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Examination of the Top 10 Stocks in the S&P500

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Murray State University Honors College

HONORS THESIS

Certificate of Approval

Examination of the Top 10 Stocks in the S&P500

Isaac Fulton

April/2024

Approved to fulfill the
requirements of HON 437

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Dr. David Durr
Finance

Approved to fulfill the
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Examination of the Top 10 Stocks in the S&P500

Submitted in partial fulfillment

of the requirements

for the Murray State University Honors Diploma

Isaac Fulton

April / 2024

Abstract

The major goal of this research was to investigate how the returns of a portfolio containing only the 10 largest stocks in the S&P500 index, based on market cap, would compare to the overall index's return and volatility over multiple time frames. This project investigated whether a portfolio of the 10 largest stocks in the S&P500, at the beginning of each year, would be considered superior in terms of returns while not unproportionately increasing volatility. First, the SPDR S&P 500 ETF Trust, or SPY, was selected as the S&P500 index measure and was used to evaluate the index's returns. Second, the largest stocks in the index for each year between 2016 and 2022 were selected and each of their market capitalizations at the beginning of that year were measured as a percentage of the total index's. Returns for each stock, for each month, were then sourced from a database provided by faculty at Murray State. Two different test portfolios were then generated containing the largest 10 stocks for each year, only differing on how the ten largest stocks were weighed. Finally, the Invesco S&P 500 Top 50 ETF (XLG)'s returns were also calculated to determine how a portfolio containing the 50 largest stocks in the index would perform compared to the index and the test portfolios. Since the XLG is comprised of only the 50 largest stocks in the S&P500, it may give us a good measure of how powerful the ten largest stocks are, even in comparison to the other 40 largest firms. Once all the returns of the four portfolios had been collected, the index and test portfolios' return, betas, and standard deviations were calculated and compared to find results. After comparing the test portfolios with the SPY, what was discovered was that during 2016 through 2022 a portfolio containing the 10 largest stocks in the S&P500, as measured at the beginning of each year and weighed in accordance with each stock's index weight, would produce the best possible returns of any

portfolio analyzed, but would increase the portfolio's standard deviation and beta. After running a risk-adjusted analysis, what ultimately was discovered was that while the portfolios containing only the largest stocks did experience larger returns during the 7 years, that on a total risk-adjusted basis, they produced less returns per unit of risk taken. This was concluded to be because of the portfolios' lack of diversification, which no matter its larger returns, could not outperform that of the market when accounting for its volatility. Finally, to demonstrate that there are still benefits to these types of portfolios and the increased returns they can generate, I ran a new scenario analysis, ending the study after 2021.

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Introduction

The S&P500 is one of the best-known equity indexes in the entire world and is comprised of the five-hundred largest companies traded on either the NYSE, Nasdaq, or CBOE. The portfolio technically includes over 500 separate stocks, as 3 of these companies have multiple classes of stock, resulting in 503 tradable stocks in the index. The Index had a market capitalization, as of January 1st, 2024, of over 40 trillion dollars, which comprises 80% of total US business's market capitalization. The S&P500 is preferred for institutional investors over its competitors, such as the DOW JONEs index (Yahoo Finance, 2024), because of its inclusion of more stocks across different sectors, and therefore is considered to be a more accurate representation of the US's equities market (KENTON, 2023). The S&P500 index's construction seeks to include stocks from all industries in an attempt to mimic how the overall economy is moving. Through including many stocks from every sector, the index is thought to diversify out unsystematic risk. This is why many investors use the S&P500 as a benchmark for the market and many ETFs and Index funds have been created to mirror the composition of the index.

Currently, there are many ETFs and index funds that track the S&P500, all with their slightly different goals. The oldest and most popular ETF mirroring the S&P500, was created in 1993 and is named the SPDR S&P 500 ETF Trust (SPY). SPY is a passively managed fund run by State Street, with a goal of mirroring the S&P500. Another ETF tracking the S&P500, is the Invesco S&P 500 Top 50 ETF (XLG), which only includes the 50 largest companies in the S&P500 and was created in 2005. Because both funds are passively managed, this means that both aim to replicate the performance of the underlying index as closely as possible. Both ETFs offer

unique ways to compare portfolios to the market and for this reason, I used both these ETFs as market measures to compare my research's portfolios return and volatility against.

Aside from ETFs, the three largest S&P500 index funds currently are the Fidelity 500 index fund, Schwab S&P 500 index fund, and the Vanguard 500 Index Admiral Fund (Reeves, 2024). While index funds and ETFs are very similar, they do have some differences that can result in different returns for the portfolio. Index funds are generally considered safer than ETFs, but they cannot be traded during the day and cannot be bought and sold on exchanges like ETFs. This allows Index funds to provide more stable, long-term investment avenues, as they primarily trade in securities via asset management companies and are therefore great for patient investors. ETFs on the other hand offer more flexibility, lower costs, and higher tax efficiency than Index funds, but are also more volatile and garner more trading fees. While both ETFs and index funds seek to match the performance of the market, ETFs have proven to be better for short-term investors and Index funds have shown to be better for long-term investors. Because this analysis only investigates 7 years' worth of data, and hence will be looking at a relatively small-time frame, it will utilize both the SPY and XLG ETFs' returns and volatility to compare to that of my test portfolios.

Overall, the S&P500 is viewed as a safe investment by most analysts as it has experienced a consistent history of long-term growth. In fact, if you invested $1000 in a portfolio mirroring the S&P500 index in 2000, by the end of 2023 you'd have $4,880.49, a return of 388.05%, or 6.93% per year (Webster, 2024). A graphical depiction of this investment can be seen in figure 1. Adjusting for inflation this would give the investor a 175.82% return over the 23 years. While the market does go through bull and bear markets, the S&P500 has proven over its

history that it will continue to grow and produce positive results in the long term. A graphic depiction of the S&P500's returns from 2000 to 2023 can be seen in figure 2. As we can see in figure 2, while there have been plenty of negative months in terms of returns, they are outnumbered by the positive returns that the index has generated. This history of long-term growth is one of the reasons the S&P500 has become so popular as a measure of the market and is why I used its measure as the benchmark for this analysis.

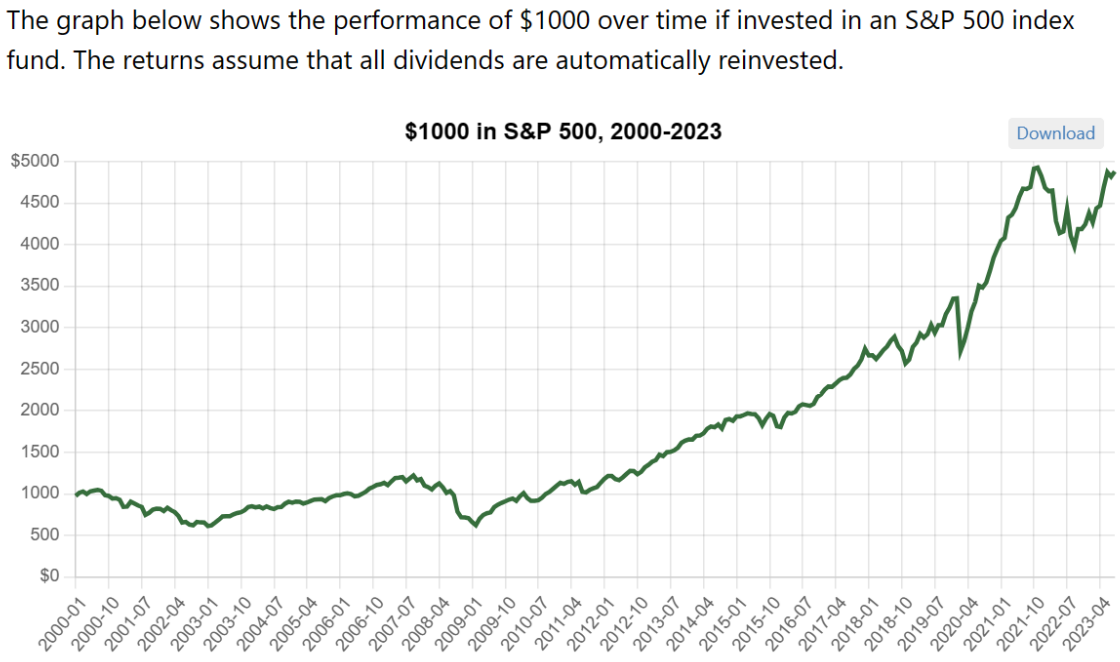

Figure 1- Investing $1000 into the S&P500 in 2000 and leaving until 2023. From Official Data, 2024., Retrieved from https://www.officialdata.org/us/stocks/s-p-500/2000?amount=1000&endYear=2023. Copyright 2024 by Ian Webster.

