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WHITE PAPER

Single Stock Risk

About a year after I started working at White Oaks, I did a portfolio review for a prospect. This prospect was a retired couple in their 80's with about \$1.5 million of investable assets. So far this does not sound unusual. Many of our prospects have reasonably similar circumstances as this one. There was one unusual aspect of this prospect though. Of the \$1.5 million, roughly \$1.2 million was invested in a single stock. That is an 80% allocation to just one stock! The obvious recommendation to the prospect was to get some diversification. Such a large allocation to a single stock was a very bad idea. Whether this prospect chose to work with us or not, reducing exposure to this stock was the most important thing this prospect should do. That was our big message. The prospect told us other advisors who were under consideration had said the same thing. This prospect seemed to have an emotional attachment to this stock though. The stock paid a regular dividend and with the size of the position this couple had, they could pay their bills with that dividend. "This stock has been good to us" is what they said. Ultimately, this prospect decided to not work with us or any other advisor and just decided to continue self-managing and continued to hold this 80% allocation to this one stock.

A few years later, the husband from this prospect couple came to our Florida office unannounced one day. He said he just wanted to talk for a few minutes. Then he told us about how his large stock position had just experienced a very significant drawdown. He explained why he thought the fundamentals were still strong and he planned to keep his position. I have not seen him since this interaction and several more years have since passed. As of the time I wrote this paper, I did notice that this stock has continued to further decline since that last interaction. Since the first meeting we had with this prospect, the share price of this stock has dropped more than 80% cumulatively. The dividend per share that had been used to pay the client's bills has been cut by roughly 95%. I would have to imagine this couple had to make some very drastic changes to their lifestyle, but I have not seen them to hear about how this has gone.

This story should be a cautionary tale to others about why having large positions in a single stock is a very bad idea. As I will attempt to show in the rest of this paper, the risk one takes by investing this way is very hard to justify in terms of the expected return.

Investors should be deciding on an appropriate amount of risk (standard deviation) to take and then attempting to get as much expected return for that level of risk as possible.

A portfolio's expected return is simply the weighted average expected return of all the positions in the portfolio. For example, assume a portfolio has only two stocks, stock A and stock B. Stock A has a 10% expected return while stock B has a 6% expected return. The portfolio has 75% allocated to stock A and 25% allocated to stock B. The portfolio's expected return is 9% ($0.75 \times 0.10 + 0.25 \times 0.06 = 0.09$ or 9%).

This portfolio's standard deviation (volatility of returns) is the square root of its variance. The variance is the weight of stock A squared times the variance of stock A plus the weight of stock B squared times the variance of stock B plus two times the correlation of stock A and stock B times the weight of stock A times the weight of stock B times the standard deviation of stock A times the standard deviation of stock B. Assume the standard deviation of stock A is 40%, the standard deviation of stock B is 30%, and the correlation of stock A and stock B is 0.8. The portfolio variance is then $(0.75^2) \times (0.40^2) + (0.25^2) \times (0.30^2) + 2 \times 0.8 \times 0.75 \times 0.25 \times 0.40 \times 0.30 = 0.09 + 0.005625 + 0.036 = 0.131625$. The portfolio standard deviation is then just the square root of the variance, so it is 0.3628 or 36.28%.

Notice that if we change the correlation from 0.8 to 1, the variance would be $(0.75^2) \times (0.40^2) + (0.25^2) \times (0.30^2) + 2 \times 1 \times 0.75 \times 0.25 \times 0.40 \times 0.30 = 0.09 + 0.005625 + 0.045 = 0.140625$. This would mean the standard deviation when the correlation is 1 would be 37.5%. Notice that the weighted average standard deviation is also 37.5% ($0.75 \times 0.40 + 0.25 \times 0.30 = 0.375$ or 37.5%). This is no accident. Correlations range between -1 and 1. When a correlation is 1, you have a perfect positive correlation. This means stock A and stock B experience their best returns at the same time as each other and their worst returns at the same time as each other. They would also experience their second-best returns at the same time as each other and their second worst returns at the same time as each other and everything in between at the same time as each other as well. As long as the correlation between stock A and stock B is anything less than a perfect positive correlation, the portfolio standard deviation is less than the weighted average standard deviation. This is an important concept because the portfolio expected return is simply the weighted average return of stock A and stock B. It stands to reason then that if we want to get the best trade-off of risk and return, having many uncorrelated positions will make the portfolio standard deviation lower than the portfolio's weighted average standard deviation of its positions. This will likely lead to a better risk-adjusted expected return unless there is one position whose expected return per unit of risk is simply much better than those of the other positions.

