a comprehensive measurement of skill. Below are descriptive statistics for all chosen criteria:

	Win Rate	Avg Damage	Avg Kills	Avg Base Def	Avg Exp	WN8
Count	200	200	200	200	200	200
Mean	0.5042	975.5	0.87	0.615	527.91	1281.46
Median	0.5005	961.5	0.85	0.555	516.5	1222
Mode	0.493	353	0.85	0.4	415	1392
Standard Deviation	0.0343	377.31	0.251	0.313	139.7	521.69
Coefficient of Variation	0.068	0.386	0.289	0.509	0.264	0.407
Range	0.233	2138	1.6	1.85	819	2597
Minimum	0.429	192	0.2	0.06	206	187
Maximum	0.662	2330	1.8	1.91	1025	2784

Table 3. Descriptive statistics for Win Rate and related statistics.

The statistics above continue to show equality among these players, as demonstrated by the coefficient of variation. Other points of interest are:

- Even among these top players with millions of battles, the typical win rate is around 50%.
- The minimum and maximum win rate are both surprising; I am surprised that there is a player in the top 200 with only a 42% win rate, and given the clustering of win rate, a 66% win rate is stunningly high, even at this skill level.
- With average kills of 0.85, most top players usually kill 1 or 0 players in each game, which makes the maximum of 1.8 highly impressive.
- Average base defense has a very wide range, which makes it quite evident that base defense is a strategic choice that some players choose to focus on.

- The minimum WN8 rating is very surprising. Considering that WN8 is a comprehensive rating algorithm, it is shocking that a player in the top 200 would have a rating that is barely higher than most beginners.

In most games, experience is the best way to improve your skills. Thus, experience is typically highly correlated to performance. Interestingly, however, that is not the case with these players, as shown in the following scattergram:

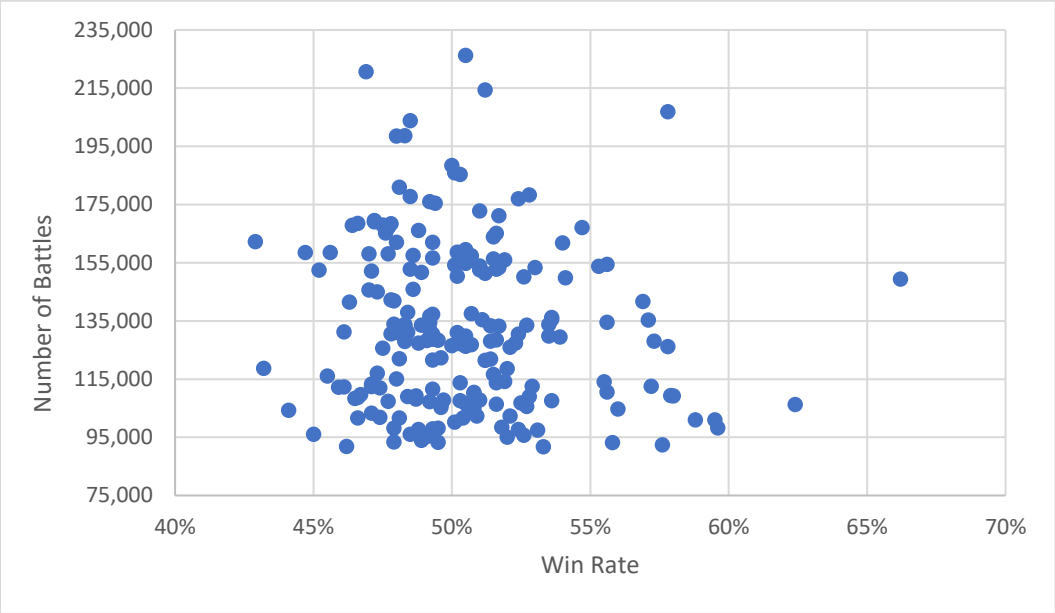

Fig. 3. Scatter plot of win rate to number of battles

The graph shows that there is little relationship between number of battles and win rate. I proposed that the reason is that the experience a player gets has diminishing returns. These are the top-200 players worldwide and the least experienced one still has 90,000 battles, so there is apparently little difference between 90,000 and 200,000+ battles, in terms of win rate, due to the diminishing returns of experience.