This chart shows the rate of gains and loss by month, including dividends:

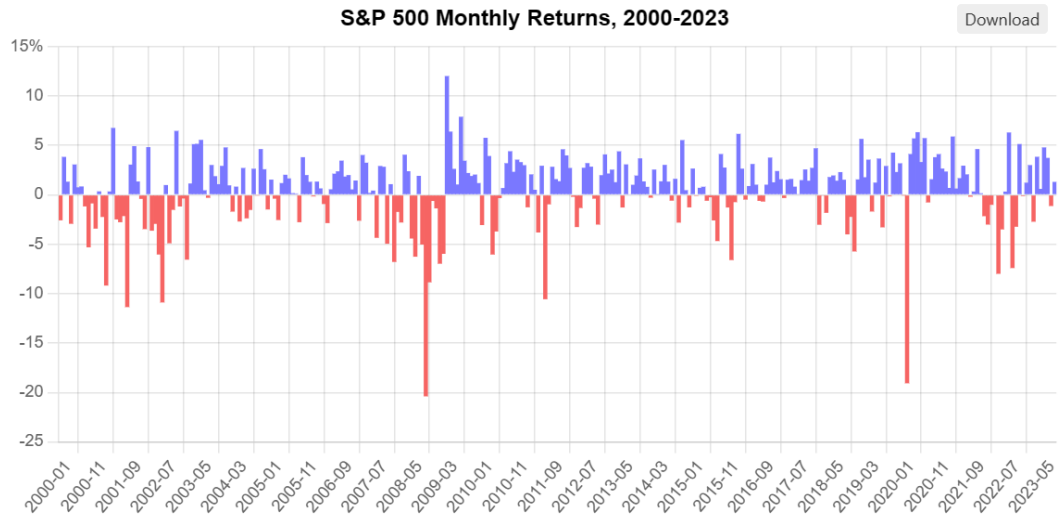

Figure 2- S&P 500 monthly returns (2000-2023). From Slick Charts, 2024., Retrieved from https://www.slickcharts.com/sp500/returns. Copyright 2024 by Slick Charts.

Goals of Research

The goal of this paper ultimately is to discover whether a portfolio containing the ten largest stocks in the S&P500 index could potentially outperform the market, as measured by the SPY, in terms of total returns as well as on a risk-adjusted basis. Additionally, a secondary goal of this paper will be to get a sense of how much the ten largest stocks of any given year affect the overall return and volatility of the index. Through analyzing the SPY, I will seek to measure the ten largest stocks impact on the overall market, and by analyzing the XLG, I will seek to view the ten largest stocks impact compared to that of only the 50 largest stocks.

S&P500 Stock Weighting

The S&P500 index weighs its stocks based on their percentage of total market capitalization, and therefore those stocks with more weight can affect the price more dramatically. Recently, a real-life example of this would be Microsoft which, as of March 12th,

2024, was the largest stock in the S&P500 with an index weight of 6.98%. V.F. Corporation as of March 12th was the smallest stock in the S&P500 with an index weight of .01%. This meant that at that time Microsoft, the largest stock, had 698 times the weight of the smallest stock in the index, demonstrating the sheer power that the largest stocks have in the index. Now while obviously the largest stock might be much greater than the smallest stock, how would it compare to the median stock, the 250th largest stock in the index? In this case, Electronic Arts (EA), the 250th largest stock as of March 12th, had an index weight of .08%. Therefore, in this case, Microsoft would still possess 87.5 times the weight of EA, demonstrating that this one stock controls much more of the total return of the index than the entire bottom half of the index.

Through this paper's analysis it was discovered that the S&P500 index is very top heavy, as its largest 10 stocks in any given year between 2015 and 2023 accounted for, on average, 26% of the total index's market cap. This 26% is also not telling of the whole story either, as the top ten stocks percentage increased throughout the 7-year period, with every year after 2020 having a larger percentage than 26%. Figure 3 below depicts just this, as it shows the rankings of the 10 largest stocks in the S&P500 as of January 1st, 2024, with these stocks collectively holding 34.7% of the whole market cap of the index. This disparity between the top stocks in the index can be seen even clearer when I also included the top 11-20 stocks. Between 2015 and the end of 2023, on average, 36.9% of the index's market cap resided within its top 20 stocks, with a similar increasing percentage trend as seen with the top 10 stocks. This concentration at the top of the index leaves the remaining 480 or so stocks to have on average .13% of the index's market capitalization per stock. This disparity at the top is what led me to our question in this

paper; would investing in a portfolio of only the top 10 largest stocks in the S&P500, over a multi-year period, produce superior returns while not unproportionally increasing risk and volatility? Many believe that to achieve the best returns, a portfolio or index must be well diversified, but with the power that resides in the ten largest stocks of the S&P500, there is room to question whether that remains true.

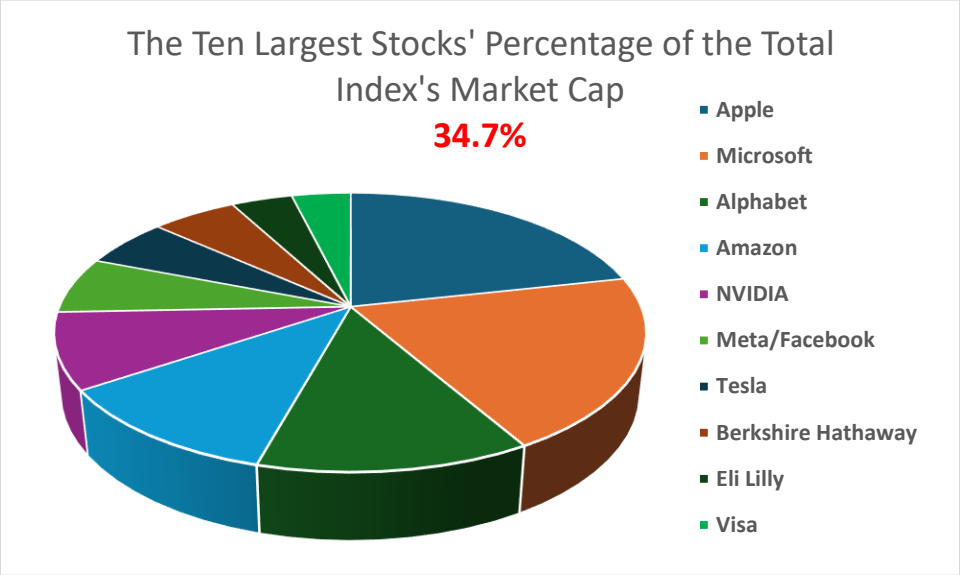

Figure 3 – Percentage of total Index market cap residing in the Largest 10 stocks in the S&P500 as of January 1st, 2024.

Analysis Methodology

The 10 and even 20 largest stocks of the S&P500 index represent a massive portion of the overall index's market capitalization. To investigate whether it is still true that the other 490 or so stocks are still necessary to diversify risk in a portfolio and return the best possible returns, an analysis and comparison of the returns of the top 10 stocks in the S&P500 over a 7-year period was conducted.

To begin this analysis, first the largest 10 stocks at the beginning of each year between 2016 and 2022 were ranked by their total market capitalization. Then the overall S&P500 index's market capitalization was found for each of these years. To test the performance of solely the largest ten stocks in the index, two test portfolios were created and compared to the index over the 7 years. After the returns for each month, year, and total period were calculated for the test portfolios and SPY, each portfolio's beta and standard deviation was calculated for the same periods. To see how returns can differ depending on frequency, multiple investing scenarios were then examined to see how investing $1000 in each portfolio could differ over the 7-year time in regards to compounding. After the returns and volatility of the test portfolios were analyzed, a risk-adjusted review was completed, to determine whether these portfolios could outperform the market without increasing risk unproportionately. The results of the analysis are shown in the following sections and figures in this paper.

Test Portfolios – Equally weighted and Index weighted

To evaluate the effect of the ten largest stocks on the total return of the S&P500, this analysis used two different test portfolios comprised of the largest 10 stocks as of the beginning of each year. The two test portfolios were comprised of the same stocks each year and differed only based upon how these stocks were weighed in the portfolio. The first test portfolio equally weighed each of the 10 largest stocks of the S&P500 each year, and therefore each stock's performance influenced the portfolio's total return equally. The second test portfolio weighed each stock relative to its weight in the index. This second portfolio allowed for the very largest stocks to influence the total portfolio's returns and volatility more than the 9^{th} or 10^{th} largest stocks and more accurately reflects the power that each stock has in the index.

We will investigate the results of both test portfolios because each weighting method brings its own benefits and drawbacks to the analysis. To begin, the benefits of the equally weighted test portfolio are that it removes the large cap bias of the index and returns results that reflect every stock's performance equally. Market-cap weighted portfolios on the other hand, are overweight in companies that are currently outperforming the market and thus they allow themselves to have a large concentration of funds at the top of the portfolio. Because of this concentration in overvalued stocks, market-cap weighted portfolios are great for when the largest companies are on a tear, but over the long-term, these portfolios can be massively hurt when the overpriced stocks inevitably fall back to their fair value. Therefore, market-cap weighted portfolios have long been viewed as a great tool for momentum investing strategies, as during good times they can outperform the market, yet during contractions are often left desolated. Oppositely, Equal Weighted portfolios are more resistant to drop offs like these, because of their better diversification due to less concentration in any one stock. Equally weighted portfolios are considered value-based investing strategies, which means that this approach favors undervalued stocks with the potential to rise in price and return to their fair value. A downside to this style of investing, however, is that it will lead to more selling and buying activities and potentially larger tax consequences than a market-cap weighted portfolio. For example, when shares in Company A grow and become more highly valued, a portion will have to be sold and deployed into the lower-priced Company B, C, and D to maintain the equal weighting of all companies in the portfolio. Therefore, while the equally weighted portfolio may have greater diversification and focus on the true value of the stocks, it too has its downsides, as its higher management fees can eat into its returns. Ultimately then, the type of weight used

in portfolios depends on the goals of the investor as each method can produce superior returns and risk depending on investment strategy.

