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Are daily fantasy sports gambling?

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Abstract. Millions of people play daily fantasy sports in the hopes of winning money. The two largest daily fantasy sports companies, FanDuel® and DraftKings® process billions of dollars in entry fees every year. Recently, daily fantasy sports have landed in a tense political climate and some states have declared these activities as gambling because they are games of chance. If daily fantasy sports are games of chance, then every strategy should perform equally well. A study of FanDuel®'s NFL® contests provides statistically significant evidence that a participant's fantasy score is not based upon chance. Another study spent $85 to enter 35 DraftKings® MLB Double Up contests with randomly selected teams. All 35 entries lost and the odds of this occurring, if these contests are chance, is 1 in 312,681,518. These odds are less likely than winning the Powerball lottery with a single ticket. Thus, daily fantasy sports are not games of chance, and the authors recommend that these contests should not be considered gambling.

Keywords: Fantasy sports, gambling law, simulation, integer programming, probability

1. Introduction

Sports is infused into modern society and impacts billions of people worldwide. The 2015 Super Bowl had the largest audience in TV history with about 114.4 million viewers (Pallotta, 2017). Ticket sales for the FIFA 2014 World Cup generated $527,000,000 in revenue (Manfred, 2015). Sports are a prominent aspect in people's lives, and a large percentage of children dream of achieving star status by becoming professional athletes.

Immersed in sports culture, many people question decisions as they cheer for their favorite teams. Coaches face either heavy criticism or praise based on the decisions they make for their team. Trades, contract extensions and free agency decisions are only a few of the decisions team owners and general managers must make. From an outsider's perspective, many fans believe that they could do better. Fantasy sports provide a partial avenue for such aspirations.

Participants in a fantasy sports contest act as an owner or general manager and select athletes to form a fantasy team. Athletes compile fantasy points throughout a sporting event based on his or her on-field performance. A fantasy team's total score is the sum of each selected athlete's fantasy points. Participants are ranked amongst each other based on the team's fantasy points and prizes are awarded.

The two primary versions of fantasy sports are season long and daily. In a season long fantasy league, participants draft players and compete over the course of the season. In contrast, daily fantasy sports (DFS) last for a single set of games, which typically range from a single day to a weekend. Thus, an individual that selected a poor team in DFS can select an entirely different team for the next contest, which may be the next day or potentially just the evening games for a day.

Fantasy sports are popular with about 60 million participants (FSTA, 2017). Two companies, FanDuel® and DraftKings®, are responsible for about 90% of the DFS business (Van Natta, 2016). According to Heitner (2016) the DFS industry is expected to grow and produce almost 15 billion dollars in revenue by the year 2020. Furthermore, fantasy sport participation has been shown to increase game attendance and sports media viewership (Nesbit, 2010).

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DFS companies offer many types of contests. Some are head to head and others have over 100,000 entries. The payout of the contests also widely vary. A common contest is a double up where 40–45% of participants win double the entry fee. Another common contest is a tiered contest where the participant who earns the most fantasy points earns the most money. Second place wins less and this pattern continues. In a tiered contest, the bottom 70–80% receive no payout. Both FanDuel® and DraftKings® have tiered contests where the top prize is a million dollars. The popularity of tiered contests developed rapidly because a small entry fee may change someone's life.

The popularity and growth of the DFS industry began to catch the attention of American politicians. In 2015, the State of Nevada deemed that operating DFS in Nevada is illegal without a gambling license. The decision by Nevada is arguably the most impactful on the daily fantasy sports industry (Drape, 2016). Shortly after this ruling, numerous states created regulations on the legality of DFS. As of March 2017, 41 states have proposed legislation on daily fantasy sports (Gouker, 2017).

The states' regulations focus on large companies hosting DFS contests and taking a "rake", a percentage of the entry fees (Grove, 2017; Purdum, 2015). FanDuel® and DraftKings® are fighting these rulings and regulations in the courts or by lobbying for favorable state laws. These companies' core argument is that DFS contests require more skill than luck and should not be considered gambling.

