The Price is Right - Strategy with Simulation Method

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1 Introduction

The stage right before the Showcase Showdown on the CBS game show The Price is Right is one of "easiest" stages to play. All a player must do is spin a giant wheel. The wheel is partitioned into 20 segments each with a value from $0.05 – $1.00. The player who spins the highest score in no more than two spins and does not exceed $1.00 wins! Each player spins in order from highest to lowest monetary wins from earlier in the game. In the case that two or more players have matching spin values, a sudden death tie breaker decides the winner. The common belief is that luck is the only element involved in this game. However, in this paper, we will discuss potential strategies for players 1-3, ways in which they can optimize their probability of going to the Showcase Showdown.

2 Methods

Approaching this problem made us aware of all possible outcomes on the show. Cases that rarely occurred such as, three way ties, tie breaking tie breakers, and winning by default. We use simulation method to see the changes in winning percentage of each player in different cases. Each player has a unique strategy for different threshold numbers to guarantee player's advantage in the game. In our code it was important for us not only to consider all the possible outcomes, but the strategies that helped to produce those outcomes as well.

We began at the end, starting with the third competitor to spin since she has the best chance to win. This is due to the fact that player 3 (P3) had the clearest strategy out of all three competitors. They simply either spin to beat another player, or they have won the game by default of the other two players exceeding $1.00. Their strategy changes in the case of tie breakers, but not due to them being the third player.

In the event of having two tie breaker, we assume that above 50% chances of winning is the lowest, and in the event of 3 way tie breaker, we assume that 35% chances of win is lowest.

The spin values of each competitor were named r_1, r_2, r_3 and the maximum score for each iteration we called X. After the first spin, the third person may find themselves in one of three circumstances. Either $r_3 > X$, $r_3 < X$ or, $r_3 =$ X.

Case 1: If $r_3 > X$ and $r_3 \leq \$1.00$, the 3rd player received an automatic win.

Case 2: If $r_3 = X$, two more cases occur: (a) $r_3 = r_2$ or $r_1 = r_2$

At this case, P3 should depends on his score to decide the 2nd spin. If his score is high enough, he should stop to have higher chance in the tie-breaker round. The winning percentage of P3 if he doesn't use 2nd spin (at his present score) is (100-r_3) and the winning percentage of him in the tie breaker round is 50%. We then pick the threshold for this case is 65.

(b) $r_3 = r_2 = r_1$. At this case, P3 also needs to base on his score to spin 2nd round or not. Using the same logic as case 2.a above, we pick 50 as the threshold to ensure the highest winning chance for him.

Case 3: If $r_3 < X$, Player 3 should spin again.

In our simulation, we considered all potential outcomes for each player, but we also considered bias towards the odds. This manifested in our code. For instance, if spin values were high in the actual game (typically \$0.70). A player, if they didn't have to, would probably not spin again.

We then come to the decision of player 2, he needed to have a threshold at which the player would be faced with the choice of spinning again to achieve a higher value. Using the same logic with player 3, however, player 2 needs to have a higher threshold value. If he gets in the case $r_2 > X$. Player 2(P2) hasn't know Player 3's score yet, so in the event of having a score that already beat the Player 1, P2 should have a score that high enough to beat P3 in the future. Additionally, r_2 also need to small enough to keep the highest winning chance for player 2, therefore, 55 is the number that we choose.

Let's look at this example: Assume the first player has $r_1 = 50$, then:

If Player 2 spins \$0.05 cents for example on their first spin, there are 8 spots on The Wheel (5 through 40) that will still come up short on their second, and they will lose. There is also 1 spot (the dollar) which will cause them to bust, and they will lose. That means that 45% of the time they will lose to you on their second spin. 5% of the time they will tie, and 50% of the time (45 through 95) they will beat you.

Hence, to reduce the chance of lose by P3, we raise the threshold to \$0.55. Otherwise, at the case $r_3 = X$, using the same logic and we also get 65 as the threshold for Player 2. Our strategy to this point has the same result with the simulation method of Rafael Tenorio and Timothy N.Cason, which we believed that our logic is correct.

In terms of strategy for player 1, since this is the most dis-advantage player, we need to run simulation based on the other two's strategy to ensure the chances and fair among three players. We ran this simulation multiple times and considered different winning percentages of each player, faced with making a strategic decision based on chance.

3 Simulation Experiment

The players act in a matter such that they would have the greatest chance to win. If the first player spins less than \$0.65 one their first roll, they would most likely spin again. Player 2 acts, already knowing the result of player 1, therefore player 2 hopes to have a result of %0.65 or higher. Although the \$0.65 threshold is also the optimal result for player 1, in the event that player 2 is able to tie or exceed player 1, then player 2 would have their greatest chance of winning. This scenario also minimizes the chance of winning for player 3. As player 3 is omniscient to the previous players, this player has the highest likely hood to win the game regardless of previous rolls.