Because of the differences in portfolios and investing strategies, this study will utilize both equally and market-cap weighted portfolios to determine which would have performed the best from 2016-2022. Even though equally weighted portfolios tend to require more rebalancing, and therefore can generate larger fees, there is a generally accepted view that they still produce superior returns and risk to that of market-cap weighted portfolios (Friedberg, 2018). While this may be held as true by many investors, this paper will seek to see if this statement would hold true between 2016 and 2022, when the market was experiencing mainly positive years. As a control for this research, the SPY was used as the benchmark for which I will compare both portfolios returns and volatility to that of the market. The XLG will also be compared to the test portfolios and the market, to see how a portfolio containing only the 50 largest stocks in the index would compare.

To begin the analysis, each of the largest stocks in the SPY, as of January 1st of each year, were selected and weighed in accordance with their test portfolio. Because the largest stocks in the index changed market capitalization and therefore index weight throughout the 7-year period, each year the manager would need to rebalance the portfolio, removing companies who had shrunk, and replacing them with the new largest companies. Once the ten largest companies had been selected for each year in the study, each stocks' monthly returns for that year were collected, and the portfolio's monthly returns were then calculated based on the test portfolio's stock weights. The SPY and XLG's monthly returns for each year during the study were then also calculated using data from Yahoo Finance. Once each portfolios' monthly returns

for the entire period were calculated, each year's twelve-monthly returns were annualized to find the year's total return. Likewise, once each year's monthly returns were calculated using the proper stocks and weights, the total 7 year holding period return was calculated.

A fault with the returns found using this method is that it does not include the processing fees that would be incurred to rebalance each of the test portfolios each year. What this ultimately means is that less money would be invested each year as compared to my calculations, as some principal would be lost to these fees. These fees would not be apparent in investments in the SPY, as it is a market-cap weighted ETF that would be fully passively invested in. The SPY would only require fees when the money is ultimately pulled out at the end of the period to realize a return. These calculations also do not account for the equally weighted portfolios larger management fees in order to keep the portfolio equal and therefore may not accurately represent the difference between equally weighted and market-cap weighted portfolios. Therefore, while these calculations can offer insight into how these investments could compare to the index, their returns may be slightly inflated.

Market Players – Test Portfolios Composition

When looking at the largest stocks throughout these seven years, it is apparent who the largest players in the market have been. Apple has been the largest company almost every year since 2016, only being usurped by Microsoft at the beginning of 2019. Between 2016 and 2019 Apple consistently comprised the largest weight of the index at approximately 3.5% of the entire index's market capitalization. However, starting in 2020, the company's market capitalization began to increase to around 7% of the total index weight. Until the end of 2019,

no stock had been over 4% of the total index weight, but during 2020, the disparity between the largest companies in the index and the smallest began to grow. By the beginning of 2022, four different stocks had individual index weights greater than 4%, with Apple reaching its peak index weight of 7.19%. Another notable trend during these 7 years is that many of the largest stocks in the index stayed consistent. Stocks such as Apple, Microsoft, Alphabet, and Amazon were among the ten largest every year during the study. While the largest five stocks were almost always the same, albeit shuffled, the sixth through tenth largest stocks in the index would occasionally differ in composition. The largest stocks and their percentage of the total Index market capitalization for 2016 through 2022 can be seen in figure 4 below.

Market Cap Rank:	2022	% of Total S&P	2021	% of Total S&P	2020	% of Total S&P	2019	% of Total S&P	2018	% of Total S&P	2017	% of Total S&P	1/1/2016	% of Total S&P
1	Apple	7.19%	Apple	7.05%	Apple	4.81%	Microsoft	3.71%	Apple	3.77%	Apple	3.16%	Apple	3.26%
2	Microsoft	6.25%	Microsoft	5.30%	Microsoft	4.48%	Apple	3.55%	Alphabet	3.21%	Alphabet	2.83%	Alphabet	2.99%
3	Alphabet	4.75%	Amazon	5.17%	Alphabet	3.45%	Amazon	3.51%	Microsoft	2.89%	Microsoft	2.51%	Microsoft	2.46%
4	Amazon	4.20%	Alphabet	3.74%	Amazon	3.44%	Alphabet	3.46%	Amazon	2.47%	Berkshire Hathaway	2.09%	Berkshire Hathaway	1.82%
5	Tesla	2.71%	Meta/Facebook	2.46%	Meta/Facebook	2.19%	Berkshire Hathaway	2.39%	Meta/Facebook	2.25%	Exxon Mobil	1.94%	Exxon Mobil	1.81%
6	Meta/Facebook	2.28%	Tesla	2.14%	Berkshire Hathaway	2.06%	Meta/Facebook	1.78%	Berkshire Hathaway	2.14%	Amazon	1.85%	Amazon	1.78%
7	NVIDIA	1.82%	Berkshire Hathaway	1.70%	JPMorgan Chase	1.61%	Johnson & Johnson	1.63%	Johnson & Johnson	1.64%	Meta/Facebook	1.72%	Meta/Facebook	1.66%
8	Berkshire Hathaway	1.64%	Visa	1.50%	Visa	1.53%	JPMorgan Chase	1.52%	JPMorgan Chase	1.63%	Johnson & Johnson	1.63%	Johnson & Johnson	1.59%
9	United Health	1.17%	Johnson & Johnson	1.31%	Johnson & Johnson	1.43%	Visa	1.40%	Exxon Mobil	1.55%	JPMorgan Chase	1.60%	Wells Fargo	1.55%
10	JPMorgan Chase	1.16%	Walmart	1.29%	Walmart	1.26%	Exxon Mobil	1.37%	Bank of America	1.35%	Wells Fargo	1.44%	JPMorgan Chase	1.35%

Figure 4 – Largest 10 stocks in the S&P500 and their index weights at the beginning of each year between 2016 and 2022. Information was adapted from "Top 20 S&P 500 Companies by Market Cap (1990 – 2024)" (FINHACKER, 2024)

Rebalancing the Portfolios

As can be seen in figure 4, each year the largest stocks in the SPY change and their weight moves in accordance with their companies' new market capitalization. Depending on investing schedule, even if funds invested in each of these test portfolios were left for the entire 7-year period, the largest stocks in the SPY would change each year and would result in the portfolios needing to be rebalanced. Each year, the manager would calculate the largest ten stocks in the SPY and then appropriately weigh the stocks based on the test portfolio. For this analysis, these calculated monthly returns of the SPY, XLG, and test portfolios were used to calculate the annualized yearly and 7-year returns.

The Efficient Market Hypothesis (EMH) demonstrates that no active manager can beat the market for long, as their success is only a matter of chance. Therefore, longer-term, passive management has proven to deliver better returns overtime. My initial questions for this paper then were: how would a hybrid strategy perform where stocks are actively selected and rebalanced, but funds are left passively to grow? I try to answer this question below, as well as: would the ten largest stocks of the index, if actively managed and rebalanced once a year, provide superior returns without increasing the risk of the portfolio unproportionately to that of the index? The following sections of this paper seek to investigate whether the two test portfolios would provide superior returns and measures of volatility as compared to the market between 2016 and 2022. The next part then seeks to compare the test portfolios to the market on a risk-adjusted basis.

Individual Stock Analysis

Throughout the 7-year period under analysis, the 10 largest stocks in the index remained relatively stable. There were 6 different stocks who maintained top 10 status throughout the entire period, with 13 different stocks in total being included at some point in the test portfolios. Each of these stocks played a role in determining the return and volatility of the test portfolios as well as the SPY and XLG. To discover where volatility came from during these years under investigation, the standard deviation, beta, and average stock rank were calculated for each stock. A summary of the individual analysis of each company included in the index can be found in figure 5.

As can be seen in figure 5, Apple was the largest company for all but one year of the study. This means that throughout my analysis, Apple was the main driver of returns and volatility for all the portfolios under analysis, except the equally weighted portfolio. In fact, after analyzing the stocks who were included in my test portfolios, 4 specific stocks, which were present every year, stood out as drivers of returns and volatility. These were, unsurprisingly, Apple, Microsoft, Alphabet, and Amazon. These four stocks consistently ranked within the largest 4 throughout the period and none of them even dropped below the 6^{th} largest position. While these stocks were found to be the largest throughout the period, they were also found to have experienced the largest standard deviation during their time in the test portfolios. This leads to the idea that while the very largest stocks are responsible for generating the majority of returns for even a portfolio containing only the largest 10 stocks, they are also responsible for generating the majority of volatility for that portfolio. In fact, every stock that ranked within the 10 largest every year of the study (7 times) had a standard deviation larger than that of the test portfolios. This means that while the largest returns of the test portfolios are generated by the

largest stocks, the risk reduction of the test portfolios comes from the bottom half of the portfolio.

