

FanDuel Skill Analysis

Introduction

With many games there are elements of both skill and luck and determining which is the dominant factor can be fairly ambiguous. There are ongoing debates as to whether poker qualifies as a skill game with different courts coming to different conclusions. To analyse whether Daily Fantasy Sports is a game of skill we have analyzed our players' performance and benchmarked results against chance and games of skill.

Methodology

Measure of Skill:

For this analysis we use player scores as our measure of skill. As scores can vary dramatically between sport and games within sports (based on the fixtures), for each game (group of contests with the same fixture list and salary cap) a player is assigned a rating based on their relative finishing position (between 0 and 1). E.g. A player enters an MLB head-to-head contest and wins. He may be first in that contest, but in fact across hundreds of H2H and tournament contests his score is only the 200th highest out of 1,000. His rating would then be 0.2.

The average of this rating over multiple games in a period then becomes the player's skill rating.

Data Selection:

To utilize as much data as possible and look at behavior within a consistent environment the latest completed seasons for the major sports (MLB, NBA, NFL and NHL) have been used for this study. Additionally, for outputs across all sports 2012 data is used in its entirety.

Control and Test Periods:

Instead of comparing one season against another season where there could be differences in the game format or player mix the outputs are all generated from two periods in the same season. To remove as many intra-season effects as possible the control period is always **odd** weeks of the season, with the test period then the **even** weeks. This is preferable to first half vs second half as we expect a significant volume of players to lapse before the second half of any season. There is also empirical evidence to suggest that players increase skill over time, a trend that can be captured in an odd vs even comparison, but may well appear as a structural shift from first half to second half.

Outputs:

There are three core outputs from the analysis, each of which should add credence to our argument

- 1) Skill Matrix – Splitting the players down into three bands based upon their average rating in each period and creating a crosstab to see the percentage in each group.
A game of chance would see even numbers of players in each segment of the matrix, whereas a game of perfect skill would see players only remaining in the same band.

- 2) Correlations – Finding the average rating of players in each period and the correlation between the two.
A game of chance would have zero correlation as performance in one period would have no effect on another period, whereas a game of perfect skill would have 100% correlation.
- 3) Matchups – Ranking players in period one and working out how many times specific groups outscore other groups in period two, where the groups are top players vs other subsets of players.
A game of chance would result in the top players only beating any other subset of players 50% of the time as their ranking in period one does not increase their probability of winning in period two.
A game of perfect skill would result in the top players outscoring all other subsets of players 100% of the time as their ranking in period one means they are always going to be better players.

Benchmarks:

Similar outputs were also created for the following datasets, where the skill level differs in each:

- Random uniform and normal distributions
- A game of dice where die 1 is always fair and die 2 has varying degrees of bias
- PGA Tour – player rounds and tournament finishes for 2008 and 2009 seasons

Results

1) Skill Matrix:

There are three main measures for comparison in the matrices

- The main diagonal – from top left to bottom right looking at players that remain in the same skill band across both periods
- Symmetry about the main diagonal – comparing the proportion of players who have moved to/from the same bands (e.g. 1 to 2 and 2 to 1)
- Trace – the sum of the main diagonal

All Sports – Minimum number of games in each period of 100 games. Period 1 is odd weeks 2012, period 2 is even weeks 2012.

% Players	Even		
	1	2	3
Odd			
1	75%	23%	2%
2	23%	54%	22%
3	2%	23%	75%

There is almost perfect symmetry in this matrix showing a very strong indicator of skill predominance with 75% of both band 1 and band 3 players in period 1 remaining in the same bands in period 2. The majority of band 2 players remain in the middle, with equal chances of improving or deteriorating. The trace of 204% is higher than that of the individual FanDuel sports.

MLB – Minimum number of games in each period of 100 games. Period 1 is odd weeks of 2012 season, period 2 is even weeks of 2012 season.

% Players	Even		
	1	2	3
Odd			
1	69%	27%	4%
2	28%	46%	26%
3	4%	27%	69%

There is a clear symmetry about the main diagonal for MLB and, though the trace is less than the overall at 184%, there are still 69% of band 1 and 3 players remaining consistent.

