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Gambler's Fallacy And Its Role In Portfolio Allocation Decisions: An Experimental Study

KEYWORDS

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ABSTRACT *Human beings are often prone to several cognitive and behavioral biases that are not recognized by conventional theory. This study examines the role of Gambler's Fallacy and Trend Chasing (Hot Hand Fallacy) in influencing the decisions taken by participants with the help of two experiments. In the first experiment, the subjects were asked to predict the outcome of a coin toss after observing the results of the previous seven outcomes of the coin toss. The second experiment was devised to test for the role of Gambler's fallacy and Trend chasing in portfolio decisions made by the subjects. The participants were allocated 2 perfectly negatively correlated risky assets giving the same dividend. At the beginning of each period, the participants could trade the stocks with the experimenter at no additional cost due to the fixed selling (and purchasing) price. So the participants could eliminate all risk and maximize their expected payoffs by simply keeping a balanced portfolio. The results of the first experiment give substantial evidence for the committal of Gambler's Fallacy. The second experiment results showed that people held imbalanced portfolios but did not provide us with a clear trend of Gambler's Fallacy or Trend chasing in portfolio allocation decisions, given the small sample size and budget constraint of this pilot experiment. Improvisations in the experimental design, sample size and salience could give more robust results.*

INTRODUCTION

Economic theory is established on the assumptions of utility maximizing behavior of its agents. In the context of a stock market it is implied by the conventional theory that all economic agents aim to maximize their expected payoffs from an investment portfolio. For the same reason, the act of balancing portfolios is seen as an obvious manifestation of the rationality of agents. However, assumptions of rational economic agents making decisions to maximize expected payoffs are widely violated in reality as people regularly possess cognitive biases. We aim to study the role of Gambler's Fallacy (GF) and Trend Chasing (Hot Hand Fallacy) (HHF) which represent two of the biases held commonly by people, in determining their decisions.

Gambler's Fallacy is the erroneous belief that a series of random events become less random in light of past outcomes. Specifically, it entails that a streak of outcomes of one kind is more likely to be broken. An example of this would be the false belief that a coin toss is more likely to result in a Tails if the past few outcomes were Heads. Laplace was the first economist to write about this fallacy. Hot Hands Fallacy is the opposing cognitive bias wherein people believe that the probability of future successes of random events is higher if the last few times have been a success. The detection of this fallacy was made by Gilovich, Vallone, and Tversky (1985) where they discovered the belief held by basketball fans that a streak should be more likely to continue if a basketball player experiences a streak of hits than if that player had experienced a streak of misses.

Both these fallacies are the manifestations of the 'Law of Small Numbers' which states that a small sample should resemble closely the underlying population. Hence, in case of Gambler's Fallacy, this leads to the belief that a streak of one type of event should soon be evened out by the occurrence of other types of events. Hot Hands Fallacies is the outcome of the same law wherein people reconcile the apparently unusual streak and their belief in the law of small numbers by assuming that the events are dependent.

After its initial discovery by Gilovich, Vallone, and Tversky (1985), this phenomenon has been covered by several studies over the years. Burns and Corpus (2004) conducted an experiment where the responses of the participants to hypothetical situations were studied vis-à-vis the perception of randomness of the situations. They discovered that the participants believed in the continuation of a streak if the process generating the events was perceived to be non-random. Ackert and Church (2011) studied the phenomena in the context of a stock market by allocating two types of negatively correlated stocks to the subjects. Their study found that the participants failed to balance their portfolios due to the presence of Gambler's Fallacy. Tyran and Suetens (2011) examined the role of gender differences in the Gambler's Fallacy using data from the Danish state lottery. They found evidence of gambler's fallacy for men but not for women.

There have also been attempts to construct theoretical models to compute and map the transition between the Gambler's Fallacy and Hot Hands Fallacy. Matthew Rabin and Dimitri Vayanos (2010) developed a formal model to explain the two fallacies. In his experimental study using basketball fans and novice, Rao (2009) discovered that the two phenomena can exist within the same subject. He also discovered a statistically significant Gambler's Fallacy after short streaks and Hot Hands Fallacy after long streaks across subjects.

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This study aims to check for these behavioral predispositions in a general scenario as well as in the context of an investment portfolio. Two experiments are conducted to examine the same. The first experiment was conducted to examine whether there were any cognitive biases present in the participants in a situation involving uncertainty of outcome. The subjects were asked to predict the outcome of a coin toss after observing the results of the previous seven coin tosses. The aim of this experiment was to investigate whether the prediction of the participants was affected by the previous outcomes, or not. A validation of economic theory would entail that the assignment of probabilities to the two outcomes would be the same. However, in case of a bias, the assignment of probabilities to the two outcomes would get influenced by the results of the previous tosses.