Another interesting thing discovered about these largest stocks was that, except for two instances at the beginning of the study, the majority of stocks experienced betas of over 1. Having a beta above 1 means these stocks are more volatile and therefore riskier than the market. What this ultimately means is that when the market reacts to changes, these stocks on a whole will react more drastically than the market. This can be good for years when the market is performing well, but as we can see when calculating yearly returns, when the market goes south, the test portfolios take even larger nose dives.

Stock Size	1	2	3	4	5	6	7	8	9	10
Top 10 as of 1/1/16	Apple	Alphabet	Microsoft	Berkshire Hathaway	Exxon Mobil	Amazon	Meta/Facebook	Johnson & Johnson	Wells Fargo	JPMorgan Chase
Equal Weight Portfolio	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Index Weighted Portfolio	16.10%	14.75%	12.13%	8.98%	8.94%	8.78%	8.18%	7.84%	7.64%	6.67%
Stock Beta	1.54	1.04	1.10	0.67	0.29	1.50	-0.03	0.09	1.48	1.59
Standard Deviation (Monthly Ret)	7.52%	5.63%	6.06%	4.03%	3.80%	7.61%	5.36%	3.33%	7.70%	6.86%

Stock Size	1	2	3	4	5	6	7	8	9	10
Top 10 as of 1/1/17	Apple	Alphabet	Microsoft	Berkshire Hathaway	Exxon Mobil	Amazon	Meta/Facebook	Johnson & Johnson	JPMorgan Cl	Wells Fargo
Equal Weight Portfolio	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Index Weighted Portfolio	15.22%	13.65%	12.07%	10.04%	9.35%	8.90%	8.29%	7.83%	7.72%	6.92%
Stock Beta	1.90	1.02	0.61	0.88	-0.32	1.85	1.13	0.95	0.91	0.30
Standard Deviation (Monthly Ret)	6.16%	3.73%	3.42%	2.10%	3.41%	5.25%	4.89%	3.38%	4.77%	4.92%

Stock Size	1	2	3	4	5	6	7	8	9	10
Top 10 as of 1/1/18	Apple	Alphabet	Microsoft	Amazon	Meta/Faceb	Berkshire	Johnson & Johns	JPMorgan Chase	Exxon Mobil	Bank of America
Equal Weight Portfolio	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Index Weighted Portfolio	16.47%	14.00%	12.63%	10.78%	9.81%	9.36%	7.18%	7.10%	6.78%	5.89%
Stock Beta	0.83	1.25	1.25	2.12	0.75	0.93	0.73	1.06	1.14	1.17
Standard Deviation (Monthly Ret)	10.21%	6.62%	5.81%	11.25%	7.56%	5.00%	5.52%	5.93%	6.69%	6.28%

Stock Size	1	2	3	4	5	6	7	8	9	10
Top 10 as of 1/1/19	Microsoft	Apple	Amazon	Alphabet	Berkshire Ha	Meta/Face	Johnson & Johns	JPMorgan Chase	Visa	Exxon Mobil
Equal Weight Portfolio	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Index Weighted Portfolio	15.26%	14.59%	14.42%	14.21%	9.83%	7.32%	6.72%	6.25%	5.75%	5.65%
Stock Beta	0.77	1.35	1.37	0.69	0.90	2.14	0.73	1.28	0.49	1.30
Standard Deviation (Monthly Ret)	4.12%	6.80%	6.58%	5.04%	4.63%	9.87%	4.20%	6.52%	3.91%	6.12%

Stock Size	1	2	3	4	5	6	7	8	9	10
Top 10 as of 1/1/20	Apple	Microsoft	Alphabet	Amazon	Meta/Faceb	Berkshire	JPMorgan Chase	Visa	Johnson & J	Walmart
Equal Weight Portfolio	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Index Weighted Portfolio	18.33%	17.07%	13.12%	13.09%	8.33%	7.86%	6.12%	5.83%	5.46%	4.80%
Stock Beta	1.23	0.64	0.98	0.83	1.22	0.88	1.24	1.05	0.71	0.35
Standard Deviation (Monthly Ret)	11.48%	6.73%	8.99%	10.01%	10.62%	7.92%	10.72%	9.19%	7.08%	5.75%

Stock Size	1	2	3	4	5	6	7	8	9	10
Top 10 as of 1/1/21	Apple	Microsoft	Amazon	Alphabet	Meta/Faceb	Tesla	Berkshire Hatha	Visa	Johnson & J	Walmart
Equal Weight Portfolio	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Index Weighted Portfolio	22.28%	16.75%	16.35%	11.81%	7.77%	6.76%	5.36%	4.73%	4.13%	4.07%
Stock Beta	0.84	1.39	0.71	1.65	1.19	1.36	1.03	0.99	0.62	1.08
Standard Deviation (Monthly Ret)	6.50%	6.01%	5.71%	6.92%	6.91%	14.96%	4.64%	7.83%	4.52%	4.78%

Stock Size	1	2	3	4	5	6	7	8	9	10
Top 10 as of 1/1/22	Apple	Microsoft	Alphabet	Amazon	Tesla	Meta/Face	NVIDIA	Berkshire Hathaway	United Heal	JPMorgan Chase
Equal Weight Portfolio	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Index Weighted Portfolio	21.67%	18.84%	14.32%	12.67%	8.16%	6.89%	5.49%	4.95%	3.53%	3.48%
Stock Beta	1.21	0.90	0.93	1.25	1.37	0.51	2.46	1.01	0.44	1.21
Standard Deviation (Monthly Ret)	9.50%	6.95%	7.72%	12.63%	18.39%	16.38%	18.14%	8.13%	4.94%	10.34%

Figure 5 – Ten largest Stocks' names, rankings, weights per test portfolio, betas, and standard deviations of monthly returns from 2016 through 2022.

Monthly Return Comparison

To perform my monthly return analysis, the returns of each of the ten largest stocks in the SPY were calculated, for each month of the 7 years. Each stock's monthly return would be weighted according to the test portfolio to calculate the portfolios' total return for each month. To calculate the returns of the XLG and SPY, their historical prices were sourced from Yahoo Finance, and the holding period formula was used to calculate their monthly returns.

When analyzing the four portfolios' returns, I began by comparing them on a monthly basis. To do this, I started by listing each portfolio's monthly returns for the entire 84-month period. Then, each of the test portfolio's returns, as well as the XLG's, were subtracted from the SPY's to see which performed better during each month. Of the 84-month period analyzed, the index weighted portfolio outperformed the index 50 times, which was far more than it lagged behind. The equally weighted portfolio performed similarly, outperforming the Index 48 times. Interestingly, the XLG, comprised of the 50 largest stocks in the SPY, outperformed the index the exact same number of months as it underperformed it. The results of this analysis are shown below in figure 6.

	Equal	Index W	XLG
Months Outperformed	48	50	42
Months Underperformed	36	34	42

Figure 6 – Number of Months the test portfolios out/underperformed the SPY from 2016-2022

The next step of analyzing the monthly returns of the portfolios was to see how correlated the 84 returns were to those of the index. After running an analysis, not surprisingly all three delivered very high scores. What can be seen from these results is that just as the Index weighted portfolio outperformed the market in more months, it was also the least correlated of the three. Similarly, the XLG with its higher correlation was also the portfolio that performed the most similarly to the SPY on the monthly comparison.

	Equal	Index W	XLG
Correlation of Monthly Returns	0.934	0.903	0.980

Figure 7 – Correlation of our test portfolios' Monthly Returns to that of the SPY

Total Return Comparison

To calculate the total return of each test portfolio, the annualized total return formula was used to calculate the returns of each portfolio. This total includes compounding monthly returns and assumes the investor would leave investments for the entire 84-month period. For each test portfolio and the two index measures, their yearly and total 7-year holding period returns were calculated for 2016-2022 using their monthly returns. As can be seen in figure 8 below, the SPY performed the worst throughout these 7 years, only experiencing a return of 113.04%. The XLG, with its less diversified holdings, experienced only a slightly higher 7-year total return, experiencing a 113.31% total annualized return.

The equally weighted portfolio was found to have experienced a 128.84% growth from 2016 to 2022, outperforming both the market and XLG in terms of total compounded returns. The Index weighted test portfolio experienced the largest total compounded return over the 7–year period, realizing a 158.09% increase by the end of 2022. A summary of these total returns is shown below in figure 8. An issue that arises with these returns is that they do not take into account the fees required to rebalance the portfolio each year, and therefore, the test portfolio's return may be slightly inflated. To get a better understanding of how the test portfolios would perform on a year-by-year basis, in the next section I calculated the yearly returns for each portfolio.

	Total HPR (2016-2022)
SPY	**113.04%**
XLG	**113.31%**
Equal	**128.84%**
Index	**158.09%**

Figure 8 – Portfolio Total Returns from 2016 through 2022.

