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Gambler's or the Hot-Hand: Illusion or Real?

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Abstract- This paper reviews literature of the Gambler's and the hot hand fallacies and the possible differences inherent in explaining investor behaviour. The Gambler's fallacy is built on the belief that the more you lose, the higher your next probability of winning in the near future; whereas the hot hand is built on the belief that the more the chances you get right now, the more likely you will get right even in the future. This beliefs are erroneous since they go contrary to the equal chances attributed to the probability of flipping a fair coin according to laws of probability.The investors tend to believe that the performance of a mutual fund is a combination of the manager's ability and luck will, at first, underestimate the likelihood that a manager of average ability will exhibit a streak of above- or below-average performance. Both Gamblers' and hot hand fallacies are illusions and ideal to a level of factual outcome which remains paradoxical. To a given level of accuracy, the paper based on the existing researches tends to give more weight unto the realness cast in the hot hand fallacy as opposed to the gambler's fallacy. However, there is no conclusiveness as to the wellbeing or vagueness of either given that both are heuristics, investors making judgments on how things appear rather than how statistically likely they are.

Index Terms- Heuristic, Gambler's Fallacy, Hot Hand Fallacy, Illusion

I. Introduction

The causal link between the gambler's fallacy and the hot hand fallacy is a common intuition in psychology. Some suggestive evidence comes from an experiment by Edwards (1961), in which subjects observe a very long binary series and are given no information about the generating process. Subjects seem, by the evolution of their predictions over time, to come to believe in a hot hand.

The hot-hand fallacy is a belief in the continuation of streaks. An alternative and closely related definition involves the agent's assessed auto-correlation of the signals (Rabin and Vayanos, 2009). Gilovich, Vallone, and Tversky (1985) and Tversky and Gilovich (1989a, 1989b) both give evidence on the hot-hand fallacy.

The Gambler's fallacy is exhibited in the works of Clotfelter and Cook (1993) and Terrell (1994) who study pari-mutuel lotteries, where the winnings from a number are shared among all people betting on that number. They find that people avoid systematically to bet on numbers that won recently. This is a strict mistake because the numbers with the fewest bets are those with the largest expected winnings.

Evidence linking the hot-hand fallacy to a belief in time-varying human skill comes from the casino-betting study of Croson and Sundali (2005). They show that consistent with the gambler's fallacy, individuals avoid betting on a color with many recent occurrences. Consistent with the hot-hand fallacy, however, individuals raise their bets after successful prior bets.

1.1 Hot Hand And Gamblers' Concepts

1.1.1 The Gambler's Fallacy

According to the formalized model by Rabin and Vayanos (2010), the gambler's fallacy arises from an expectation that outcomes in random sequences will soon exhibit systematic reversals. Many Financial decisions are based on beliefs concerning the likelihood of uncertain events. The gambler's fallacy which is also known as the Monte Carlo fallacy or the fallacy of the maturity of chances refers to the mistaken belief that if something happens more frequently than normal during some period, then it will happen less frequently in the future; likewise, if something happens less frequently than normal during some period, then it will happen more frequently in the future (presumably as a means of *balancing* nature).

Many people fall under the spell of the "gambler's fallacy", expecting outcomes in random sequences to exhibit systematic reversals. When observing flips of a fair coin, for example, people believe that a streak of heads makes it more likely that the next flip will be a tail. Gambler's fallacy arises out of a belief in a "law of small numbers", or the erroneous belief that small samples must be representative of the larger population. According to the fallacy, "streaks" must eventually even out in order to be representative.

In situations where what is being observed is truly random (i.e. independent trials of a random process), this belief, though appealing to the human mind, is false. This fallacy can arise in many practical situations although it is most strongly associated with gambling where such mistakes are common among players.