The accusations that daily fantasy sports should be considered gambling causes a major issue for the industry. Fewer players are legally able to enter contests. The issue has damaged the reputation of FanDuel® and DraftKings® as well as their financial status. Media conglomerate Fox withdrew 65 million dollars of their investment in DraftKings® in early 2016, claiming that the value of DraftKings® had plummeted by 60% (Isidore, 2016). Due to legal fees and lobbying costs, the companies decided to merge (Drape, 2017). Recently, the Federal Trade Commission blocked the merger due to anti-trust laws (Perez, 2017).

As lawmakers, courts and companies have struggled in this conflict, the question of what constitutes gambling has been a central focus. The true definition of gambling is based upon laws, which vary from state to state or even by a few feet. For instance, a casino can be legally located in the middle of a river that separates two states. Moving this casino to either shore makes the casino illegal.

A gambling definition not based upon the whims of individuals or states is necessary for any academic study. For instance, online poker was legal in the U.S.A. until The Unlawful Internet Gambling Enforcement Act (UIGEA) of 2006. In 2012, federal judge Jack Weinstein ruled that poker games are more games of skill than chance (Secret, 2012). Judge Weinstein's opinion relied heavily upon a study of over 100 million online Texas Hold'em poker hands (Hope and McCulloch, 2009). This study showed that 75% of hands were won because every person, except one, folded. Furthermore, only 12% of hands were won by the individual with the starting two best cards. The strategy and skill of betting plays a critical role in whether or not an individual wins a poker hand. Consequently, the judge ruled that poker has enough skill (betting strategy) that it is not gambling.

The definition of gambling for this paper is summarized from Rose (2009). All gambling activities must have three properties: consideration, prize and chance. The definitions of prize and chance are obvious. Consideration occurs when an individual must decide to participate in an activity. Consequently, the participant must offer an item of value. If any one of these three properties is missing, then the activity is not considered gambling. For instance, a no-purchase-necessary sweepstakes is not gambling due to a lack of consideration. A charity casino night has an entry fee and all proceeds go to the charity, but it lacks a prize and is not gambling. Finally, entering a sporting event with an entry fee and a cash prize for first place is not gambling due to the skill needed to win.

Clearly daily fantasy sports satisfy the consideration and prize components of gambling. This paper focuses on whether or not these contests satisfy the chance condition. Two studies show that chance has no reasonable probability of outperforming skill in DFS contests.

The previous statement is fairly bold as chance impacts everything. For instance, the addition of a single player to a chess tournament may change the number of times a player plays with the white or the black pieces. Since white has a small advantage, the number of entrants, which is certainly a product of chance, may aid in determining the champion. In a particularly famous instance, the Pittsburgh Steelers correctly called a coin flip, but the referee said that the Steelers lost and awarded the ability to receive the overtime kickoff to the Detroit Lions. Thus, events where chance is not supposed to exist have randomness. Attempting to argue that chance does not impact DFS is flawed.

FanDuel® and DraftKings® would like to claim "All DFS winners are skilled." Directly proving this statement is next to impossible, as every winner must be evaluated for skill. However, the contrapositive statement, which is logically equivalent, states "Unskilled participants never win in DFS." This paper shows this contrapositive statement has an extremely high probability of being true. Consequently, one can probabilistically argue that all winners of DFS are skilled and thus DFS are games based primarily upon skill. Therefore, the authors recommend that public servants no longer classify DFS contests as gambling.

The remainder of the paper is organized as follows. Section 2 describes DFS in more detail. A study applying statistics to the earned fantasy points from FanDuel®'s NFL contest is in section 3. Section 4 presents the impact of luck on DraftKings® DFS MLB contests. The paper concludes in section five with some final comments and recommendations.

2. Daily fantasy sports

Fantasy football, one of the most popular fantasy sports, began in 1962 (Lomax, 2006). Bill Winkenbach, a limited partner of the Oakland Raiders, was on a trip to New York with the Raiders and two journalists for the Oakland Tribune. In their hotel room, the Greater Oakland Professional Pigskin Prognosticators League, known today as fantasy football, was born. Since then, developments in technology have taken fantasy sports to a new level. Providing participants real-time statistics, fantasy sport websites make it much easier and enjoyable for a person to participate.