The analysis will now further focus on categories that will become important for win rate. The most directly related values are kills, as a way to win, and base defense, as a way to not lose. Below are graphs of win rate and these criteria:

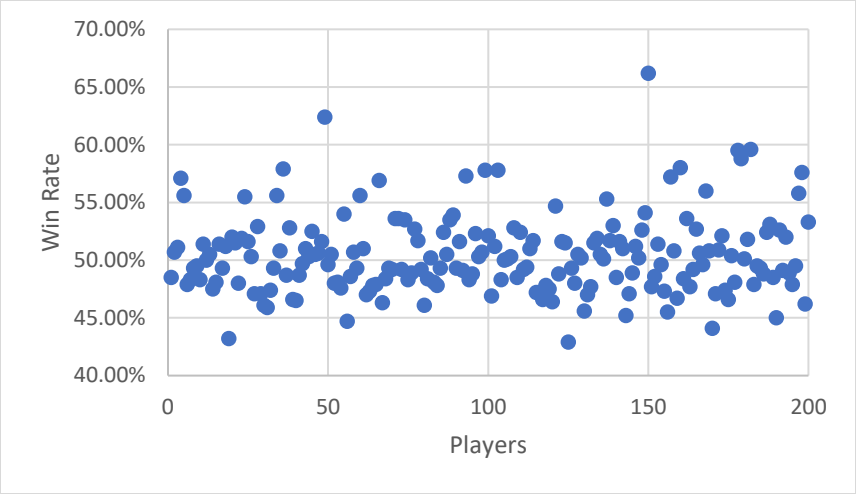

Fig. 4. Scatter plot of win rate of individual players

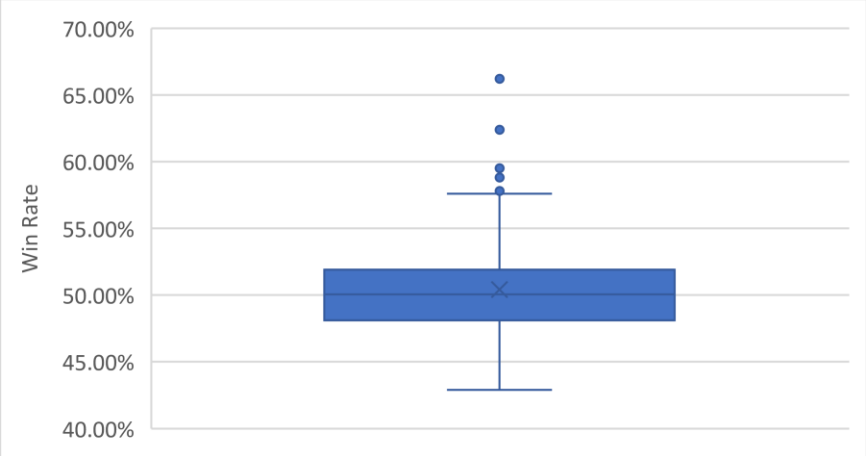

Fig. 5. Box & Whiskers plot of win rate of individual players

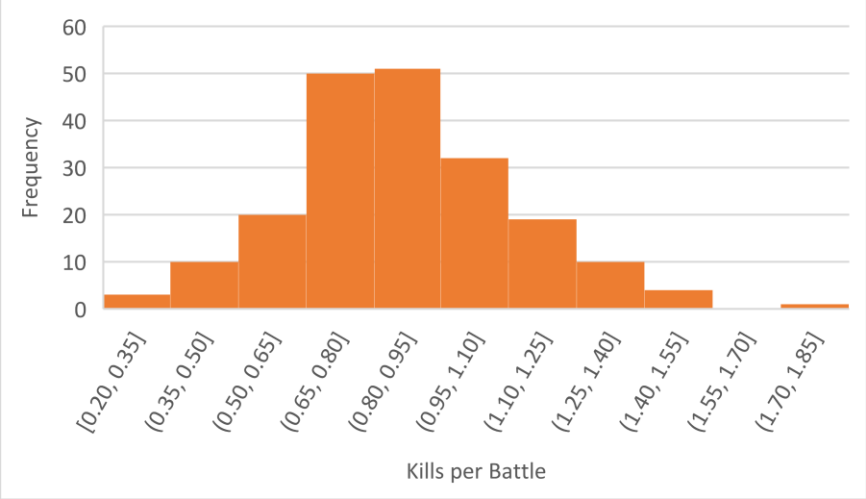

Fig. 6. Histogram of kills per battle for individual players

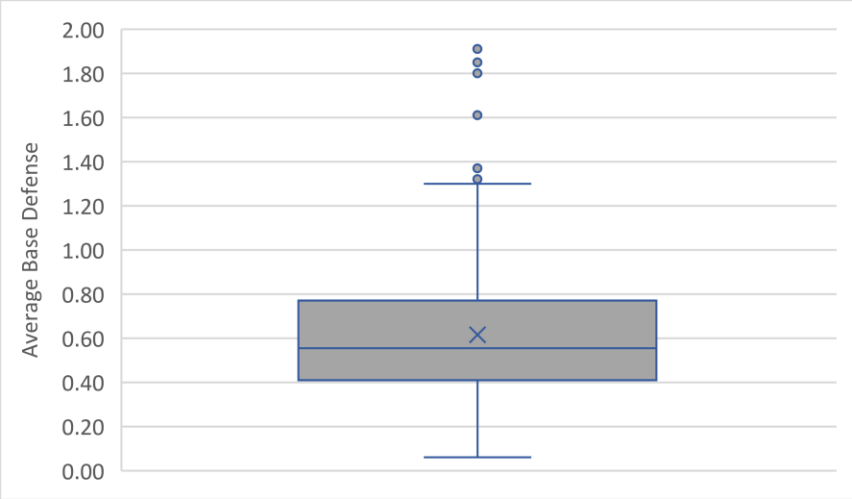

Fig. 7. Box & Whiskers of average base defense for individual players

Win Rate clearly shows a group of better players, while most are clustered around the average. Kills has tails but is not a pointy distribution due to clustering. Base defense has the largest differences, as first shown by the coefficient of variance and evidenced in the graph clearly. In addition to the large group of outliers over the upper whisker, the 25th to 75th percentile is close to a 2x difference (0.77 and 0.40). As evidenced by the graphs, while the spread of each criteria is tight, there are still significant variations in results, and therefore gameplay, among these top players.

In order to analyze these differences, I will use a radar chart, but to do so with 200 players would be impossible. Therefore, the below radar chart demonstrates these differences with three cohorts of players: the five players with the highest win rate, the five players with the lowest win rate, and the five players closest to the median win rate:

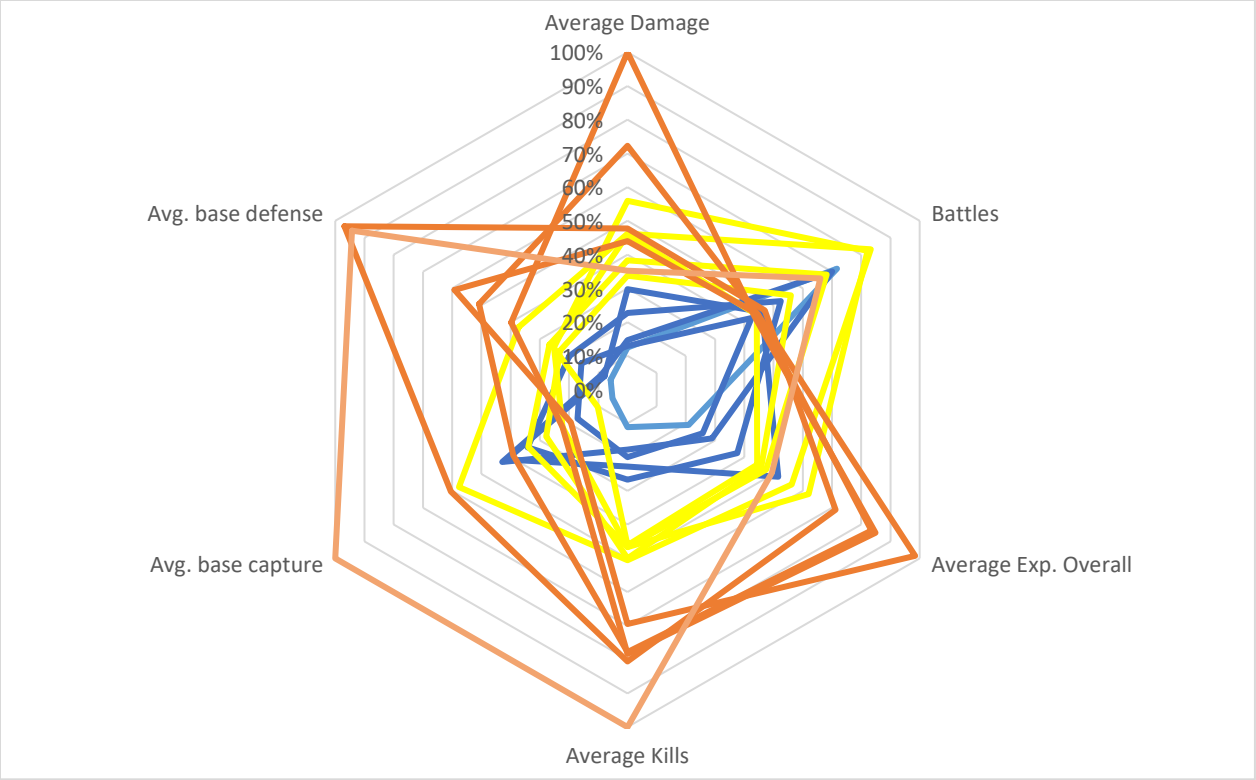

Fig. 8. Radar graph of player statistics of the top 5, median 5, and bottom 5 players in the top 200.

The orange lines represent the top 5 players, with the lightest orange representing the top player. The yellow lines represent the 5 median players. The blue lines represent the worst 5 players in the data set, with the light blue line representing the worst of the 5. There are many interesting observations to be made here:

- As shown before, number of battles is not correlated to ranking or skill. This is demonstrated here with the median and bottom player groups having many more battles than the top player group, while the top player group has the most in nearly every other value in the graph.
- For average damage, the bottom players have very similar values, while the median players all converge together with nearly identical average damage. This sort of clustering is only this prevalent in damage, with even the top players having similar values, albeit much higher than the other two groups.
- Average kills appear to be the most reliable indicator of performance, with the bottom group consistently scoring under the median group, and the median group scoring under the top group.
- The top players earn substantially more experience overall than the other groups. This is most likely due to higher tiers of tanks granting more experience, and the best players consistently scoring well with those high tier tanks.
- Base capture remains, as expected not an area of focus for most players and only slightly predictive, although there is one notable outlier in the top group, and it is the player with the highest win rate overall. This player clearly focusses on both base defense and base capture as a primary strategy, and it reaps rewards in the highest win rate.

- Interestingly, although the top player also has the most kills, they actually do substantially less damage than all of the other top 5 players and even less than most of the median players. This could be because they are meticulous with their damage dealing, and make sure to confirm their kills instead of just dealing as much damage as possible.

The final part of the analysis will focus squarely on win rate, and the factors that affect win rate. The first step is to understand the correlation between all analyzed criteria. The correlation matrix below demonstrates correlation between all analyzed criteria, and highlights in green any correlation above 0.5.