The use of the term *Monte Carlo fallacy* originates from the most famous example of this phenomenon, which occurred in a Monte Carlo Casino in 1913 when the ball fell in black 26 times in a row. This was an extremely uncommon occurrence, although no more or less common than any of the other 67,108,863 sequences of 26 red or black. Gamblers lost millions of francs betting *against* black, reasoning incorrectly that the streak was causing an "imbalance" in the randomness of the wheel, and that it had to be followed by a long streak of red.

The gambler's fallacy can be illustrated by considering the repeated toss of a fair coin. With a fair coin, the outcomes in different tosses are statistically independent and the probability of getting heads on a single toss is exactly 1⁄2 (one in two). It follows that the probability of getting two heads in two tosses is 1⁄4 (one in four) and the probability of getting three heads in three tosses is 1⁄8 (one in eight).

Croson and Sundali (2005) conducted a research on decision making under uncertainty where they demonstrate that intuitive ideas of randomness depart systematically from the laws of chance. Two such departures involving random sequences of events have been documented in the laboratory, the gambler's fallacy and the hot hand. This study presents results from the field, using videotapes of patrons gambling in a casino, to examine the existence and extent of these biases in naturalistic settings. We find small but significant biases in our population, consistent with those observed in the lab.

1.1.2 Explaining why the probability is 1/2 for a fair coin

If one flips a fair coin 21 times, then the probability of 21 head is 1 in 2,097,152. However, the probability of flipping a head *after having already flipped 20 heads in a row* is simply 1⁄2. This is an application of Bayes' theorem. This can also be seen without knowing that 20 heads have occurred for certain (without applying of Bayes' theorem). Consider the following two probabilities, assuming a fair coin:

- probability of 20 heads, then 1 tail = 0.520 × 0.5 = 0.521
- probability of 20 heads, then 1 head = 0.520 × 0.5 = 0.521

The probability of getting 20 heads then 1 tail, and the probability of getting 20 heads then another head are both 1 in 2,097,152. Therefore, it is equally likely to flip 21 heads as it is to flip 20 heads and then 1 tail when flipping a fair coin 21 times. Furthermore, these two probabilities are equally as likely as any other 21-flip combinations that can be obtained (there are 2,097,152 total); all 21-flip combinations will have probabilities equal to 0.521, or 1 in 2,097,152. From these observations, there is no reason to assume at any point that a change of luck is warranted based on prior trials (flips), because every outcome observed will always have been as likely as the other outcomes that were not observed for that particular trial, given a fair coin. Therefore, just as Bayes' theorem shows, the result of each trial comes down to the base probability of the fair coin: 1⁄2

1.1.3 Non-examples of the fallacy

There are many scenarios where the gambler's fallacy might superficially seem to apply, when it actually does not. When the probability of different events is *not* independent, the probability of future events can change based on the outcome of past events (see statistical permutation). Formally, the system is said to have *memory*. An example of this is cards drawn without replacement. For example, if an ace is drawn from a deck and not reinserted, the next draw is less likely to be an ace and more likely to be of another rank. The odds for drawing another ace, assuming that it was the first card drawn and that there are no jokers, have decreased from 4⁄52 (7.69%) to 3⁄51 (5.88%), while the odds for each other rank have increased from 4⁄52 (7.69%) to 4⁄51 (7.84%). This type of effect is what allows card counting systems to work (for example in the game of blackjack).

1.1.4 Variations of the gambler's fallacy

Some researchers believe that there are actually two types of gambler's fallacy: Type I and Type II. Type I is the "classic" gambler's fallacy, when individuals believe that a certain outcome is "due" after a long streak of another outcome. Type II gambler's fallacy, as defined by Keren and Lewis (1994) occurs when a gambler underestimates how many observations are needed to detect a favorable outcome (such as watching a roulette wheel for a length of time and then betting on the numbers that appear most often). Detecting a bias that will lead to a favorable outcome takes an impractically large amount of time and is very difficult, if not impossible, to do; therefore people fall prey to the Type II gambler's fallacy (Keren and Lewis, 1994). The two types are different in that Type I wrongly assumes that gambling conditions are fair and perfect, while Type II assumes that the conditions are biased, and that this bias can be detected after a certain amount of time.