With this understanding, if we look at a collection of stocks like the S&P 500, we should expect that the S&P 500's expected return is the weighted average expected return of all the stocks in the S&P 500. The S&P 500's standard deviation is less than the weighted average standard deviation of all the stocks in the S&P 500. This means if we pick any stock in the S&P 500 at random, we

should expect that stock to have the same expected return as the S&P 500, no higher or lower. We should also expect that randomly selected stock will be more volatile than the S&P 500 as long as correlations across the stocks in the S&P 500 are less than perfectly positively correlated, which tends to be a safe assumption in practice.

We can even test this theory. Over the next several pages, I will go through each of the ten largest stocks in the S&P 500 and look at the full history of each stock. For each full calendar year, I will ask two questions. “Did this stock earn a higher return than the S&P 500?” and “Was this stock more volatile than the S&P 500?” I look at what percentage of the total years each stock has a higher return than the S&P 500 and what percentage of the total years each stock is more volatile than the S&P 500. According to the theory I have already explained, I would suggest that most stocks will earn a higher return than the S&P 500 close to 50% of the time. Some will have a higher percentage or a lower percentage, but most stocks will be close to 50%. I would suggest that most stocks will be more volatile than the S&P 500 much more than 50% of the time.

Microsoft (MSFT) is the largest stock in the S&P 500 (at the moment). The size rankings by market capitalization do change over time though. As you can see from Figure 1, Microsoft has a reasonably long history, going all the way back to 1987. Over this time, MSFT has outperformed the S&P 500 70% of years and has been more volatile than the S&P 500 95% of years.

Figure 1

Single Stock Concentration Risk		
MSFT		
12/31/1986 - 12/31/2023		
Percent of years MSFT earns a higher return than the S&P 500	70%	It's a coin flip whether or not having a concentrated position in this stock will earn a higher return than the S&P 500.
Percent of years MSFT is more volatile than the S&P 500	95%	A concentrated position in this stock is riskier than owning a more diversified portfolio like the S&P 500. You don't need to flip a coin.

By definition, a monthly return for the S&P 500 index is the weighted average of the monthly returns of the stocks in the index. The probability for any given stock of earning a higher return than the index in any given year or month is likely close to 50%, so it is essentially a coin flip on whether or not any given stock earns a higher return than the index.

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Data Sources: YCharts, Morningstar, Robert Shiller, and Standard & Poor's

Apple (AAPL) is the next largest stock. Its history goes all the way back to 1981. AAPL has outperformed the S&P 500 60% of years and has been more volatile 98% of years.

Figure 2

Single Stock Concentration Risk		
AAPL		
12/31/1980 - 12/31/2023		
Percent of years AAPL earns a higher return than the S&P 500	60%	It's a coin flip whether or not having a concentrated position in this stock will earn a higher return than the S&P 500.
Percent of years AAPL is more volatile than the S&P 500	98%	A concentrated position in this stock is riskier than owning a more diversified portfolio like the S&P 500. You don't need to flip a coin.

