Resource Accumulation: A Study of Real-World Success through League of Legends

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Objective: *The impact of specific resource accumulation and lane/role impact on game outcomes in the MOBA game League of Legends.* ***Background:*** *Statistics and apps for League of Legends show champion win rates, best champion builds, best items, and highest play rate in a lane, however, statistics on resource accumulation are lacking and objective results that display the impact of the lanes/roles are also either lacking or unseen.* ***Methods:*** *Collecting data from games, Kaggle datasets, and Riot Games' Developer API, we can perform statistical analysis using R to find relations between win rate and resource accumulation, while also using models such as the linear model to determine the impact of resources on game outcomes.* ***Results:*** *There is a clear positive change to win rate when the main focus is resource accumulation. Things like gold, experience, vision score, dragons, and towers destroyed all greatly contribute to winning the game. From testing, it seems that the highest impact variables on game outcome would be gold and experience, earned by killing enemies and minions, followed by dragons killed and vision on the map. From these results we can see that focusing on fundamentals during the game, such as killing minions and being able to kill enemy players results in the best outcomes, with the effectiveness of objective control, i.e. dragons, towers, heralds, and baron, being a bit less effective but not by much.* ***Conclusion:*** *We suggest that there is a significant association between gold combined with experience accumulation, and winning. There is also a significant, but not as impactful, association between objective control and winning.* ***Application:*** *Smaller businesses or job teams are not able to risk as much as other larger businesses, so knowing what resources to build upon or what should be sacrificed to collect resources is vital for success.*

Keywords: League of Legends, team performance, team experience, resource accumulation, team outcomes, performance outcomes, win rate, economics

I. Introduction

I will be researching the importance of resource accumulation and other early signs on team performance and outcomes. Factors such as the differences in resources accumulated over time will be studied to try and show whether or not there is a significant impact of resources on team performance. In competitive and economic scenes, resource accumulation and other data can be analyzed to accurately predict team performance and outcomes. Using League of Legends (LoL), a MOBA (Multiplayer Online Battle Arena) game, as a proxy to look at resource accumulation, we can determine the impact of such factors on team performance, and whether the team wins or loses in the end, or if performance changes based on such early signs.

II. Background

LoL is a video game where ten players, five on either team on the red or blue side, are against each other. Each team has a "nexus," or their main base, which they have to protect to stay in the game. Each player will be piloting a different "champion," which will be characters that the players control that have different abilities and fit into different places on the map depending on the said champion. These teams are assumed as players that have a common goal that depend on each other and adapt as scenarios change to overcome challenges " (Salas, Dickinson, Converse, & Tannenbaum, 1992). To win, players on each team must eventually find a way to break past the many defenses protecting the enemy nexus and then destroy this enemy nexus. Defenses such as turrets, minions, and enemy players will be attempting to stop the allied players from breaking through all these defenses and ending the game. These players, split into five different lanes as shown in Figure 1, will be collecting individual resources, and helping out their allies to try and close out each game with a victory. The map is usually covered by something termed the "Fog of War," which disallows players from seeing anything except the terrain itself both on the map and the mini-map, which gives a certain value to "vision." Champions can either have abilities that grant vision, which removes the Fog of War in certain areas, or the players, who each have something called a "ward," can place these wards on sections of the map with the Fog of War to reveal a small section around the ward.

Figure 1. League of Legends Summoner's Rift Map

There are multiple objectives that each player in a lane should be trying to achieve. The main one is resource accumulation. Resource accumulation is, in this paper, defined as anything the team and players can obtain that will help them to defeat their enemies. On a more macro scale, resource accumulation is economically important. In managerial firms, the term "resource conceptualization," or a focus on specific resource accumulation, is a major player in the success of said managerial firm (Kunc, M.H. and Morecroft, J.D.W., 2010). Resource accumulation also takes time, in both League of Legends and the real world. The usefulness of collecting resources rather than investing time in other factors can also be measured, helping to show when a managerial firm or a team should lag behind in resources in trade for a different investment (Gonçalo Pacheco-De-Almeida, James E. Henderson, and Karel O. Cool, 2008).

Another thing to note is the team's experience. Earlier, we defined teams as players that work towards a common goal and try to overcome challenges. Because our dataset is taken from matches played in higher levels of play in the Ranked Solo/Duo mode offered by League of Legends, the teams are often built around random players with similar skill levels. However, these random teams built temporarily have been shown to display high levels of interaction and

experience even though they really have no experience with each other (Yubo Kou, Xinning Gui, 2014). Resource accumulation, although sometimes independent, does factor into team experience. If the teams manage to overcome such a disparity in having no information on their teammates and continue to accumulate the required resources, it does bring into question the impact of team experience or familiarity on team performance and outcomes.