Another variety, known as the retrospective gambler's fallacy, occurs when individuals judge that a seemingly rare event must come from a longer sequence than a more common event does. For example, people believe that an imaginary sequence of die rolls is more than three times as long when a set of three 6's is observed as opposed to when there are only two 6's. This effect can be observed in isolated instances, or even sequentially. A real world example is that when a teenager becomes pregnant after having unprotected sex, people assume that she has been engaging in unprotected sex for longer than someone who has been engaging in unprotected sex and is not pregnant (Oppnheimer and Monin, 2009)

1.2.1 Hot hand Fallacy

The "hot-hand fallacy" (also known as the "hot hand phenomenon" or "hot hand") is the fallacious belief that a person who has experienced success with a random event has a greater chance of further success in additional attempts.

1.2.2 Hot hand fallacy discovery

Three men discovered the fallacy, with Thomas Gilovich and Amos Tversky acting as the primary investigators. Gilovich's primary focus was on judgment, decision-making behaviors and heuristics (Gilovack, 2012); while Amos Tversky came from a cognitive and mathematical psychology background (Tversky, 2012). The pair collaborated with Robert Vallone, a cognitive psychologist, and all three became pioneers of the hot hand fallacy theory. Their study, "The Hot Hand in Basketball: On the Misperception of Random Sequences" (1985), investigated the validity of people's thoughts on "hot" shooters in basketball.

The "Hot Hand in Basketball" study provided a large body of evidence that disproved the theory the basketball players have "hot hands", that is, that they are more likely to make a successful shot if their previous shot was successful.

The study looked at the inability of respondents to properly understand randomness and random events; much like innumeracy can impair a person's judgment of statistical information, the hot hand fallacy can lead people to form incorrect assumptions regarding random events. The three researchers provide an example in the study regarding the "coin toss"; respondents expected even short sequences of heads and tails to be approximately 50% heads and 50% tails (Gilovich, Tversky and Vallone, 1985). The study proposed two biases that are created by the kind of thought pattern applied to the coin toss: it could lead an individual to believe that the probability of heads or tails increases after a long sequence of either has occurred (known as the gambler's fallacy); or it could cause an individual to reject randomness due to a belief that a streak of either outcome is not representative of a random sample (Gilovich, Tversky and Vallone, 1985).

The first study was conducted via a questionnaire of 100 basketball fans from the colleges of Cornell and Stanford. The other looked at the individual records of players from the Philadelphia 76ers during the 1980–81 seasons. The third study analyzed free-throw data and the fourth study was of a controlled shooting experiment. The reason for the different studies was to gradually eliminate external factors around the shot. For example, in the first study there is the factor of how the opposing team's defensive strategy and shot selection would interfere with the shooter. The second and third take out the element of shot selection, and the fourth eliminates the game setting and the distractions and other external factors mentioned before. The studies primarily found that the outcomes of both field goal and free throw attempts are independent of each other (Gilovich, Tversky and Vallone, 1985).

In the later studies involving the controlled shooting experiment the results were the same; evidently, the sense of being "hot" does not predict hits or misses (Gilovich, Tversky and Vallone, 1985).

1.2.3 Hot-hand consumers

There are more places than sport that can be affected by the hot-hand fallacy. A study conducted by Joseph Johnson et al. examined the characteristics of an individual's buying and selling behavior as it pertained to the hot hand and gamblers' heuristic. Both of these occur when a consumer misunderstands random events in the market and is influenced by a belief that a small sample is able to represent the underlying process (Roney and Trick, 2009).

