Regression to the Mean at The Masters Golf Tournament

A comparative analysis of regression to the mean on the PGA tour and at the Masters Tournament

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1. Introduction

Every sport involves elements of luck and skill. Even on the PGA tour, which is considered as the highest level of golf, scores and winners are often determined by a fortuitous bounce onto the green or an unlucky kick into a hazard. Because golf is such a game of inches, there is an imperfect correlation between player performance and skill. This imperfect correlation can be seen in all sports, and is especially evident in the game of golf. This is why we see so many different winners on the PGA tour and why it is so difficult for players to win multiples tournaments in a given season and even throughout a player's career. The aforementioned imperfect correlation leads to a phenomenon known as *regression to the mean.*

1.1 Regression to the Mean

Regression to the mean is the phenomenon where someone who performs toward an extreme one year is likely to perform closer to the mean the following year. Regression to the mean can be seen in many different aspects of life, but is especially noticeable in sports. It was first observed in 1886 when Sir Francis Galton studied the relationship between the heights of parents and their children (Galton, 1886). This inaugural work has led to further research on the phenomenon. A well-known example of regression to the mean is the "sophomore slump". The sophomore slump is where a player who has a particularly exceptional rookie season shows decline in their second season. This is very much the definition of regression to the mean. A rookie who had an exceptional season likely outperformed their true ability and will regress

towards the mean the following year. Just as a player who underperforms in their first season will likely perform better in their second season.

1.2 The Masters

Each season there are nearly 50 PGA tour events. Of these tournaments there are four major tournaments (majors). The four majors are viewed as the most important tournaments each year. Of the four, The Masters Tournament is the only one played at the same course every year. The Masters was first played in 1934 and typically has a field of eighty to one hundred of the best golfers in the world. Each year The Masters is played at Augusta National, one of the most famous golf courses in the world.

The Masters has been played at Augusta National 73 times, of those 73, 47 have been won by multiple time winners. That is, people who have one at least twice account for nearly two-thirds of the victories at Augusta. That means there have been 26 one-time winners at The Masters. Trevor Immelman won the tournament in 2008 as one of his only two wins on the PGA tour. Furthermore, he has only finished in the top 10 twice in his fifteen appearances at Augusta. This is a rare occurrence at The Masters. Typically, fans see familiar names atop the leaderboard each year. For example, Phil Mickelson has finished in the Top 10 at The Masters in fourteen of his twenty-four professional starts, winning three times. To put that into perspective, Phil has finished in the top 10 in 58% of his Masters starts compared to 34% of his PGA tour starts. Similar to Mickelson, many players seem to 'show up' at The Masters every year. Whether it be the course, the fact that many players tailor their schedule around the tournament, or some other reason, it seems that certain players show less regression to the

mean from year to year at The Masters. It is because of this that I hypothesize that we will see less regression to the mean at The Masters than is seen during the entire PGA Tour season. This goes for both year-to-year as well as from round-to-round.

2. Literature Review

Regression to the mean is studied in a number of different areas, with sports being one of the main focuses. When it comes to sports, a player's performance can be modeled by a combination of luck and skill. Essentially, each athlete has a base skill level and then has different levels of luck on a given day or during a given season. In terms of golf, we see these fluctuations in luck more often than the typical sport. In Kahnemen's *Thinking Fast and Slow* (2011) he offers a simple model of luck and skill, which is as follows:

$$success = talent + luck$$
$$great\ success = a\ little\ more\ talent + a\ lot\ of\ luck$$

This simple model offers insight on regression to the mean in golf and how to intuitively understand the fluctuations in player's scores. Think of the first two rounds of a golf tournament. Say that the average score is par, or a 72. One would expect that a player that shot a 65 has above average skill, but also experienced above average luck. This player is likely to be successful on the second day, but probably less successful because they will not be as lucky as they were on the first day (Kahneman, 2011). Kahneman does a good job of describing the theory behind regression to the mean and more specifically luck and skill in golf, but does not offer any data on the subject.

