

Stop Stealing Bard's Gold!

An Analysis of Gold Efficiency in League of Legends

Saahil Claypool
WPI Computer Science 2019
Summoner Name: SaaRoony

Abstract

A common distinction in League of Legends is the difference between a “support” and a “carry”. Supports, as the name implies, are there to make sure the carry can perform as well as they can. This means that the support attempts to give up their share of the team gold and give it to the carry. Using RIOT's API, I attempted to see if the data supported this style of play where the gold is shared disproportionately in a team. To do this, I sampled the recent games of the Challenger players and recorded how well each champion did and compared that to their relative amount of gold earned. I will refer to this gold and performance relationship as *gold scaling*. I found that carries scaled better with gold, as expected. But, not every carry scaled better than every support; there were a few individual supports who's scores were impacted more heavily by gold than a set of carries. This raises an interesting question: Who should get the gold?

Introduction

For years Marksmen have been complaining when supports take their precious last hits and thus depriving them of gold.¹ Common knowledge has it that the carries are more dependent on gold than the support and therefore the support's only job is to help the carry do well. But what if the complaints of all the angry Vayne players² are unfounded? Each champion does better when they have more gold, but the question is: how much better?

While win rate would seem to be the best measure of how effective a champion is, the data for win rates is noisy. For instance, a single player could perform very well, but there are four other players that could ruin the good performance. There are too many factors that go into a victory or a loss and it becomes hard to tell who really was instrumental to the result. I chose to measure performance using a score based off just kills and deaths. The use of a kill and death score creates a more accurate portrayal of performance than a win and loss ratio because it is not an all or nothing measure. Additionally, the margins for a win-loss metric are extremely small. This means it would require much more data to create a meaningful prediction of gold income to a win-loss ratio.

Data and Methods

¹. <http://forums.euw.leagueoflegends.com/board/showthread.php?t=625415>

“What do you do when you play AD carry and your support steal all creeps? Tired of these guys....” (Forum Post, 03-17-12)

² Vayne is a typical Marksman

I obtained the data using Riots API and a Python library called Riot-Watcher³. I analyzed the 10 most recent games from each of the players in the Challenger league. After removing duplicate games, I recorded the kills, deaths and assists of each champion along with their share of the game's gold. While it may seem more intuitive to use the actual amount of gold each champion earned, this causes some issues. A champion with 15,000 gold in a 15 minute game could be rich in that game, but in a different 45 minute game, having just 15,000 would mean that champion is very poor. Instead, I recorded each champion's share of the total game gold for each game. For example, if a champion has 10 gold in a game where all of the champion's gold pooled together is 100 that champion would have a gold percentage of 10%. This means that any champion with more than 10% of the gold is richer than would be expected if the gold was shared evenly.

Next I combined all of the kills, deaths and assists of a single champion into a single "score". To create this score, assigned a weight to kills, deaths and assists. If a kill is one "point," then the weight of an assist and death fall into a grey area. With an assist, it is much harder to tell how much a champion contributed to that team kill. Some assists can be very important plays that secure a kill for the team whereas others can be a minor contribution or heal in a team fight. Sites such as [LoLDB](#) choose to weight assists the same as kills and deaths. The issue becomes that assists are not as fair a measure of how well an individual champion did but rather how well their team did. I opted to keep it simple; kills are worth one "point" and deaths are worth a negative point. This provided a data point for each champion for each game, gold as the x-value and score as the y-value.

To make sense of the data, I fit each set of ordered pairs to a linear regression, providing a prediction for a score based on the gold earned.