	WN8 Rating	*Performance Ratin*	*Battles*	*Win Rate*	*Average Damage*	*Average Exp. Over*	*Average Kills*	*Avg. base capture*	*Avg. base defense*	*Vehicles spotted*	*Average Tier*
WN8 Rating	1.000										
Performance Rating	0.992	1.000									
Battles	-0.127	-0.149	1.000								
Win Rate	0.898	0.888	-0.106	1.000							
Average Damage	0.805	0.806	-0.063	0.554	1.000						
Average Exp. Overall	0.758	0.757	-0.129	0.589	0.821	1.000					
Average Kills	0.897	0.890	-0.074	0.865	0.726	0.695	1.000				
Avg. base capture	0.152	0.143	0.122	0.301	-0.022	0.159	0.298	1.000			
Avg. base defense	0.624	0.611	-0.047	0.690	0.329	0.342	0.739	0.345	1.000		
Vehicles spotted	0.126	0.110	-0.007	0.234	0.029	0.228	0.012	0.022	-0.119	1.000	
Average Tier	0.400	0.404	0.008	0.058	0.800	0.588	0.246	-0.236	-0.083	-0.054	1.000

Table 4. Correlation matrix of all relevant criteria

One thing of note is that, because many of these criteria relate to each other, such as kills and experience, there are numerous correlations above 0.5. My focus is on correlations with win rate, which include average damage, average overall experience, average kills, and average base defense. I am dismissing average overall experience from the analysis, because experience is directly earned through kills, base defense, damage, and win rate itself.

The next step is to analyze the relationship between these factors and win rate, using the scattergrams below, with resulting trendines:

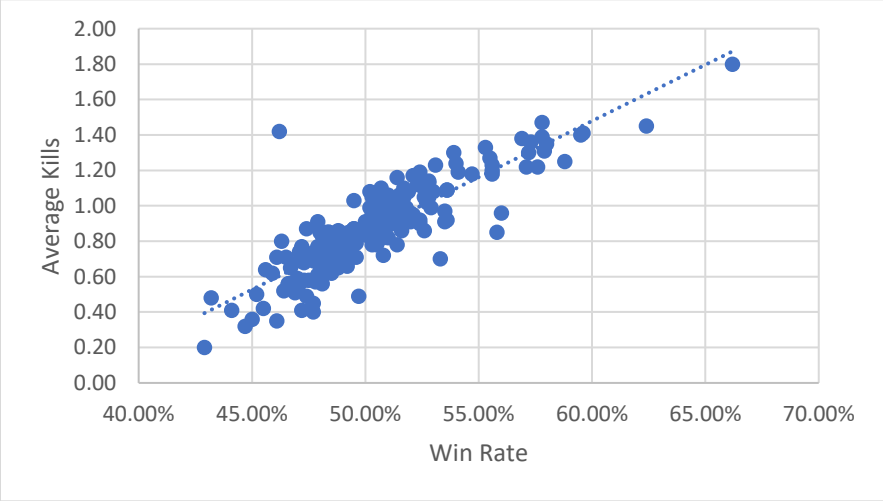

Fig. 9. Scattergram of win rate to average kills with trendline.