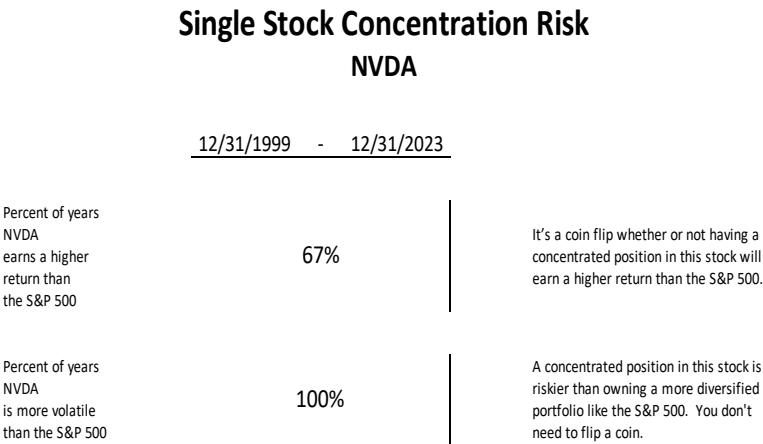
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Data Sources: YCharts, Morningstar, Robert Shiller, and Standard & Poor's

NVIDIA Corporation (NVDA) is the third largest stock in the S&P 500. Its history is shorter than MSFT's and AAPL's, only going back to 2000. Its performance has been quite remarkable in recent years with the important role it plays in supporting large language models like ChatGPT. NVDA has earned a higher return than the S&P 500 in 67% of years and has been more volatile in 100% of years.

Figure 3



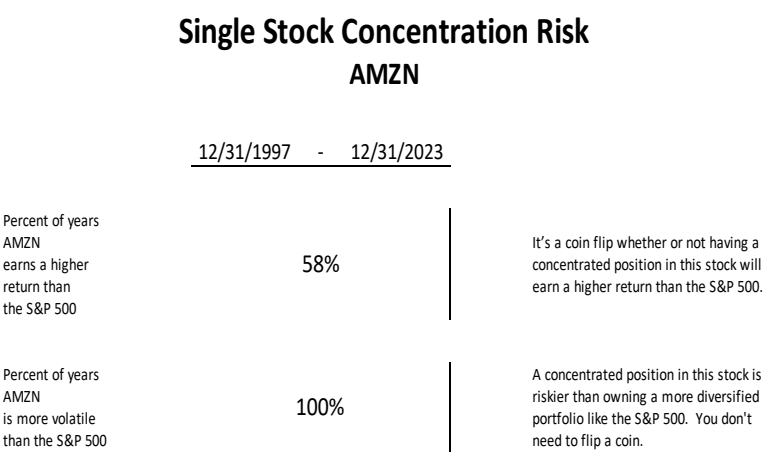
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Data Sources: YCharts, Morningstar, Robert Shiller, and Standard & Poor's

Amazon (AMZN) has a similar length of history as NVDA with performance data going back to 1998. AMZN has earned a higher return than the S&P 500 in 58% of years and has been more volatile in 100% of years.

Figure 4



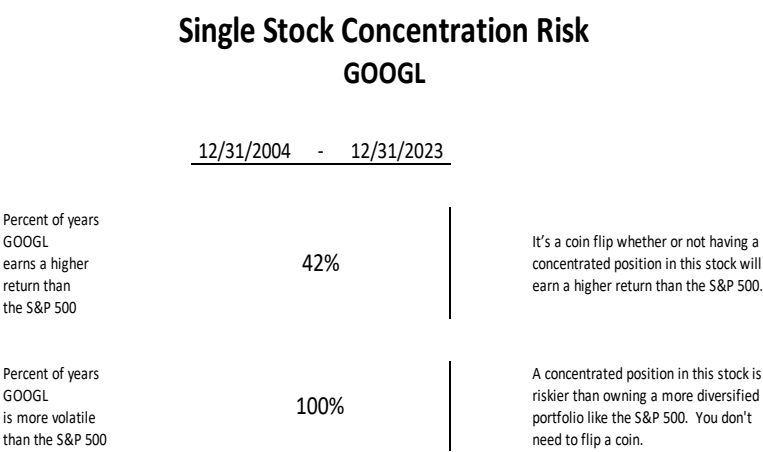
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Data Sources: YCharts, Morningstar, Robert Shiller, and Standard & Poor's

Alphabet (GOOGL) is the fifth largest stock in the S&P 500. This is the first stock we have listed so far to have fewer than 50% of its years earning a higher return than the S&P 500 with higher returns in only 42% of years. Like the last few stocks, it has been more volatile than the S&P 500 in 100% of years.