³ Riot-Watcher by pseudonym117 Github: <https://github.com/pseudonym117/Riot-Watcher>

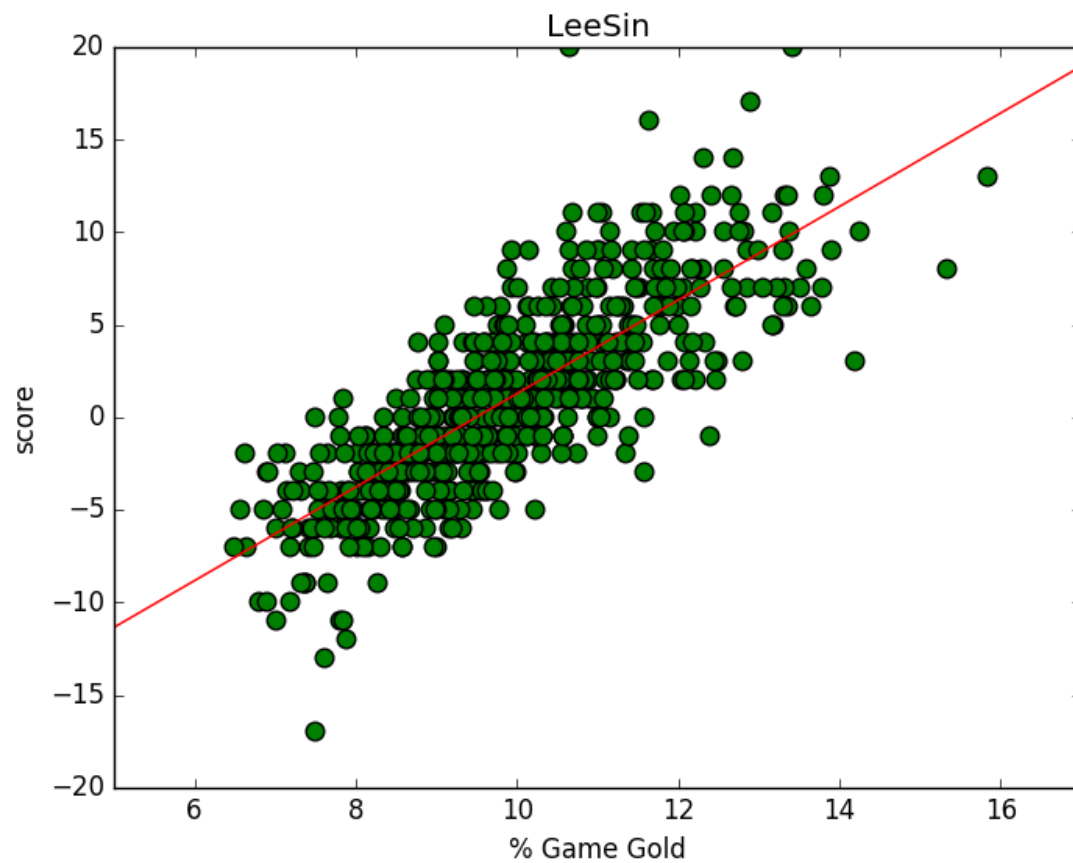


Figure 1: Lee Sins score compared to his percentage of the game's gold as well as a linear regression of these data points. The linear relation predicts Lee Sin's score given a certain amount of gold. The X axis represents the percent of the games gold that Lee sin has and Y axis represents the score of Lee Sin.

As seen in figure 1, as Lee Sin gains more of the game's gold, his predicted score increases in an approximately linear fashion. This graph predicts that if a Lee Sin has his "fair share" of gold at around 10% of the games gold, he would roughly get a score of 0. For each additional percentage of the game's gold that he earns, his predicted score increases around 4 points, or four more kills than deaths. The slope, the amount the score increases per percentage of gold, is the number that I used to determine how dependent a champion is on gold. The slope is the value of the aforementioned *gold scaling*.

