

# Predicting Lotto Numbers: A Natural Experiment on the Gambler's Fallacy and the Hot-Hand Fallacy

Suetens, Galbo-Jørgensen, & Tyran (2016)

Timothy Nguyen

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Professor Jawwad Noor

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# Introduction: A Tale of Two Fallacies

- As discussed in our course notes, people often exhibit two seemingly contradictory biases when judging random sequences:
- **The Gambler's Fallacy (GF):** The belief that a recent outcome makes the opposite outcome *more* likely. (e.g., "Red is due after a streak of black.")
- **The Hot-Hand Fallacy (HHF):** The belief that a recent streak of an outcome makes that same outcome *more* likely. (e.g., "The player is on fire, pass him the ball!")
- **The Research Question:** Can these two opposing fallacies coexist? Specifically, do lotto players bet *less* on numbers drawn last week (GF), but *more* on numbers that have been drawn frequently in the recent past (HHF)?

# Background: The Law of Small Numbers

- **Course Context:** This paper provides field evidence for the theories of belief formation under uncertainty discussed in our class.
- **The "Law of Small Numbers":** The core idea, proposed by Tversky & Kahneman and formalized by Rabin & Vayanos (2010), is that people mistakenly believe small samples should be representative of the large population.
- **Fallacy Reversal Intuition:**
  - A belief in the law of small numbers leads to the **Gambler's Fallacy** in the short run (expecting reversals to maintain representativeness).
  - However, a *long streak* violates this belief so strongly that the person starts to doubt the randomness of the process itself, inferring an underlying cause or "hotness." This leads to the **Hot-Hand Fallacy**.

# Data & Methodology: Danish Lotto

- **A Natural Experiment:** The study uses data from the Danish state lottery, a truly random process, avoiding the confound of "skill" present in studies like basketball.
- **Key Advantage:** The data is from online players who have a unique ID, allowing the researchers to track *individual betting choices* over 28 weeks in 2005. The individual analysis uses data from 7,323 players.
- **Dependent Variables:** Two proxies for betting confidence.
  - NumberBet: Whether a player picks a number.
  - MoneyBet: How much money a player bets on a number, weighted by the size of the set of numbers they chose.

# The Empirical Model

- **Key Independent Variables:**

- $\text{Drawn}_{t-1}$ : = 1 if number  $j$  was drawn in week  $t - 1$ .
- $\text{Hotness}_{t-1}$ : Count of how often number  $j$  was drawn from week  $t - 2$  to  $t - 6$ .

- **Aggregate Regression Model :**

$$DV_{ijt} = \beta_0 + \beta_1 \text{Drawn}_{jt-1} + \beta_2 \text{Hotness}_{jt-1} + \beta_3 (\text{Drawn}_{jt-1} \times \text{Hotness}_{jt-1}) + \dots$$

- **GF Test:**  $\beta_1 < 0$
- **HHF Test:**  $\beta_2 > 0$  and/or  $\beta_3 > 0$

- **Individual-Level Model :**

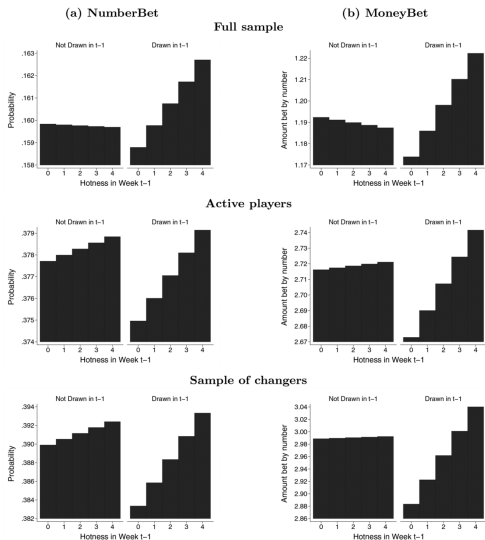
$$\Delta \text{MoneyBet}_{ijt} = \beta_{0j} + \beta_{1i} \text{Drawn}_{jt-1} + \beta_{2i} \text{Hotness}_{jt-1} + \dots$$

- Regressions are run for each player  $i$  to get their individual biases,  $\beta_{1i}$  and  $\beta_{2i}$ .