Figure 5



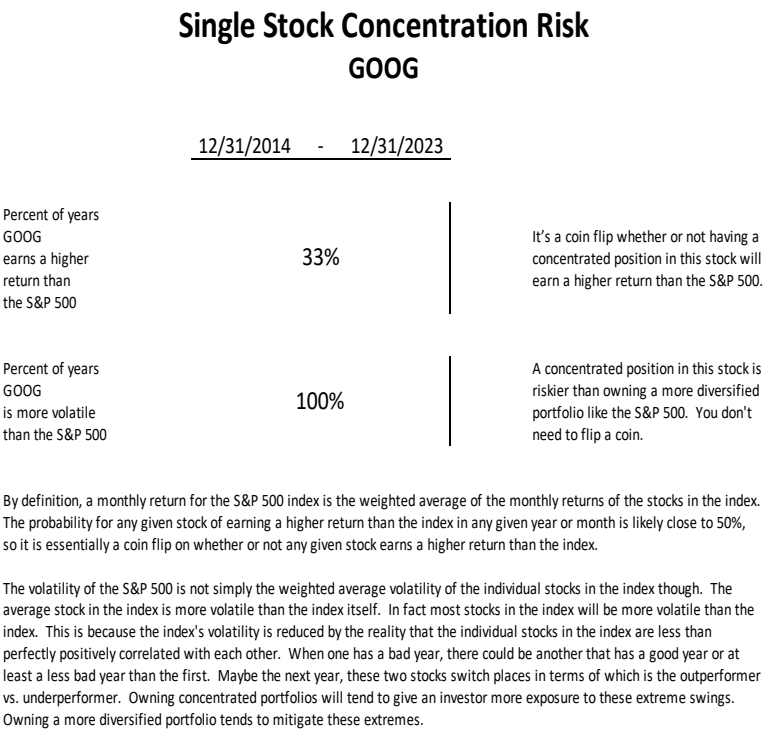
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Data Sources: YCharts, Morningstar, Robert Shiller, and Standard & Poor's

The other share class of Alphabet (GOOG) is the seventh largest stock. I just chose to go a little out of order because this is the same issuer, Alphabet, just a different share class. It seemed easier to follow if we just put them one after another. With GOOG, the history is not as long as it is for GOOGL, only going back to 2015 as opposed to 2005. GOOG earned a higher return than the S&P 500 in 33% of years and was more volatile in 100% of years. Given that GOOGL and GOOG represent the same company, the biggest difference here is just the difference in the sample time period.

Figure 6



Data Sources: YCharts, Morningstar, Robert Shiller, and Standard & Poor's

The stock that is smaller than GOOGL and larger than GOOG is Meta Platforms (META), formerly known as Facebook. This is a stock that grew to a very large size quite quickly. Its publicly traded history only goes back to 2013, but it is the sixth largest stock in the S&P 500. META has earned a higher return than the S&P 500 in 64% of years and has been more volatile in 100% of years. We should probably take the results for this stock with a bit more of a grain of salt given the short history.

Figure 7

Single Stock Concentration Risk META		
12/31/2012 - 12/31/2023		
Percent of years META earns a higher return than the S&P 500	64%	It's a coin flip whether or not having a concentrated position in this stock will earn a higher return than the S&P 500.
Percent of years META is more volatile than the S&P 500	100%	A concentrated position in this stock is riskier than owning a more diversified portfolio like the S&P 500. You don't need to flip a coin.

