Winning Strategies: A Case Study of Oyo State Lottery, Nigeria

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Abstract

In this study, we investigated three common lottery strategies: random, low and high frequency strategies, usually employed by lottery players. The Oyo State Lottery, a type of lottery in Oyo State, Nigeria was used as a case study. For the three strategies, we considered whether the selection of numbers in Oyo State lottery occurred with equal probability, whether the lottery winning numbers occurred with equal probability, whether a game strategy outperformed others using the game's history and whether the performance of a strategy was associated with the amount of historical information considered. It was discovered that lottery numbers were not chosen randomly by the players. Also, the winning numbers occurred with equal probability. The low frequency strategy performed better than the random and high frequency strategies. Further tests involving amount of historical information however showed that no strategy was better than others in the long run.

Keywords: Tickets, Lottery strategy, Winning numbers, Hypothesis testing, Historical information

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1.0 Introduction

Lottery is a game of chance and it involves the distribution of prizes among purchasers of tickets. The game of lottery has a very long history. This can be found in [1] and [2]. Among all the games of chance, lotteries have been and still are very popular. According to [3], the most prevalent form of lottery game is lotto, which involves random selection of numbers. Participants in this type of game randomly choose n distinct numbers from a large pool of m integers. The organisers stop the sale of tickets at a certain point and then select p winning numbers randomly from the m numbers. If any of the tickets sold match t or more of the p winning numbers, a prize is given to the holder of the matching ticket. To receive a prize, t is usually three or more [4].

In this study, we investigated three common lottery strategies: random, low and high frequency strategies, usually employed by lottery players. The Oyo State Lottery, a type of lottery in Oyo State, Nigeria was used as a case study.

2.0 Previous Research

Lotteries are often run by the government to raise funds for the improvement of infrastructural facilities. For example, the California lottery was created to raise supplemental funds for

public schools [5]. The Big Lottery Fund in the UK is a non-departmental public body that distributes 46% of all funds raised by the national lottery for "good causes". It funds a diverse range of programmes and projects in the fields of health, education, the environment and charitable purposes [6].

The profile of people playing lottery was studied in [7] and it was found that people with lower income and education level contribute greatly to the funds obtained from lottery. Also, older people buy more lottery tickets than younger people [8], [9]. It was showed in [10] that an increase of 1% of a country's education index led to a decrease of about 3% of total lottery sales. Sociological approaches were adopted by [11] in explaining why the poor spend more on lottery tickets than their wealthier and better educated peers while [12] argued that lottery is associated with increasing social inequality.

The possibility of winning a huge amount of money is a great feature that attracts players despite the very low probabilities of winning. For instance, in the USA, the odds of winning the Mega Millions jackpot is 1 in 175 million and that of the Powerball jackpot is 1 in 195 million. The drive to win the jackpot or any of the other prizes has led players to devising strategies that are different from the traditional selection of numbers in a random fashion. Some of the strategies adopted include repeated play of the same number, choosing or avoiding certain numbers, for instance, numbers that belong to the same interval of tens, consecutive numbers and so on [13].

In this study, three common strategies will be studied to determine whether their performances are significantly different from one another.

2.1 Lottery Formats

Draws for lotteries are performed in various ways today. Each lottery format has its own rules for establishing the prize fund and distributing prizes to winners, but drawing a selection of numbered balls without replacement from an urn is still very popular among lottery organizers. The Genoese and Keno formats were described in [14] and [15] respectively while [16] presented some lotteries and their formats from Nigeria.

2.2 Description of Oyo State Lottery

The Oyo State Lottery is organized by the Oyo State Lottery Commission. The lotto which is a 5/79 game opens by 7 a.m. and closes by 7 p.m. every day. Three different kinds of games are organized by the Commission: the Glad draw, the Daily draw and the Saturday draw for which tickets are purchased at 20, 50 and 100 naira per ticket respectively. Tables I, II, and III respectively show the prize monies for different numbers players are able to match in each of Glad, Daily and Saturday draws. The prize money is calculated by multiplying the fixed value by the prize of the ticket. The organizers pick five winning numbers at random from the first seventy-nine integers. If a player matches less than two numbers, no prize is won. Two, three, four and five matches attract prizes. Five matches entitle the player to the jackpot.

Table I: Glad Draw at ₦20 per ticket

Number of matches	Fixed value (₦)	Amount won (₦)
2/5	75	1,500
3/5	200	4,000
4/5	295	5,800
5/5	3,025	60,500

Table II: Daily draw at ₦50 per ticket

Number of matches	Fixed value (₦)	Amount won (₦)
2/5	100	5,000
3/5	206	10,300
4/5	836	41,800
5/5	2,400	120,000

Table III: Sat draw at ₦100 per ticket

Number of matches	Fixed value (₦)	Amount won (₦)
2/5	120	12,000
3/5	180	18,000
4/5	720	72,000
5/5	3250	325,000

2.3 Lottery Strategies

Players use different strategies in determining the winning numbers. Some of these include the use of birthdays, numbers seen in a dream, happiest day and so on. In this study, we shall consider three common strategies. These are the random, low frequency and high frequency strategies.