The second experiment was conducted to specifically test for behavioral biases in the situation of investment decisions taken by the participants. The subjects were randomly allotted varying proportions of two shares – A and B as well as a cash endowment. They were given the liberty to trade their shares with the experimenter at a fixed price of 10 tokens. The dividends from the two shares was to be determined by a coin toss, and in each period only one of the two paid dividend. According to economic theory, a rational utility maximizing agent would hold a balanced portfolio with equal shares of each type to ensure receipt of dividend in every period. However, it was discovered that people often failed to balance their portfolios and the decision regarded the proportion of the two shares depended not on maximization of expected dividends, but on other factors.

OVERVIEW

The experiments were conducted in the campus of Jawaharlal Nehru University. A total of 29 students participated in the experiment- 16 in the first experiment and 13 in the second. All the participants were undergraduate and postgraduate students of the same university and all of them were inexperienced and had never participated in an economic experiment before. Except for five students, all belonged to a non- Economics background.

EXPERIMENT 1

The first experiment was carried out with 16 participants. There were a total of 20 trials. At the beginning of the experiment, a set of instructions was provided to all the students and technical queries, if any, were addressed by the experimenter. The experimenter chose a participant through a draw of lots to perform the action of flipping the coin. This was done to assuage any fears of partiality in the experiment. All participants (including the one who was tossing the coin) were then told to record the outcome of each coin toss in a table provided in the same sheet, and they were asked to write their prediction about the eighth outcome in a designated column in the table. Each participant was given Rs. 50 for taking part in this experiment. The participant with the most number of correct guesses by the end of the 20^{th} trading period was given an additional amount of Rs. 100.

EXPERIMENT 2

13 students participated in the second experiment, which consisted of three parts. The first part was done as an exercise to test the subjects' attitude towards risk. The second part was the main task wherein the subjects were randomly allotted with varying endowments of two stocks- A and B as well as a cash endowment. The pay offs from the two stocks were equal and perfectly negatively correlated. In every trading period, either Stock A paid dividend or Stock B paid dividend (based on the outcome of a coin toss after every trading period). The participants were given the flexibility to trade the stocks with the experimenter at the beginning of every trading period for a fixed selling price. The final part of the experiment consisted of another questionnaire to record the details of the subjects, such as the age, gender, previous exposure to financial asset trading scenario etc.

The first part was a questionnaire that was filled out by the participants to assess their attitude towards risk. In this questionnaire, the participants were presented with a hypothetical situation in which they were endowed with Rs. 500 and they had to choose to invest a part of this endowment in a risky asset. The asset had a 50% chance of success. In case of a success, the amount invested in the investment would double, however, in case of failure the participant would lose the amount invested. The participants were given the instructions and explained the conditions of the experiment in English as well as Hindi to ensure complete clarity. Once their answers were recorded, the participants moved on to the second part of the experiment.

The second part of the experiment was an exercise in portfolio balancing in a stock market situation. All transactions were done in tokens, the experimental currency, which could be converted into Rupees at a fixed rate. Random allocations of two stocks- A and B were made across the participants. Each participant was given a total of 10 stocks and 100(tokens) in notional currency (1 token=Rs 0.1). The proportion of Stock A and B was varied across the subject pool but the total endowment of shares was kept constant at 10 shares for every player. Each share had a stock life of 1 period and the number of shares was not transferable to the next period. Both stocks gave an equal dividend of 20 tokens per stock and their pay offs were perfectly negatively correlated. In every period, the dividend was received from either A or B. The dividends accrued from each type relied on the state that occurred in that period. State 1 occurs if a coin tossed by the experimenter results in Heads. In state 1, B gives a dividend of 20 tokens. On the other hand, if coin toss resulted in Tails then it would lead to State 2, in which stock A would give a dividend of 20 tokens.

The players were given the instructions at the beginning of the experiment with a payoff matrix depicting the payoff in different states. Instructions were verbally explained and all technical queries were addressed. An unpaid session was conducted to ensure the instructions were understood completely. Once the experiment commenced, the subjects were endowed with a specific proportion of A and B. They were given the opportunity to trade the shares of their endowment so that the portfolio at the end of each period was that of the participants' choice. Transaction costs were ruled out to ensure the players could costlessly hold the portfolio of their choice. After this step, a coin was tossed by the experimenter to determine which state occurs and this was announced publicly. The players were given their total payouts (cumulative tokens) at the end of the 15 periods.