NBA – Minimum number of games in each period of 50 games. Period 1 is odd weeks in 2012/13 season, period 2 is even weeks of 2012/13 season

% Players	Even		
	1	2	3
Odd			
1	73%	25%	2%
2	24%	54%	22%
3	2%	24%	74%

NBA has the highest trace of the individual sports (200%) and previous studies have shown it to be the

sport of the greatest variance in skill, requiring the least number of “average” games to be added to reach a mean regressed skill rating.

NFL - Minimum number of games in each period of 40 games. Period 1 is odd weeks in 2012/13 season, period 2 is even weeks of 2012/13 season

% Players	Even		
	1	2	3
1	57%	24%	20%
2	29%	50%	21%
3	8%	26%	67%

With NFL being our only weekly sport the opportunity to play as many games in a season as the daily sports is limited. For this reason we are often looking at smaller samples and slightly less robust results. At 40 games minimum we do not observe so much symmetry as the other sports, but high proportions on the main diagonal still give a trace of 174%.

NHL – Minimum number of games in each period of 50 games. Period 1 is odd weeks in 2012/13 season, period 2 is even weeks of 2012/13 season (though the season didn’t start until 2013 due to a lockout)

% Players	Even		
	1	2	3
1	61%	33%	6%
2	28%	41%	31%
3	7%	32%	61%

The lockout in this season limited the volume of NHL players, but at 50 games we are still able to observe good symmetry in the matrix with very few players moving from band 1 to band 3 (and vice versa). Bearing in mind that we expect 33% of players in each band, even on NHL we have nearly double that for the corners on the main diagonal which contribute to a 163% trace.

Random Uniform Distribution – A simulation of 20,000 random uniform distributed observations (evenly distributed between 0 and 1 to represent average rating in the FanDuel model) between 100 players who have approximately 200 “games” each.

% Players	Even		
	1	2	3
1	27%	42%	30%
2	38%	32%	29%
3	33%	27%	39%

The main diagonal does not stand out in this flat matrix that randomly varies about 33% for each segment. The trace is only 98% and whilst there is some symmetry this is to expected

Random Normal Distribution – A simulation of 20,000 random normally distributed observations (distributed about a bell curve and scaled between 0 and 1 to represent average rating in the FanDuel model) between 100 players who have approximately 200 “games” each.

% Players	Even		
Odd	1	2	3
1	27%	33%	39%
2	32%	35%	32%
3	39%	33%	27%

The normal distribution matrix is almost a carbon copy of the uniform distribution as theoretically it should also have all segments at 33%. The trace here is 89%, though with increased observations we’d expect to see this tend to 100%.

Game of Dice – A simulation of 20,000 random throws of a fair die between 200 players who have approximately 100 throws each. The average score is used as a proxy to average rating for FanDuel players (where that rating is based on relative scores in any game).

% Players	Even		
Odd	1	2	3
1	33%	34%	33%
2	35%	37%	28%
3	30%	34%	36%

Throwing a die will randomly land between 1 and 6, but over time we would expect the average score to tend to 3.5. After 100 throws each we see that players average scores on odd turns do not have any impact on their scores on even turns as all segments are roughly around 33%. The matrix trace is 106%.

PGA Tour Tournaments – Average tournament finishing position for the 192 golfers who played in 10 or more tournaments in both the odd and even weeks of the 2008 and 2009 seasons.

% Players	Even		
Odd	1	2	3
1	63%	30%	8%
2	30%	36%	34%
3	8%	34%	58%

A highly symmetric matrix, but with a trace below that of all FanDuel sports. There is high consistency among groups 1 and 3, but group 2 shows a lot of migration, almost to the point where it follows a random pattern.

PGA Tour Rounds – Average round ranking for the 234 golfers who completed 20 or more rounds in both the odd and even weeks of the 2008 and 2009 seasons.

% Players	Even		
Odd	1	2	3
1	67%	27%	6%
2	29%	41%	29%
3	4%	32%	64%

Breaking out tournaments into rounds gives more data points and this matrix shows a little more consistency within each band leading to a higher trace. However, comparing to the FanDuel matrices it looks a lot weaker than most.