A fantasy sport is a game that allows its participants to act as the owner of a sports team. As the owner of a fantasy team, a game participant selects real-life players of the professional sport to be a part of his or her team. DFS companies limit what constitutes a feasible team, which varies by company, sport and type of contest. A DraftKings® NFL classic team requires one quarterback, two running backs, three wide receivers, one tight end, one defense/special teams and one flex (an extra running back, wide receiver or tight end). Each player is assigned a salary and each team must consist of players with salaries that sum to a value less than a salary cap ($50,000 for DraftKings®).

The on-field performance of the selected professional athletes is used to calculate the amount of fantasy points earned for the fantasy team. For example, a player who throws a touchdown in a game is awarded 4 fantasy points. Fantasy point values are based on key statistics relative to the player's sport and position on the team. For example, Carolina Panthers quarterback Cam Newton played during week 10 of the 2016 NFL regular season against the Kansas City Chiefs. His statistics for the game are shown in Table 1 along with DraftKings® points per category. Cam Newton earned $0.04(261) + 4(1) + 6(1) + 0.1(54) - 1(1) = 24.84$ fantasy points for the week.

Table 1
Cam newton's fantasy points for week 10 of the 2016 NFL season

Statistic	Point Value	Cam Newton's Performance	Fantasy Points
Passing yards	0.04	261	10.44
Passing touchdowns	4	1	4
Rushing touchdowns	6	1	6
Rushing yards	0.1	54	5.4
Interceptions	–1	1	–1
Total			24.84

The goal of a DFS participant is to win money. With so many different contests and so much information, participants try to gain a competitive advantage. Participants spend an average of 8.67 hours each week participating in fantasy sports (Smith et al., 2006), including researching athlete ability and likelihood of their team performing well. Participants also invest money into decision making tools as they construct their fantasy teams. An estimated 30% of fantasy sport participants use additional websites to research athletes and other factors. Together, these participants spend over $250 million annually to purchase additional information and decision-making tools (FSTA, 2017).

Many scholarly articles have been written on estimating an athlete's fantasy performance (Becker and Sun, 2016; Boyd, 2014; Ware and Webb, 2006). Other articles (Burke et al., 2016; Bonomo et al., 2014; Belien et al., 2013; Newell and Easton, 2017) focus on building mathematical models that optimize the team selection process to maximize the amount of fantasy points earned.

3. Statistical and probabilistic analysis of fantasy sports

As this paper is designed to help politicians and lawmakers, the next two sections begin with a brief discussion of the arguments and logic used in basic

statistics and probability theory. The sections then describe the study and its implications on whether or not DFS should be considered a game of chance.

3.1. FanDuel®'s NFL contests

The vast majority of statistical arguments begin with a strong assumption, known as the null hypothesis. A probabilistic tolerance is then selected that represents the statistical significance, denoted by α. Data is gathered and used to compute the test statistic. The test statistic generates the probability, p, that the data came from a population that satisfies the null hypothesis. If $p < \alpha$, one rejects the strong assumption (null hypothesis) and is at least 1-α confident in this rejection. Here $\alpha = 0.001$ and thus the conclusion is drawn with at least 99.9% accuracy. As with all statistical methods, there is a probability, 0.001 in this case, that the conclusion is incorrect.

This study focuses on NFL FanDuel® fantasy points and studies whether or not the amount of fantasy points achieved is a game of chance. FanDuel®'s rules slightly differ from DraftKings®. FanDuel® has a salary cap of $60,000, does not have a flex, but adds a kicker. The remaining requirements for a feasible team are identical to those of DraftKings®.

The strong assumption for this study is that the amount of fantasy points earned from an NFL FanDuel® team is entirely a game of chance. If this is a game of chance, then every strategy should perform equally well. In particular, a random team should perform as well as a team selected by any other strategy. To have a high probabilistic assurance, α is set to .001.

This paper uses random teams to model a completely "unskilled" DFS participant. Such a participant cannot use additional information, strategy or insight. Consequently, past performance, matchups, playing time, the weather, or any other general strategy must not impact the athletes selected for the team. Thus, randomly selected teams accurately depict an unskilled participant.