To examine the effect of the hot hand and gambler's heuristic on the buying and selling behaviors of consumers, three hypotheses were made. Hypothesis one stated that consumers that were given stocks with positive and negative trends in earning would be more likely to buy a stock that was positive when it was first getting started but would become less likely to do so as the trend lengthened. Hypothesis two was that consumers would be more likely to sell a stock with negative earnings as the trend length initially increased but would decrease as the trend length increased more. Finally, the third hypothesis was that consumers in the buy condition would be more likely to choose a winning stock over those in the selling condition (Roney and Trick, 2009)

The results of the experiment did not support the first hypothesis but did support hypotheses two and three, suggesting that the use of these heuristics is dependent on buying or selling and the length of the sequence. This means that those who had the shorter length and the buying condition would fall under the influence of the hot-hand fallacy (Roney and Trick, 2009). The opposite would be in accordance with the gambler's fallacy which has more of an influence on longer sequences of numerical information. This particular study explores a portion of the possibilities that the hot hand and gambler's fallacies affect other aspects of consumers' potential behavior, especially when selling instead of buying, because it is a more complex task.

1.2.4 The Hot-hand or the gambler's fallacy?

A study was conducted to examine the difference between the hot-hand and gambler's fallacy. The gambler's fallacy is the expectation of a reversal following a run of one outcome (Roney and Trick, 2009). Gambler's fallacy occurs mostly in cases in which people feel that an event is random, such as rolling a pair of dice on a craps table or spinning the roulette wheel. It is caused by the false belief that the random numbers of a small sample will balance out the way they do in large samples; this is known as the law of small numbers heuristic.

The difference between this and the hot-hand fallacy is that with the hot-hand fallacy an individual expects a run to continue (Roab, Markus and Gigerenzer, 2011). There is a much larger aspect of the hot hand that relies on the individual. This relates to a person's perceived ability to predict random events, which is not possible for truly random events. The fact that people believe that they have this ability is in line with the illusion of control (Roney and Trick, 2009).

In this study, the researchers wanted to test if they could manipulate a coin toss, and counter the gambler's fallacy by having the participant focus on the person tossing the coin. In contrast, they attempted to initiate the hot-hand fallacy by centering the participant's focus on the person tossing the coin as a reason for the streak of either heads or tails. In either case the data should fall in line with sympathetic magic, whereby they feel that they can control the outcomes of random events in ways that defy the laws of physics, such as being "hot" at tossing a specific randomly determined outcome (Roney and Trick, 2009) They tested this concept under three different conditions. The first was person focused, where the person who tossed the coin mentioned that *she* was tossing a lot of heads or tails. Second was a coin focus, where the person who tossed the coin mentioned that *the coin* was coming up with a lot of heads or tails. Finally there was a control condition in which there was nothing said by the person tossing the coin.

Roney and Trick (2009) assert that the participants were also assigned to different groups, one in which the person flipping the coin changed and the other where the person remained the same. The researchers found the results of this study to match their initial hypothesis that the gambler's fallacy could in fact be countered by the use of the hot hand and people's attention to the person who was actively flipping the coin. It is important to note that this counteraction of the gambler's fallacy only happened if the person tossing the coin remained the same (Roney and Trick, 2009). This study shed light on the idea that the gambler's and hot hand fallacies at times fight for dominance when people try to make predictions about the *same* event (Roney and Trick, 2009).

1.2.5 Why the "Hot Hand" May Be Real After All

Jeffrey Zwiebel, a Stanford Finance professor finds that hot streaks in sports are no illusion. Economists should take heed. Sports fans, rejoice: You may have been right all along about hot streaks. They aren't a figment of your imagination.

Contradicting academic studies dating back 30 years, researchers at Stanford, Berkeley, and Harvard are now finding that a "hot hand" in basketball or baseball is not a statistical illusion. In fact, hot streaks can help predict a player's likelihood of getting another hit or sinking another basket (Zwiebel, 2013).