Trace Summary:

Type	Data	Trace
FanDuel	All	204%
FanDuel	MLB	184%
FanDuel	NBA	200%
FanDuel	NFL	174%
FanDuel	NHL	163%
Simulation	Uniform Distribution	98%
Simulation	Normal Distribution	89%
Simulation	Fair Dice	106%
PGA Tour	Tournaments 2008/9	156%
PGA Tour	Rounds 2008/9	172%

FanDuel across all sports has the highest trace and is then followed by FanDuel NBA. All FanDuel variations have a higher value than the PGA Tour tournament rankings and aside from NHL the same can be said for round rankings. The random values are roughly around 100% as is the expectation and the difference between chance games and skill games is very obvious to see here.

2) Correlations:

The table below summarizes correlations between odd and even periods:

Type	Data	Minimum Requirements	Players	Correlation
FanDuel	All	100 Games	1,101	83%
FanDuel	MLB	100 Games	266	71%
FanDuel	NBA	100 Games	185	86%
FanDuel	NFL	40 Games	132	57%
FanDuel	NHL	50 Games	221	64%
Simulation	Uniform Distribution	200 Observations	100	3%
Simulation	Normal Distribution	200 Observations	100	-3%
Simulation	Fair Dice	100 Throws	200	2%
PGA Tour	Tournaments 2008/9	10 Tournaments	192	63%
PGA Tour	Rounds 2008/9	20 Rounds	234	70%

Note: The simulated events are an average number of observations per player and the correlation is calculated as an average of 20 outputs.

Chance games have zero correlation as we see from the results of the random distributions and the average scores of a fair die. It doesn't matter how well you score in one period for these games as it does not have any impact on your scores in a different period.

Golf is frequently used as a prime example of a game of skill and this is evident from the correlation coefficients in the above table. If players generally finish towards the top of the field in tournaments then we can expect them to have similar finishes in additional tournaments. Similarly, for players who tend to miss the cut, the prediction would be for them to struggle in other tournaments and shoot higher rounds.

For FanDuel the overall correlation across all sports in 2012 was 83%, significantly higher than both measures from the PGA Tour data. Generally the more games played then the closer each player's mean rating is to their true skill level as anomalies will be smoothed out. With NHL and, in particular, NFL not having the luxury of as many players and/or games we can expect a little more variability in ratings and therefore do see slightly lower correlations. Yet the correlation for NHL is higher than that of the PGA tournaments and as NFL is still safely above 50% the indication would be for skill dominating chance even at this lower end of the FanDuel scale.

3) Matchups:

By creating groups of players in a control period (i.e. odd weeks) we can then see how often one group outscores another in a test period (i.e. even weeks). The table below shows the results of matchups between different groups:

Type	Data	Player	Opponent	Matchups	Win Rate
FanDuel	All Sports 2012	Top 1%	Bottom 1%	7,956	78%
FanDuel	MLB 2012 Season	Top 1%	Bottom 1%	6,202	66%
FanDuel	NBA 2012/13 Season	Top 1%	Bottom 1%	29,939	82%
FanDuel	NFL 2012/13 Season	Top 1%	Bottom 1%	19,054	71%
FanDuel	NHL 2012/13 Season	Top 1%	Bottom 1%	2,130	67%
FanDuel	All Sports 2012	Top 10%	Bottom 10%	792,553	67%
FanDuel	MLB 2012 Season	Top 10%	Bottom 10%	710,740	62%
FanDuel	NBA 2012/13 Season	Top 10%	Bottom 10%	3,098,596	73%
FanDuel	NFL 2012/13 Season	Top 10%	Bottom 10%	2,230,291	65%
FanDuel	NHL 2012/13 Season	Top 10%	Bottom 10%	266,225	61%
FanDuel	All Sports 2012	Top 10%	Single Game Player	153,194	73%
FanDuel	MLB 2012 Season	Top 10%	Single Game Player	25,024	71%
FanDuel	NBA 2012/13 Season	Top 10%	Single Game Player	55,914	83%
FanDuel	NFL 2012/13 Season	Top 10%	Single Game Player	506,379	73%
FanDuel	NHL 2012/13 Season	Top 10%	Single Game Player	7,406	69%
FanDuel	All Sports 2012	Bottom 10%	Single Game Player	137,461	57%
Simulation	Random Uniform	Top 10%	Bottom 10%	100	50%
Simulation	Random Normal	Top 10%	Bottom 10%	100	50%
Simulation	Dice Game	Fair Die	Fair Die	16,683	50%
Simulation	Dice Game	Loaded Die - 2/7 chance of 6	Fair Die	16,577	57%
Simulation	Dice Game	Loaded Die - 3/8 chance of 6	Fair Die	16,627	62%
Simulation	Dice Game	Loaded Die - 4/9 chance of 6	Fair Die	16,631	66%
Simulation	Dice Game	Loaded Die - 1/2 chance of 6	Fair Die	16,609	70%
Simulation	Dice Game	Loaded Die - 7/12 chance of 6	Fair Die	16,638	75%
Simulation	Dice Game	Loaded Die - 2/3 chance of 6	Fair Die	16,612	80%
Simulation	Dice Game	Loaded Die - 3/4 chance of 6	Fair Die	16,600	85%
PGA Tour	Tournaments 2008/9	Top 10%	Bottom 10%	2,004	80%
PGA Tour	Rounds 2008/9	Top 10%	Bottom 10%	5,454	70%