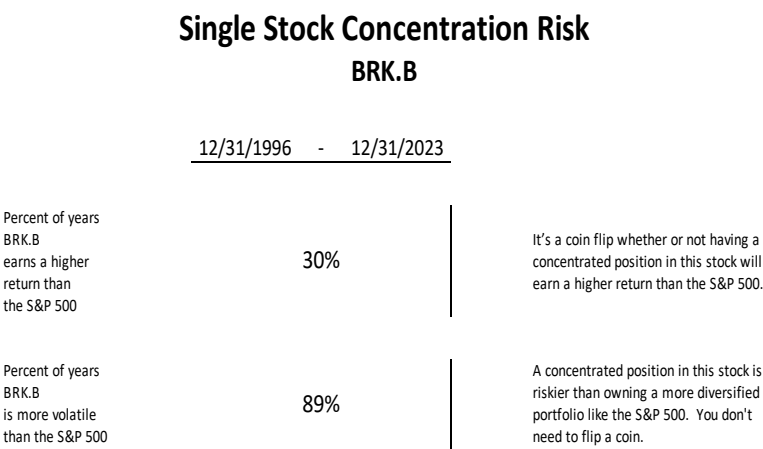
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Data Sources: YCharts, Morningstar, Robert Shiller, and Standard & Poor's

Berkshire Hathaway (BRK.B) is the eight largest stock in the S&P 500. With history going back to 1997, BRK.B has earned a higher return than the S&P 500 in 30% of years while being more volatile than the S&P 500 in 89% of years. This is the best result we have seen of any of these stocks on the volatility front so far amongst these largest stocks in the index. There is a fundamental explanation for this result. Berkshire Hathaway is a holding company, which means it invests in the stocks of other companies. This means that although it is technically just a single stock, its performance acts more like that of a portfolio of a handful of stocks. Admittedly, it does not have nearly as many stocks as the S&P 500, so it is still more volatile than the S&P 500, as we can see.

Figure 8



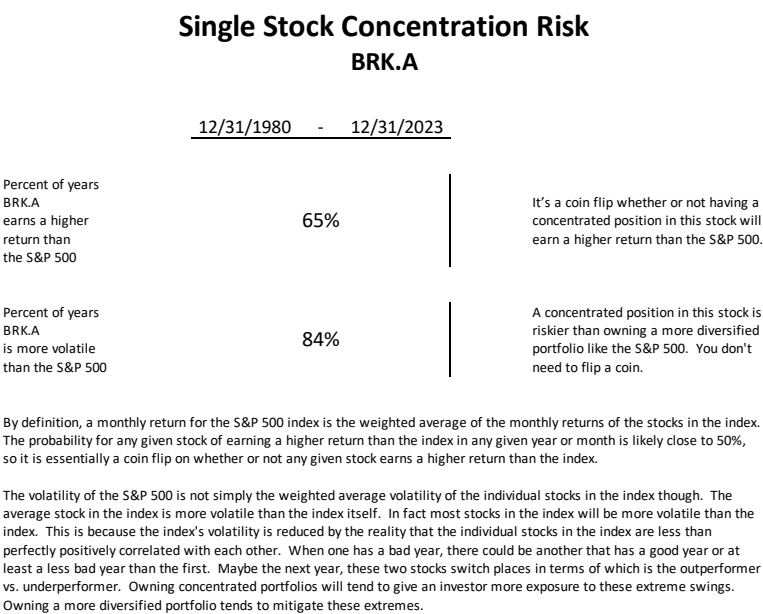
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Data Sources: YCharts, Morningstar, Robert Shiller, and Standard & Poor's

Berkshire Hathaway’s A-shares (BRK.A) are not part of the S&P 500’s top ten, but I thought I would include them because the B-shares were in the top ten and the A-shares have a much longer history. Many readers would have probably been surprised to have seen BRK.B having a lower return than the S&P 500 more often than not, but the longer-term history the A-shares provide shows that Warren Buffet has actually earned a higher return than the S&P 500 65% going back to 1981. BRK.A has been more volatile than the S&P 500 84% of the time though. Buffet’s performance in recent years, which the shorter history from BRK.B emphasizes has been a little more challenging because value stocks have been out of favor compared to growth stocks in recent years. Buffet is known for being a value investor, so that has made for a challenging backdrop. This makes less of an impact when we look at the longer history though.

