Modeling the IL Recreational Cannabis Lottery

Perception Farms

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1 Introduction

The Illinois Department of Financial and Professional Regulation (IDFPR) recently announced the list of perfect scoring apps entering the tie breaker lottery for the 1st round of dispensary licenses. Only 21 companies achieved perfect scores, with winning entities having submitted anywhere from 1 to 20 applications. In an unprecedented move, Governor J.B. Pritzker announced that the IDFPR will be issuing "Supplemental Deficiency Notices" in order to allow other groups to achieve perfect scores as well. This is in keeping with Article 7, Section 7-1 of the Illinois Cannabis Reform and Tax Act (CRTA) which says:

> "The General Assembly finds that the medical cannabis industry, established in 2014 through the Compassionate Use of Medical Cannabis Pilot Program Act, has shown that additional efforts are needed to reduce barriers to ownership. Through that program, 55 licenses for dispensing organizations and 20 licenses for cultivation centers have been issued. Those licenses are held by only a small number of businesses, the ownership of which does not sufficiently meet the General Assembly's interest in business ownership that reflects the population of the State of Illinois and that demonstrates the need to reduce barriers to entry for individuals and communities most adversely impacted by the enforcement of cannabis-related laws"

For each Bureau of Labor and Statistics (BLS) region, all tied applications participate in a sequential lottery until all licenses have been issued. All of the applications by Perception Farms were submitted in the Chicago-Naperville-Elgin BLS region, so our analysis is focused on that lottery, which will issue 47 licenses. We're going to model our chances (or anyone's really) of winning the IDFPR lottery for a cannabis business license.

This white paper is organized as follows. First, we'll review how to calculate the probability that you throw a pair of snake eyes after n throws in a game of Craps. This will help us get our bearings and also remind us how to calculate probabilities in the first place. Next, we'll build on that to calculate the probability that a given team will win once in the IDFPR lottery for the Chicago-Naperville-Elgin BLS region. Finally, we're going to model many lotteries explicitly (by drawing random numbers) and catalogue which teams win. By averaging over many runs, we'll make a prediction about the distribution of licenses won (and by who) if the lottery were held today with 21 teams playing with a total of 112 total submitted applications.

2 Snake Eyes

Let's say you're deciding when to place a bet at the Craps table and since you've been watching, you notice that the player has thrown 34 rolls in a row without throwing "Snake Eyes". You might think that since the probability of throwing snake eyes on a single roll is 1/36, that you would need to roll 36 times (on average) to hit a pair snake eyes once, so at roll 35 you eagerly start pulling the money out of your wallet, assuming the probability is fast approaching certainty. While not an unreasonable assumption, you're drastically over-estimating your chances of making a "good" bet.

The way it actually works is that you have to consider the total probability of the system, *i.e.* you have to consider the probability that the player did and the probability that the player didn't roll snake eyes. Said another way,

$$1 = P_{\text{win after } n \text{ throws}} + P_{\text{lost after } n \text{ throws}}. \tag{1}$$

In Craps, much as in life, it's win or you lose, but the probability that you *either* win or lose is certain.

So what's the probability that the player throws snake eyes after 1 roll? It's just $P_{\text{win}} = 1 - P_{\text{lose}}$, where $P_{\text{lose}} = 35/36$. For one throw this is all just a very long-winded way of saying your chances of throwing snake eyes is 1/36 (which we already knew). Where things get interesting is when you start asking "What is the chance the player will throw snake eyes after n throws. In that case, the probability of hitting snake eyes at least once is 1 minus the probability of never hitting it after n rolls,

$$P_{\text{won once after } n \text{ throws}} = 1 - \left(\frac{35}{36}\right)^n. \tag{2}$$

To get to close 100% certainty, the player would need to roll the dice an infinite amount of times (the Universe is 14 billion years old btw). After 35 throws, your chances are $\sim 66\%$. After 165 throws, your chances rise to $\sim 99\%$. If you're a gambler, putting money down on the 36^{th} throw is a "good" bet, and you should probably do it. But

you should also keep putting down the same bet many times in a row, smug in your knowledge that with each passing throw your chances continue to improve.