Note 1: For the random distributions the number of matchups and win rates are the average of 20 outputs.

Note 2: For the dice game in every instance where the first die is loaded the chances of all other numbers are equal. So "Loaded Die – 1/2 chance of 6" has a 1/10 chance to land on any other number.

For the random distributions being in the top 10% or bottom 10% for one period is irrelevant when matching players against one another in a different period. After enough matchups the win rate will always tend to 50% where no group of players has an edge over another group.

Looking at the dice game next we see that two completely fair dice, when rolled against each other 20,000 times (tied games have been excluded), would result in a 50/50 split between player (die 1) and opponent (die 2) winning. Considering on average each die would score 3.5 this is the expected result in a totally random, or chance, experiment.

Once we begin to tamper with die 1 we are increasing the average score of that die and giving it an edge over the fair die. So over time we see that die 1 outscores and beats die 2. When the probability of hitting a 6 is 1/2 the average score for that die will be 4.5, which then beats our fair die, scoring only 3.5 on average, 70% of the time. The bias in these examples are a proxy for skill where we are saying that the fair die would

finish in a random position of any game, but the loaded die would finish in the top 16.7% of positions half the time and the bottom 83.3% positions the other half the time.

On the PGA Tour there is a spectrum of skill amongst the golfers where the best players win the most tournaments and have the highest earnings. 80% of the time the top ranked players finish above the bottom ranked players in tournaments, excluding those where players shoot the same overall scores. Most of the time a familiar name will be victorious, but it's not hugely uncommon for a relatively unknown player to win or get close to winning a tournament.

As tournaments are a collection of rounds it eliminates some of the variability in scores, where a good player can shoot an uncharacteristic high round or a bad player shoot a low round if all facets of their game come together. For this reason it may make more sense to concentrate on the analysis at the round level without the grouping together and resultant smoothing seen at the tournament level. This is more akin to FanDuel, where the best players can draft a bad team like the best golfers shooting a bad round. With matchups on rounds instead of tournaments the top ranked golfers shoot better rounds the bottom ranked golfers 70% of the time.

Now to see where FanDuel fits in relative to the games of chance and skill. If we take the top 10% vs bottom 10% across all sports the win rate is 67%, which is a clear edge demonstrating that the top player beats the bottom player twice as often as he loses to him. This is clearly no longer a fair game and over so many matchups any chance elements are then dominated by skill. Going back to the dice examples, this win rate is equivalent to throwing a die that lands on a 6 nearly half the time against a fair die. With ties eliminated that means a *guaranteed* win between 45% and 50% of the time.

Comparing to golfers' rounds the win rate of the top players against the bottom players are very closely matched, which compounds the skill argument for FanDuel. In both golf and FanDuel the "bottom players" are not unskilled, they simply finish further down the field than the expert players over time. A golfer on the PGA tour, regardless of a low ranking, would still dominate an amateur club player, much like a frequent FanDuel player with lower finishes would score more than somebody with little knowledge or ability to utilize their salary cap.