Each role or lane has various levels of freedom and will behave differently along with having varying relationships or interactions with their teammates (Webb, 2004; Welbourne, Johnson, & Erez, 1998; McMichael, Beverly, Noon, Patterson, & Webb, 1999). Roles like middle lane have access to the dragon and baron/herald objectives, marked by the gray dot between middle and bottom lane, which are very important resources later in the game. Top lane is the most isolated, however, this lane gets to prioritize a smaller scale of resource accumulation in terms of minion kills (CS) and experience. Bottom lane is shared by both a support and attack damage carry, which as implied by the name, is the role that attempts to deal the most damage, and can go to the dragon objective. The Jungle role has the most freedom and can go to any lane to help their team accumulate resources by either helping to get kills or helping get major objectives like the dragon or baron/herald.

These roles have their resources to accumulate with the occasional help from other teammates, and there are many resources in League of Legends that can be collected. Currently, we believe that resources such as gold and experience are the most important, and there are a few others that make an impact but not as much. As such, we will go through these resources to help answer the following questions:

RQ1: What is the impact of early-stage resource accumulation on team performance and outcomes?

RQ2: What is the impact of the early-stage difference in resource accumulation across the teams on team performance and outcomes?

III. METHOD

My data comes from the Kaggle website, op.gg, and Riot Games' official developer API, containing detailed and processed information about multiple games. We can fetch the game's data from the API using python scripts, and we have a massive sample of ten thousand games from the Kaggle dataset. We can also take random games in the upper brackets and fit them into the dataset as well, clearing out the major outliers where there are uncooperative single players, and help clean up the data to maintain a relatively and approximately normal dataset.

To analyze all this collected data, we used mostly linear regression to model different factors and test for statistical significance. Linear regression allows us to create a nearly straight-line model that is relatively straightforward and helps to display whether or not there are strong relationships between two factors, such as resource accumulation of a specific resource versus the team's performance. However, to perform the linear regression model, we have to check for a few specific things in for our analysis to be useful.

First, we must determine that all the games that we have recorded are independent of each other, meaning that each game is completely free of influence from another game. Looking at the result and modeling them in RStudio, an IDE that runs R which is a language perfect for modeling statistics, we can see that all the games seem to not have any sort of influence on each other, and the cleaned-up data makes it so that there are no outliers, which are where independence is likely to be violated. We must also check to see that changes or variations in data do not follow any pattern, and graphing multiple factors from each game, we determined that the variation is also completely random. Finally, the model must be linear, or else the results it gives would be completely useless were it to be modeled linearly. In the results shown later, we will see that the results do indeed follow a linear model, and thus we can proceed to use such a model.

Our independent variable will commonly be the resources or difference in resources between teams that one can accumulate throughout the game, and our dependent variable meant to simulate team performance will often be the win rate over many games.

For convenience purposes, a resource "difference ratio" will be defined as the difference between the blue and red team's resources, divided by blue team's accumulated resources.

IV. RESULTS

As described previously, each of these models will be following a linear model.

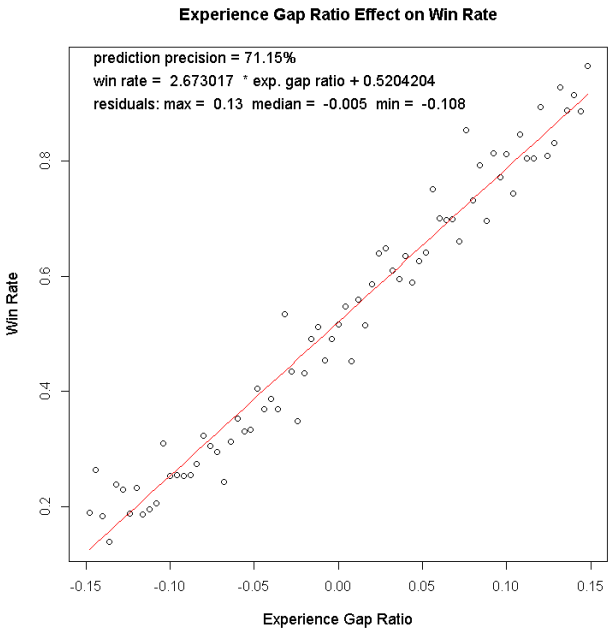

Figure 2. Linear Model of an Experience Gap vs. Win Rate

Independent Variable: The Experience Difference Ratio
Dependent Variable: The Win Rate Across Many Games
p-value: < 2.2e-16
Multiple R-squared: 0.9617