3 Chances of Winning One License Given N_{sub} Submitted Applications

It's convenient to define an average application density

$$\rho = \frac{\text{\# of Applications}}{\text{\# of Teams}}. \tag{3}$$

Application density ends up being a useful way to look at things because the focus (in the public's eye) is on the number of teams winning, and not the overall number of applications in the lottery (what matters statistically). Using the current list of the Top Scoring Applicants by BLS region, $\rho = 5.33$ (21 teams with 112 application submitted). The distribution of submitted applications of course matters if you want to predict how many licenses each team will win, which is what we do in the next section.

Now we just have to follow the rules of the lottery. Your probability of winning any single lottery is your number of perfect-scoring applications divided by the total number of perfect scoring-applications applications ($\rho\times$(Number of Teams with perfect scores)). You also have to take into account that every time someone wins a license, the pool decreases in size by 1, so you chances increase slightly with each license won by another team. Finally, you have to also consider that each teams is limited by how many available licenses are left. So if there are 5 licenses left and you have 6 tickets, you can only submit 5 of them. Taking all this into account and following the same rules we used to calculate the snake eyes example (with the caveat that the probability of winning changes lottery to lottery because the size of the pool changes, *i.e* they dependent, not independent events). You can calculate the chances that you'll win at least 1 license after 47 lotteries. The results for this are shown in 1. Clearly, you can see that if you have any significant chance of winning, the more applications the better (more on this in the next section).

With only 1 application submitted, even with only 21 teams and using the parameters derived from the current set of ticket-holders, your chances never get better than a coin flip. The more applications you submit, the better your chances are. The take away message here is that if you want a decent chance at winning, you need to have more applications submitted than the application density for a given set of teams. While a useful thing to look at, what we really want to do is predict the number of applications a given team will win given a set number of submitted applications. This is what we do in the next section.

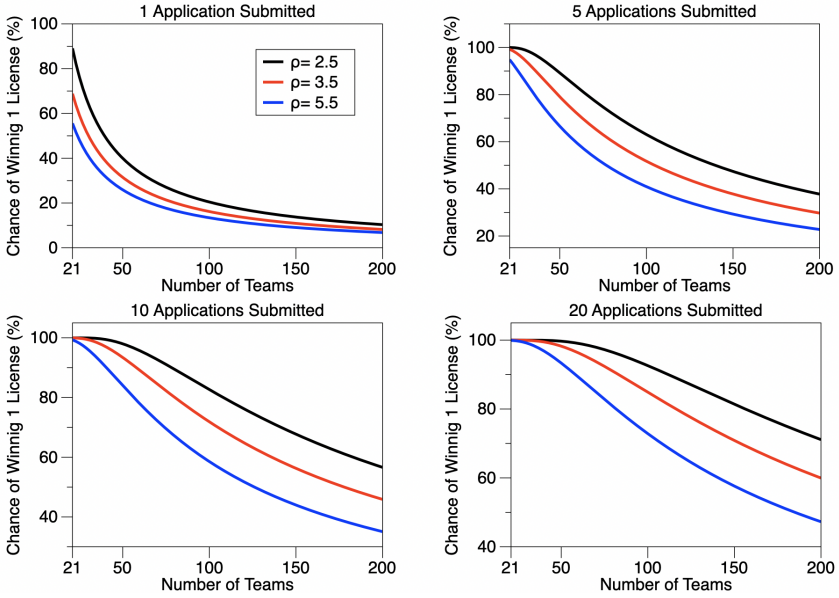

Figure 1: Probability of winning one license in Cook County BLS region for different number of submitted applications and varying application density $\rho = 2.5, 3.5, 5.5$ average applications per team.

4 Lottery Simulation

Perception Farms has developed an open source tool for simulating the IDFPR tie breaker lottery. The tool can be found at https://github.com/perceptionfarms/lottery-simulation where setup and usage is detailed. The lottery is parameterized by the following inputs:

- Number of Simulations
- Application Density
- Number of Additional Participants
- Our Number of Perfectly Scoring Applications.

Simulating the IDFPR tie breaker lottery system requires that the following conditions be met at all times:

1. A player's number of applications decreases with each license that player wins.

2. A player can never have more applications in play than there are licenses remaining in the lottery for a given BLS region.