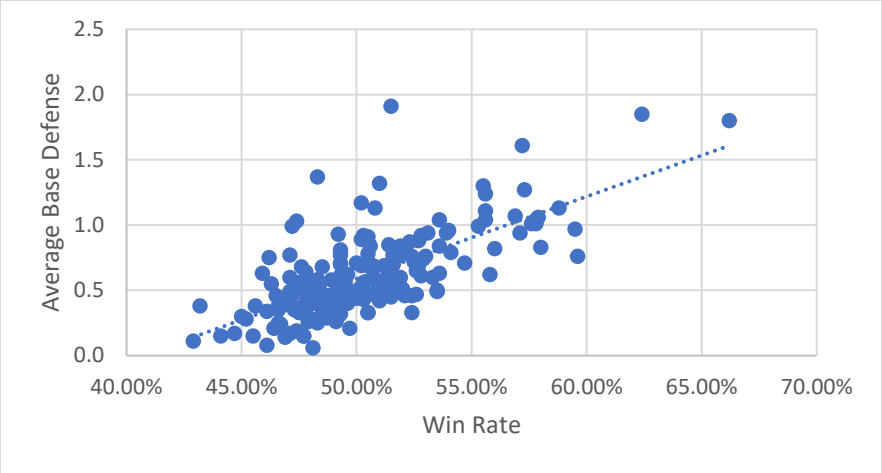

Fig. 9. Scattergram of win rate to average base defense with trendline.

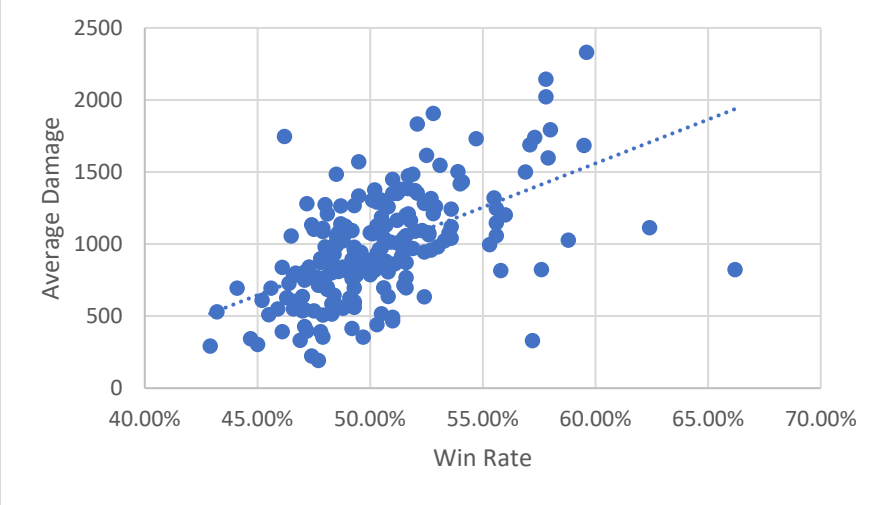

Fig. 9. Scattergram of win rate to average damage with trendline.

As shown by the scattergrams, average kills have the strongest positive correlation to win rate, followed by base defense. Out of the three criteria, damage has the weakest positive correlation, which makes sense - while a player must deal damage to get kills, not all damage dealt leads to a kill. Moreover, all correlations appear linear.

Linear regression analysis will demonstrate how much these factors affect win rate, and yield a formula for predictions. The following table is the result of linear regression of each of these criteria:

Criteria	Coefficient of Determination (R2)	Intercept	Coefficient	P-value
Average Kills	.748	.401	.118	$3.2*10^{-61}$
Average base defense	.476	.458	.076	$1.2*10^{-29}$
Average damage	.307	.455	0.00005	$1.7*10^{-17}$

Table 5. Linear regression of kills, base defense, and damage to win rate.

All three regression analyses show statistical significance and Average Kills has a substantial R2 of .75. Note that the seemingly low coefficients on Average Kills and Average base defense are fine because they are predicting a percentage. For instance, the .118 coefficient on Average kills means that for each kill, the predicted win rate increases by 11.8%, while each successful base defense increases win rate by 7.6%. Average damage is not useful with a .31 R^2 and a coefficient of virtually 0.
It is possible that a multiple regression analysis could produce a higher R^2 and a more useful formula, so I combined average kills and average base defense for the following regression results:

Criteria	Coefficient of Determination (R^2)	Intercept	Coefficient	P-value	Significance
Average Kills	.754	.404	.107	$4.02*10^{-34}$	$1.0*10^{-60}$
Average Base Defense			.012	.034	

Table 6. Multiple regression of kills and base defense to win rate.