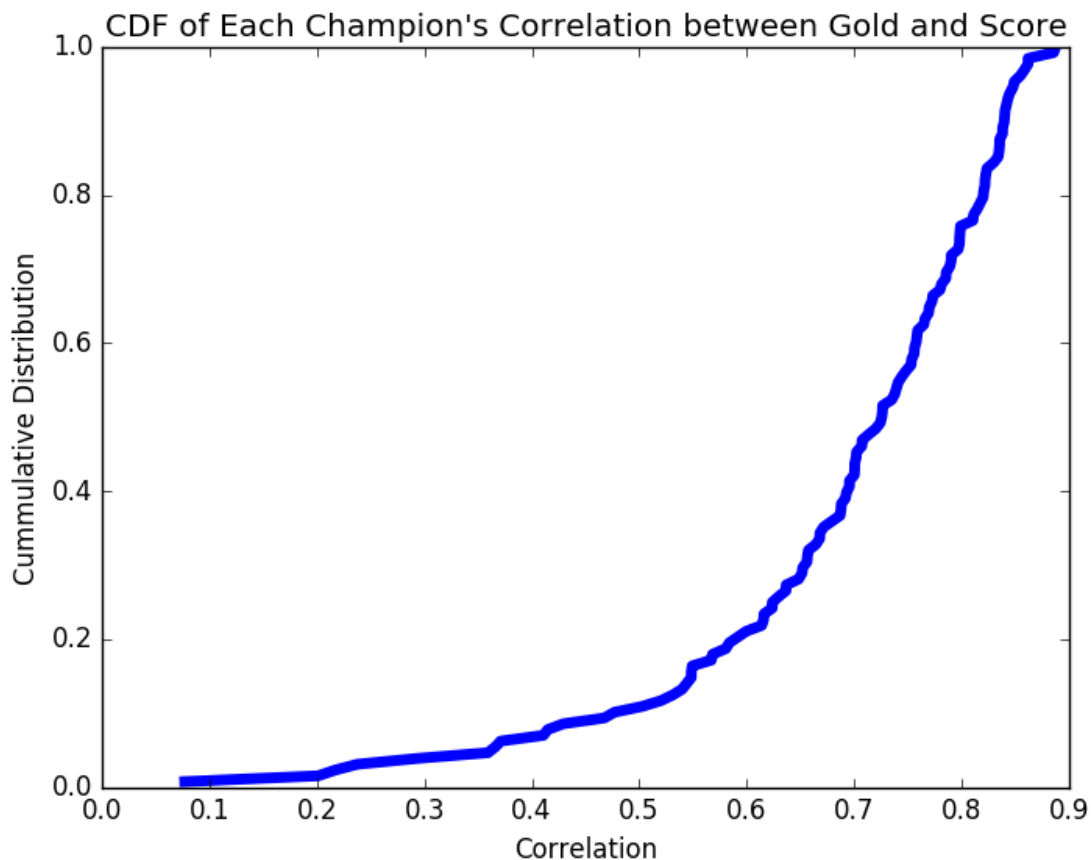


Figure 2: CDF of the correlations of each champion. The X axis represents the correlation coefficient of each linear regression and the Y axis represents the percentage of champions that has a correlation of that score coefficient or lower.

Figure 2 depicts a CDF of the correlations of the linear regression for each champion. The correlation coefficient is the value that explains how well the variation in the data can be explained by a linear model. In other words, it is a measure for how well a straight line can be drawn through the data. The CDF depicts the probability of a champion having a correlation less than a given x axis value. For example, the x axis value of .3 would be read as *the probability of a champion having a correlation of .3 or lower*. Around 90% of the champions had a correlation of .5 or greater. That implies that for that 90% of the champion pool, at least 25% of the variation in their score can be accounted for by the variation in their gold. Any champions that had a correlation lower than .5 I discounted as their data could not be explained in a meaningful fashion by a linear relationship. This included:

Support: Soraka, Zilean, Janna

Mage: Heimerdinger, Viktor, Karma

Marksman: Teemo

Assassin: Zed

Tank: Nautilus, Leanoa, Singed

Fighter: Olaf, Tryndamere

This does not mean these champions did not have higher scores when they obtained more gold, but rather that their relationship could not be described as linear.

