Journal of Physics Special Topics

A4_14 Which Lottery Ticket

J.F. Barker, T.M. Conlon and J.C. Coxon

Department of Physics and Astronomy, University of Leicester. Leicester, LE1 7RH.

Mar 7, 2011.

Abstract

This paper looks at the ratio of prize amount won to chance of winning that is present in the different variants of a drawn lottery game. The Lottery, and it's variants, run by the UK's Camelot Group are analysed to see if all the games have a similar relationship linking the amount won to the chance of winning that amount. It is found, by visual inspection of the data, that all the games have a very similar relationship governing the chance of winning and the prize payed out.

Introduction

The Camelot Group in the United Kingdom have operated the National Lottery for over 15 years [1]. The National Lottery is a luck based game where players pick a combination of numbers and attempt to match these numbers to a selection that is drawn. If a player has a combination of numbers that matches those drawn then that player wins a cash prize. Two of the games do have a slightly different setup. Lotto and Thunderball both have a bonus ball system, in Thunderball the ball takes the same name as the game. This bonus ball is drawn in addition to the draw of the main balls. The system is incorporated into the prize hierarchy to give additional levels of prizes available.. The Camelot group operate several different variants of this game with differing odds of winning and prize level. This paper looks at the correlation between the odds of winning and the potential prize won.

Analysis

We can look up the odds:estimated prize information from the Lottery website [2]. For the flagship game, Lotto®, the following distribution is given,

Numbers Matched	Odds	Estimated Win
6 main (jackpot)	1:13,989,816	£2,000,000
5 main + bonus	1:2,330,636	£100,000
5 main	1:55,492	£1,500
4 main	1:1,033	£62
3 main	1:57	£10

Table 1: A table showing the estimated win against the required conditions and odds for that level of prize taken for the National Lottery's flagship game, Lotto® [2].

Table 1 can be plotted and a line of best fit can be calculated. The line of best fit can be seen to follow a power law relationship. We will now plot a similar plot for the other game variants offered by the Camelot Group in order to determine if the same relationship for all the games is used or if one game grants a higher payout for the same chance of winning. The estimated win amount and odds of correct number matching can be found in Table 2. In order to compare these odds and prize payouts we plot the data against that of the Lotto game. The plot is on a logarithmic scale and can be seen in Fig.2.
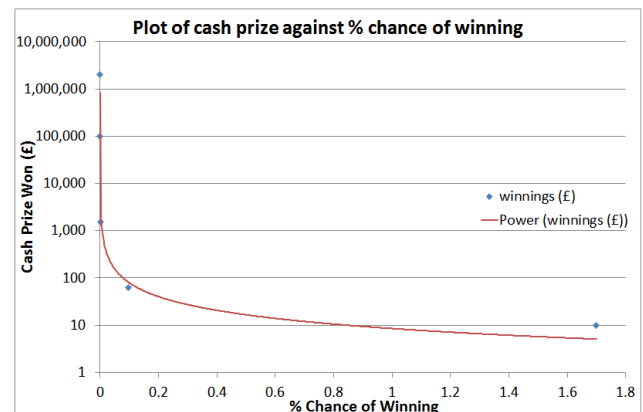

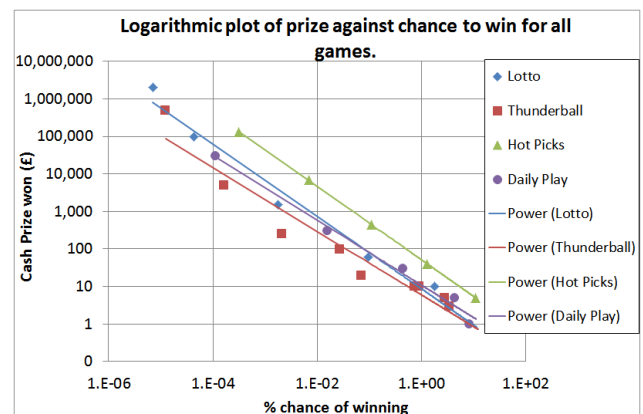Fig. 1: Plot showing the relation between Estimated Cash prize and chance of winning.

Fig. 2: Plot showing the data from Table 2 plotted with logarithmic axis.

Game	Win Condition	Odds	Prize (£)
Thunderball	5balls + T[1]	1:8,060,598	500,000
	5balls	1:620,046	5,000
	4balls + T[1]	1:47,415	2500
	4balls	1:3,647	100
	3balls + T[1]	1:1,437	20
	3balls	1:111	10
	2balls + T[1]	1:135	10
	1balls + T[1]	1:35	5
	0balls + T[1]	1:29	3
Hot Picks	5balls	1:317,814	130,000
	4balls	1:14,126	7,000
	3balls	1:922	450
	2balls	1:79	40
	1ball	1:9	5
Daily Play	7balls	1:888,030	30,000
	6balls	1:6,344	300
	5balls	1:223	30
	4balls	1:23	5
	0balls	1:12	1

Table 2: Table showing estimated prize amounts and odds of fulfilling the win conditions for all possible wins in all of the Camelot Group offered games [3] [4] [5].

Conclusion

We can see from visual inspection of Fig.2 that all the games show a strong similarity in the function that defines the ratio of prize won to chance of winning. From this it can be seen that there is no major advantage from playing one game instead of another. Minor points we can observe is that the best value game would be Hot Picks as that pays out more for the same win percentage than the other games, where as Thunderball has the lowest cash prize to payout chance of all the games. Overall we can see that as the amount being won rises, the chance of winning decreases rapidly which can be expected from such a game. It is worth noting that the exact values won do fluctuate depending on the number of players and the number of people who achieve each prize bracket, but the data presented gives a good account of what can be expected. We can conclude from the analysis done that regardless of the variant played while playing the Camelot Group's lottery you can expect a similar return in terms of prize won to chance of winning. This investigation has only made a basic analysis of the mechanics involved in the design of commercial luck-based games. Further analysis could be done on the mathematical correlation and statistical significance of the difference in the ratios used in the games. It would be interesting to explore the other games offered by the Camelot group such as the Euromillions draw that they take part in, although a similar analysis would be difficult as the maximum jackpot does not have an estimated amount, it depends purely on player numbers [6]. Also another style of game offered by the Camelot group is the scratch card game, where plays scratch panels of a pre-printed card, usually attempting to match symbols or something similar to win a prize. It would be interesting to see whether these games follow the same relationship for prize against chance of win as the drawn lottery games. Further investigation could also explore other nations Lotteries to see if the relationship used is a general one that has been optimised.

REFERENCES

[1] http://www.camelotgroup.co.uk/KeyLandmarks.pdf, (07/03/2011)

[2] http://www.national-lottery.co.uk/player/p/help/aboutlotto/prizecalculation.ftl, (07/03/2011)

[3] http://www.national-lottery.co.uk/player/p/help/aboutthunderball/prizecalculation.ftl, (07/03/2011)

[4] http://www.national-lottery.co.uk/player/p/help/aboutlottohotpicks/prizecalculation.ftl, (07/03/2011)

[5] http://www.national-lottery.co.uk/player/p/help/aboutdailyplay/prizecalculation.ftl, (07/03/2011)

[6] http://www.national-lottery.co.uk/player/p/help/abouteuromillions/prizecalculation.ftl (07/03/2011)

---

[1]T=Bonus ball known as the Thunderball