Connolly and Rendleman (2008, 2009) use this model of luck and skill, but offer more insights on the direct result that it has on golfers. They discovered that the winner of a normal PGA tour event experiences roughly 2.5 strokes per round of abnormally favorable random variation in scoring. Broadie and Rendleman (2015) went deeper in their analysis of luck and skill at all levels of golf by looking at how player's performance changed from the first round to the second round of tournaments. They split players into two groups, based on their first round performance. Group 1 being players in the top half and Group 2 being players in the bottom half. They then looked at how players in each group performed in the second round. They found that Group 1 as a collective performed much worse on the second day while Group 2 showed much improvement. This test showed clear evidence of regression to the mean between the first two round of professional golf tournaments. Their analysis also looked at how different skill levels are effected by luck and skill. They discovered that as you decrease the skill level of golfers from professionals to amateurs to your everyday country club golfer, the variation in scores is more likely to be due to skill rather than luck when the players are less skilled. This is known as the paradox between luck and skill.

Schall and Smith (2000) looked at regression to the mean in professional baseball players. Their analysis did not focus on the model of luck and skill, but used a very similar model for player performance. They did a season-by-season analysis of batting averages and earned run averages standardized each season to have a mean of zero and a standard deviation of 1. They found that there was an imperfect correlation in performance from one year to the next. Because performance is imperfectly measured, players batting averages and earned run averages regress towards the mean.

3. Data

This paper utilizes data obtained from the PGA tours ShotLink database. The database has data on the overall results of tournaments as well as shot-by-shot data for every shot hit in competition play. The PGA tour has hundreds of volunteers at each tournament to help with the collection of the shot-by-shot data. They use this shot-by-shot data to run analyses on players and tournaments to offer insight into how players individually and as a group perform on a number of different layers of skill sets.

In terms of this analysis, the shot-by-shot data is not necessary. This paper utilizes player scores during the first two round at The Masters Tournament as well as average first and second round scores for players throughout the entire season. Scores from the third and fourth rounds are not used as they occur after a number of players are "cut" from the tournament. Data was pulled for the ten-year stretch from 2008 until 2017.

4. Methodology

This analysis differs from previous analyses in that it is a comparative analysis between the PGA tour season and The Masters Tournament. I look to see if there is a significant difference in how players regress to the mean at The Masters compared to throughout the season. Regression to the mean is looked at from year-to-year as well as from round-to-round in a given year. A typical professional golf tournament consists of four rounds of tournament play with poorer performing players being cut following the second round. This paper focuses on the first two rounds of the tournament in order to include every player in the field for a given tournament. In order to see how players perform from one round to the next, this study

uses a test very similar to the one performed by Broadie and Rendleman (2015). The second part of the analysis is to see how players perform across seasons. In order to run this analysis this paper will use a model similar to that used by Schall and Smith (2000).

4.1 Round-By-Round Analysis

The round-by-round analysis compares how players perform from one round to the next during the PGA Tour season and at The Masters. For each group, players are assigned to a one of two groups after the first round of play. The top half (the players who shot the lowest scores) are placed in Group 1, and the bottom half is placed in Group 2. Then the average second-round score is computed for the same groups.

There are several different factors that go into the grouping of players. Players in the first group may simply be more skilled than those in the second group. Or, it could be that the first group just experienced more favorable random variation, also known as “luck”. If it was only the skill of the player that determined the groups one would expect that the players from Group 1 would have a second-round average score roughly the same number of strokes better than Group 2 as they did in the first-round. If luck was the only factor in the first round, then one would expect that the two groups would have averages that are close to equal in the second round. Finally, if a combination of luck and skill is what determines scores then one would expect that the difference between second-round scores would be smaller than the difference was for first-round scores. The difference for groups are then compared between the PGA Tour season and The Masters. This comparison can be quantified by looking at the correlation between differences.