The random strategy involves the use of the random number generator or any other device that can generate numbers randomly. This generates numbers for players to select randomly. The low frequency strategy involves players picking the numbers that occur less frequently in the previous games to play in the subsequent ones while in the high frequency strategy, players pick the numbers that occurs often in the history of the game to play in the subsequent ones.

3.0 Research Methodology

In this study, we are interested in answering the following research questions:

a. Does the selection of numbers in Oyo State lottery occur with equal probability?

b. Do the Oyo State lottery winning numbers occur with equal probability?

c. Is there a game strategy that outperforms others in the history of the game?

d. Is the performance of a strategy associated with the amount of historical information considered?

Specifically, the hypotheses for testing are:

H_1: Each number is equally selected by the public

H_2: The winning numbers occur with equal probability

H_3: There is no difference in the performance of the three strategies

H_4: There is no performance difference in the strategies with small amount of historical information

H_5: There is no performance difference in the strategies with large amount of historical information

3.1 Simulation of Lottery Strategies

The data used for this research work consisted of the year 2011 lottery winning numbers of the Daily draw type of game as collected from the Oyo State Lottery Commission. The data was used to simulate the random, low frequency and high frequency game strategies. The details of the simulation procedure are presented in Appendix A.

The effectiveness of each of the lottery strategies was analyzed by comparing the lottery winning numbers, also referred to as historical data, to data simulated using each of the strategies. For this study, the performance of a strategy was gauged by the average number of matches to the winning numbers chosen in a month. The higher the number of matches, the more effective the strategy used by the player.

3.2 Hypothesis Testing

Statistical tests were conducted on the simulation results. To test hypothesis H_1, i.e. whether some numbers are more popularly selected than others in the Oyo State Lottery, a runs test was performed at 5% level of significance on a total of 4785 numbers selected in the game of June 21, 2011. For hypothesis H_2, a chi-square goodness of fit test was conducted at 5% level of significance to test whether the winning numbers occur with equal probability. Adjustment for sampling without replacement was made following [17] and [18]. To test hypothesis H_3, a one-way analysis of variance (ANOVA) test at 5% level of significance was conducted to compare the average performance of the three simulated strategies. Where a significant difference in the performance of the strategies existed, a multiple comparison test (Least Significant difference Test) was conducted to ascertain which one was different from the other.

Furthermore, to test hypothesis H_4 and H_5, i.e. whether small and large amount of historical information had any effect on the strategy performance, the data set was divided into two groups [5]: small and large amount of historical information. A one-way ANOVA test was conducted to check for differences in performance among the three strategies.

4.0 Results And Discussion

The results of testing the different hypotheses are presented and discussed in this section.

4.1 Hypothesis H_1

Figure 1 shows the frequency of selection of each number between 1 and 79 by the public on June 21, 2011. It shows that Oyo State lottery numbers do not have equal probability of being selected by the public. Also from Table IV, $|Z|>Z_{1-\alpha/2}$ implies significance at the 5% level and this leads to a decision to reject the hypothesis that each number is equally likely to be selected. This implies that players prefer some numbers over others based on specially selected strategies. Thus lottery numbers selected by players are not chosen at random

