

Kelly Or Bust

We would like to play a betting game with you: for the next thirty minutes you will flip a coin, and each time you will bet that it will come up either heads or tails. We will even bankroll your stake; we'll give you \$25 at the outset, and you are welcome to bet as much as you want on each flip. So, for instance, if you bet \$20 on the first flip and correctly call heads, then you win \$20 and may therefore wager up to \$45 on the second flip.

At the end of this half hour, whatever amount of money you have amassed is yours to keep, up to a maximum of \$250. Oh, and one more thing. The coin is biased—it has a 60% probability of coming up heads.

How would you play this game? What would be your strategy? Would you bet on heads every time, or would you sprinkle in some guesses for tails as well? What percent of the time would you bet on each outcome? How much would you be willing to bet on each flip? And, most importantly, how much money do you think you'd walk away with at the end of the half hour?

Going Bankrupt When You Shouldn't

As you may have guessed, this exact experiment has recently been performed. Two fund managers, [Victor Haghani and Richard Dewey, tried this game](#) with 61 subjects, most of whom were college-age economics students or young professionals working at finance firms. The results of their experiment were fascinating, if not surprising and startling.

Before we tell you all the specifics of how the subjects played the game and how much money they walked away with, we'll skip to the punchline and tell you the experimenters' assessment of their subjects' success: it was not good. To quote the authors of the study:

“Suboptimal betting came in all shapes and sizes: over-betting, under-betting, erratic betting, and betting on tails were just some of the ways a majority of players squandered their chance to take home \$250 for 30 minutes of play.”

Here is a summary of the findings of the experiment:

- Only 13 of the 61 participants (21%) reached the maximum payout of \$250.
- One-third of the participants ended up with less than their initial \$25 stake.
- Nearly all of those, or 28% of the total, went bust and received no payout at all.
- The average payout across all subjects was \$91.
- 21% reached the \$250 maximum and 28% went bust. Of the remaining 51%, the average payout was \$75.
- 41 participants bet on tails at some point of the experiment, and 29 of them bet on tails more than 5 times during the course of the game.
- 30% of the subjects bet their entire bankroll on one flip.
- Some of these whole-bankroll bettors *actually bet on tails for their all-in flip*.



Given that the participants were financially sophisticated students and young investment professionals, the results of the experiment are unexpected. The experimenters ended up paying just \$5,574 in winnings, much less than the \$15,250 they should have paid had the subjects played the game using an optimal strategy which would have virtually assured them each of the maximum \$250 payout.

And just what is the optimal strategy for this game? Enter the Kelly criterion.

Betting the Kelly Way

John Kelly Jr. was a scientist who worked at Bell Labs in the 1950s. At the time, Bell Labs was one of the most prestigious scientific research centers in the world, and Kelly was working on data compression schemes for television. At the time, the show *The 64,000 Question* was the most popular program on TV, and people were betting each other on which contestant would win a given episode. The show was aired live on the East Coast and was delayed for the West Coast audience, giving rise to a widely publicized scam: a West Coast gambler learned of the winners and then placed his bets before the show was aired on the West Coast.

Kelly heard about this and started thinking how a gambler with inside information should bet in order to achieve the highest possible return on his capital. In 1956 he [published an article](#) in the *Bell System Technical Journal* with his findings, laying the groundwork for the powerful economic principle which was later dubbed the Kelly criterion.

The Kelly criterion is a formula which provides an optimal betting strategy for maximizing the rate of growth of money in games where the odds are in your favor. The proportion of a gambler's bankroll that should be wagered on each bet is defined by the function:

$$2^*p - 1, \text{ where } p = \text{the probability of winning.}$$

In our experiment with the biased coin, the probability of winning was 60% (since the coin was biased to come up heads 60% of the time). Thus, the optimal betting strategy was to never bet on tails and to always bet 20% (since $2^*0.6 - 1 = 0.20$) of the bankroll on heads.

So how is it that the Kelly criterion is able to both achieve maximum profit and protect someone from going broke? As quoted in the excellent book *Fortune's Formula* by William Poundstone:

“The Kelly system avoids gambler's ruin quite simply. It is a “proportional” betting system. This means that each wager is scaled to the current size of the bankroll. Since you bet only a prescribed fraction of what you've currently got, you can never run out of money. When you lose repeatedly, as will happen in any game of chance, bets scale down in proportion to your diminished wealth.”



We can spend some time here exploring how the Kelly criterion has been used by successful investors such as Ed Thorp, Bill Gross, and James Simons to achieve market-beating returns, but we will leave that for another article. We will, instead, concentrate our attention here to the results of the experiment and its ramifications for investors.

Using Kelly and Avoiding Biases

After running the game and analyzing the results, the experimenters concluded:

“...we did not appreciate just how ill-equipped so many people are to appreciate or take advantage of a simple advantageous opportunity in the presence of uncertainty. The straightforward notion of taking a constant and moderate amount of risk and letting the odds work in one’s favor just doesn’t seem obvious to most people.”

Over the last 100 years, our stock market has returned around 10% per year, more than most (if not all) other investments. While there has certainly been uncertainty and volatility along the way, the U.S. stock market has never experienced a 20-year period in which it has lost money. Yet many people that have 20, 30, and even 40-year investment horizons fail to invest in the stock market due to heightened anxiety about the day-to-day or year-to-year fluctuations of stocks. A [recent Gallup poll](#) shows that only about half of Americans say that they invest in stocks. Further, adults younger than 35, which is to say those with the longest time horizons, are even less likely to invest. This is worse than betting on tails in a heads-biased coin flipping game. It’s tantamount to not even playing the game at all.

The experimenters further concluded:

“Without a Kelly-like framework to rely upon, we found that our subjects exhibited a menu of widely documented behavioral biases such as illusion of control, anchoring, over-betting, sunk-cost biases, and gambler’s fallacy.”

None of these biases are unique to the participants in the game. They are prevalent in many investors, both professional and amateur. Being aware of these and other behavioral biases, though, can limit their impact, and consciously working against them can further improve the odds of success. Our goal as investors should be to behave like robots, paying no attention to our emotions, trying to suppress our inherent human biases, and thinking as rationally as possible. We should always strive to treat investing in a more Kelly-like, probabilistic way, by minimizing the impact of emotion in our decision-making process.

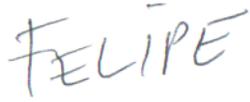
Conclusion

The intersection of gambling and investing has been explored and studied throughout the ages. As most successful gamblers and investors will attest, a sharp mathematical mind is a great asset



to have in either of these two realms. Being familiar with the Kelly criterion, along with proficiency in the mathematics of probability and statistics, can only help in the investing game.

But that is not enough. The right temperament, one that will keep at bay our inherent behavioral biases, is also an imperative requirement in the quest to maximize returns, whether in the gambling parlor or in the stock market.



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