4.2 Year-To-Year Analysis

In order to compare player scores from different years' performance can be standardized by finding the difference between a player's performance from a given year and the mean performance for all players during said year. This number must be divided by the standard deviation of performance across all players for the season.

Following the work of Schall and Smith (2000), a player's performance for a given year is determined by an expected value (x), which can be thought of us the player's skill level or true ability. The player's actual performance then differs from their true ability by a random term (E) that has an expected value of zero and is independent of skill as well as the random terms value in other seasons. This then gives us the following equation:

$$Y = x + E$$

Once players scores are standardized, player's performance can be compared from year-to-year and between the PGA Tour season and The Masters.

5. Results

Analyses of the past 10 seasons show that regression to the mean at The Masters is not significantly different than it is during the PGA tour season. If anything, there is more regression to the mean at The Masters than during the season. When looking at the difference between player score and the average score, the R-squared value at the Masters for the 2015 and 2016 seasons is .105. This is compared with a value of .185 for the PGA tour season. One can see

that while both values are low, the R-squared for The Masters is significantly lower than during the PGA Tour season.

When looking from round-to-round in 2015, the PGA tour season shows as expected regression to the mean with an r-squared value of .131. The masters showed an even smaller value. The R-squared for The Masters in 2015 is .00034, showing nearly no relationship between first and second round scores of players. This seems to show the paradox of luck and skill, which has been seen in previous works.

This lack of correlation between the scores of players between rounds is evident in the round-by-round analysis using two groups. Table 1a below shows that the groups converge towards the mean in the second round. This gives solid evidence confirming the work of Broadie and Rendleman (2015), saying that a combination of luck and skill is what leads to total performance in professional golf. Furthermore, there was no significant difference between the groups at The Masters and during the regular PGA Tour season. During the PGA Tour season, players in the first group still have a lower score than those in the second group in the second round. This is not true for The Masters. At the Masters we see that the first group has a slightly negative correlation between the first and second rounds. Regression to the mean is so severe that Group 1 scores worse than the second group during the second round at The Masters. This seems to suggest that deviation in scores between groups at The Masters is caused solely by luck.

When comparing the correlation of first and second round scores between the different groups, one sees very little correlation for both groups. Maybe the most interesting part is the

manner in which correlations fluctuate from year to year as can be seen in Table 1b. For example, in 2015 Group 1 had saw a fairly significant positive correlation both during The Masters (.24) and during the season (.44) while the group was nearly zero for all other seasons. Group 2, on the other hand, showed a positive correlation in 2016 during the season (.28) and a similarly negative correlation at The Masters (-.22). The fact that the correlation is typically close to zero, and that they fluctuate year by year and group by group goes to show just how random golf can be.

Looking at the correlation between rounds for the entire field at both The Masters and during the PGA season over the past 10 years further reveals the randomness between rounds. The PGA season is much more consistent than The Masters with correlations fluctuating between .29 and .51 over the past 10 years. On the other hand, The Masters fluctuates from .08 to .47 over the same years. The PGA season has a higher correlation between rounds in 8 of the 10 seasons, again suggesting less regression to the mean during the season than during The Masters (Figure 1).

I then split players into two groups based on their average score on tour over the past four years. Group 1 consists of the top half of players of the period and Group 2 consists of the bottom half. The point of this was to split players into groups based on their true ability in order to determine if better players regress to the mean less than less skilled players. Group 1 being the better players and Group 2 being the less-skilled players. I then looked at how each group performed from the first to the second round at The Masters and during the entire PGA Tour season. I found that the players in Group 1 played the first round of The Masters nearly half a stroke better than the second round over the last three tournaments. This is compared

to them shooting .15 strokes better in the first round during the entire season over the past three years. On the other side, the second group shot nearly half a stroke better in the second round of The Masters than the first. This compared to scoring slightly better in the second round throughout the PGA Tour season. These larger difference between rounds at the Masters provides further evidence of more regression to the mean at The Masters than during the PGA Tour season.