Random teams are generated using simulation. Simulation is widely used in both industry and academia (Law, 2015). Simulation uses pseudorandom numbers to approximate the theoretical outcome of a situation. Random fantasy teams are selected using Python 2.7. To demonstrate this selection process, consider a DFS contest with 25 available quarterbacks. Python generates a random number from 1 to 25 and selects the corresponding quarterback. This repeats for all position requirements on the fantasy team. Once a team is formed, the sum of all selected player salaries is computed to determine whether or not the team is feasible. To strengthen the conclusions, a team's salary lower bound is set to $50,000. Thus, a randomly selected team is only used for this study if the team's salary is between $50,000 and $60,000. This process of generating random scenarios and rejecting infeasible solutions is called the acceptance-rejection principle. On average, the code threw away over 4,500 teams for every acceptable team.

An integer programming model creates a skilled strategy to select a team. Integer programming is widely taught in engineering, math, business and economics. The integer program (IP) optimizes the expected fantasy points that a FanDuel® team earns.

The input data of the IP is all athletes that are playing during the current week. Each athlete is placed into the set A, which is divided into subsets by position. All athletes who play the position of quarterback are members of subset Q, running backs are members of subset R, wide receivers of subset W, tight ends of subset T, kickers of subset K, and each team in the NFL® is a member of subset D, used to select a team defense/special teams.

The input parameters are s_i, which is the salary that FanDuel® assigns for the week, and μ_i, the anticipated fantasy points for each $i \in A$. Here μ_i represents the average fantasy points earned by the player in the previous weeks of the season. Let fp_{ij} equal the fantasy points earned by player i in week j. Since this study is for the 2015-2016 season, all fp_{ij} are known. Thus, in week w, $\mu_i = \sum_{j=1}^{w-1} fp_{ij}/(w-1)$ for each $i \in A$. The obvious adjustment is made to this average if the player did not play in a particular week due to a bye for the team or an injury.

Each decision variable, all binary, represents whether or not the athlete is selected for the fantasy team. Thus, each athlete is assigned a variable $x_i = 1$ if the athlete is selected for the fantasy team and $x_i = 0$ if not. The Expected Fantasy Points Integer Program (EFPIP) is

$$\text{Maximize} \sum\nolimits_{i \in A} \mu_i x_i$$

$$\text{Subject to} \sum\nolimits_{i \in Q} x_i = 1$$

$$\sum\nolimits_{i \in R} x_i = 2$$

$$\sum\nolimits_{i \in W} x_i = 3$$

$$\sum\nolimits_{i \in T} x_i = 1$$

$$\sum_{i \in K} x_i = 1$$

$$\sum_{i \in D} x_i = 1$$

$$\sum_{i \in A} s_i x_i \leqslant 60000$$

$$x_i \in \{0, 1\} \text{ for all } i \in A$$

Constraints (1) through (6) ensure that the appropriate number of athletes or defense are selected. FanDuel's® team salary cap is set to 60,000. Thus, constraint (7) ensures that the sum of the selected athlete salaries does not exceed the salary cap. The objective function maximizes the expected fantasy points. To the best of the authors' knowledge, EFPIP is the first IP to model DFS for the NFL. This model is trivial and is similar to the corresponding model developed for the English sport cricket (Bhattacharjee et al., 2015).

To provide a reasonable estimate of expected fantasy points, the study compares weeks 8–17 of the 2016 NFL® season. EFPIP is solved using CPLEX 12.5, a commercial software package (IBM, 2017). It should be noted that every EFPIP team's salary was within $500 of the salary cap. Furthermore, none of the problems required over 1 second on a Pentium 4 3.3 GHz processor with 12 GB of RAM. Thus, EFPIP is simple to solve.

For each week, Python generated 100 random feasible teams and calculated the fantasy points. The average of the 100 random teams' fantasy points and the fantasy points earned by EFPIP are given in Table 2. One can easily see how much better EFPIP did on average than the random teams.

