



Probability

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Probability is the likelihood that an event will occur, measured by the ratio of favorable cases to the whole number of cases (Wikipedia). For example, consider tossing a coin. There are two possible outcomes, heads or tails. If we toss the coin once, the probability of either heads or tails is $\frac{1}{2}$ or 0.5, usually expressed as 50%. If we toss the coin twice, the probability of getting two heads is 0.5×0.5 which equals 0.25 or 25%.

In a simple mathematical system like coin flips, there is a certainty that the probability of getting 2 heads when flipping the coin twice is 25%. Thus, if we do four sets of two flips, we would expect one of the four outcomes to be two heads. When we do the experiment of four trials, it is quite possible that two heads occur twice or not at all. In small sets of data, the mathematical probabilities are often not expressed due to the randomness of chance. Expand our experiment to 1000 trials and the number of two heads occurrences will likely converge toward 250 (25%). Even at 1 million trials, the two heads outcomes will not be exactly 250,000, but it will be very close. While doing the 1 million individual trials, we will see several sequences when two heads occurs multiple times in a row and many streaks when two heads doesn't occur at all. The point is that the probabilities didn't change, but the outcomes in small sets of data can look quite different than the outcomes in a sufficiently large number of trials. This randomness is inherent to probability but should not cause us to lose faith in the mathematical rule.

Moving from coin flipping to the business world, probabilities are the bedrock of many industries. Gambling casinos rely on the mathematical probabilities that ensure if enough bets are made at any given game of chance, the casino will win close to a predicted percent of the dollar value of the bets. For life insurers, the actuarial data on average life expectancies allow them to price insurance contracts so that over large numbers of insured lives, they earn an expected profit. As opposed to the gambling industry's mathematical certainties, the life insurance industry uses far less certain data in their projections. The average life expectancy of the past will likely change in the future. Advances in medical technology work in the favor of the insurers, pushing life expectancies higher and giving the life insurers longer use of the money before eventual benefit payouts. On the other hand, unforeseen forces may work against them. The emergence of HIV and AIDS was an unexpected negative. The subsequent emergence of effective treatment for HIV was a positive. For life insurers, all other insurers, banks and a host of other industries, past data is an imperfect but necessary foundation of their business practices. They must analyze the probabilities that certain events will occur based on the historical evidence, build their business accordingly but understand that periods of randomness and occasional shifts in the future outcomes will occur. Similar to our coin flipping experiment, they can't let random, low probability sequences of events change their business model. They differ from a purely mathematical model such as coin flipping because they must discern when historical data is shifting due to structural change and adjust their probabilistic models accordingly. However, probabilities will always drive their business.

Against the Odds

While businesses do their best to put probabilities in their favor, we see many instances of individual behavior that goes against the odds. For the gambling casinos to stay in business, large numbers of players must walk through their doors even when those players know the probabilities do not favor them. Each player hopes

their pull of the slot machine handle or roll of the dice will bring a low probability outcome to their benefit. More outrageous are the millions of lottery players. The Powerball Lottery keeps \$0.68 of each dollar of ticket sales; they pay out only \$0.32 to the winners. That makes your 50/50 charity raffle look like a good deal! Your odds of picking the right six numbers to win the Powerball lottery are one in 292.2 million. Clearly, lottery players believe in low probability outcomes! The possibility of an asymmetrically large payoff is the siren song of the casino and the lottery. Somebody won \$533 million in the most recent Powerball Lottery, why wouldn't I buy a \$3 ticket to give myself a similar chance, no matter how unlikely? For \$3 of pocket change, you can be irrational. But how about buying 100,000 tickets with your IRA savings?

Probability Investing

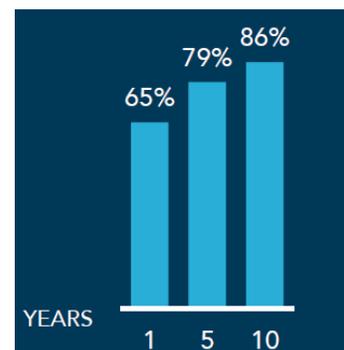
With important funds at stake in the investment effort, most investors hope to find a strategy that has a high probability of success. Yet, here too we see considerable behavior "against the odds". Not all this behavior is irrational; examination of probabilities and investor psychology help us understand proper investment strategy for specific investors.