While this test did not show any difference in regression to the mean between different skill groups, it did show that the groups performed much differently from round to round. The test shows evidence that the more skilled players on tour play better in the first round than the second round and vice versa for less skilled players. This could be because the worse players have to play better to make the cut, or it could be caused by some other reason.

	PGA TOUR SEASON											
	2015				2016				2017			
	Group 1		Group 2		Group 1		Group 2		Group 1		Group 2	
	RD 1	RD 2	RD 1	RD 2	RD 1	RD 2	RD 1	RD 2	RD 1	RD 2	RD 1	RD 2
Average Score	69.67	69.88	71.04	70.29	69.83	70.39	70.75	70.58	70.00	70.06	71.24	71.02
Std. Dev	0.44	0.53	0.48	0.69	0.32	0.82	0.55	0.71	0.65	0.48	0.39	0.78

	MASTERS											
	2015				2016				2017			
	Group 1		Group 2		Group 1		Group 2		Group 1		Group 2	
	RD 1	RD 2	RD 1	RD 2	RD 1	RD 2	RD 1	RD 2	RD 1	RD 2	RD 1	RD 2
Average Score	68.38	70.69	73.15	70.46	70.54	75.23	76.23	74.00	71.85	73.15	75.77	72.54
Std. Dev	1.98	2.72	1.34	2.44	1.81	2.59	2.52	1.83	2.41	3.21	1.09	2.70

Table 1a: round-by-round comparison

	2015		2016		2017	
Correlation	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2
PGA	0.44	-0.03	-0.02	0.28	-0.08	0.03
Masters	0.24	-0.13	0.04	-0.22	-0.10	0.05

Table 1b: round-by-round correlation

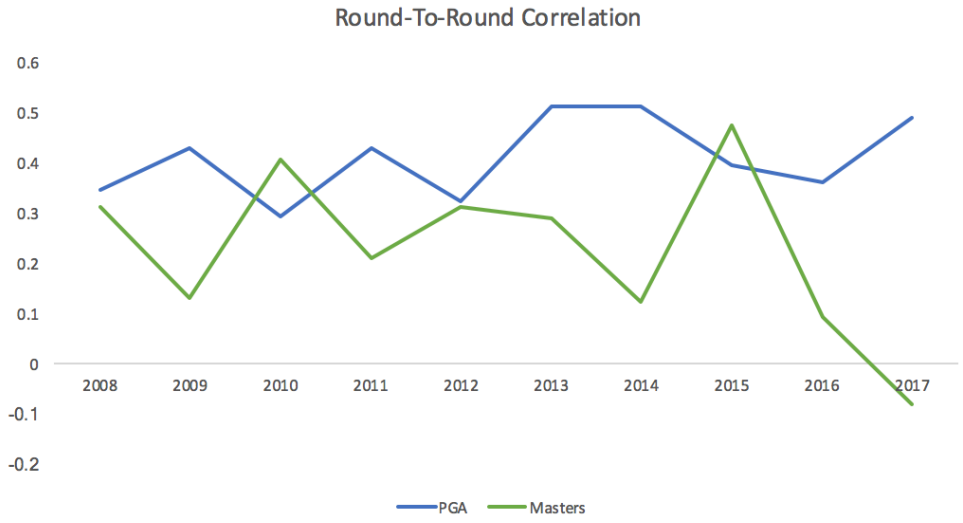

Figure 1: Round-to-round correlation during PGA season and at The Masters from 2008-2017

6. Conclusion

Analyses show that there is not a significant difference in regression to the mean between The Masters Tournament and the PGA tour season. This is apparent on both the round-to-round level as well as the year-to-year analysis. It is of note that the number of observations are low because of the fact that the average golf tournament has fewer than one hundred players.