To formalize this improvement, a two tail statistical t test is performed for weeks 8 through 17 of the 2016-2017 NFL® season. The null hypothesis is that the fantasy points mean of the random teams is equal to the fantasy points generated from EFPIP's team. For 10 weeks, the p value of the test is strictly less than 0.001. Thus, all 10 null hypotheses are rejected. Consequently, one is at least 99.9% confident that random teams with salaries between 50,000 and 60,000 will perform worse than EFPIP's team. Therefore, the average fantasy points earned from Fan Duel®'s NFL® DFS contests are not games of chance in a statistically significant manner.

Table 2
Fantasy points earned

Week	Average Fantasy Points of Random Teams	Fantasy Points of EFPIP
8	61.25	132.30
9	68.74	95.34
10	61.30	101.46
11	59.69	72.28
12	60.77	72.62
13	67.30	109.14
14	55.31	100.20
15	59.81	102.08
16	55.59	108.68
17	60.48	93.92
Average	61.02	98.80

To further analyze the data, if each random team played head to head versus EFPIP's team, then the random teams would have won 70 contests with the vast majority occurring in weeks 11 and 12 where EFPIP performed poorly. If the chance assumption is true, then the probability of a random team winning is 0.5 and the sum of the number of wins is a binomial distribution with 1,000 trials. A normal curve typically estimates such binomial distributions. Thus, the probability of winning 70 or fewer contests is equivalent to a cumulative normal distribution being less than 27 standard deviations below the mean. This probability is infinitesimally small. In fact, at only 10 standard deviations away from the mean, Microsoft Excel® reports a probability of 0 with 20 decimals of accuracy. Consequently, DFS contests are not games of chance.

Using a similar analysis, one could attempt to argue how much chance exists in DFS contests. That is, in a head to head contest what is the likelihood that a chance team beats a skilled team. For instance, if one assumes the EFPIP team is 9 times more likely to win than the random teams, then the probability of the EFPIP team winning every contest is 90% and the random teams win 10% of the time. The normal approximation of winning 70 or fewer such contests is 3.16 standard deviations away from the mean. Thus, the probability of the chance team winning 10% of the time is rejected even if $\alpha = 0.001$.

The most common acceptable error in statistics is 5%. In other words, one is willing to reject the assumption 5% of the time when the assumption is correct. Working backwards, this amount of error would imply that the random teams' probability of winning should be 0.0844. Thus, any assumption where skill is less than 11 times more likely to win than chance would be statistically rejected with at least 95% confidence. Consequently, the impact of chance on DFS is small.

This study is academic in nature and did not evaluate whether any of the random or EFPIP teams would have won a DFS contest. The next study enters actual

DFS contests and focuses on whether or not random teams (unskilled) can win.

3.2. *DraftKings® MLB contests*

The previous study applied simulation and statistics to determine the amount of fantasy points earned. This study tests random teams in 35 DraftKings® Double Up MLB contests. It is important to emphasize an account at DraftKings® was created and actual money was spent entering live contests. The total cost of playing these 35 double up contests was $85. It must be stated that the money to perform this study was provided by the first author and no money from Kansas State University was used for this study. Additionally, the study was performed on the second author's personal laptop, which had the code to generate random teams. None of the work associated with this study, other than writing the paper used any of Kansas State University's resources.

The primary probabilistic argument behind this study is to assume that DraftKings® Double Up MLB contests are games of chance. If these contests are games of chance, then each participant has an equal probability of winning, doubling their entry fee. Thus, a randomly selected team, which represents an unskilled participant, should perform as well as any strategy.

By entering DraftKings® contests, this random team is competing against actual fantasy participants. Whether or not these participants have skill is unknown. However, if fantasy games are games of chance, then randomly selected teams should win a prize with a reasonable frequency.

The random teams were selected using the same acceptance-rejection simulation concepts as described in the previous section. The model was updated to reflect the player positions of baseball rather than football. Furthermore, every player that was eligible for a particular contest could be randomly selected. A lower bound on the team's salary was not incorporated. Thus, the only rejected teams had a salary over $50,000.

Once a feasible team was generated, the second author manually entered the team into a selected DraftKings® Double Up contest. When entering this team, if the random team had a player identified by DraftKings® as unlikely to play (injured, suspended or questionable), then that team was rejected and a different random team was selected and entered into the contest.