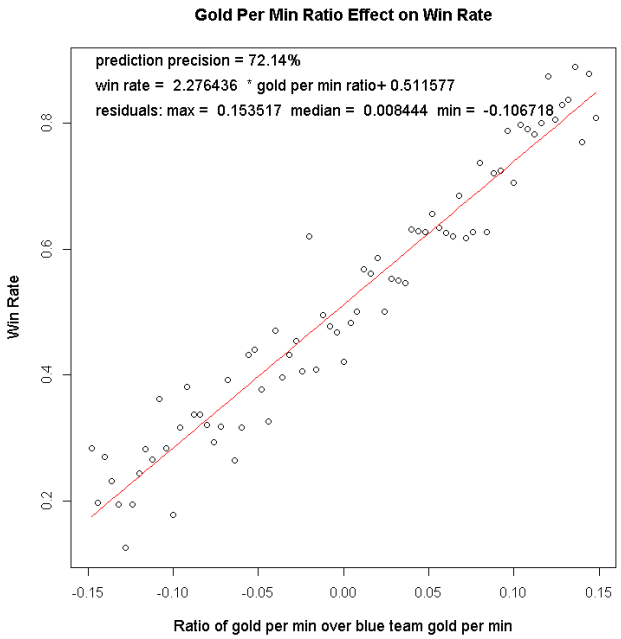

Figure 3. Linear Model of the Gold Rate Difference Ratio vs. Win Rate

Independent Variable: The Gold Per Minute Difference Ratio
Dependent Variable: The Win Rate
p-value: < 2.2e-16
Multiple R-squared: 0.9375

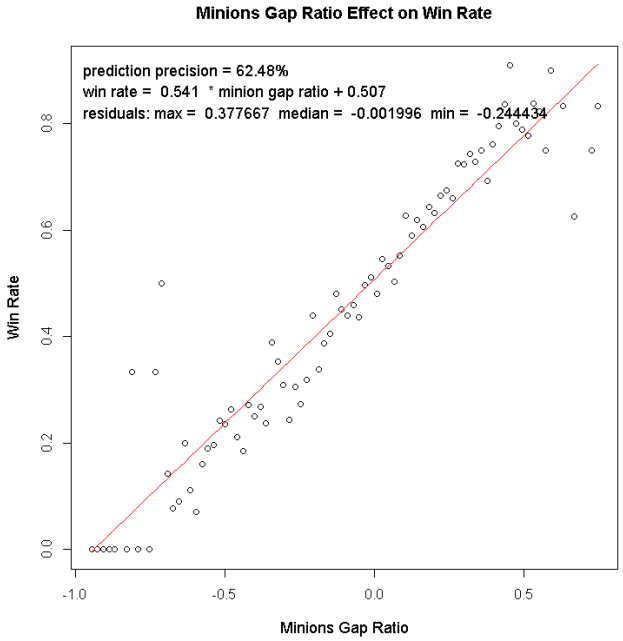

Figure 4. CS Difference Ratio vs. Winrate

Independent Variable: CS Difference Ratio
Dependent Variable: Winrate
Multiple R-squared: 0.906
p-value: < 2.2e-16

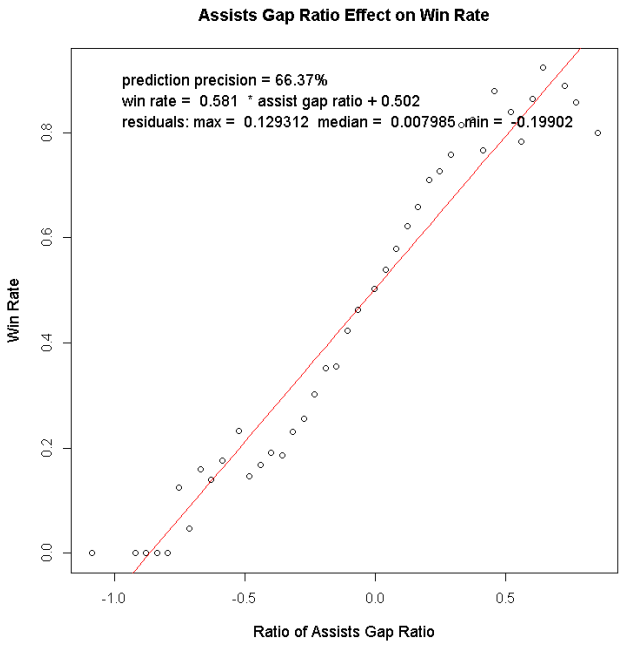

Figure 5. Assists Difference Ratio vs. Win Rate

Independent Variable: Assists Difference Ratio
Dependent Variable: Winrate
Multiple R-squared: 0.9492
p-value: < 2.2e-16