The key point I drew from each of the linear regressions was the slope. The slope is the value that indicates how much better a champion would perform as they gained more gold. In other words, the champions that have greater slopes are the ones that seemed to scale better with gold.

To visualize each of the champions in a meaningful way, I sorted the champions into their most common role as defined by RIOT in their API and created a CDF of the slopes of each champion.

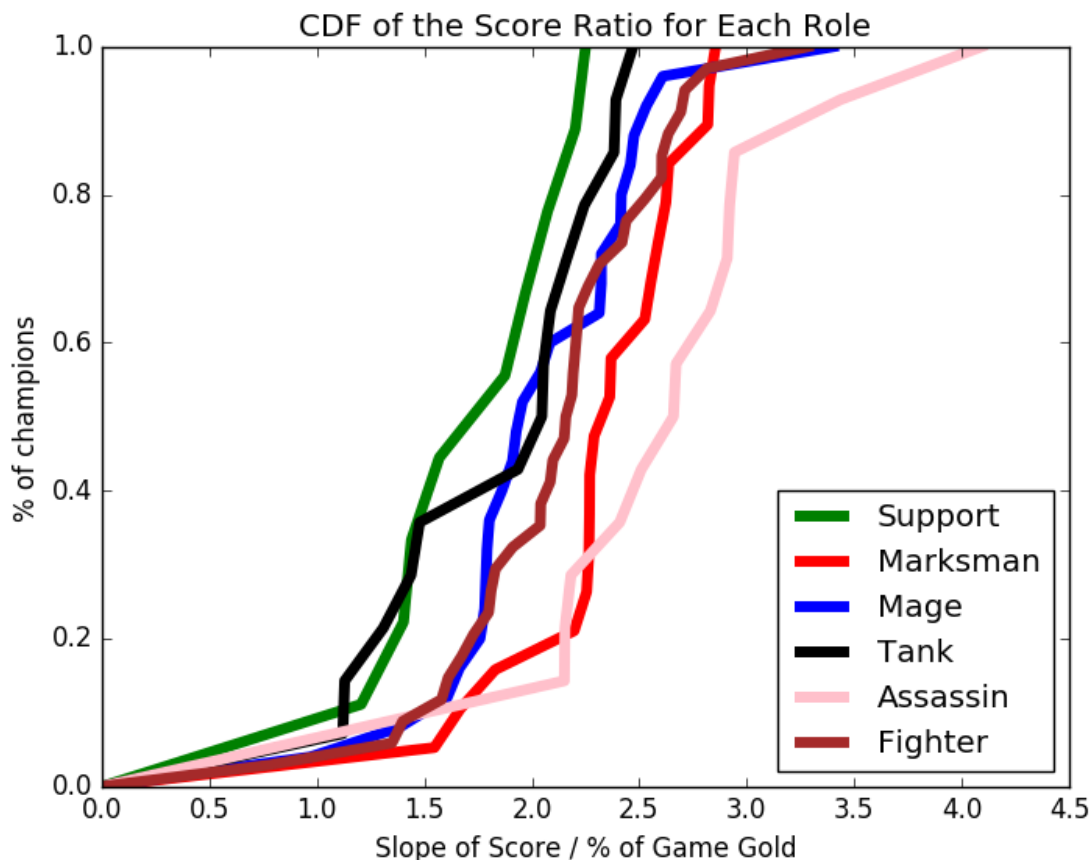


Figure 3: CDF of the ratio of gold to score for each champion. Results Grouped by role. Each line represents a role. The x axis is the increase in score per percentage of gold the champion gains and the y axis is the percentage of champions that have a ratio of gold to score of that value or less.