One of the main investment categories is public equities. Equities provide returns that vary over time, including both positive and negative outcomes in short time frames. To help understand whether investment in equities is a reasonable proposition, we measure the historical returns and variance against the return available in Treasury bill, a "risk free asset". In exchange for taking on the chance of a negative return and the variability of returns, we expect that equity returns over time should be higher than the riskless T-bills. Over the past nine decades, stocks have provided an average excess return (also called the premium) of approximately 8 % per year. However, this attractive premium was not earned in every year or in some cases, not earned over longer periods. Table 1 shows the probability that equities outperform T-bills in various time periods, based on historical data.

As shown, based on the long-term data, stocks are expected to outperform in two out of three (66%) future years. Investors often think in terms of five-year time horizons. Here we see that stocks should provide a premium in 79% of five-year periods. In one out of five rolling five-year time periods, you can expect stocks to fall short. Moreover, even out to 20-year time periods, there is no certainty that stocks will outperform. Yet, to shun stocks because of the uncertainty, you leave behind the opportunity to earn the substantial, highly probable premium available in equities.

Despite the favorable long-term probability of equity market returns, many investors rationally diversify away from a 100% allocation to stocks. For those with short term spending needs, like endowments and retirees, adding less variable, more stable asset categories makes sense. Also, negative short-term returns, coupled with attendant doom and gloom publicity, cause powerful emotional reactions for investors which can lead to highly damaging strategy changes at inopportune moments such as equity market bottoms. A very common mistake among investors is to disproportionately fear a short-term loss such that they have too little allocated to equities. The behavioral driver here is "loss aversion". Research has shown that people are much more sensitive to a loss than a gain. This results in them shunning stocks despite the high probability of a gain from equity exposure over time. The risk of loss is why there is a return premium in equities. If there were no risk of underperformance, more money would flow into equities and stock prices would rise until the future return premium disappeared. However, because of the emotional

Table 1: Estimated Probability the Equity Market Outperforms One-Month US Treasury Bills¹



Probability of outperformance is computed using one-hundred thousand simulations that bootstrap historical monthly returns from July 1926 to December 2017 for "Market Outperforms one-month US Treasury Bills", utilizing Fama/French Total US Market Index vs. one-month US Treasury Bills.

reaction to losses, investors must find their preferred balance of ‘return seeking’ versus ‘risk avoiding’ positioning.

Risk drives behavior in the bond market too. Consider the “term factor”: the difference in return between a long-term government bond and very short-term bond. From 1927 through 2015, the average annual excess return from a 20-year maturity Treasury over a one-month maturity Treasury was 2.5%. This term premium is equally as persistent as the equity market premium.

The term premium for a 5-year Treasury note over the same period was 1.8%. While the probability favors the longer-term bond exposure, should interest rates rise sufficiently, the one-month Treasury may outperform both the 5-year and 20-year Treasury bonds. In fact, this is exactly what happened in the first quarter of 2018, when the 5-year and 20-year Treasuries posted negative returns. This risk keeps many investors disproportionately invested in money market funds. Thus, they are betting against the long-term favorable odds for the term factor due to fear of a short-term loss.

While there are many examples of investors betting against the odds and fleeing from reasonable risk exposures, there is no “right” risk and factor exposure to fit everyone. It is important to find a portfolio strategy that balances risk and return factors in a way that suits each investor. The goal is to find a strategy with exposures to asset classes and return/risk characteristics that allow the investor to stick with a strategy for the long term.

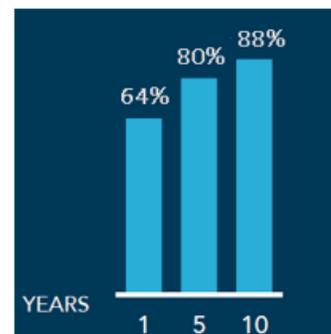
Shifting Probabilities

Probability-based investing shares similar challenges to many other probability-based industries. We’ve noted how high probability outcomes can be obscured by short term random sequences of events, as seen in our coin flip examples. We also see that the highly probable equity market premium over Treasury bills can disappear occasionally. Aside from random events, there can be shifts in future data patterns fostered by structural changes. The data patterns in actuarial life expectancy exhibit gradual change. The increases in life expectancy are a boon to the life insurance industry but a disaster for the Social Security and Medicare programs. Businesses must be sensitive to such changes.

Will future structural shifts impact investing probabilities? Will historically observed factor premiums persist into the future? These are good questions for all investors since most are basing their approach on some observed success from the past. Considerable academic research has focused on why factor premiums exist and whether they will persist.³⁻⁹ For the prominent equity factors of value, size, momentum, quality and minimum volatility, research suggests that the structural limitations on investors’ ability to sell short those stocks with poor factor expression plus the deeply ingrained behavioral biases combine to explain the existence of these factors’ excess return (premia).