The third part was conducted once the second part of the experiment was completed. The players were given a questionnaire which included demographic questions as well as their reactions to the experiment.

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ANALYSIS

EXPERIMENT ONE

Note: No. of predictions = No. of subjects * No. of trials

There were 13 subjects.

To examine how the probability of predicting tails was determined by the percentage of tails outcomes in the history, we calculated the percentage of tails predictions given the number of tails occurrences in all the seven coin tosses. Table 1 and Figure 1 show that as the number of tails occurrences increase, people initially followed the trend(Hot Hand Fallacy) and predicted Tails but interestingly as the number of Tails occurrences further increased, people fell prey to Gambler's fallacy thereby predicting Heads more often than Tails. When all seven coin tosses turned out to be Tails, only 10 out of 16 people predicted Tails, thereby giving substantial evidence of Gambler's Fallacy.

LENGTH OF THE LAST RUN EFFECT

Another possibility was that besides the Gambler's fallacy, there were other patterns (such as streaks) influencing the predictions. To test the influence of the length of the last run on the predictions, we analyzed the percentage tails predictions made by the subjects given the number of Tails occurrences in the last three coin tosses.

The graph above shows that as the number of tails occurring in the last three coin tosses increase, people less and less predict that Tails would occur on the last coin toss showing that people's cognitive responses to a scenario are possibly influenced by recent outcomes. Table 2 and Figure 2 reflects that Participants' predictions were negatively dependent on the length of the last run i.e. participants showed a tendency to avoid long streaks.

EXPERIMENT TWO

We observed percentage holdings of stock A in trading period t=1 given the outcome of a coin toss after period t. If the outcome of the coin toss was Tails(Heads) after session t, stock A's (B's) dividend got doubled. If in period t+1, percentage holdings of stock A fell(rose) as a result, subjects fell prey to Gamblers fallacy. On the other hand, if in period t+1, percentage holdings of stock A rose(fell) after a Tails(Heads) outcome in session t, subjects were chasing the trend and leaning towards the stock that performed well in the previous period.

The sequence of coin toss outcomes was as follows:
T,T,H,T,T,T,H,T,T,T,H,T,T,T,T

Given our experimental design, we find no clear trend of Trend Chasing or Gambler's fallacy with subjects alternatively falling prey to each cognitive response(Figure 3). Confusion regarding the instructions and feelings of the subjects that they were inexperienced to participate in the "market" experiment could have made them make random choices of portfolio allocations. However, this gives us an insight to investigate the role of experience in portfolio allocations. To test this, we could create a trading environment for two subject pools- experienced market traders on one hand and market novices on the other hand and analyze their portfolio decisions.

GENDER EFFECTS AND GAMBLER'S FALLACY

We study gender differences in the gambler's fallacy using percentage holdings of stock A for women per trading period given the coin toss outcomes after every trading session. Figure 4 reflects no clear trend of Trend Chasing or Gambler's fallacy for women. Prior research on gender effects and Gambler's Fallacy shows that men on average commit Gambler's fallacy more than women. Figure 5 reflects a clear inclination of men towards trend chasing when they see a stock doing well persistently. However, it is followed by a committal of Gambler's Fallacy to avoid too long a streak. After observing and chasing a long streak of good performance, men eventually start believing that the stock will now fall in value thereby reducing their holdings of the stock.

ENDOWMENT EFFECT

Average Absolute Imbalance per subject

To investigate whether a participant's final holdings depended on the initial endowment we considered imbalance in final stock holdings by initial endowment. Recall that our participants were endowed with varying proportions of stocks A/B to each subject, keeping the proportion fixed throughout every trading session. And all subjects were given more of A than B.

Table 3 and Figure 6 shows that people on average held imbalanced portfolios in favor of stock A, showing possible Endowment effect (towards Stock A). However, this cannot be claimed with much confidence since we only looked at Endowment effect for stock A. To better investigate the Endowment effect, we need a larger subject pool so as to divide them into three groups each with 10/0, 0/10 and 5/5 proportions of endowments of Stock A/B and then compare each group's frequency of average absolute imbalance per participant. A better possession condition can be developed for the subjects if the dividends on each share are higher.

CONCLUSIONS

EXPERIMENT 1

The direct effects of Gambler's fallacy and length of last run on the probability of tails predictions could have been confounded by factors like Subject fatigue and boredom, given the fact that the coin was tossed seven times for each of the 20 trials. Increasing the sample size, reducing the number of trials and giving greater salience can help us prevent this confounding and get much stronger results.