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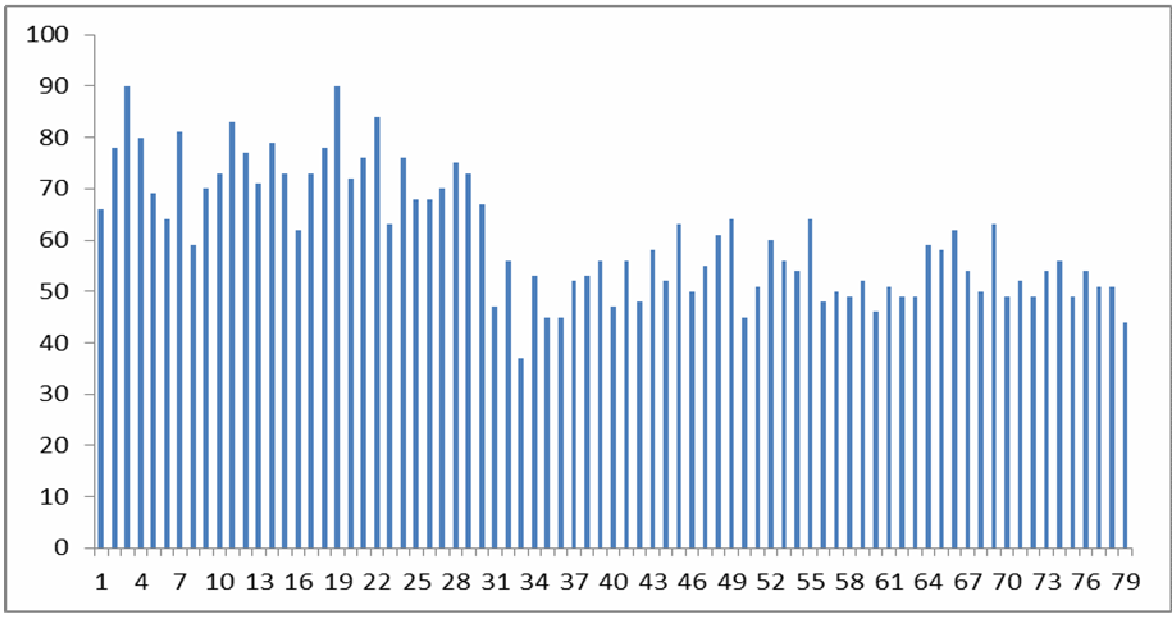

Figure 1: The number of times that each number was selected by the public on June 21, 2011

Table IV: Results of Runs Test on Numbers Selected by the Public

N(var1 > 34)	2384
Number of observations	4785
Number of runs	1668
Z	-20.98
$Z_{1-\alpha/2}$	1.96

4.2 Hypothesis H_2

The result of the Chi-square test on lottery winning numbers is displayed in Table V. Since the *p*-values are greater than the significance level,0.05, in all the cases, the hypothesis that the winning numbers occur with equal probability in all the months is accepted. This implies that the winning lottery numbers appear to be distributed equally in their range. Therefore, one can reasonably believe that the process and machines that the Oyo State Lottery commission is using in generating winning numbers are not biased
.

Table V: Results of chi-square test on the lottery winning numbers

Month	χ^2 *Statistic*	*p-value*
January	40.467	0.952
February	28.267	1.000
March	54.089	0.853
April	30.527	0.999
May	23.900	1.000
June	39.048	0.937
July	18.933	1.000
August	40.000	0.992
September	32.462	1.000
October	57.941	0.551
November	50.277	0.835
December	30.467	0.999

4.3 Hypothesis H_3

Results of the one-way ANOVA test to determine whether there is difference in the performance of the three strategies are shown in Tables VI and VII. Since the $p - value\ (0.013) < 0.05$ (in Table VII), the hypothesis H_3 is rejected and it is concluded that there is significant difference in the performance of the three strategies. This implies that the use of any of the three strategies will yield different results in terms of the numbers of matches with the winning numbers.

Since there is significant difference in the performance of the strategies, a multiple comparison (Least Significant Difference) test was carried out to know the pair of the game strategies that are different from each other. The result of this test is shown in Table VIII and it reveals that the random and low frequency, low and high frequency strategies are significantly different from each other at 5% level of significance. Thus, the low frequency strategy's performance is better than the other two strategies.

Table VI: Descriptive Statistics of Lottery Strategies

	N	Mean	Standard Deviation	Standard Error	95% confidence interval for mean		Minimum	Maximum
Random Strategy	11	0.2336	0.07474	0.02253	0.1834	0.2838	0.14	0.38
Low frequency strategy	11	0.3409	0.09449	0.02849	0.2774	0.4044	0.19	0.50
High frequency strategy	11	0.2236	0.11483	0.03462	0.1465	0.3008	0.02	0.39
Total	33	0.2661	0.10753	0.01872	0.2279	0.3042	0.02	0.50

Table VII: ANOVA Table for the Strategies

	Sum of Squares	Df	Mean Squares	F	Sig.
Between groups	0.093	2	0.046	5.035	0.013
Within groups	0.277	30	0.009		
Total	0.370	32			

Table VIII: Multiple Comparisons (Least Significant Difference) Test

(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Standard Error	Sig.	95% Confidence Interval	
Random Strategy	Low frequency strategy	-.10727(*)	.04097	.014	-.1910	-.0236
	High frequency strategy	.01000	.04097	.809	-.0737	.0937
Low Frequency Strategy	Random Strategy	.10727(*)	.04097	.014	.0236	.1910
	High frequency Strategy	.11727(*)	.04097	.008	.0336	.2010
High Frequency Strategy	Random Strategy	-.01000	.04097	.809	-.0937	.0737
	Low Frequency Strategy	-.11727(*)	.04097	.008	-.2010	-.0336

* starred values indicate pairs of means that are significantly different.