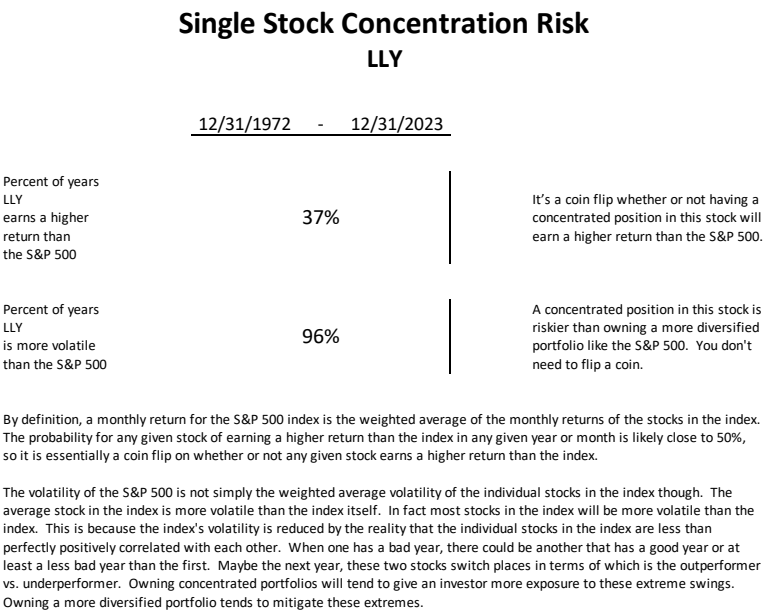
Figure 9



Data Sources: YCharts, Morningstar, Robert Shiller, and Standard & Poor's

Eli Lilly and Company (LLY) is the ninth largest stock in the S&P 500. It has the longest history of the ones currently in the top ten with data going back to 1973. This stock has only earned a higher return than the S&P 500 in 37% of years while being more volatile in 96% of years.

Figure 10



Data Sources: YCharts, Morningstar, Robert Shiller, and Standard & Poor's

Finally, Broadcom Inc. (AVGO) is the tenth largest stock in the S&P 500. This stock only has history going back to 2010, so, like the other stocks with a short history, its results should be taken with a grain of salt. AVGO has earned a higher return than the S&P 500 in only 21% of years while being more volatile in 100% of years.

Figure 11

Single Stock Concentration Risk AVGO		
12/31/2009 - 12/31/2023		
Percent of years AVGO earns a higher return than the S&P 500	21%	It's a coin flip whether or not having a concentrated position in this stock will earn a higher return than the S&P 500.
Percent of years AVGO is more volatile than the S&P 500	100%	A concentrated position in this stock is riskier than owning a more diversified portfolio like the S&P 500. You don't need to flip a coin.