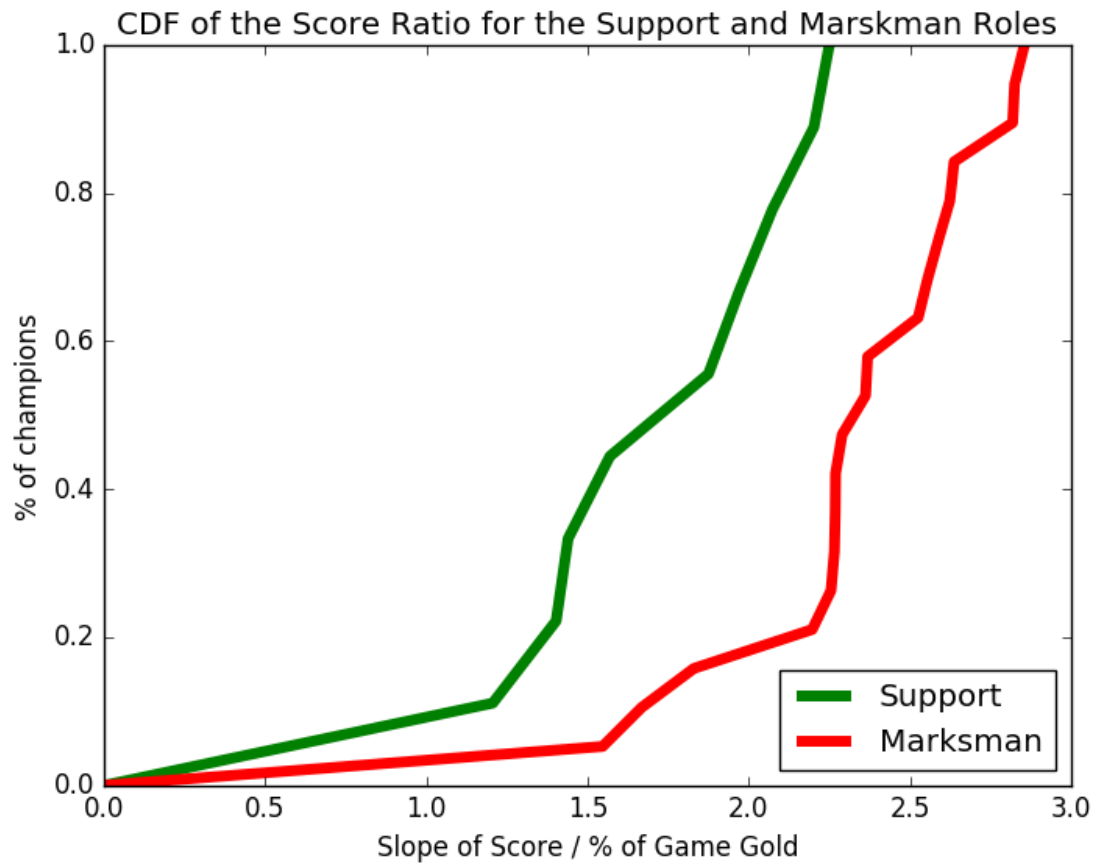


Figure 4: The CDF of the gold to score ratio for just the marksman and support roles. The x axis is the increase in score per percentage of gold the champion gains and the y axis is the percentage of champions in the given role that have a ratio of gold to score of that value or less.

Marksman		
Rank	Champion	Score : Gold Ratio
1	Quinn	2.85
2	Urgot	2.82
3	Varus	2.81
4	MissFortune	2.63
5	Graves	2.62
6	Caitlyn	2.58
7	Vayne	2.55
8	Ezreal	2.52
9	Ashe	2.36
10	Corki	2.36
11	Kalista	2.28
12	Draven	2.26
13	Jinx	2.26
14	Kindred	2.26

Table 1: Numerical values of the gold to score ratio of Marksmen

The right column is the increase in score per percentage of the games gold.
(Other roles can be found in the appendix)

15	Tristana	2.25
16	KogMaw	2.19
17	Lucian	1.82
18	Twitch	1.66
19	Sivir	1.54

Support		
Rank	Champion	Score : Gold Ratio
1	Nunu	2.24
2	Bard	2.20
3	TahmKench	2.07
4	Sona	1.96
5	Thresh	1.87
6	Lulu	1.56
7	Nami	1.43
8	Braum	1.40
9	Taric	1.20

Table 2: Numeric values for the gold to score ratio of the Supports. The right column is the increase in score per percentage of the game's gold.