Perhaps surprisingly, this has implications for a raging debate in finance about the rationality, or lack of it, in markets. In a major new study of baseball data, Jeffrey Zwiebel at Stanford Graduate School of Business and Brett Green at University of California's Haas School of Business at Berkeley find that hot hands are real and have predictive power. Why would business professors jump into a sports debate? Because the "hot-hand fallacy" has become a staple in arguments by supporters of behavioral economics to argue that individuals can be irrational. For example, the behaviorists have argued that investors often get lured into bad decisions by seeing patterns that aren't real. According to the behaviorists, investors make a wide range of cognitive mistakes that range from overconfidence in their own abilities to a tendency to over-react to news.

That critique gained a lot of traction in the wake of the mortgage bust and the great financial crisis. A 2009 paper lays out the theory and potential financial applications of the hot-hand fallacy. A 2012 paper argues that the hot-hand fallacy explains why people pay for useless investment advice. And in a brand new paper, German scholars even found evidence that people who believe in the hot-hand fallacy are more at risk of long-term unemployment.

Zwiebel (2013) says the earlier researchers were too quick to conclude that the belief in a hot hand was evidence of a cognitive or behavioral mistake. Most likely, what's really at work is not so much a mistake but an "equilibrium adjustment" around the hot-handed player, similar to the kinds of equilibrium adjustments that occur in finance and economics.

"The behavioral camp jumps too quickly to the conclusion that almost all sports fans and participants are under a dumb illusion that there are hot hands," (Zwiebel, 2013) says. "They have jumped to that conclusion because it fits their story that everyone is making cognitive mistakes and that these mistakes are extraordinarily pervasive."

Investment bankers have been criticized for underestimating the risks of subprime mortgages, for being irrational in their optimism. But it's possible that their excessive risk-taking wasn't irrational as much as it was encouraged or even subsidized by regulatory policies, such as those that protected banks considered "too big to fail." The difference between those two diagnoses of the financial crisis leads to very different proposals for reform. "One can portray the financial crisis as being triggered by a bunch of mistakes, or one can portray it as the consequence of risky decisions that were made based on the incentives and subsidies in the system," he says. "I see it as more of the latter."

II. CONCLUSION

'Gambler's Fallacy' occurs when an individual erroneously believes that the onset of a certain random event is less likely to happen following an event or a series of events. This line of thinking is incorrect because past events do not change the probability that certain events will occur in the future. This line of thinking represents an inaccurate understanding of probability because the likelihood of a fair coin turning up heads is always 50%. Each coin flip is an independent event, which means that any and all previous flips have no bearing on future flips. This can be extended to investing as some investors believe that they should liquidate a position after it has gone up in a series of subsequent trading session because they don't believe that the position is likely to continue going up.

Rabin (2002) and Rabin and Vayanos (2010) outline a model in which believers of "the law of small numbers" – i.e. those who believe that a small sample of signals represents the parent population from which it is drawn (Tversky & Kahneman, 1971) – will be willing to pay for services by financial analysts after observing randomly occurring streaks of profitable financial performances predicted by these professionals. This fallacious belief in the hot-hand of a financial expert arises as a consequence of the gambler's fallacy, which is defined as an individual's tendency to expect outcomes in random sequences to exhibit systematic reversals. The authors suggest that an investor who believes that the performance of a mutual fund is a combination of the manager's ability and luck will, at first, underestimate the likelihood that a manager of average ability will exhibit a streak of above- or below-average performance. Following good or bad streaks, however, the investor will revert to overestimate the likelihood that them manager is above or below average, and so in turn will over-infer that the streak of unusual performance will continue (Gilovich et al., 1985).

The implication of this is that believers of the law of small number will be happy to pay for real-time price information provided by experts, such as stockbrokers or managers of actively-managed funds, even when it is well-documented that actively-managed funds do not outperform their market benchmark on average (Fama, 1991).

While the Gambler's fallacy investors tend to belief that events exhibit systematic reversals, the hot hand counterparts tend to argue that there are more chances of making a winning investment decision if you have been doing it right before. Both Gamblers' and hot hand fallacies are illusions and ideal to a level of factual outcome. However, Gamblers being the opposite of hot hand means that the two cannot happen one and the same time. Both are fallacies ideal to certain circumstances and an illusion to others. Whereas Gamblers can be ideal in some situation, hot hand can be an illusion in such a situation, the opposite is true.