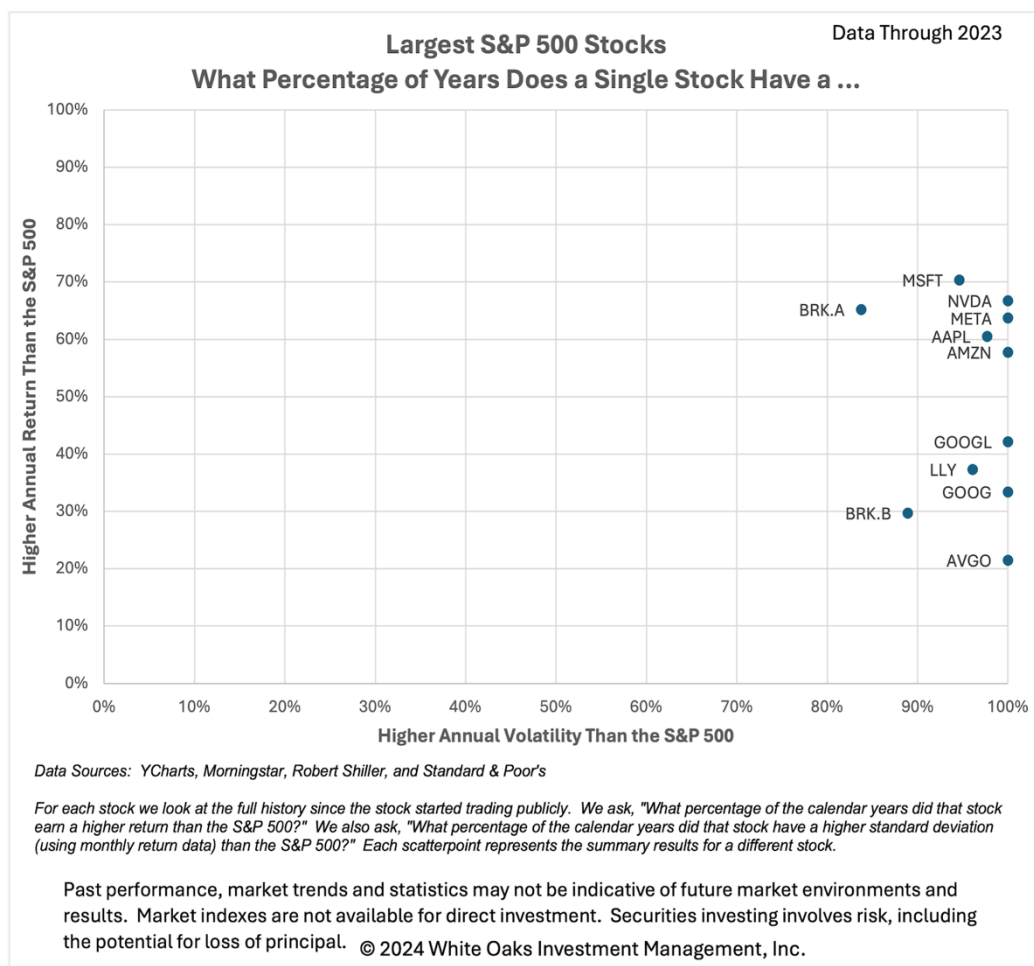
By definition, a monthly return for the S&P 500 index is the weighted average of the monthly returns of the stocks in the index. The probability for any given stock of earning a higher return than the index in any given year or month is likely close to 50%, so it is essentially a coin flip on whether or not any given stock earns a higher return than the index.

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Data Sources: YCharts, Morningstar, Robert Shiller, and Standard & Poor's

The below chart shows a summary of the results of the top ten stocks in the S&P 500. In terms of the percentage of years where these stocks earn a higher return than the index, some of them are a little above 50% while others are a little below 50%. Roughly half of them are above 50% and half are below 50%. Of course, the time period will always matter for any given stock. Notice that BRK.A is above 50%, but the same company's B-shares, which are studied with a shorter history, are below 50%. This is a reminder that even stocks that have been above 50% since their inception can still go through lengthy periods of time being under 50%. While the probabilities of having a higher return than the index seem to center around 50%, none of these stocks is anywhere close to 50% when it comes to probabilities of being more volatile than the index. BRK.A is the lowest at 84%. Several of these stocks were literally more volatile than the index every single year since their inception. There is no stock that has earned a higher return than the index at least 84% of the years. The evidence from the ten largest stocks in the S&P 500 clearly shows that individual stocks ARE more volatile than the index as a whole. Any given stock in the index MIGHT have a higher return than the index. This is not a given though.

Chart 1



I can even extend the concept I am showing in Chart 1 to every stock in the S&P 500 with at least twenty years of history. This is what Chart 2 shows. Chart 2 removes the labels though. There would be too many and they would clutter the chart. The important thing is seeing where the scatter points are, not knowing which stock is represented by any single scatter point.