Here you can see how these 2 factors are handled, in addition to the core lottery engine code:

```
const runLottery = (lottery) => {
    const results = lottery.participants.reduce(
    (agg, cur, ind, arr) => {
        agg[cur.name] = 0;
        return agg;
    }, {});
    for(i = lottery.licensesAvailable; i >= 1 ; i--){
        const flattenedLottery = lottery.participants.reduce(
        (agg, cur, ind, arr) => {
            // Each win reduces number of apps left.
            const numAppsLeft = cur.appCount - results[cur.name];
            // Limit participants to no more apps
            // than number of licenses available in BLS region.
            const numAppsInPlay = Math.min(numAppsLeft, i);

            for(j = 1; j <= numAppsInPlay; j++){
                agg.push(cur.name);
            }
            return agg;
        }, []);
        const diceRoll = randomIntFromInterval(
            1,
            flattenedLottery.length
        );
        const winner = flattenedLottery[diceRoll-1];
        results[winner]++;
    }

    return results;
};
```

First we simulate the distribution of licenses among the original 21 players who were announced in the tie breaker notice. This represents the reality which would have played out had Governor J.B. Pritzker not halted the original lottery. The simulation parameters are as follows:

```
{
  '127 IL LLC': 0.46143, // 1 Application
  'Alchemy Curations LLC': 0.46083, // 1 Application
  'AmeriCanna Dream LLC': 5.74055, // 15 Applications
  'Black Rain LLC': 0.46193, // 1 Application
  'Clean Slate Opco LLC': 4.03396, // 10 Applications
  'Dealership LLC': 4.0364, // 10 Applications
  'Deer Park Partners LLC': 2.14703, // 5 Applications
  'EHR Holdings LLC': 1.33317, // 3 Applications
  'Fortunate Son Partners LLC': 4.03104, // 10 Applications
  'Green Equity Ventures 1 LLC': 1.3297, // 3 Applications
  'GRI Holdings LLC': 7.24555, // 20 Applications
  'Mint IL LLC': 2.14326, // 1 Application
  'SB IL LLC': 1.74833, // 5 Application
  'So Baked Too LLC': 0.90267, // 4 Application
  'Suite Greens LLC': 1.74333, // 2 Application
  'Terra House LLC': 2.53436, // 6 Application
  'TPFB LLC': 0.45947, // 1 Application
  'V3 Illinois Vending LLC': 2.15027, // 5 Application
  'Vertical Management LLC': 4.03672 // 10 Application
}
```

- 20 Applications: 15.07x odds (75%)
- 15 Applications: 12.44x odds (83%)
- 10 Applications: 8.74x odds (87%)
- 5 Applications: 4.65x odds (93%)

Clearly there are diminishing returns on the odds... but that isn't the whole story. For large operators, 20 applications multiplied by the $2,500 application fee (half of the $5,000 fee Non Social Equity Applicants pay) is $50,000... chump change for a large Multi State Operator, but unrealistically expensive for your average applicant. Luckily, there is still a chance for applicants like Perception Farms to make it into the lottery, and there will be several others who aggressively charge the bridge across the "perfect app gap". Let's assume for the sake of this simulation (and argument) that the applicant pool doubles in size once all supplemental deficiency responses are processed.

In that case the simulation parameters look like the following:

- Number Of Simulations: 100,000
- Application Density: 3.5
- Number Of Additional Participants: 20
- Our Number Of Perfectly Scoring Applications: 4

The output of this simulation is:

```
{
  'Perception Farms, INC': 1.0875,
  '127 IL LLC': 0.29107,
  'Alchemy Curations LLC': 0.29006,
  'AmeriCanna Dream LLC': 3.56785,
  'Black Rain LLC': 0.28943,
  'Clean Slate Opco LLC': 2.52005,
  'Dealership LLC': 2.52206,
  'Deer Park Partners LLC': 1.34182,
  'EHR Holdings LLC': 0.82753,
  'Fortunate Son Partners LLC': 2.528,
  'Green Equity Ventures 1 LLC': 0.82969,
  'GRI Holdings LLC': 4.48716,
  'Mint IL LLC': 1.33855,
  'SB IL LLC': 1.09133,
  'So Baked Too LLC': 0.56552,
  'Suite Greens LLC': 1.08829,
  'Terra House LLC': 1.58715,
  'TPFB LLC': 0.28989,
  'V3 Illinois Vending LLC': 1.33143,
  'Vertical Management LLC': 2.51531,
  'NPC1 INC': 0.82839,
  'NPC2 INC': 0.82922,
  'NPC3 INC': 0.82902,
  // ...
  'NPC18 INC': 0.83328,
  'NPC19 INC': 0.83339,
  'NPC20 INC': 0.82934
}
```