Yearly Return Comparison

What if an investor did not want to leave their money in any of these portfolios for the entire 7-year period? If an investor were to invest $1000 in one of these portfolios each year, leaving their money passively compounding throughout the year, then withdrawing it at the end of each year and realizing a return, how would the portfolio's returns compare? Figure 9 below shows the yearly returns for each of my analyzed portfolios.

	XLG	SPY	EQUAL	INDEX
2016	11.28%	12.00%	16.17%	14.92%
2017	22.97%	21.80%	31.59%	33.27%
2018	-3.66%	-4.64%	-1.85%	0.16%
2019	32.32%	31.34%	37.32%	40.46%
2020	23.82%	18.41%	30.82%	40.99%
2021	30.60%	28.82%	27.80%	32.22%
2022	-24.37%	-18.26%	-33.56%	-35.74%

Figure – 9 Portfolio's yearly returns. (Dark Green Means Highest, Dark Red Means Lowest, Yellow means middle)

The equally weighted portfolio consistently performed in between both the SPY and Index weighted portfolio from 2016 through 2022. The index weighted portfolio outperformed the SPY in every year but 2022, when the market turned south, and all 4 portfolios felt large losses. Not surprisingly, the index weighted portfolio, as well as the equally weighted portfolio, appeared to follow a similar trend as the SPY in terms of yearly and monthly returns. The index weighted portfolio outperformed the index in 6 out of the 7 years, making a case for itself as the smartest investment during this period. While the index weighted portfolio did appear to perform better on a year-to-year comparison as well as overall, the drastic loss in 2022 cannot be ignored. Since the largest stocks of the S&P500 have the largest effect on the returns of the index, the other 490 stocks mainly aid the index by diversifying some of the largest stocks' losses in bad years. As a result, while a portfolio of the largest ten stocks in the S&P500 would

appear to produce superior returns in years when those companies did well, the lack of diversification outside of those stocks, would lead to larger losses in years when these stocks did not perform well. What can be seen by looking at the SPY, XLG, and index weighted portfolios is that as the portfolio becomes less diversified in its holdings (500,50,10 stocks), the returns appeared to become larger but change more drastically on a yearly basis.

It has long been taught that passively managed portfolios outperform actively managed ones over the long-term. However, the superior returns of the test portfolios do offer some potential that a combination of actively managing the composition of the portfolio while passively investing the money could outperform the market in the short-run and potentially even in the long run. Whether or not these larger returns are accompanied by additional risk will be investigated next.

Standard Deviation Comparison – Yearly and Monthly Basis

Now that I have investigated the monthly, yearly and total returns for each of the portfolios, I shall look at the risk involved in each. To measure each portfolios' risk, the standard deviation of each portfolio was first calculated using the monthly returns. The standard deviation of a portfolio includes both systematic (market) risk and unsystematic risk. The standard deviations of each portfolio's monthly returns as well as the standard deviation of the SPY and XLG, between 2016 and 2022, are shown in figure 10 below.

	Monthly Return SD (2016-2022)	Yearly Return SD (2016-2022)
SPY	**4.79%**	**14%**
XLG	**4.87%**	**21%**
Equal Weighted	**5.44%**	**25%**
Index Weighted	**5.71%**	**28%**

Figure 10 – Comparison of Portfolio Standard deviation

We can see from the table above, as well as in Figure 11 below, that all the portfolios had similar risk structures. Each test portfolio's standard deviations only varied above the market's by less than 1% each month. Yet when comparing the yearly return's standard deviations, the increased variability that the test portfolios experienced was made even more evident. The portfolios containing only the largest 10 stocks of the S&P500 would clearly have more variability in their returns than that of more diverse portfolios like the SPY or XLG. Additionally, as I would expect, the equally weighted portfolio, with its lower concentration risk, had a lower standard deviation than the market-cap weighted portfolio during every year.

STANDARD DEVIATION	2016	2017	2018	2019	2020	2021	2022
SPY	2.21%	1.85%	4.90%	3.25%	7.65%	3.81%	7.11%
XLG	2.66%	1.41%	4.61%	3.84%	7.51%	3.44%	6.90%
EQUAL WEIGHTED	2.92%	1.68%	5.21%	4.36%	7.24%	3.93%	8.38%
INDEX WEIGHTED	3.29%	1.88%	5.43%	4.37%	7.64%	4.45%	8.43%

Figure 11 – Portfolio Monthly return standard deviation for each year in study. (red means low, green means high, goes by year)

Beta

The beta of each stock is comprised of the market's variance and the stock returns' covariance. Variance measures how far apart the market's data points spread out from their average, while covariance measures how changes in a stock's returns are related to changes in the market's returns. When the covariance of the stock is divided by the variance of the market, the beta of the stock is produced. To calculate each portfolio's beta, I first found the beta each

year, of the ten largest stocks. To determine the portfolio beta for the year, these individual stock betas were then weighed in accordance with their test portfolio. The equally weighted portfolio would average the beta out evenly among the stocks, while the index weighted portfolio would allow for the largest stocks to influence the beta more. Another way I found the beta of the test portfolios was to run the EXCEL slope function on the returns of the test portfolios and SPY, which unsurprisingly returned the same results as the previous method. The beta of the test portfolios was calculated using monthly and yearly returns and we will investigate the results in the section below.

The monthly returns of the equally and index weighted portfolios were found to have had a 1.06 and 1.08 beta respectively throughout the entire period. This means that the monthly returns of both test portfolios moved more dramatically in the face of market changes than did the S&P500. While the monthly returns of the test portfolios did experience a beta above 1, there were multiple years where the betas were below 1. However, a beta of .90 is still considered very high and would indicate that the test portfolios were only slightly less volatile in those years. Figure 12 through 14, below, depicts the betas for the test portfolios on a yearly basis as well as two different measures of the portfolios' beta during the entire period.

Beta of Monthly Returns			
	Equal W	**Index W**	**XLG**
2016	0.93	0.98	0.94
2017	0.92	0.99	1.00
2018	1.12	1.13	1.00
2019	1.10	1.09	1.00
2020	0.91	0.93	0.96
2021	1.09	1.09	0.99
2022	1.13	1.11	1.00

Figure 12 – Portfolio Beta of each year – using Monthly returns for each year (2016-2022)

	Equal W	Index W	XLG
Beta of Monthly Returns (84-Count)	1.06	1.08	.996

Figure 13 – Portfolio Beta of entire period – Using Monthly Returns for entire period (2016-2022)

	Equal W	Index W	XLG
Beta of Yearly Returns	1.34	1.46	1.13

Figure 14 – Portfolio Beta of entire period – Using yearly Returns for entire period (2016-2022)

Since both the test portfolios' monthly returns experienced positive betas each year of the study, the idea that the largest stocks could greatly outperform the market without adding risk can be brought under serious question. With the beta of the test portfolios yearly returns being found to be 1.34 and 1.46, this brings the idea even more under scrutiny. But all hope is not lost. While these test portfolios have indeed been proven to increase the volatility of the portfolio, as their high betas represent, it is yet to be seen whether or not they still produced adequate returns for risk-averse investors to have chosen to accept their additional risk.

The benefits of calculating the betas of these portfolios using their monthly returns included having a higher frequency of data points to give us a better idea of short-term fluctuations, as well as increased sensitivity, as using monthly returns allows for a more granular analysis of how a portfolio reacts to market movements. The benefits of using yearly returns, on the other hand, is that yearly returns smooth out short-term fluctuations, giving us a better long-term perspective. While each method has its benefits and drawbacks, they both provide valuable information about the volatility of the portfolios and give us some insight into how returns will behave on a yearly and entire period basis.

Investing Scenarios

To get a better picture of how investors could utilize these test portfolios, a couple investing scenarios were conducted. Each scenario assumed that an investor would invest $1000 into one of the four portfolios only differing in their investment frequency. To begin, my first scenario analysis assumed that an investor would invest $1000, starting on January 1st, 2016, into each of the portfolios for each month and realize a return. The manager would then reinvest $1000 into the portfolio for the next month, keeping the weight the same as at the beginning of the year, only changing stocks and weights at the beginning of the next year. These monthly returns, added together throughout each year, provide us with the simplest form of the investor's total returns for the 7 years. In this scenario the index weighted, equally weighted, XLG and SPY portfolios would produce returns of 108.95%,95.62%, 85.97% and 83.76% respectively. The benefit of this investing scenario is that it allows us to investigate each month's returns separately, without the effect of compounding. What I discovered was that the SPY experienced the most months with a positive return (58), the equally weighted portfolio was close behind with 57, and both the XLG and market-cap weighted portfolios had positive returns 55 times. This means that the portfolio with the lowest total return also had the most positive monthly returns. This is because the SPY did have more months of growth, but the other portfolios, with their larger betas, produced larger returns during their good months that ultimately made up for their additional few months of losses. Interestingly, while this scenario's yearly returns were obviously less than those that allowed for compounding in most years, this scenario performed the best in 2018 for all four portfolios. While every portfolio felt a loss in 2018, this scenario's portfolios experienced the smallest loss, as losses too are not compounded in this scenario. Ultimately, this scenario yet again depicts the larger variance of the test

portfolios and demonstrates that this scenario's returns would be much smaller than if an investor were able to let their investment compound for the entire 7-year period.