Chart 2

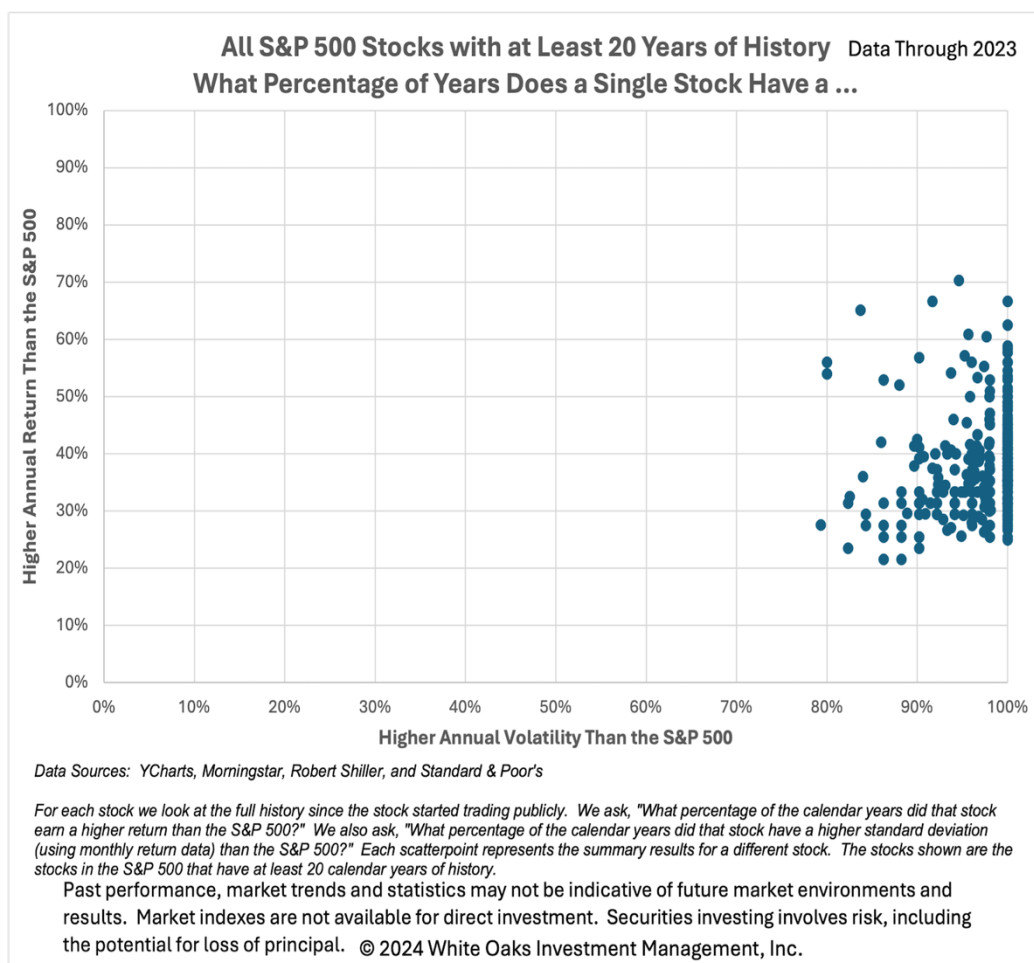


Chart 2 shows the percentage of years where any given stock earns a higher return than the index clustering around 50% with a maximum of 70% (MSFT) and a minimum of 22% (CL and PG). When it comes to the percentage of years where a stock was more volatile than the index, several stocks were more volatile than the index every year. The lowest probability of a stock being more volatile than the index was 79% (AEE). There are 400 stocks in the S&P 500 with at least twenty years of history. The fact that we can look through the full history on 400 different stocks and the least volatile of those is still more volatile than the index in 79% of the years is very compelling empirical evidence that individual stocks are more volatile than the index as a whole.

Conclusion

This empirical evidence combined with the theory presented at the beginning of this paper, should make it obvious that individual stocks are more volatile than the index as a whole. This result is even quite consistent over different periods of time, so one can reliably expect it. One cannot reliably expect any stock to consistently earn a higher return than the index though.

This evidence should make it obvious that investing in individual stocks leaves one with roughly a 50% probability of earning a higher return than a more diversified stock portfolio and pretty much a guarantee of being more volatile. Why would you want to be guaranteed to have a more volatile portfolio for close to a 50% probability of earning a higher return? If you have stocks that you think have higher expected returns than the index as a whole, a better decision would be to overweight those stocks while still allocating to a diverse portfolio of stocks.