One may question why a lower bound on the salary was not enforced. Requiring a lower bound on the salary is providing a type of skill to the random selection of teams. For instance, the previous study generated about 4,500 teams before it found a single team that met the salary requirements. Thus, requiring a lower bound for the salary is a strategy that selects the "best", in terms of salary, from over four thousand teams to compete in a contest. Evaluating 4,000+ teams and selecting one to represent the group is clearly an indication of skill. Consequently, no lower bound on the salary should be set due to the chance assumption and the desire to show the contrapositive statement that unskilled participants probabilistically never win in DFS.

From September 8 to October 13, 2016, a total of 35 distinct random fantasy teams were entered into double up contests. To provide sufficient randomization, no individual contest had more than three entries. Additionally, the contests ranged from 50 to over 2,500 contestants. Consequently, the data is taken from a wide range of double up contests offered by DraftKings®. The most relevant aspects of these contests are presented in Table 3.

The most astonishing result is that not a single team won a payout. Furthermore, the teams performed extremely poorly. The teams ranked in the lowest 6.12% of the participant pool on average. Thus, the average performance was worse than 93.88% of double up entries. Of all the 35 contests, only one randomly selected team performed even close to winning, but its fantasy points were still worse than 52.33% of the other teams.

The strong assumption that these double up contests are games of chance enable the calculation of the probability of winning, which is the number of winning participants divided by the number of total participants. For instance, the first contest entered had 574 contestants and 250 won. Thus, the probability of winning the first contest is $\frac{250}{574} = 0.4355$. Obviously, the probability of losing the contest is one minus this value or equivalently the number of losing participants divided by the total number of participants $\frac{324}{574} = 0.5645$.

Since the teams were entered in various sized contests, one can assume that the contests are independent. The probability that two independent events occur is the probability of one event multiplied by the probability of the second event. Thus, the probability of losing the first three contests is 0.5645*0.5*0.5648 = 0.1594. Extending this concept results in the probability of losing every

Table 3
Results of 35 MLB DraftKings® double up contests

Entry Fee	Contest Date and Time (EST)	Team's Fantasy Points	Rank	Number of Contestants	Percent Rank	Number Paid	Prize Pool	Probability of Losing
$2.00	10/13/2016 20:08	26.3	572	574	0.35%	250	$1,000	0.5645
$1.00	10/13/2016 20:08	10	50	50	0.00%	25	$45	0.5000
$5.00	10/10/2016 16:08	68	664	1149	42.21%	500	$5,000	0.5648
$5.00	10/10/2016 16:08	32	1142	1149	0.61%	500	$5,000	0.5648
$5.00	10/10/2016 16:08	12.5	1147	1149	0.17%	500	$5,000	0.5648
$5.00	10/10/2016 16:08	9	1148	1149	0.09%	500	$5,000	0.5648
$3.00	10/10/2016 16:08	15	112	114	1.75%	50	$300	0.5614
$1.00	10/10/2016 16:08	0	114	114	0.00%	50	$100	0.5614
$2.00	10/6/2016 16:38	35	542	574	5.57%	250	$1,000	0.5645
$2.00	10/6/2016 16:38	29	557	574	2.96%	250	$1,000	0.5645
$2.00	10/6/2016 16:38	22	562	574	2.09%	250	$1,000	0.5645
$5.00	9/29/2016 19:05	87.95	842	1609	47.67%	700	$7,000	0.5649
$5.00	9/29/2016 19:05	44.25	1597	1609	0.75%	700	$7,000	0.5649
$2.00	9/28/2016 19:05	79.95	1602	2298	30.29%	1000	$4,000	0.5648
$2.00	9/28/2016 19:05	56	2065	2298	10.14%	1000	$4,000	0.5648
$2.00	9/28/2016 19:05	4	2297	2298	0.04%	1000	$4,000	0.5648
$2.00	9/27/2016 19:05	54	2257	2298	1.78%	1000	$4,000	0.5648
$2.00	9/27/2016 19:05	33.45	2293	2298	0.22%	1000	$4,000	0.5648
$2.00	9/27/2016 19:05	22.25	2297	2298	0.04%	1000	$4,000	0.5648
$2.00	9/20/2016 19:05	84.2	2664	2873	7.27%	1250	$5,000	0.5649
$2.00	9/20/2016 19:05	42	2867	2873	0.21%	1250	$5,000	0.5649
$2.00	9/20/2016 19:05	8	2871	2873	0.07%	1250	$5,000	0.5649
$2.00	9/19/2016 19:05	38	2251	2298	2.05%	1000	$4,000	0.5648
$2.00	9/19/2016 19:05	28	2285	2298	0.57%	1000	$4,000	0.5648
$2.00	9/19/2016 19:05	26.3	2286	2298	0.52%	1000	$4,000	0.5648
$2.00	9/13/2016 19:05	15	2296	2298	0.09%	1000	$4,000	0.5648
$2.00	9/13/2016 19:05	14	2297	2298	0.04%	1000	$4,000	0.5648
$2.00	9/13/2016 19:05	14	2297	2298	0.04%	1000	$4,000	0.5648
$2.00	9/12/2016 19:05	55.35	2025	2298	11.88%	1000	$4,000	0.5648
$2.00	9/12/2016 19:05	39	2255	2298	1.87%	1000	$4,000	0.5648
$1.00	9/12/2016 19:05	34	564	574	1.74%	250	$500	0.5645
$3.00	9/9/2016 19:05	51	218	229	4.80%	100	$600	0.5633
$2.00	9/8/2016 19:05	50.15	805	1149	29.94%	500	$2,000	0.5648
$2.00	9/8/2016 19:05	13.85	1147	1149	0.17%	500	$2,000	0.5648
Total: $85						Odds of losing all contests:		1/312,681,517.77