One thing that is not controlled for in the round-by-round analysis is differing weather conditions. Players typically have one round in the morning and one round in the afternoon during the first two rounds of a tournament. On occasion there is an extreme difference in playing conditions between the morning and afternoon. This change in weather could be a cause for regression to the mean when looking at a singular tournament. It is unlikely that this would be a factor when looking at the entire season.

The fact that at The Masters players from differing groups score practically the same in the second round reveals that scoring at The Masters is based more on luck than during the PGA season. This could be due to the fact that it is much more difficult to qualify for The Masters than it is for regular events. Meaning that the players at The Masters are closer in true ability than they are in a normal tournament.

If players at the Masters show more regression to the mean than during the season, then why is it that players like Phil Mickelson seem to perform better at The Masters? One explanation could be that Mickelson and other players simply match up well with Augusta. It is seen in other tournaments that players play better at certain courses. It could be that Mickelson just so happens to have a game that fits well with one of the most prestigious courses in the world.

7. References

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8. Graphs and Figures

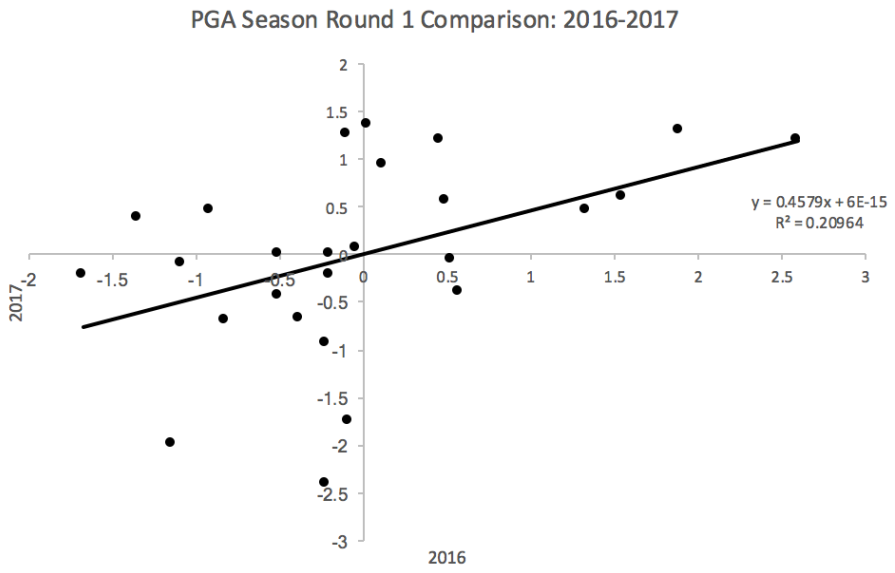

Figure 2: PGA round 1 comparison 2016-2017

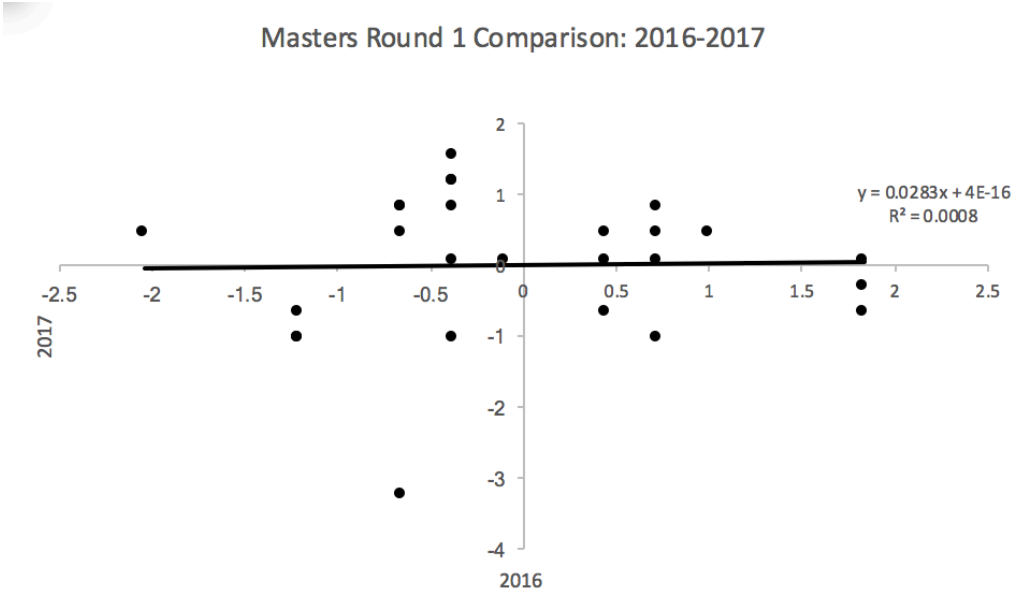

Figure 3: Masters round 1 comparison 2016-2017

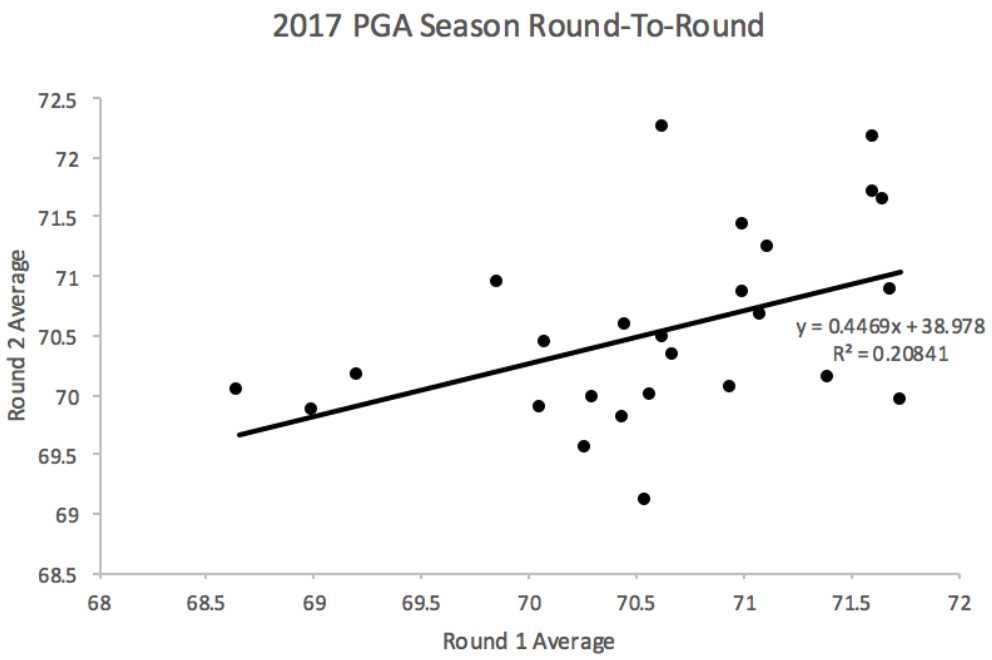

Figure 4: PGA round-to-round 2017

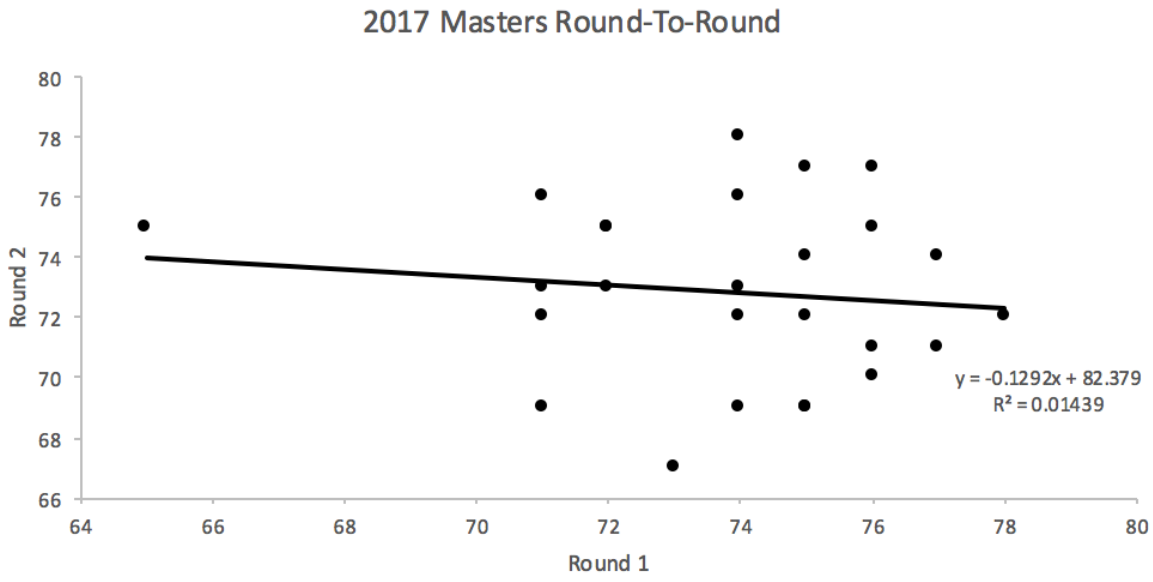

Figure 5: Masters round-to-round 2017

PGA Tour Season

2015			2016			2017		
Player Name	Rd 1 Season Avg	Rd 2 Season Avg	Player Name	Rd 1 Season Avg	Rd 2 Season Avg	Player Name	Rd 1 Season Avg	Rd 2 Season Avg
Group 1			**Group 1**			**Group 1**		
Jason Day	68.68	69.21	Sergio Garcia	69.21	69.86	Paul Casey	68.65	70.04
Bubba Watson	69	69.78	Jason Day	69.42	69.78	Jordan Spieth	69	69.86
Matt Kuchar	69.46	69.92	Jordan Spieth	69.55	69.7	Rickie Fowler	69.2	70.15
Paul Casey	69.57	70	Hideki Matsuyama	69.59	72	Phil Mickelson	69.86	70.95
Zach Johnson	69.58	70	Patrick Reed	69.7	70.41	Justin Rose	70.06	69.88
Kevin Na	69.64	69.52	Justin Rose	69.76	71.65	Matt Kuchar	70.08	70.44
Patrick Reed	69.69	69.92	Charley Hoffman	69.96	70.8	Jason Dufner	70.27	69.55
Webb Simpson	69.81	70.19	Jason Dufner	69.96	70.26	Webb Simpson	70.3	69.96
Jordan Spieth	69.88	68.67	Matt Kuchar	70.04	69.76	Sergio Garcia	70.44	69.81