The second investing scenario assumed that the investor would invest $1000 into each of the portfolios at the beginning of each year and wait to fully realize and withdraw their gains only after that year ends. After rebalancing the portfolios at the beginning of each year, the investor would then only invest $1000 into each portfolio at the start of the new year. This scenario would garner some of the benefits of compounding, and would produce returns of 126.27%, 108.28%, 92.94% and 83.41% for the index weighted, equally weighted, XLG and SPY, respectively. While this scenario would take some advantage of compounding returns, each year the $1000 would only compound for 12 months. This scenario allows us to get a sense for how these portfolios differ depending on year and allows us to see trends in the long-term. While this scenario takes advantage of compounding, there is still one more scenario to maximize investor returns.

In the third scenario, the investor would invest $1000 into each of the portfolios on January 1st, 2016, and leave the total value of the investment in the portfolios for the entire 7-years. This scenario differs from scenario two because while the investor would still rebalance his portfolio yearly, choosing the new largest 10 stocks each year and weighing them accordingly, they would reinvest their initial $1000 *as well as any money they had made from previous years*. If investors let their money grow and were able to reap the full benefits of compounding returns, then the index weighted, equally weighted, XLG and SPY, would experience returns of 158.09%,128.84%, 113.31% and 113.04%, respectively. In this scenario,

both the equally weighted portfolio (128.84%) and index weighted portfolio (158.09%) would vastly outperform the index in terms of total returns.

While analyzing the entire holding period return can be useful for comparing which portfolio would perform the best in the long run, it can vastly depend on starting and ending points. As an example of this, if in this analysis I had placed the end date at the end of 2021, all three portfolios' total returns would be higher, because up until 2022, all four portfolios had experienced only positive, or near positive yearly returns. In 2022, however, both test portfolios compounded returns sharply fell by 142.57% and 115.62% respectively. These large losses over the final year of the analysis vastly underperformed the index, which only felt a loss in its compound returns of 47.61% in 2022. A summary of all the portfolios compounded returns for each year can be seen in figure 19, later in this paper.

While compounding returns are obviously beneficial for every investor, what is yet to be seen is whether these larger returns would still be present if all three portfolios were compared on an equally risk-adjusted basis. To determine whether these portfolios' returns actually provide superior results to that of the S&P500, a risk-adjusted analysis was completed to determine how much return was added per percentage of risk for each portfolio.

Analysis Limitations

The limitations to this research begin with only having access to returns from 2016 to 2022, and therefore this research may not reflect the entire history of the S&P500 or accurately predict its future. While this research can be useful for portfolios that can be left and rebalanced yearly, this may not work for some investors who are seeking to actively trade their

stocks and rebalance their portfolios daily, monthly, or quarterly. This research additionally has a limitation of only using the stocks and index weights of the ten largest market cap stocks in the S&P500 index as of the beginning of each year. Therefore, while this analysis can give us a rough estimate of how a portfolio of the ten largest stocks would perform, it would not account for changes in individual stock market capitalizations and index weights throughout the year, potentially vastly changing returns and variability.

Risk-Adjusted Comparison

To better compare the returns of these portfolios, a risk-adjusted analysis was completed to decern which portfolios performed the best when holding risk constant. A risk-adjusted analysis is meant to discern how well portfolios perform above the risk-free rate in relation to their volatility. Therefore, to begin my analysis, the risk-free rate, as measured by 1-year T-bills, for each month between January 2016 and December 2022 was collected. Then, the excess returns of the equally weighted portfolio, index weighted portfolio, XLG, and SPY were calculated, and their average monthly excess returns discovered. In this section I computed the Sharpe ratio, Treynor ratio, and Jenson's Alpha to compare my three portfolios on a risk-adjusted basis. A summary of the results of this risk-adjusted analysis is shown below in figure 15.

	Equally Weighted	Index Weighted	XLG	S&P500
Sharpe	12.61	13.24	13.25	13.73
Treynor	62.59%	67.98%	62.54%	63.48%
Alpha	0.0006	0.0020	0.0001	0

Figure 15 – Risk-Adjusted Ratio Analysis Summary

Sharpe

To begin my risk-adjusted analysis, the Sharpe measure was first calculated for each portfolio. To calculate the Sharpe ratio, first the risk-free rate was subtracted from each portfolio's monthly returns. Then, each portfolio's total excess returns for the 7-year time period were calculated, as well as the standard deviation of the portfolios' raw returns. Once the excess returns and standard deviation for each portfolio was calculated, each portfolio's excess returns were divided by their standard deviation. These ratios resulted in Sharpe measures of 12.61, 13.24,13.25 and 13.73 for the equally weighted, index weighted, XLG and SPY, respectively.

The Sharpe ratio is a mathematical expression that considers the portfolio's excess returns in relation to its volatility and risk over time. Essentially, the formula is used to quantify the total amount of excess returns earned above the risk-free rate, per unit of risk taken. The Sharpe ratio formula subtracts the risk-free rate on a 1-year T-bill, from the monthly historical return of the portfolio and divides the result by the portfolio's standard deviation. The standard deviation of a portfolio's returns is a measure aimed at considering both the systematic and unsystematic risk that the portfolio contains. By dividing the excess returns of each portfolio by their standard deviation, the Sharpe ratio puts them all on the same risk-adjusted level, and by doing so, aims to discover which portfolio will produce superior returns when accounting for its total risk. The portfolio with the highest ratio is the one that produced the largest excess returns with the smallest level of total risk.

The excess returns of each of portfolio can give us insight into their performance before I even divide by their standard deviation. The excess returns, standard deviation, and beta, for each portfolio can be seen below in figure 16. What the findings in figure 16 depict, is that while

the two test portfolios clearly have larger excess returns, they also have larger standard deviations. The question that the Sharpe ratio answers then is, how much more risk is added to those portfolios to garner those larger returns? As well as is the risk added low enough to warrant investment into those portfolios rather than the S&P500?

A higher Sharpe measure is always desirable, as it means the portfolio has garnered larger returns relative to its risk and therefore it is a better investment decision than lower ratioed portfolios. Simply put, what a higher Sharpe ratio directly means is that holding risk constant for all portfolios, the portfolio with the highest ratio will produce the largest returns. A generally accepted benchmark for what is considered a "good Sharpe measure" would be anything above 3, which all this study's portfolios fall far above.

What can be discovered by looking at the portfolios' Sharpe ratios is that, while all the portfolios I evaluated performed well over the period, none outperformed the SPY on both a systematic and unsystematic risk-adjusted comparison. What can be discerned from this research is that, while the index weighted and equally weighted test portfolios did perform almost as well as the XLG, the much more diversified SPY remained the most resistant to volatility. The SPY, while producing smaller returns than the test portfolios, would still be the best choice for a risk-adverse investor. While this ratio can give us useful insights into which portfolio might be the best investment decision for investors, it does not give a complete picture of the portfolio return and risk relationship.

Drawbacks of Sharpe's Measure

There are a few drawbacks to the Sharpe Ratio that can make it untrustworthy as a standalone metric. To begin, the ratio is calculated in an assumption that investment returns are normally distributed, which results in relevant interpretations of the Sharpe ratio potentially being misleading. The ratio's effectiveness can also vary based on the choice of the risk-free rate and market benchmark. While for this analysis 1-year T-Bills and the SPY were selected as the risk-free rate and market benchmark, other rates could have been selected. Another drawback is that the risk-free and benchmark rates do not remain constant, meaning that while this analysis's findings might be true for 2016-2022, the risk-free rate and benchmark are always moving, causing this analysis to not necessarily reflect future performance. The Sharpe ratio additionally, places relatively higher weight on short-term volatility, which might not accurately reflect an investment's long-term potential. Despite these limitations, the Sharpe ratio remains a valuable tool for assessing risk-adjusted returns.

	Equally Weighted	Index Weighted	XLG	S&P500
Excess Return	68.65%	75.64%	64.51%	65.72%
Standard Deviation	5.44%	5.71%	4.87%	4.79%
Monthly Return Beta	1.06	1.08	.996	1

Figure 16– Sharpe and Treynor Measure Component Information

Treynor's Measure

Treynor's ratio is another risk-adjusted measure that is similar to Sharpe's ratio in many aspects. Both metrics attempt to measure the risk-return trade-off in portfolio management by dividing the excess returns of portfolios by a measure of risk. While the Sharpe ratio aims to capture all elements of a portfolio's total risk (systematic and unsystematic) by dividing excess returns by standard deviation, the Treynor ratio only captures the systematic component by

dividing the portfolios excess returns by the portfolio's beta. By dividing the excess returns by the beta, the Treynor ratio only seeks to see how much systemic risk the portfolio contains and does not account for the unsystematic risk associated with the individual monthly returns. This difference in focus on systematic vs total risk is why most investors choose the Treynor ratio over the Sharpe ratio for a well-diversified portfolio. For this paper however, since the test portfolios are not well diversified, but the XLG and SPY are, I will utilize both measures to try to get the most comprehensive insight possible.