As expected, roles such as Assassins and Marksman tend to have higher gold to score ratios. This can be seen in figure three as most of the Assassin and Marksman lines fall to the right of the others. This means a higher percentage of Assassins and Marksman have higher score to gold ratios. This follows the intuition that Marksmen are supposed to get more gold than the supports. But, the interesting part is that not all of the marksman have greater gold to score ratios than the other roles. For example, when looking at the CDF of the Marksman role and the CDF of supports role, there is a sizeable overlap. The top 20% of the supports seem to have a better gold to score scaling than the bottom 20% of the Marksman. For example, Bard has a ratio of gold to score of 2.20 as seen in Table 2. This means for every additional percentage of the total game gold that Bard obtains, he is predicted to have a score of 2.20 points higher than his average performance, or two more kills than deaths. Sivir, a common Marksmen, only has a gold to score ratio of 1.55 as seen in Table 1. This means that for each additional percentage of the game's gold Sivir earns, she is only predicted to have her score increase by 1.55, or one and a half kills more than deaths.

This results in the previously stated question: for the best performance, who should get the gold? In most cases, it is clear that the Marksman seem to have a greater increase in performance when have the gold, but for a select few cases, such as the case with Bard and Sivir, it seems that the support is predicted to have a larger increase in performance than the Marksman. While this is only a correlation, it would support the claim that some supports will have a larger increase in performance than some Marksman. In other words, some supports scale with gold more steeply than some attack damage carries. And, if that is the case, it could be more beneficial to give those champions the gold than the Marksman.

Limitations

This analysis has the limitation of only looking at correlations. It may be that some other factor is the cause of this relationship and it is not gold that causes the increase in score. For example, the supports that have a high gold to score ratio might not have this because they perform better with gold, but rather in games where they happen to have gold, their team does better. These results only indicate a relationship between score and gold, not a causation. Additionally, scores are not standardized by time. In longer games, scores will tend to deviate farther from the mean, 0. In the future, it could prove more accurate to use a metric that takes time into account, such as kills and deaths per minute.

Conclusions and Future Work

The data supports the common assumption that the marksmen roll will perform better with gold than the support roll. But, this is found to not be true for every combination of support and marksman. There are some traditional supports that scale better with gold than traditional marksman. This analysis focuses on the support and marksman rolls because these two rolls are the most clearly related. But, the appendix section includes data for each of the roles. This could lead to a similar analysis of the other roles. For example, Leblanc has the lowest gold to score ratio of the assassin category. This could indicate that Leblanc would perform nearly as well in a supporting role where she is expected to gain less gold. This would allow another champion to use the middle lane and gain more gold.

In the future it would be interesting to find a different metric for performance. It would be interesting to see how different gold distributions affect win rates. But, it is very hard to see a difference in win rate. The difference between a good and a bad win rate is extremely small. But, different metrics of performance could be better metrics of how well a singular champion performed. For example, the amount of damage they do to other champions or the amount of siege damage they do to towers and minions could be other ways of measuring a champion's performance.

To determine if gold is the cause for the change in score there needs to be an experiment. There are too many variables to create a controlled study, thus the only way to determine if these results do indicate a causation will be to try giving gold to different champions in a game and determining how well each champion does. This can be as easy as joining a game with a friend and playing Bard and Sivir. But, instead of having Sivir take the gold from minion last hits, the bard can take it.

APPENDIX

This appendix contains the raw data for each champion. Below is a table for each role and a table for all roles.