one of these 35 consecutive double up contests is 0.0000000031939340, which is equivalent to an event happening 1 in 312,681,518 times.

It is difficult to truly comprehend the extreme rarity of losing all 35 contests. This is less likely than a single ticket winning the Powerball® (Lazarus, 2017). It is less likely than flipping a coin and getting heads 28 times in a row. It is 300 times less likely than being struck by lightning this year (Chan, 2016).

The probability of losing all 35 contests is so ridiculously small that one can state that unskilled participants probabilistically never win in DFS. Thus, nearly all winners of DFS contests have some skill. Consequently, DraftKings® Double Up MLB contests are not games of chance. Therefore, these double up contests must be games of skill and should not be classified as gambling. Due to similarities among sports and contests, the authors believe that this conclusion can be extended to any DFS contest with a salary cap.

4. Conclusions

Whether or not individuals in a state can participate in daily fantasy sports has a massive economic and societal impact. This paper determines that daily fantasy sports are not games of chance. The key argument probabilistically shows that "Unskilled participants never win at DFS." The contrapositive of this statement, which is logically equivalent, states "With extremely high probability, all DFS winners have skill." Although the study only derives this probabilistic analysis for DraftKings® Double Up MLB

contests, the authors believe that similar results can be obtained for other DFS contests. Consequently, DFS contests with salary caps are games of skill.

Even though DFS contests with salary caps are games skill, one should not infer that randomness does not play a vital role in determining the winners. This paper probabilistically verified that all DFS winners implement some type of strategy. Thus, DFS is primarily a competition between skilled participants. When similarly skilled participants compete, luck typically plays a vital role in determining the outcome. In DFS, the winner may be determined due to an athlete's error, a missed defensive assignment, or even a ruling by an official. It is not surprising that some individuals and lawmakers have mistakenly interpreted the randomness of outcomes between skilled participants for the gambling definition of chance.

Although daily fantasy sports are not games of chance, that does not imply that DFS is not gambling. For instance, the Powerball® lottery clearly satisfies the three properties of gambling and is legal in the majority of states. Surprisingly, many of these same states outlaw craps and roulette. Elected leaders and the judges of the country or state determine what constitutes gambling. This paper has shown that DFS contests do not meet one the necessary requirements of gambling: chance. Thus, the authors recommend that states should no longer legally consider DFS salary cap contests as gambling and encourage the use of this research to inform the public and lawmakers of these new developments in this controversial topic.

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