Similarly to the Sharpe measure, the Treynor measure begins with computing the excess return of the portfolios relative to the risk-free rate. This time, instead of dividing by the standard deviation, I divided the excess returns by the portfolio's beta, which is a measure of systematic risk. The Treynor measure, excess returns, and betas of the monthly returns for each of the three portfolios is shown below in figure 17. What we can see once the Treynor measures are computed, is that while the SPY resulted in a positive 63.48% ratio and outperformed both the XLG and equally weighted portfolios, the Index weighted test portfolio outperformed the market with a Treynor measure of 67.98%. This means that on a risk-adjusted basis, only accounting for systematic risk, the index weighted portfolio would outperform the market during this period. This could be attributed to the index weighted portfolio having the highest beta and the market mainly experiencing only growth years during this study, with only the final year of the analysis seeing any real downturn. This could also be due to the ratio only taking into account systematic risk, as it does not include the unsystematic risk that the non-well-diversified portfolio could bring.

	Equal W	Index W	XLG	SPY
Treynor	62.59%	67.98%	62.54%	63.48%
Excess Returns	68.651%	75.636%	64.505%	65.719%
Beta	1.06	1.08	0.996	1.00

Figure 17 – Treynor Measure Component Information

What these two measures tell us then, is that while the top 10-stock portfolios do outperform the S&P500 index in terms of total returns, and the index weighted portfolio does outperform the index on a systematic adjusted basis, all three test portfolios underperform the benchmark in terms of total risk-adjusted returns. Because all three of these portfolios are not as well diversified as the SPY, I would put more weight into the results of the Sharpe measure and conclude that while the test portfolios do garner larger returns, they do so at the sake of adding unproportionately larger risk. As a result of the high unsystematic risk associated with my two top-10 stock portfolios, I can begin to confidently say that while these two portfolios outperform the S&P500 in terms of total raw returns, they are not superior in terms of risk-adjusted returns.

Jenson's Alpha

The third risk-adjusted measure I will compute is Jenson's alpha. Jenson's alpha is a measure that quantifies the excess returns obtained by a portfolio of investments above the returns implied by the capital asset pricing model (CAPM). Alpha is defined as the incremental returns from a portfolio of investments, typically consisting of equities, above a certain benchmark return (Jensen's Measure, 2024). When using Jensen's measure, the chosen benchmark return is the Capital Asset Pricing Model, rather than the S&P500 market index. After calculating the portfolios return, risk-free rate, portfolio beta, and expected market return,

I can calculate Jenson's alpha. This analysis was done on Excel, so to begin, each portfolio's excess returns were calculated, and a regression was done on the returns of each portfolio. Once the regression was completed, the intercept of the test portfolio and SPY's monthly returns was found in the summary table and noted as the portfolio's alpha. The results of this analysis can be seen in figure 15 back on page 27.

A good Jenson's alpha measure is usually considered anything positive, as this positive number indicates that the portfolio outperformed the benchmark on a risk-adjusted basis over the time period. When an investment has an alpha of one, it means that its return during the specified time frame outperformed the overall market average by 1%. If the measure were to come back as zero, the portfolio would be said to be priced fairly, as it returned exactly what was estimated by the CAPM. The S&P500, as represented by the SPY in this analysis, is an example of a 0-alpha portfolio, as it itself is the benchmark for which alphas are compared. If a portfolio's result is negative, however, the portfolio could be seen as underperforming its expected return and could be viewed as a poor investment decision. In general, for return-oriented investors, a positive, higher Alpha is always the desired outcome.

As we can see from the table above, all four of this study's portfolios had very low alphas. This means that all four of the portfolios were priced fairly for their experienced return and risk throughout the period. This also means that all four of the portfolios realized returns would have compared favorably with the return associated with the level of expected risk. As with many of this analysis's other measures, the index weighted portfolio had the largest alpha, with equally weighted coming in second, and the XLG being barely above the market.

This relationship can be easily seen on a graph, when the Security Market line is plotted, and the portfolio's alpha's shown in relation. The graph will be set up with the X-Axis representing the beta of the portfolio's yearly returns and the Y-axis showing each portfolio-related yearly average return. To begin, a portfolio only containing assets with the risk-free rate is plotted. The average return of the risk-free rate during 2016-2022 was 1.19% and since an asset with the risk-free rate has no systematic risk, its beta is 0. After the risk-free rate had been marked, the S&P500, as measured by SPY, was plotted and the Security Market Line drawn between them. What was found was, that during 2016 to 2022, the average return for the S&P500 was 13.93%, which would mean a 12.74% market risk premium.

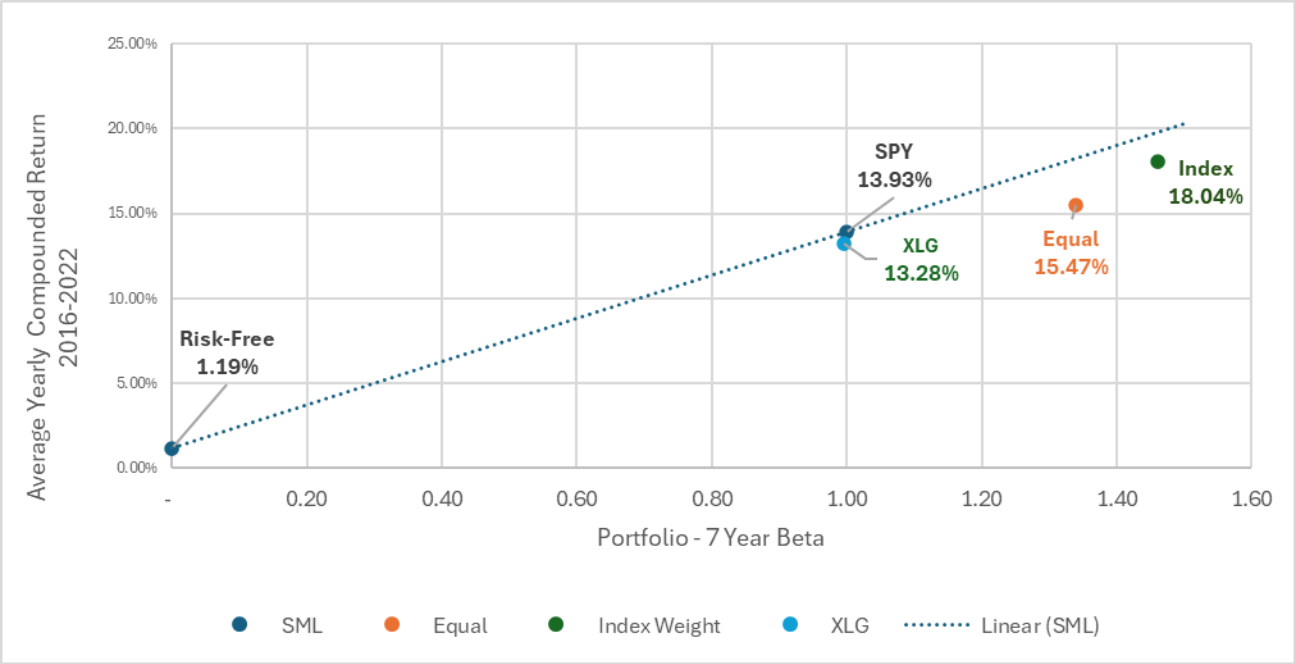

Figure 18– The SML on investments invested from 2016 through 2022.

The security Market Line above depicts different levels of systematic risk (or market risk) for the different portfolios. The line plots the portfolios betas against the expected return of the

entire market at any given time. The SML can help analysts determine whether a portfolio would offer a favorable expected return compared to its level of risk. All stocks or portfolios who lie above the SML are considered undervalued because they offer larger returns compared to their inherent risk. Portfolios above the line are superior to those stocks or portfolios with the same or larger beta below the SML. Therefore, the two test portfolios, while indeed producing superior returns to that of the SPY and XLG, also lie below the SML. This means that the test portfolios would unproportionately add risk compared to their returns. Through my Jenson's alpha comparison then, the Equal weighed and Index weighted portfolios would appear to underperform the market in terms of proportionately adding risk for return. This does not make the portfolio useless, however, because for risk-neutral and risk-loving investors the added returns that these test portfolios produce could still be worth the added risk that they would have to accept.

Risk-Adjusted Comparison Summary

We can see through my risk-adjusted comparison of the four portfolios that while the two top-10 stock test portfolios did underperform the market benchmark on a total risk-adjusted basis (Sharpe measure), they did outperform the market when adjusted for only their systematic risk (Treynor Measure). This is not surprising as the SPY is very well-diversified, with over 500 or so stocks, but my two test portfolios have much less ground to spread their variability over. My risk-adjusted analysis indicates then that the test portfolios did perform well in terms of the systematic risk they contained, however, they also had high unsystematic risk due to the fact that they only contained ten stocks. The small size of the test portfolio means even if only a few stocks have a bad month, then the whole portfolio could be greatly affected.