EXPERIMENT 2

Given the budget constraint, the subject pool was small. A larger sample size would allow us to use logistic regressions (Logit and Probit models) to estimate the probability of decreased/increased holdings of a stock given the performance of the stock in the previous period and get robust results.

The language of the instructions needed to be more simple and clear enough for the subject pool that we had. Lack of clarity left the subjects confused and made them make random portfolio allocation choices. The subject pool comprised of 5 subjects with an understanding of Economics. These subjects attempted to create a feeling amongst the pool that prior knowledge was required to participate in the trading environment. Greater control over subject communication was imperative. Also, a pool of completely inexperienced subjects could have been a better choice.

However, the experiment did provide us with the insight to investigate the role of experience in portfolio allocation decisions. We can diversify the sample size and study the allocation behavior and role of Gambler's fallacy for two

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groups- market traders v/s market novices. Lastly, as per induced value theory, the subjects needed to be given high salient rewards (dividends) to induce subjects to behave as per the demands of the experiment.

Table 1

No. of times tails occurred (x)	No. of trials	No. of predictions	Responses of subjects		Percentage of tails predictions
			No. of Heads	No. of Tails	
0	0	0	0	0	0
1	2	32	13	19	40.62%
2	3	48	28	20	41.67%
3	6	96	44	52	54.16%
4	5	80	37	43	53.75%
5	3	48	26	22	45.83%
6	0	0	-	-	-
7	1	16	10	6	37.5%
Total no. of predictions		320			

Table 2

No. of times tails occurred in the last three outcomes (x) i.e Length of Last run	No. of trials	No. of predictions	Responses of the subjects		Percentage of tails predictions (%)
			No. of Heads	No. of Tails	
0	3	48	20	28	58.33
1	5	80	41	39	48.75
2	8	112	71	41	36.61
3	3	48	30	18	37.5
Total no. of predictions		288			

Table 3

SUBJECTS	1	2	3	4	5	6	7	8	9	10	11	12	13
AVERAGE ABSOLUTE IMBALANCE	2.4	0.47	4	7.8	0.6	1	-1.47	1.53	-1.87	10.8	-8	2.47	0.27

Where Absolute Imbalance=Final Number of Stock A held-Final Number of Stock B held after 15 trading periods for each of the 13 subjects

Figure 1

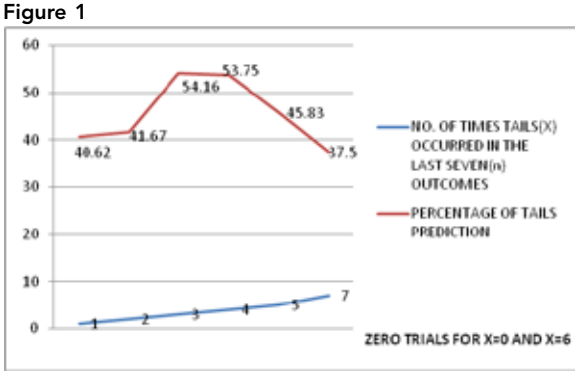


Figure 2

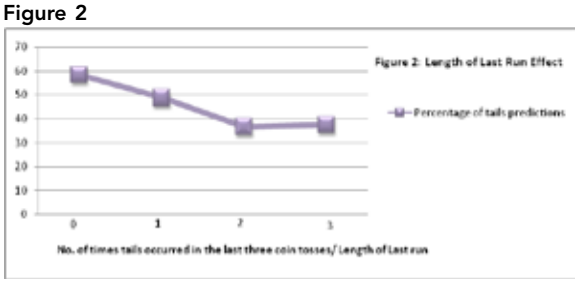
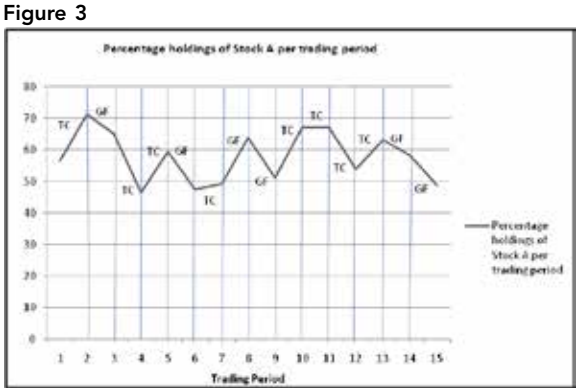