In the above results it can be seen that we have simulated both our own placement in the lottery (assuming we are able to perfect our applications), along with 20 other "NPC INC" companies simulated with an app density of 3.5. With the size of the lottery field now just more than doubled, it can also be seen that the 20 application strategy of "GRI Holdings LLC" has a significantly lower expected payoff relative to the original 75%. That being said, with a street value topping and estimated $13,000,000 "GRI Holdings LLC" may rest soundly knowing that their $50,000 in application fees was

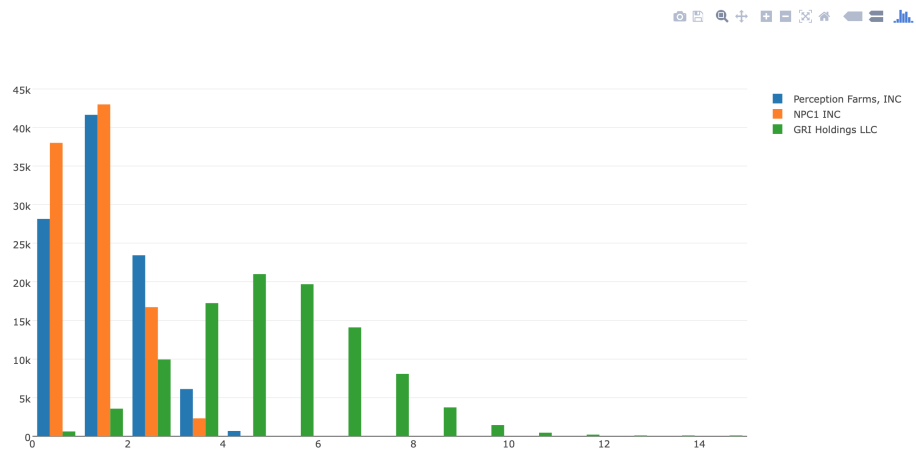

Figure 2: Distribution of wins for 3 sample teams.

money well spent!

Of course, the simulation results discussed thus far only tell the most likely story. Along the way there are numerous parallel realities where some players fair better, and others worse. In the above histograms, we select 3 players and follow them through each simulation, charting the distribution of their winnings. These players are:

- Perception Farms Inc: Blue
- NPC1 Inc: Orange
- GRI Holdings LLC: Green

So, while GRI's upside is more limited in the average universe, there does exist measurable tail events where GRI could come away with 10 or more dispensary licenses in this round.

5 Recommendations

Given the modeling and simulation results outlined here, we make the following recommendations to the State Of Illinois and the IDFPR:

1. Remove the ability for applicants to submit UNLIMITED applications.

2. Reduce max number of dispensary licenses any entity can apply for to 5 per year application round.

3. Make it so no deal can include a baked-in buy-out clause.

4. Make social equity cumulative.

5. Make social equity points for companies trying to get there through hiring employees be part 50% binary, 50% weighted, with the weighted part being based on the strength of the companies social equity strategy.

6 Conclusion

Based on the evidence presented here, and the nature of the point distribution in the Illinois Adult Use Dispensary License Application, the above recommended measures would greatly equalize the playing field and allow home grown startups like Perception Farms a real chance at attaining licenses. Certainly we can't compete with the large MSOs in terms of disposable cash, but we ought to be able to compete based on the quality of our work and likelihood of business success. These simulations have helped us to better understand the "risk vs reward" surface on which we are competing. It also has provided insight into the potential ROI for those with deep enough pockets to flood the application pool with applications. In order to prevent this scenario from playing out next round, we urge lawmakers and legislators to take careful consideration of our recommendations and truly open up the potential for the Illinois cannabis industry to flower not only for big cannabis, but for any qualified applicant the market can support.