We then come to the final strategy for three players in the Wheel round of Price is Right:

1. P1 should spin 2nd time if their score after 1st spin smaller or equal 65

2. P2 should spin 2nd time if their score after 1 spin

(a) smaller than score of P1

(b) equals to score of P1 and smaller than 65

(c) higher than score of P1 and smaller than 55

3. P3 should spin 2nd time if (a) their score smaller than maximum score at that time

(b) their score equals to 1 player and smaller than 65

(c) their score equals to both other two player and smaller than 50

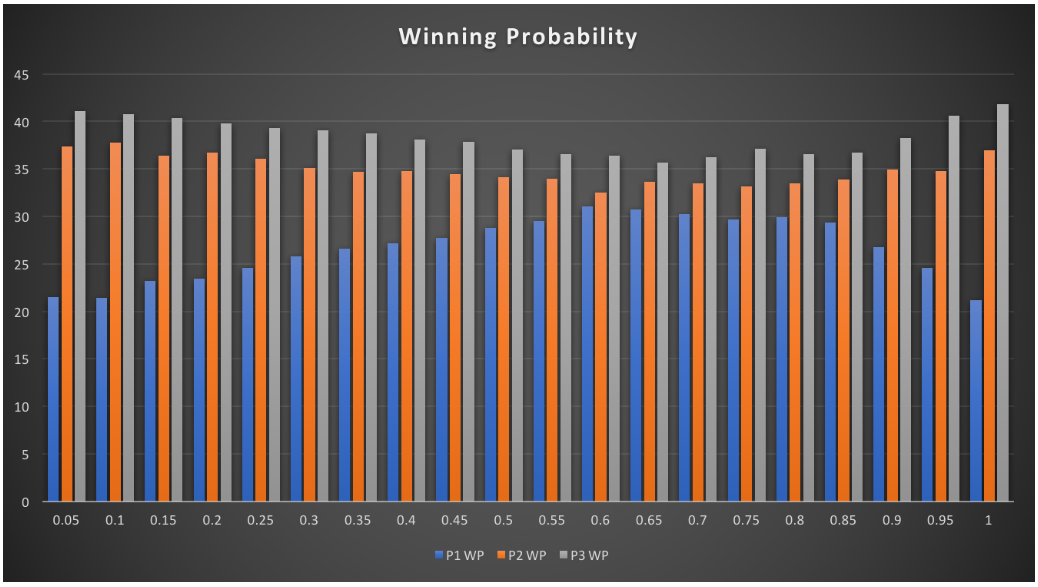

Figure 1: Winning percentage of three player based on number A

4 Extension to the Game

The extension we made to the original game, was to change the increments of the spinning wheel. The updated wheel is constructed in increments of \$0.10. Thus each player must slightly adjust their strategy, as it is more likely that a player may go over the \$1.00 maximum. The optimum result for player 1 is \$0.80. By the same logic of the original simulation, players 2 and player 3 would act in accordance , but their strategies do not depend on chance. Thus the strategy for each player for the extension is as follows:

(1) P1 spins again if the first spin is less than \$0.80.
(2) P2 should spin 2nd time if their score after 1 spin:
(a) smaller than score of P1
(b) equals to score of P1 and smaller than 60
(c) higher than score of P1 and smaller than 50
3. P3 should spin a 2nd time by the same logical progression in the simulation.

5 Conclusion

In our method, the strategy of the first player relies on whether or not they spin a 65 or greater. In terms of uncontested spins, 65 was the threshold that after which each would have the greatest outcome. We found this number by simulation, reassuring that a player has the greatest statistical chance if they receive a 65 or greater.

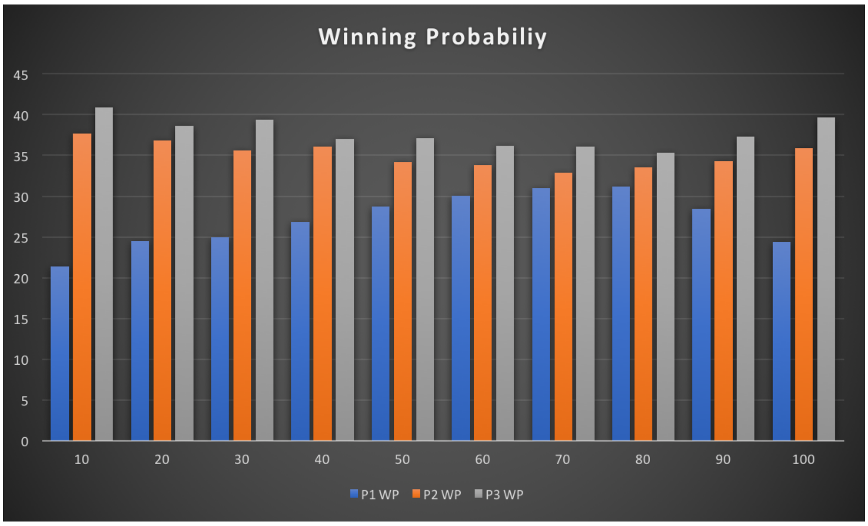

Figure 2: Winning percentage of three player based on number A, with the wheel increments changed to $0.10

References

[1] Rafael Tenorio and Timothy N. Cason
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