REFERENCES

[1] Ayton, P.; Fischer, I. (2004). "The hot-hand fallacy and the gambler's fallacy: Two faces of subjective randomness?" Memory and Cognition 32: 1369–1378.

[2] Castel, Alan; Drolet Rossi, A., McGIllivary, S. (2012). "Beliefs About the "Hot Hand" in Basketball Across the Adult Life Span". Psychology and Agin.

[3] Clotfelter, C. and P. Cook, 1993, "The 'Gambler's Fallacy in Lottery Play," Management Science, 39, 1521-1525.

[4] Croson, R. and J. Sundali, 2005, "The Gamblers Fallacy and the Hot Hand: Empirical Data from Casinos," Journal of Risk and Uncertainty, 30, 195-209.

[5] Edwards, W., 1961, "Probability Learning in 1000 Trials," Journal of Experimental Psychology, 62, 385-394.

[6] Fama, Eugene F. 1991. Efficient capital markets: II. Journal of Finance, 46, 1575-1617.

[7] Gilovich, Thomas; Tversky, A. & Vallone, R. (1985). "The Hot Hand in Basketball: On the Misperception of Random Sequences". Cognitive psychology 3 (17): 295–314.

[8] Gigerenzer, G. (2011). "The Hot hand Exists in Volleyball and Is Used for Allocation Decisions". Journal of Experimental Psychology: Applied

[9] Gilovich, Thomas (1991). How we know what isn't so. New York: The Free Press. pp. 16–19. ISBN 0-02-911706-2.

[10] Koehler, Jonathan (2003). "The "Hot Hand" Myth in Professional Basketball". Journal of Sport Psychology 2 (25): 253–259.

[11] Keren, G. and Lewis, C. (1994). "The two fallacies of gamblers: Type I and Type II". Organizational Behavior and Human Decision Processes, 60, 75-89.

[12] Matthew Rabin and Dimitri Vayanos (2009). "The Gambler's and Hot-Hand Fallacies:Theory and Applications." University of California, Berkeley

[13] Oppenheimer, D. M. and Monin, B. (2009). "The retrospective gambler's fallacy: Unlikely events, constructing the past, and multiple universes". Judgment and Decision Making, 4, 326-334.

[14] Oskarsson, Van Boven (2009). "What's Next? Judging Sequences of Binary Events"

[15] "Raab, M., Gula, B., & Gigerenzer, G. (2011)". Journal Of Experimental Psychology: Applied. doi:10.1037/a0025951.

[16] "Roney, C. R., Trick, L. M. (2009)". Sympathetic magic and perceptions of randomness: the hot hand versus the gambler's fallacy. Raab, Markus; Gula, B.;

[17] Roney, C. J.; Trick, L. M. (2003). "Grouping and gambling: A gestalt approach to understanding the gambler's fallacy". Canadian Journal of Experimental Psychology

[18] Rachel Croson and James Sundali (2005). "The Gambler's Fallacy and the Hot Hand: Empirical Data from Casinos." Journal of Risk and Uncertainty

[19] Rabin, Matthew; and Dimitri Vayanos. 2010. The gambler's and hot-hand fallacies: theories and applications. Review of Economics Studies, 77(2), 730-778.

[20] Tversky, Amos; Daniel Kahneman (1974). "Judgment under uncertainty: Heuristics and biases". Science 185 (4157): 1124–1131.

[21] Tversky, Amos; Daniel Kahneman (1971). "Belief in the law of small numbers".

[22] Tversky, A. and T. Gilovich, 1989a, "The Cold Facts about the 'Hot Hand' in Basketball," Chance, 2, 16-21.

[23] Tversky, A. and T. Gilovich, 1989b, "The Hot Hand: Statistical Reality or Cognitive Illusion?" Chance, 2, 31-34.

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