Hideki Matsuyama	69.92	69.88	Paul Casey	70.14	70.76	Brooks Koepka	70.45	70.59
J.B. Holmes	69.96	70.63	Phil Mickelson	70.14	71.1	Hideki Matsuyama	70.55	69.1
Sergio Garcia	70.21	70	Brooks Koepka	70.16	69.63	Brandt Snedeker	70.57	70
Rickie Fowler	70.25	70.7	Adam Scott	70.16	69.37	Charley Hoffman	70.63	70.47
Group 2			**Group 2**			**Group 2**		
Brandt Snedeker	70.27	70.62	Bubba Watson	70.22	70.94	Adam Scott	70.63	72.25
Phil Mickelson	70.63	70.74	Rickie Fowler	70.23	69.91	Bill Haas	70.67	70.33
Justin Rose	70.68	69.63	Bill Haas	70.26	70.87	Jason Day	70.94	70.06
Brooks Koepka	70.77	69.55	Zach Johnson	70.3	70.22	Patrick Reed	71	70.85
Bill Haas	70.83	70.42	Ryan Moore	70.36	70.09	J.B. Holmes	71	71.43
Adam Scott	70.86	70.71	Jimmy Walker	70.58	71.46	Kevin Na	71.08	70.67
Ryan Moore	70.87	70.26	Kevin Na	70.6	70	Charl Schwartzel	71.12	71.24
Ernie Els	71.06	71.89	Brandt Snedeker	70.62	70.88	Ryan Moore	71.39	70.14
Charley Hoffman	71.15	70	Webb Simpson	70.65	70.4	Jimmy Walker	71.6	71.7
Jimmy Walker	71.17	69.57	J.B. Holmes	71.14	70.67	Ernie Els	71.6	72.17
Louis Oosthuizen	71.5	69.44	Charl Schwartzel	71.28	69.11	Bubba Watson	71.65	71.63
Jason Dufner	71.7	70.15	Louis Oosthuizen	71.5	71.5	Louis Oosthuizen	71.69	70.88
Charl Schwartzel	72.06	70.83	Ernie Els	71.95	71.48	Zach Johnson	71.73	69.95