Another question: Once a factor premium (excess returns) is discovered and publicized, will rational investors flock into stocks expressing those factors, boosting those stock’s price until the factor premium disappears in the future? Research on this question shows that following major publications on the factors, the premium on those factors seem to diminish somewhat, but they remain statistically significant.¹⁰⁻¹¹ Some research on international markets has found little to no decay in factor premiums post publication and in specific cases an increase in the size of the premium has been confirmed.¹² Further evidence that investors haven’t moved

Table 2: Estimated Probability the Twenty-Year Treasury Outperforms One-Month US Treasury Bills²



Rolling Time Periods from 1927 to 2015

significantly toward the factors is found by examining the corresponding asset levels of the relevant categories.¹³ If investors were moving dramatically to take advantage of factor premia discoveries, we should observe a strong bias towards value, small size, high quality, low volatility...etc. Also, if investor money was pouring in, funds representing those categories should have posted significantly higher short-term excess returns during the ramp up.¹⁴ Neither of these effects are visible.

Proper Strategy Amid Uncertain Outcomes

No investment strategy, even one trained on the highest probability factors, is guaranteed to succeed in all periods. Even bedrock factors like equity market beta and bond market term factors fall short at times. Random, low probability events occasionally occur, causing rational strategies to fail in unpredictable instances. There is no certainty for any outcome. What is an investor to do?

First, we are grateful to deal in probability and not certainty. It is the uncertainty (risk) that provides the opportunity to add value for our clients. In each portfolio strategy, our job is to maximize exposure to profitable factors within the client's appropriate risk model. Our focus is to find efficient investment vehicles, allocate and diversify properly across the various factors in stocks, bonds and other assets. The result should be a portfolio tilted to a high probability of success.

Logic tells us that portfolio strategy should not be set to succeed only in the presence of low probability events such as betting in the casino, buying lottery tickets, investing only in Treasury bills or holding equity portfolios with poor factor construction. Your financial plan needs a higher probability of success, which is why we focus on academically proven, effective factors in construction of our portfolios. This is High Probability Advisors' mission; delivering to our clients the best opportunity for future investment success.

1. Dimensional Fund Advisors. "Estimated Probability of Outperformance". The Advisor Community. March 2018.
2. Berkin, Andrew L. & Swedroe, Larry E. "Your Complete Guide to Factor Based Investing". BAM Alliance Press. 2016. pp. 263-264
3. Banz, R. W. "The relationship between return and market value of common stock". Journal of Financial Economics 9(1). pp. 3-18. 1981.
4. DeBont, Werner F. M. and Richard H. Thaler. "Further Evidence on Investor Overreaction and Stock Market Seasonality". Journal of Finance. 42:3. pp. 557-81. 1987.
5. Fama, Eugene F. "Market Efficiency, Long-Term Returns, and Behavioral Finance". Journal of Financial Economics, 49(3), pp. 283-306. 1997.
6. Hong, Harrison, Terence Lim, and Jeremy C. Stein. "Bad News Travels Slowly: Size, Analyst Coverage, and the Profitability of Momentum Strategies". Journal of Finance, 55(1). pp. 265-295. 2000.
7. Hirshleifer, David. "Investor Psychology and Asset Pricing". Journal of Finance. 56(4). pp. 1533-1597. 2001.
8. Fama, Eugene F., and Kenneth R. French. "Dissecting Anomalies". Journal of Finance 63. pp. 1653-1678. 2008.
9. Zhang, X.F. "Information uncertainty and stock returns". Journal of Finance 61(1). pp. 15-136. 2006.
10. Berkin, Andrew L. & Swedroe, Larry E. "Your Complete Guide to Factor Based Investing". BAM Alliance Press. 2016. pp. 280-281
11. McLean, R. David & Pontiff, Jeffrey. "Does Academic Research Destroy Stock Return Predictability". Journal of Finance. January 2016, 71(1). pp. 5-32
12. Heiko, Jacobs & Muller, Sebastian. "Anomalies Across the Globe: Once Public, No Longer Exist?". <http://papers.ssrn.com> July 2016
13. Dimensional Fund Advisors LP, "Global Market Breakdown - Q1 2018". The Advisor Community. April 2018.
14. Swedroe, Larry E. "Factor Investing Alive & Well". ETF.com. March 2018. pp. 2

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