Table A: All Roles

RANK	CHAMPION	Score : Gold Ratio
1	Akali	4.09
2	Katarina	3.43
3	Cassiopeia	3.40
4	Warwick	3.28
5	Shaco	2.94
6	Talon	2.91
7	MasterYi	2.90
8	Quinn	2.85
9	Kassadin	2.83
10	Urgot	2.82
11	Varus	2.81
12	XinZhao	2.81
13	Irelia	2.71
14	Yorick	2.69
15	Evelynn	2.67
16	Rengar	2.65
17	MisnsFortune	2.63
18	Mordekaiser	2.63
19	Graves	2.62
20	Veigar	2.60
21	Fiora	2.60
22	Udyr	2.60
23	Caitlyn	2.58
24	Vayne	2.55
25	Ryze	2.53
26	Ezreal	2.52
27	LeeSin	2.52
28	Fizz	2.50
29	Elise	2.47
30	Poppy	2.47
31	Velkoz	2.45
32	Volibear	2.43
33	Riven	2.41
34	Karthus	2.41
35	Lux	2.41
36	Nocturne	2.40

37	Rammus	2.39
38	JarvanIV	2.38
39	Ashe	2.36
40	Corki	2.36
41	Ahri	2.32
42	Swain	2.32
43	Yasuo	2.31
44	Azir	2.31
45	Kalista	2.28
46	Draven	2.26
47	Jinx	2.26
48	Kindred	2.26
49	MonkeyKing	2.26
50	Tristana	2.25
51	Nunu	2.24
52	Amumu	2.24
53	Rumble	2.21
54	Vi	2.21
55	Bard	2.20
56	Garen	2.20
57	KogMaw	2.19
58	Darius	2.19
59	Illaoi	2.18
60	Nidalee	2.18
61	Galio	2.16
62	RekSai	2.15
63	Khazix	2.15
64	Ekko	2.15
65	Jax	2.15
66	Jayce	2.09
67	Zac	2.08
68	Pantheon	2.08
69	Lissandra	2.08
70	TahmKench	2.07
71	Chogath	2.05
72	Malphite	2.04
73	Gangplank	2.04
74	Kennen	2.03
75	Aatrox	2.03
76	Sona	1.96
77	Zyra	1.95
78	Blitzcrank	1.93

79	TwistedFate	1.92
80	Nasus	1.91
81	Orianna	1.90
82	Thresh	1.87
83	Annie	1.86
84	Gragas	1.83
85	Lucian	1.82
86	Trundle	1.81
87	Brand	1.80
88	DrMundo	1.79
89	Ziggs	1.79
90	Xerath	1.78
91	FiddleSticks	1.78
92	Syndra	1.75
93	Shyvana	1.72
94	Renekton	1.67
95	Twitch	1.66
96	Anivia	1.66
97	Gnar	1.61
98	Vladimir	1.60
99	Kayle	1.57
100	Lulu	1.56
101	Sivir	1.54
102	Sion	1.47
103	Nami	1.43
104	Alistar	1.43
105	Braum	1.40
106	Skarner	1.39
107	Morgana	1.38
108	Hecarim	1.34
109	Sejuani	1.30
110	Taric	1.20
111	Maokai	1.12
112	Shen	1.12
113	Leblanc	1.07
114	Malzahar	0.96
115	Diana	0.78

Table B: Mage

Rank	Champion	Score : Gold Ratio
1	Cassiopeia	3.40260960992
2	Veigar	2.60879932584
3	nRyze	2.53278027154
4	Elise	2.47519900711
5	Velkoz	2.45815732929
6	Karthus	2.41609838675
7	Lux	2.41249854342
8	Ahri	2.32331830893
9	Swain	2.32289072302
10	Azir	2.3135237244
11	Lissandra	2.08426924517
12	Kennen	2.0398405894
13	Zyra	1.95629377765
14	TwistedFate	1.92728295031
15	Orianna	1.90991140265
16	Annie	1.86062374784
17	Brand	1.80205676391
18	Ziggs	1.79119570674
19	Xerath	1.78591708205
20	FiddleSticks	1.78056665291
21	Syndra	1.75872341268
22	Anivia	1.6629648905
23	Vladimir	1.60535998472
24	Morgana	1.38343542858
25	Malzahar	0.969487325869