Ultimately then, for investors interested in the high returns these test portfolios can offer, they must also be willing to accept the added unsystematic risk that comes with the simplicity of these portfolios.

Alternative Analysis: What if the analysis ended after 2021?

If the analysis were to have ended at the end of 2021 the compounded returns of all four of these portfolios would have been much higher. When computing the compounded returns of the portfolios it is clear to see when would have been the ideal time to have withdrawn our funds. Figure 19 below shows the compounded returns at the end of each year of this study. Clearly, the end of 2021 would have been the ideal time to have withdrawn funds invested in any of these portfolios, but would the test portfolios have performed any better on a risk-adjusted basis? To discover the answer to that question, I performed the same analysis as above, but only included data through the end of 2021.

	Yearly Returns Compounded						
	2016	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
	1 Year Return	**2 year return**	**3 Year Return**	**4 Year Return**	**5 Year Return**	**6 Year Return**	**7 Year Return**
SPY	12.00%	36.42%	30.09%	70.87%	102.33%	160.65%	113.04%
Equal	16.17%	52.86%	50.04%	106.04%	169.53%	244.46%	128.84%
Index	14.92%	53.16%	53.41%	115.47%	203.78%	301.66%	158.09%
XLG	11%	37%	32%	74%	116%	182%	113%

Figure 19 – Portfolios' Yearly Compounded Returns from one to seven years (2016-2022)

As we can see, throughout the first six years, the index and equally weighted portfolios vastly outperformed the market in terms of total compounded returns, with the XLG slowly surpassing the market throughout the period. During the first six years of this study the test portfolios also outperformed the market when adjusted for both total and only systematic risk, most likely due to the sheer size of their returns. The Sharpe and Treynor measures, as well as

Jenson's alpha for each of the portfolios monthly returns from 2016-2021 are show below in figure 20. After replotting the portfolios on a new graph, it was discovered that both test portfolios as well as the XLG, all appeared above the SML for the first six years and outperformed the market in terms of risk and return. This means that, at least for the first six years of this study, investors of all risk preferences would ideally have chosen my test portfolios or the XLG over investing in the market.

	Equally weighted	Index Weighted	XLG	S&P500
Sharpe	32.72	35.46	28.76	27.01
Treynor	148.43%	168.08%	126.12%	115.79%
Alpha	0.0041	0.0061	0.0014	0

Figure 20 – Alternative Analysis – Risk-Adjusted Analysis Summary

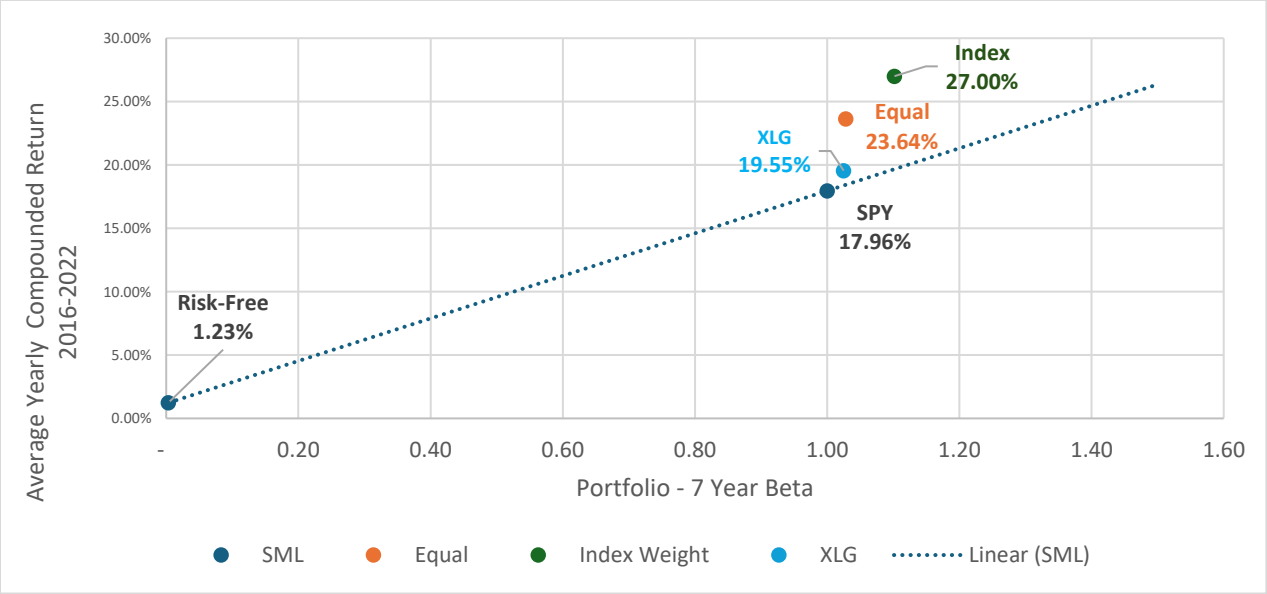

Figure 21 – The SML on investments invested from 2016 through 2021.

Research Findings Summary

This research's test portfolios were designed specifically to investigate how much weight the ten largest stocks in the S&P500 carried, and whether a portfolio of just those stocks could

outperform the market in terms of total, yearly, and monthly returns on a risk-adjusted basis. What this analysis discovered was that monthly, the test portfolios outperformed the market far more often than they underperformed it. On a yearly basis, the test portfolios outperformed the market every year but 2022, where every portfolio felt a massive drop off in returns, but the test portfolios specifically felt a far worse impact than the market. While the test portfolios did outperform the market in the first 6 years in terms of both raw returns and risk-adjusted returns, their higher betas eventually led them to feel much worse reductions in their compounded returns by the end of 2022. Overall, this loss in the final year of the study did not keep the test portfolios from having larger total returns over the entire 7-years, as both the index and equally weighted portfolios still were able to beat the market in terms of total compounded returns from 2016 through 2022.

While the ten largest stocks in the index did perform well, and even performed very closely to the market during these years, as the equally and index weighted 7-year monthly return betas were only 1.06 and 1.08 respectively, they did appear to have underperformed the market in terms of total return per unit of total risk taken. While the portfolios appeared to outperform the market in terms of returns per unit of unsystematic risk taken, they failed to surpass the market when the portfolios' total risk was accounted for. Because I sought to have a hybrid investing strategy, it was unsurprising to see my test portfolios had near zero alphas. While these alphas were slightly positive, indicating that they did produce returns larger than expected for their level of risk taken, they were still very low and should not be overvalued. Therefore, while this study may not show that the largest stocks would outperform the total index on a risk-adjusted basis, it does show that, the largest stocks in the S&P500 are

responsible for the majority of the index's returns as well as its volatility, while the rest of the index would appear to be responsible for diversifying the returns and aiding in loss reduction in bad years. My research showed that as the portfolios grew and contained more stocks, their returns would diminish, but so would their variability. What can be seen then from this analysis, is that while the equally weighted and index weighted test portfolios may not contain enough stocks to adequately diversify their returns, the XLG, with its 50 component stocks, did appear to barely outperform the index in terms of both its compounded raw returns and risk-adjusted metrics. The XLG experienced superior raw returns for most of the years analyzed and even had the lowest portfolio standard deviation of monthly returns for 4 of the 7 years. The XLG also experienced yearly betas of exactly 1 or less, meaning it reacted to market changes the same or even slightly less than the SPY. Therefore, on a risk-adjusted basis, the XLG outperformed the SPY when it comes to all measures analyzed for the 7 years. On the Security Market Line, however, the XLG appeared to barely underperform the market, as its 7-year beta was near 1, yet it garnered a slightly lower average yearly return than the SPY. Altogether, my research would appear to demonstrate that the index can be beaten in the short-term and even can potentially be beaten in the long-term, albeit only slightly, and that more than the 10 largest stocks are required in order to maintain proper diversification. While my test portfolios may not have outperformed the market on a risk-adjusted basis for the entire 7-year period, I was able to see that in cases of bull markets, that this investment strategy could be a wise investment decision.

Overall, even though I have proven that my test portfolios cannot outperform the market in the long term, they are not useless. Both test portfolios still performed well during

most of the years analyzed and while they did not perform well enough during the entire period to beat the market on a risk-adjusted basis, they did ultimately produce larger compounded returns. The fundamental principle of the risk-return tradeoff holds true for the test portfolios, as in search of the larger returns both could in fact have generated, an investor would have also had to accept their larger risk/volatility. This would mean that for investors who are risk-neutral or risk-loving, these portfolios would have been attractive during these years. However, even risk-adverse investors could have been interested in these portfolios, had they only been working with information from the first six years. While there are ways to match the market and even surpass it slightly with less than 500 stocks, in the long run, the sheer size and diversity of the S&P500 index protects it from many of the unsystematic risks that can arise in a smaller, not as well-diversified portfolio. While managers can outperform the market on year and even multi-year stretches, this research shows that the passively managed S&P500 index, with its use of proportionately market cap weighted stocks, allows for it to be better prepared for both bull and bear markets and perform the best in the long run.

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