4.4 Hypothesis H_4

The results of the one-way ANOVA test to determine if there is a difference in performance in the three lottery game strategies when only a small amount of

historical information is used are shown in Table IX. Since the $p - value\ (0.056) > \alpha\ (0.05)$, we accept H_4 and conclude that there is no performance difference in the three strategies with small amount of historical information

.

Table IX: ANOVA test on all three strategies using small amount of information

	Sum of Squares	Df	Mean Squares	F	Sig.
Between groups	.072	2	.036	3.704	.056
Within groups	.117	12	.010		
Total	.190	14			

4.5 Hypothesis H_5

For the case when a large amount of historical data was used, the results of the one-way ANOVA test conducted are shown in Table X. Since the $p - value\ (0.200) > \alpha\ (0.05)$, the hypothesis H_5 is accepted and it is concluded that there is no performance difference in the three strategies with large amount of historical information

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Table X: ANOVA test on all three strategies using large amount of information

	Sum of Squares	Df	Mean Squares	F	Sig.
Between groups	.033	2	.016	1.793	.200
Within groups	.137	15	.009		
Total	.170	17			

Therefore, the introduction of small and large amount of historical information component into the ANOVA tests revealed that no strategy is better than others. This also corroborates the views of [5] that no strategy is better than others in the long run.

5.0 Conclusion

From the results, the following conclusions can be drawn:

a. Players do not select lottery numbers randomly, but rather based on certain strategies.

b. Oyo State lottery winning numbers are selected with equal probability. Thus, we can say that the process and machines that the Oyo State Lottery Commission is using in generating winning numbers are not biased.

c. Among the three strategies considered, it was discovered that the Low frequency strategy outperformed the

Random and High frequency strategies. Therefore, players who selected unpopular numbers stood a better chance of winning higher prizes than those who selected popular numbers and those who selected numbers randomly.

d. The introduction of small and large amount of historical information component into the ANOVA tests revealed that no strategy is better than others. This implies that no strategy is better than others in the long run.

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Appendix A: Simulation Procedure for the Three Lottery Strategies

A. Random Strategy

To simulate the random strategy, random numbers, equivalent to the numbers in each month, are generated from R package. The random numbers are compared to the lottery winning numbers data one on one and the numbers of matches to the winning numbers are recorded for each month. The average numbers of matches are obtained. These are shown in Table A.1.

Table A.1: Random Strategy

Month	No of Matches	Average
February	5	0.21
March	5	0.19
April	3	0.14
May	3	0.15
June	5	0.24
July	3	0.17
August	7	0.27
September	10	0.38
October	8	0.30
November	8	0.31
December	5	0.21

B. Low Frequency Strategy

To simulate the low frequency strategy, we find the number of matches of the five least frequent numbers of a month in the next month. The average numbers of matches are obtained. These are shown in Tables A.2 and A.3.

C. High Frequency Strategy

To simulate the high frequency strategy, we find the number of matches of the five most frequent numbers of a month in the next month. The average numbers of matches are obtained. These are shown in Tables A.2 and A.3.

Table A.2: Least and Most Frequent Numbers in a Month

Month	Least frequent numbers	Most frequent numbers
January	3, 7, 9, 11, 12	2, 21, 39, 67, 72
February	2, 4, 6, 10, 11	28, 34, 41, 66, 79
March	1, 2, 3, 6, 7	73, 74, 76, 78, 79
April	8, 9, 10, 12, 13	74, 76, 77, 78, 79
May	33, 34, 35, 36, 37	71, 74, 75, 78, 79
June	18, 19, 21, 22, 23	67, 69, 76, 77, 79
July	5, 13, 15, 28, 39	70, 71, 73, 75, 77
August	4, 9, 16, 20, 25	71, 73, 74, 75, 76
September	8, 13, 17, 24, 27	75, 76, 77, 78, 79
October	1, 10, 18, 19, 23	70, 74, 75, 76, 78
November	6, 13, 19, 26, 30	71, 73, 75, 76, 77
December	4, 8, 16, 25, 33	72, 73, 75, 78, 79

Table A.3: Number of Matches for Low Frequency and High Frequency Strategies

	Low Frequency Strategy		High Frequency Strategy	
Month	**No of Matches**	**Average**	**No of Matches**	**Average**
February	11	0.44	4	0.16
March	5	0.19	9	0.33
April	9	0.41	8	0.02
May	7	0.35	7	0.35
June	7	0.33	4	0.19
July	5	0.28	7	0.39
August	10	0.38	7	0.27
September	7	0.27	6	0.23
October	6	0.22	3	0.11
November	10	0.38	3	0.12
December	12	0.50	7	0.29