Table C: Tank

Rank	Champion	Score : Gold Ratio
1	Poppy	2.47033509306
2	Rammus	2.39098753422
3	JarvanIV	2.38223905752
4	Amumu	2.2441924635
5	Galio	2.16354566623
6	Zac	2.0862444267
7	Chogath	2.05440199581
8	Malphite	2.04636758866
9	Blitzcrank	1.93473659883
10	Sion	1.47794112748
11	Alistar	1.43779939419
12	Sejuani	1.30886753219
13	Maokai	1.12914659206

14	Shen	1.12027693578
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Table D: Assassin

Rank	Champion	Score : Gold Ratio
1	Akali	4.09207628547
2	Katnarina	3.43727651814
3	Shaco	2.94243224243
4	Talon	2.91985834872
5	MasterYi	2.90900601532
6	Kassadin	2.8304654506
7	Evelynn	2.67116776063
8	Rengar	2.65843377485
9	Fizz	2.50903425514
10	Nocturne	2.40890941284
11	Nidalee	2.18189154116
12	Khazix	2.15387367645
13	Ekko	2.15122719497
14	Leblanc	1.07980374881

Table E: Fighter

Rank	Champion	Score : Gold Ratio
1	Warwick	3.28565099695
2	XinZhao	2.81447993841
3	Irelia	2.71136493872
4	Yorick	2.69289363112
5	Mordekaiser	2.63462711243
6	Fiora	2.60485531039
7	Udyr	2.60383413084
8	LeeSin	2.52507493059
9	Volibear	2.43873010191
10	Riven	2.41922348783
11	Yasuo	2.3136979319
12	MonkeyKing	2.26213756976
13	Rumble	2.21784316446
14	Vi	2.21003762783
15	Garen	2.20137658098
16	Darius	2.19213578498
17	Illaoi	2.18618327952
18	RekSai	2.1580821193
19	Jax	2.1500764753
20	Jayce	2.09788150457

21	Pantheon	2.08525828104
22	Gangplank	2.04120298615
23	Aatrox	2.03868258409
24	Nasus	1.91076363003
25	Gragas	1.83041900369
26	Trundle	1.81040739794
27	DrMundo	1.79858730659
28	Shyvana	1.72918457785
29	Renekton	1.67415092054
30	Gnar	1.61060063732
31	Kayle	1.57984306387
32	Skarner	1.39937937608
33	Hecarim	1.34880998603
34	Diana	0.78395813047

Table F: Marksman

Rank	Champion	Score : Gold Ratio
1	Quinn	2.85
2	Urgot	2.82
3	Varus	2.81
4	MissFortune	2.63
5	Graves	2.62
6	Caitlyn	2.58
7	Vayne	2.55
8	Ezreal	2.52
9	Ashe	2.36
10	Corki	2.36
11	Kalista	2.28
12	Draven	2.26
13	Jinx	2.26
14	Kindred	2.26
15	Tristana	2.25
16	KogMaw	2.19
17	Lucian	1.82
18	Twitch	1.66
19	Sivir	1.54

Table G: Support

Rank	Champion	Score : Gold Ratio
1	Nunu	2.24988376831
2	Bard	2.20193601718
3	TahmKench	2.07343725858
4	Sona	1.96967016582
5	Thresh	1.87482852394

6	Lulu	1.56928152156
7	Nami	1.43953888717
8	Braum	1.40246939174
9	Taric	1.20572486792

Support: Soraka, Zilean, Janna

Mage: Heimerdinger, Viktor, Karma

Marksman: Teemo

Assassin: Zed

Tank: Nautilus, Leanoa, Singed

Fighter: Olaf Tryndamere