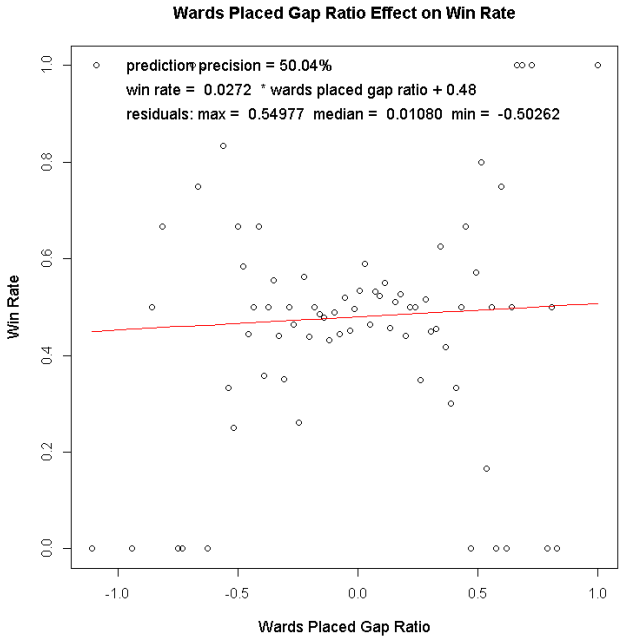

Figure 6. Wards Placed Difference Ratio vs. Win Rate

Independent Variable: Wards Placed Difference Ratio
Dependent Variable: Win Rate
Multiple R-squared: 0.002788
p-value: 0.6505

V. DISCUSSION

After much experience with the game itself, it is surprising to see that in the earlier stages of the game, where kills are extremely important, assists show little significance

in improving team outcomes. Similarly, the number of wards placed seems to have almost no significant effect on the win rate, which is unexpected because wards allow players to see spots on the map where they usually would not be able to see, thus allowing those in a lane to avoid being killed by other roles, such as the jungle lane. However, as expected, the experience and gold resources showed to have the greatest effect on team performance and outcomes, as a larger early difference showed a greater chance of succeeding in the game. The minions killed, or CS difference, which is directly tied to gold collection, does explain a fundamental to winning in higher, more competitive brackets of League of Legends. Because you can only accumulate resources and not lose them, the focus should be on gaining instead of protecting either yourself or what you already have. For example, the stigma of deaths in League of Legends is that they are extremely bad, but in more advanced and more in-depth cases, a good death can lead to resources being gained at an even faster rate which will outdo the resources that you may have given to the enemy (Maymin, Philip Z, 2021). This level of importance in a CS difference, which results in a gold difference and an experience difference, does go against a common stigma of top lane being the least impactful. Because top lane is mostly focused almost purely on gathering the two resources that have the most effect on team outcomes, it is possible that top lane is one of the more impactful lanes as they usually focus mostly on the two resources that win games most.

We can also begin to consider how an early lead in resources could help with collective behavior and overall team performance. A team's collective behavior will depend on many factors, mainly the state of a situation that the team is facing, the team's performance, and more generally, the team's positivity towards each other (Driskell J.E. & Salas, E. 1992). The games that have been analyzed do not consider the level of positivity, as that cannot be measured through any means provided by Riot games' API, however, we can see that an early lead in the important resources does give a win rate higher than fifty percent, which is the average win rate that is expected of a team. Not only does this mean that the team with an early lead has performed well in different ways in their ability to collect resources, but it also may help in that an early lead is a major morale boost to the winning team while also showing that the team may have a level of experience with each other developed quickly that helped in cooperation (Melita Prati, L., Douglas, C., Ferris, G.R., Ammeter, A.P. and Buckley, M.R. (2003)). In application, we can see that proper leadership and an ability to work together are crucial to a team, and in many job firms, the ability of a team to complete a task coherently is what decides the success of both the business and the individuals that are working together.

VI. Conclusion

This research project aimed to explore the impact of early collection of fundamental resources and other factors on team performance and outcomes. Finding that certain resources impact team outcomes more than others does make sense and helps to show that strong knowledge of what to focus on can help teams to succeed, whether it be in games or teams working together for a job. Future research papers have the freedom to not only just explore Riot Games' evolving developer API, which will have more data as time passes, but more data regarding the economy and the ever-changing availability of resources in the world will become readily accessible so a study similar to this one can be conducted.

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