# Aggregate Results: Both Fallacies are Present

- The researchers run pooled regressions on different samples (all players, active players, and "changers" who alter their bets).
- **Evidence for Gambler's Fallacy ( $\beta_1 < 0$ ):**
  - On average, players bet significantly *less* on numbers that were drawn in the preceding week.
  - The effect is strongest for active "changers", who bet about **2-3% less** on a number if it was drawn last week.
- **Evidence for Hot-Hand Fallacy ( $\beta_3 > 0$ ):**
  - Players bet significantly *more* on numbers as their 'Hotness' increases, but primarily if that number was also drawn last week.
  - The marginal effect is about a **1% increase** in bets for each additional time the number was drawn in the recent past.

# Aggregate Results: Visualized



# Interpreting Figure 1: A Closer Look

- **How to Read the Plots:**

- **Gambler's Fallacy (GF):** Compare the first bar on the left ('Not Drawn') with the first bar on the right ('Drawn'). If the right bar is lower, players avoid last week's numbers.
- **Hot-Hand Fallacy (HHF):** Look at the trend on the right side ('Drawn'). If the bars rise with 'Hotness', players chase streaks.

- **Key Observation Across Samples:**

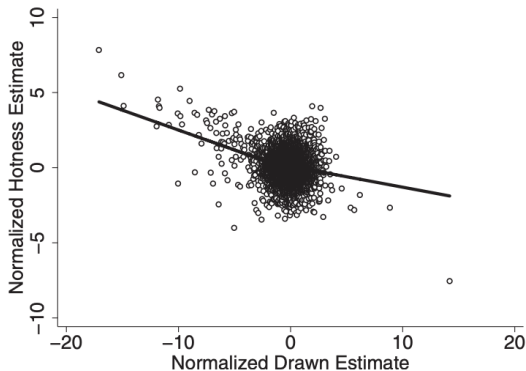
- **Top Row (Full Sample):** Effects are small.
- **Middle Row (Active Players):** Effects become clearer.
- **Bottom Row (Sample of Changers):** The effects are strongest and most significant. This shows the biases are driven by active players who change their bets, not by people quitting after a win.



## Individual-Level Analysis: Are the Fallacies Related?

- **The Core Question:** Do the fallacies just coexist in the aggregate, or do the *same individuals* exhibit both biases?
- **Method:** The authors run separate regressions for each of the 7,323 individual players to estimate their personal sensitivity to Drawn ( $\beta_{1i}$ ) and Hotness ( $\beta_{2i}$ ).
- **Finding:** There is a significant negative relationship between the two estimates. Players who most strongly exhibit the Gambler's Fallacy (large negative  $\beta_{1i}$ ) also tend to most strongly exhibit the Hot-Hand Fallacy (large positive  $\beta_{2i}$ ).
- **Quantitatively:** Among players with statistically significant biases, **55%** (71 out of 129) exhibit both fallacies simultaneously—more than double the 25% expected by chance.

# Individual Results: Visualized



# Upshots & Take-Aways

- **Main Take-Away:** This paper provides the first field evidence that the Gambler's Fallacy and the Hot-Hand Fallacy are systematically related and can coexist within the same individual.
- **Link to Theory:** The findings strongly support the "law of small numbers" and "fallacy reversal" models proposed by Rabin and Vayanos.
- **Broader Implications:**
  - This framework can help explain financial market anomalies, like short-term underreaction (GF) and long-term overreaction (HHF) to earnings news.
  - It shows that even in a purely random environment, people's beliefs and behaviors are predictable and systematically biased.

# Personal Reactions & Comments

## Strengths of the Paper

- The paper is strong because it uses real-world data from the lottery. This is better than a lab experiment because people are acting naturally, and it's better than studying sports because the lottery is purely random, so there's no confusion with skill. It gives us a very clean look at people's psychology.

## Avenues for Discussion & Critique

- **Heterogeneity:** The paper finds the effects are strongest for male, frequent, and heavy players. This suggests the biases are not uniform.
- **Selection Bias:** People who believe they can predict lotto numbers are more likely to play. The observed biases might be stronger in this population than in the general population.

# Thank you.

Questions?