According to the R^2, this is a slightly better formula, and while the p-value of the components decreased, the significance is valid. It is noteworthy that the power of Base Defense decreased dramatically between the single and multiple regressions, while the power of Average Kills only decreased slightly. Therefore, I now have a formula to predict win rates:

$$Y = 0.404 + .107(\text{Average Kills}) + .012(\text{Base Defense})$$

In order to assess the quality of the regression analysis I reviewed the residuals plot, to identify any patterns that would impugn the formula.

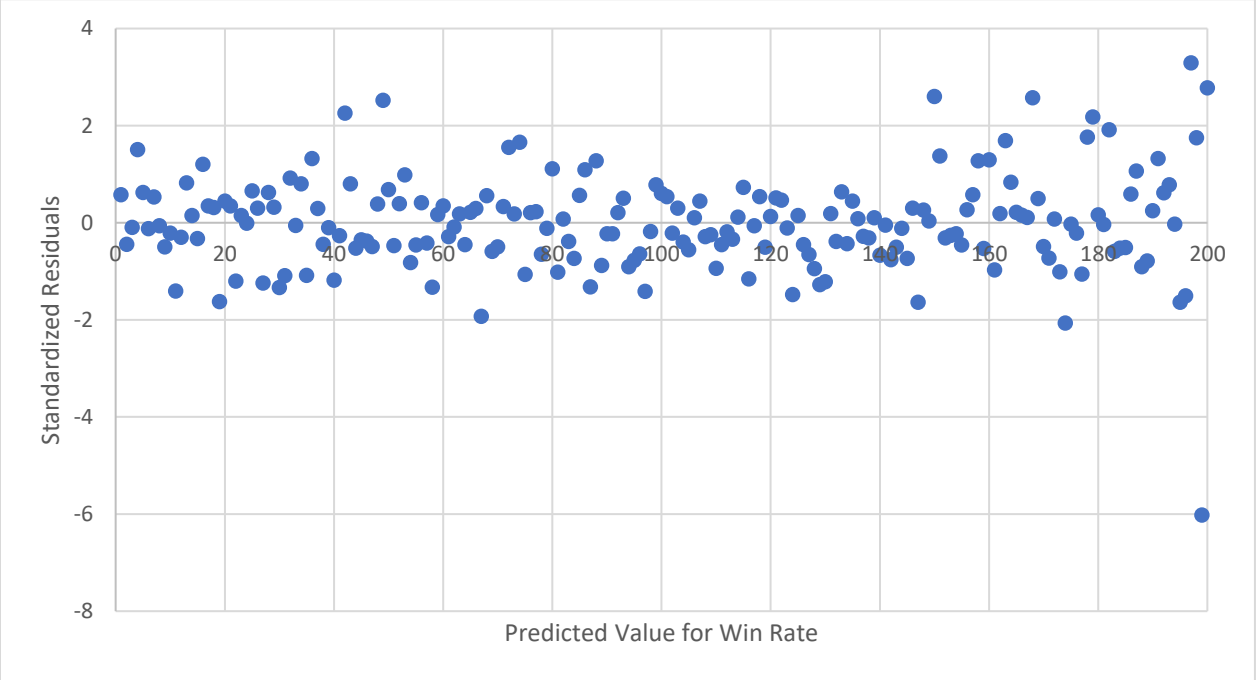

Fig. 10. Residuals for multiple regression analysis of average kills and base defense to win rate

The residuals plot shows no pattern and appears random, with one noteworthy outlier, observation 199, where the prediction was off by 10 percentage points. Overall, the prediction was too high 96 times and too low 104 times, while the average of the absolute values of the residuals was only 1.2%. It is noteworthy that the last 50 players have greater residuals. The last 50 players are off 1.7%, which is 69% greater than the first 150 players (1.004%). This is noteworthy due to the ordering of the data. The data is ordered by server, so all 50 players at the bottom are from the Southeast Asia server. In preparation for this project, I originally planned on analyzing differences among the severs but preliminary work, including descriptive statistics indicated little difference, so I decided to forego those analyses and instead focus on the entire group, because that increased the number of observations. This final finding indicates that there could be value in further research focusing on the servers. Below are the descriptive statistics on Win Rate that lead me to decide not to analyze the servers separately:

	Entire Group	North America	Europe	SE Asia	Russia
Count	200	50	50	50	50
Mean	0.5042	0.50426	0.50334	0.50706	0.50214
Median	0.5005	0.503	0.493	0.496	0.5015
Mode	0.493	0.493	0.493	0.477	0.512
Standard Deviation	0.0343	0.0336	0.02943	0.03839	0.03597
Coefficient of Variation	0.068	0.067	0.058	0.076	0.072
Range	0.233	0.192	0.131	0.155	0.233
Minimum	0.429	0.432	0.447	0.441	0.429
Maximum	0.662	0.624	0.578	0.596	0.662

Table 7. Descriptive statistics of win rate and related statistics separated by region server.

Overall, it seems likely that separating the data by servers would yield superior regression analysis results, and the specific independent variables may even change. To test this theory, I ran a regression analysis on the top-50 players from the Russian server and found that the results did change. When using both Average Kills and Base Defense, Base Defense failed the p-value test at 0.23, while overall model significance was still achieved. Using only Average Kills, the regression analysis achieved a superior R^2 of .89, with a low p-value of $6.8*10^{-25}$, without a pattern for residuals, an average absolute value of residuals of 0.86% and resulted in the following formula for predicting win rate:

$$Y = 0.395 + .121(\text{Average Kills})$$

Since this is a superior model for only the Russia players, it would be useful to analyze each server individually, as a further area of research.

Conclusion

The analysis here shows the work that Wargaming has put in to develop a well-balanced game that over 20 million active players worldwide can enjoy at a wide range of skill levels, with or without spending money to purchase premium tanks. I believe that this level of balance is achieved through not only the

team aspect of the game, but also a very low time-to-kill; It doesn't matter so much if one player has an expensive tank, as they likely only manage to kill one or two players before they get killed themselves. The balance is also evident in the wide spread of tanks that even the top players use. If there were certain tanks that significantly outperformed the rest, these skilled players would quickly find them and exclusively use them in battles, but if the tanks were also all the same, these skilled players wouldn't ever bother switching the ones they use. However, these players each use a wide variety of different tanks across and within each tier, which means that every tank must be at least different enough to make these players want to change up their playstyle every so often. Considering the sheer number of tanks in the game, this is an incredible feat of game design- nearly 600 tanks that are all unique enough that they are all interesting to use, and yet still balanced enough that no one tank has a distinct advantage over the others in its tier. Even the premium tanks, which can cost up to $80 to purchase, do not have a significant advantage over other tanks, which seems to go directly against the idea of a "freemium" game- instead of pushing players to buy tanks by putting all the best tanks behind paywalls, I suspect that Wargaming has made the premium tanks all *interesting* to play, which would incentivize the players to purchase new tanks without putting them at a disadvantage or ruining the experience of players who choose to play only for free. Even the very best tanks in the game can be earned for free by playing the game, and they even seem to outperform even the best premium tanks! All in all, the data in this data set is very interesting, and it is no wonder that Wargaming has created such a large and devoted player base.

Endnotes

[1] Brown, Fraser. (21 March 2018). *What 1.0 means for World of Tanks*. Rock Paper Shotgun. https://www.rockpapershotgun.com/what-1-0-means-for-world-of-tanks

[2] MMO Stats. (April, 2023). *World of Tanks*. https://mmostats.com/game/world-of-tanks

[3] Sanchez-Cartas, Juan-Manuel. (16 May 2019). *Data on players' performance and gameplay in the free-to-play online videogame World of Tanks.* Mendeley Data. https://data.mendeley.com/datasets/bgjmbfx93g