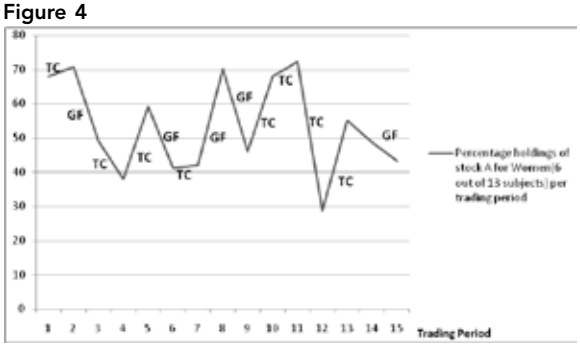
Figure 3



TC- Trend chasing observed from Trading period t to Trading period t+1(Increased(decreased) percentage holdings of stock A in period t+1 if Stock A's(B's) dividend got doubled i.e. Outcome=Tails(Heads) at the end of period t)

GF- Gambler's Fallacy observed from Trading period t to Trading period t+1(Decreased(Increased) percentage holdings of stock A in period t+1 if Stock A's(B's) dividend got doubled i.e. Outcome=Tails(Heads) at the end of period t)

Figure 4



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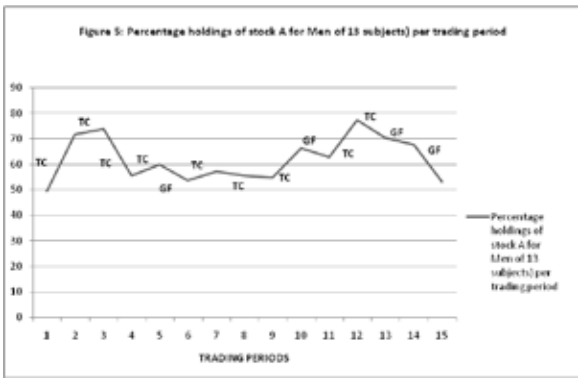
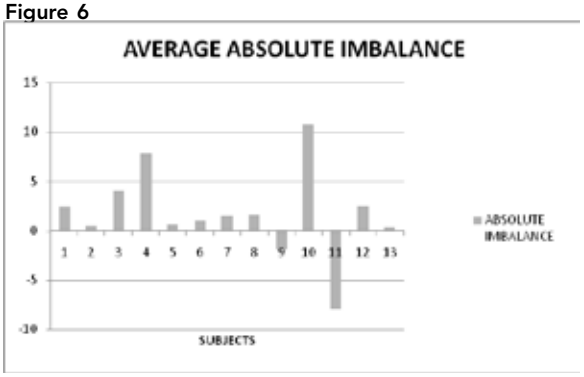


TC: Trend chasing from period t to t+1

GF: Gambler's fallacy from period t to t+1

Figure 6



REFERENCE Burns, B. (2004). Heuristics as Beliefs and as Behaviors: The Adaptiveness of the Hot Hand. Cognitive Psychology, 48, 295-331. | Camerer, C. F. (1989). Does the Basketball Market Believe in the 'Hot Hand'? The American Economic Review, 79(5), 1257-1261. | Carhart, M. M. (1997). On Persistence in Mutual Fund Performance. The Journal of Finance, 52(1), 57-82. | Clotfelter, C., & Cook, P. (1993). The "Gambler's Fallacy" in Lottery Play. Management Science, 1521-1525. | Croson, R., & James, S. (2005, May). The Gambler's Fallacy and the Hot Hand: Empirical Data from Casinos. Journal of Risk and Uncertainty, 30(3), 195-209. | Estes, W. (1950). Toward a Statistical Theory of Learning. Psychological Review, 57(2), 94-107. | Gilovitch, T., Villone, R., & Tversky, A. (1985). The Hot Hand in Basketball: On the Misperception of Random Sequences. Cognitive Psychology, 17, 295-314. | Kareev, Y. (1995). Positive Bias in the Perception of Covariation. Psychological Review, 102(3). | M., R., & Vayanos, D. (2010). The Gambler's and Hot-Hand Fallacies: Theory and Applications. Review of Economic Studies, 77, 730-778. | Massey, C., & Thaler, R. (2007). The Loser's Curve: Over Confidence vs. Market Efficiency in the NFL Draft. SSRN Working Paper. | Rao, J. M. (2009a). "He Got Game" Theory: Optimal Decision Making and the NBA. | Suetens, S., & Tyran, J. R. (2011). The Gambler's Fallacy and Gender. Center Discussion Paper. |