Table 2: PGA Tour groups for round comparison

The Masters

	2015			2016			2017	
Player Name	RD 1 Score	RD 2 Score	Player Name	RD 1 Score	RD 2 Score	Player Name	RD 1 Score	RD 2 Score
Group 1			**Group 1**			**Group 1**		
Jordan Spieth	64	66	Jordan Spieth	66	74	Charley Hoffman	65	75
Jason Day	67	74	Paul Casey	69	77	Sergio Garcia	71	69
Justin Rose	67	70	Sergio Garcia	69	75	Phil Mickelson	71	73
Ernie Els	67	72	Justin Rose	69	77	Justin Rose	71	72
Charley Hoffman	67	68	Hideki Matsuyama	71	72	Jason Dufner	71	76
Sergio Garcia	68	74	Brandt Snedeker	71	72	Matt Kuchar	72	73
Paul Casey	69	68	Charley Hoffman	71	77	Paul Casey	72	75
Webb Simpson	69	75	Jimmy Walker	71	75	Ernie Els	72	75
Bill Haas	69	71	Jason Day	72	73	Rickie Fowler	73	67
Patrick Reed	70	72	Zach Johnson	72	80	Jason Day	74	76
Phil Mickelson	70	68	Kevin Na	72	74	Bubba Watson	74	78
Bubba Watson	71	71	J.B. Holmes	72	73	Brooks Koepka	74	73
Hideki Matsuyama	71	70	Phil Mickelson	72	79	Ryan Moore	74	69
Group 2			**Group 2**			**Group 2**		
Charl Schwartzel	71	70	Louis Oosthuizen	72	77	Charl Schwartzel	74	72
Matt Kuchar	72	74	Brooks Koepka	73	72	Webb Simpson	75	77
Zach Johnson	72	72	Bubba Watson	75	75	Jordan Spieth	75	69
Adam Scott	72	69	Matt Kuchar	75	73	Brandt Snedeker	75	74
Louis Oosthuizen	72	69	Bill Haas	75	74	Bill Haas	75	72
Rickie Fowler	73	72	Patrick Reed	76	73	Adam Scott	75	69
Jimmy Walker	73	72	Adam Scott	76	72	Kevin Na	76	75
Kevin Na	74	66	Jason Dufner	76	77	Patrick Reed	76	77
Brandt Snedeker	74	73	Charl Schwartzel	76	76	Hideki Matsuyama	76	70
Brooks Koepka	74	71	Webb Simpson	77	72	Jimmy Walker	76	71
Ryan Moore	74	66	Rickie Fowler	80	73	Zach Johnson	77	74
Jason Dufner	74	71	Ryan Moore	80	75	Louis Oosthuizen	77	71
J.B. Holmes	76	71	Ernie Els	80	73	J.B. Holmes	78	72

Table 3: Masters groups for round comparison