To prove this, if we look at the bottom 10% of FanDuel players across all sports, who have at least 100 games experience, and match them against new players who only ever played in a single game, then we observe a 57% win rate for the so-called bottom players. The same set of matchups for the top 10% of players yields a 73% win rate, higher than the 67% of top vs bottom matchups previously highlighted.

If we tighten the player and opponent groups to top and bottom 1% we now have a 78% win rate for the top players, outscoring their opponent nearly 4 times more than they lose to them. This win rate is now above the PGA result at the round level and virtually on par with the result at the tournament level. The increase in win rate (11%) by shrinking the FanDuel groups from 10% to 1% is very similar to the increase (10%) seen by using tournaments instead of rounds on the PGA Tour, which can be explained by the smoothing factor experienced by combining 4 or 5 rounds into a single score.

Comparing to the game of dice this 78% win rate is like throwing a 6 and guaranteeing a win 63% of the time against a fair dice. If the only two factors are skill and chance then this analogy must prove that skill dominates chance.

Summary

Combining the results from the three outputs we have evidence that FanDuel players are consistent in their ability over two random periods, they're overall ratings in games are highly correlated, and higher ranked players frequently outscore lower ranked players as well as new players with less experience. The vast deviations of FanDuel from pure chance outcomes are readily demonstrated by the replication of results on the random distribution and simulated dice games. The key comparisons here are:

	FanDuel	Random
Trace	204%	100%
Players in Main Diagonal	68%	33%
Correlation	83%	0%
Top 10% vs Bottom 10%	67%	50%

Having establishing that FanDuel has no resemblance to a pure chance we can then look at the comparisons to the results from the PGA Tour data, which is a game of irrefutable skill and that follows a familiar format with regard to the tournament rankings:

	FanDuel	PGA Tour	
		<i>Tournaments</i>	Rounds
Trace	204%	156%	172%
Players in Main Diagonal	68%	52%	57%
Correlation	83%	63%	70%
Top 10% vs Bottom 10%	67%	80%	70%

As previously discussed in the most relevant comparison between FanDuel and golf is on the round level, though for completion the tournament results are also be referenced. For all statistics FanDuel is very clearly on the same level as golf and scores marginally lower only in the matchups category. This is compelling evidence to suggest that FanDuel is, like golf, a game of skill, where skill predominates over chance.

Appendix

All FanDuel matchups:

Player	Opponent	Sport	Min Games	Players	Opponents	Matchups	Player Wins	Win Rate
Top 1%	Bottom 1%	ALL	100	12	13	7,956	6,180	78%
Top 1%	Bottom 10%	ALL	100	12	123	74,888	53,198	71%
Top 1%	Bottom 50%	ALL	100	12	614	397,416	263,066	66%
Top 1%	Bottom 90%	ALL	100	12	1,105	751,208	474,252	63%
Top 1%	Bottom 99%	ALL	100	12	1,215	836,035	520,272	62%
Top 10%	Bottom 10%	ALL	100	122	123	792,553	532,717	67%
Top 10%	Bottom 50%	ALL	100	122	614	4,208,881	2,616,533	62%
Top 10%	Bottom 90%	ALL	100	122	1,105	7,846,513	4,639,955	59%
Top 10%	Single Game FTDs	ALL	100	122	2,521	153,194	111,700	73%
Bottom 10%	Single Game FTDs	ALL	100	123	2,523	137,461	78,589	57%
Top 1%	Bottom 1%	MLB	50	14	15	6,202	4,097	66%
Top 1%	Bottom 10%	MLB	50	14	150	65,772	42,750	65%
Top 1%	Bottom 50%	MLB	50	14	746	358,232	218,485	61%
Top 1%	Bottom 90%	MLB	50	14	1,342	660,572	389,883	59%
Top 1%	Bottom 99%	MLB	50	14	1,477	731,735	428,196	59%
Top 10%	Bottom 10%	MLB	50	149	150	710,740	441,900	62%
Top 10%	Bottom 50%	MLB	50	149	746	3,911,587	2,260,037	58%
Top 10%	Bottom 90%	MLB	50	149	1,342	7,215,274	4,020,002	56%
Top 10%	Single Game FTDs	MLB	50	149	362	25,024	17,849	71%
Bottom 10%	Single Game FTDs	MLB	50	150	363	19,489	11,466	59%
Top 1%	Bottom 1%	NBA	50	27	28	29,939	24,543	82%
Top 1%	Bottom 10%	NBA	50	27	272	309,491	238,546	77%
Top 1%	Bottom 50%	NBA	50	27	1,357	1,628,721	1,169,681	72%
Top 1%	Bottom 90%	NBA	50	27	2,442	2,993,310	2,025,920	68%
Top 1%	Bottom 99%	NBA	50	27	2,686	3,309,454	2,200,737	66%
Top 10%	Bottom 10%	NBA	50	271	272	3,098,596	2,257,041	73%
Top 10%	Bottom 50%	NBA	50	271	1,357	16,290,893	10,952,677	67%
Top 10%	Bottom 90%	NBA	50	271	2,442	29,906,024	18,833,561	63%
Top 10%	Single Game FTDs	NBA	50	271	335	55,914	46,486	83%
Bottom 10%	Single Game FTDs	NBA	50	272	335	49,068	31,062	63%
Top 1%	Bottom 1%	NFL	20	48	49	19,054	13,561	71%
Top 1%	Bottom 10%	NFL	20	48	483	214,969	142,256	66%
Top 1%	Bottom 50%	NFL	20	48	2,414	1,115,724	695,593	62%
Top 1%	Bottom 90%	NFL	20	48	4,345	2,046,157	1,225,448	60%
Top 1%	Bottom 99%	NFL	20	48	4,779	2,254,589	1,335,279	59%
Top 10%	Bottom 10%	NFL	20	482	483	2,230,291	1,442,197	65%
Top 10%	Bottom 50%	NFL	20	482	2,414	11,580,335	7,017,072	61%
Top 10%	Bottom 90%	NFL	20	482	4,345	21,239,003	12,299,817	58%
Top 10%	Single Game FTDs	NFL	20	482	2,026	506,379	368,008	73%
Bottom 10%	Single Game FTDs	NFL	20	483	2,026	481,445	277,254	58%
Top 1%	Bottom 1%	NHL	20	13	14	2,130	1,420	67%
Top 1%	Bottom 10%	NHL	20	13	131	22,879	14,070	61%
Top 1%	Bottom 50%	NHL	20	13	655	126,705	73,697	58%
Top 1%	Bottom 90%	NHL	20	13	1,179	236,991	132,449	56%
Top 1%	Bottom 99%	NHL	20	13	1,296	260,749	144,327	55%
Top 10%	Bottom 10%	NHL	20	130	131	266,225	162,308	61%
Top 10%	Bottom 50%	NHL	20	130	655	1,493,873	864,004	58%
Top 10%	Bottom 90%	NHL	20	130	1,179	2,788,054	1,550,045	56%
Top 10%	Single Game FTDs	NHL	20	130	115	7,406	5,085	69%

Bottom 10%	Single Game FTDs	NHL	20	131	115	6,686	3,618	54%
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Dice Game:

Die	Prob (6)	Prob (Others)	Exp(Score)	Avg Score	Non-tied Trials	Wins	Win Rate	6 Rate
Normal	1/6	1/6	3.50	3.51	16,683	8,337	50%	17%
Loaded 1	2/7	1/7	3.86	3.87	16,577	9,498	57%	29%
Loaded 2	3/8	1/8	4.13	4.12	16,627	10,277	62%	38%
Loaded 3	4/9	1/9	4.33	4.32	16,631	11,006	66%	44%
Loaded 4	1/2	1/10	4.50	4.50	16,609	11,613	70%	50%
Loaded 5	6/11	1/11	4.64	4.64	16,631	12,100	73%	55%
Loaded 6	7/12	1/12	4.75	4.75	16,638	12,479	75%	59%
Loaded 7	8/13	1/13	4.85	4.85	16,571	12,791	77%	62%
Loaded 8	9/14	1/14	4.93	4.93	16,635	13,064	79%	64%
Loaded 9	2/3	1/15	5.00	5.00	16,612	13,266	80%	67%
Loaded 10	3/4	1/20	5.25	5.24	16,600	14,049	85%	75%
Loaded 11	1	0	6.00	6.00	16,609	16,609	100%	100%