# FIN 496 Capstone Project: Factor Based Investing With REITs

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# Introduction

**Introduction to Factor Based Investing**

Factor based investment strategies have become increasingly popular over the past 10 ten years. Referring to stocks, a factor is defined as any characteristic of a group of securities that is important in explaining their risk and return. There is a large amount of research that suggests that the long term performance of an equity portfolio can be explained by factors. MSCI currently identifies six of the most popular equity factors. These are value, low size, low volatility, high yield, quality, and momentum. The value factor aims to capture the returns of stocks that have low prices compared to their fundamental value. Common metrics used to capture this factor include price to book ratio, price to earnings ratio, book value, sales, earnings, cash earnings, net profit, dividends, and cash flow. The size factor aims to capture the returns of stocks with smaller market cap compared to their larger peers. The low volatility factor aims to capture the returns of stocks with lower than average volatility compared to peers. The popular metrics used for this factor are 1-year, 2-year, and 3-year standard deviation and Beta. The high yield factor aims to capture the returns of stocks with higher than average dividend yields. The quality factor aims to capture the returns of stocks characterized by low debt, stable growth, and other metrics. Some of the common metrics used for the quality factor are return on equity, earnings stability, dividend growth stability, balance sheet strength, financial leverage, accruals, and cash flows. The momentum factor aims to capture the returns of stocks with strong recent performance. It is commonly measured by 3 month, six month, and 12 month returns, and relative strength index (RSI). Historically, these factors have shown excess returns above the market benchmark when investing in the equity markets.

**Factor Based Investing with REITs**

Factor based investment strategies have become popular in the equity markets in recent years, but haven't yet caught on with REITs. According to a research paper by O'Shaughnessy Asset Management titled "A Factor Alpha Approach to REITs", this is mainly due to the fact that REITs require a different set of underlying factors than normal equities. Common metrics like price to earnings ratio and price to book ratio are effective when building a value factor for equites, but are ineffective when used to value REITs.

Also, the REIT market is also extremely top heavy. Meaning the top 25 REITs make up over half of the total sector market cap. Because of this, these top 25 stocks receive a majority of the analyst coverage. Any market cap weighted index fund will be heavily concentrated in these top 25 names. So, the smaller market cap REITs tend to get overlooked by analysts and institutional investors. About half of the small cap REITs are covered by two or fewer analysts and have 75% less institutional ownership compared to large cap REITs. Small cap REITs receive coverage levels similar to those of microcap public equities. Because of this, high quality REITs that are undervalued and have good recent price trends can offer better risk adjusted returns compared to a market cap weighted REIT index.

# Factors

The factors utilized in this strategy are based on the factors defined in the research paper, "A Factor Alpha Approach to REITs" by O'Shaughnessy Asset Management

**Momentum**

The first of the 5 factors in this portfolio is momentum. Similar to equities, REITs with good recent price trends tend to outperform peers in the next period. To measure momentum, the metrics used are quarterly price changes and relative strength index.

**Growth**

The growth factor measures growth trends in earnings and profitability. REITs with above average growth tend to outperform peers. The metrics used to measure growth are funds from operations growth, net income growth, operating income growth, and EBITDA growth.

**Quality (Financial Strength + Earnings Quality)**

For the financial strength factor, REITs that are highly levered or have poor balance sheet strength compared to peers are avoided. The metrics used were Debt to EBITDA, which shows how capable a company is of paying its debt, Debt to Equity, which tells you about a firm's financial structure and amount of leverage, and interest coverage ratio which tells you about a company's ability to pay its debts using its earnings. It essentially tells you how many times a company can pay its interest using earnings. A high interest coverage ratio indicates that a company has enough operating income to cover their interest payments many times over, while low interest coverage signals a higher risk of defaulting on debt. Debt growth rate was also used which shows if a firm is adding more debt or paying it down over each period.

The Earnings Quality factor focuses on reported FFO numbers vs audited GAAP earnings. Because funds from operations is not a GAAP audited item, it faces less scrutiny by auditors. Because of this, it has the most potential for firms to manipulate in a more favorable light. For this factor, we use a firm's net income, depreciation and amortization expense, gain on sale of property, loss on sale of property, and interest income to calculate what their fund from operations should be using their GAAP metrics. Any large discrepancies between their reported FFO and their GAAP audited earnings is a red flag. In the final portfolio, the Financial Strength and Earnings Quality factor were combined to create a single Quality factor.

**Value**

For the value factor, as can be expected, REITs that are undervalued when looking at key metrics tend to outperform peers. However, REITs require a different set of metrics to define value compared to the equity market. The most popular measures of value for equities are price to earnings ratio and price to book value which can be misleading when evaluating REITs. This is because historical cost accounting doesn't recognize the appreciation of underlying real estate assets. Cost accounting assumes real estate assets depreciate predictably over time when in reality they appreciate. Recording a depreciation expense on an asset that's increasing in value causes distortions in metrics like price to earnings and price to book. Book value and earnings per share are understated because they are reduced by depreciation expenses while gain on asset appreciation is unrealized. For valuing REITs, the metrics used are funds from operations and net asset value. Funds from operations adjusts for distortions caused by depreciation and property sales which makes Price to FFO a better metric compared to price to earnings. Net Asset Value estimates the market value of all real estate assets making it a better metric than price to book for valuing REITs

**Low Volatility**

The volatility factor measures how volatile or risky an asset is. REITs with lower volatility tend to outperform peers over a long period of time and generate more stable returns. The metric used to measure volatility is quarterly standard deviation of daily returns.

## Codebase

### Data Processing

To start, data was pulled from bloomberg with daily metrics for about two-hundred REITs in the following format going back to the beginning of 2000. The next step was to build dataframes for each individual metric and each REIT as the column index. To do this, we needed to iterate through the first row in the original data frame and store all the ticker values in a separate data frame called tickers. Then, the first data frame constructed was with price. To build this, first we remove the first 2 rows from the original data frame and store this as a new data frame called df1. Then, it iterates through the first row in df1 which is made up of different metrics like PX_LAST, CF_FFO, etc. To build the price df, we take the date column and only the columns titled PX_LAST. This is stored as a new dataframe called price_df. Then, we take the tickers data frame from before and make this our column index for price_df. The price_df data frame will look like this. It shows daily prices for each REIT going back to 2000. Anytime a dataframe was constructed with one of the metrics, a similar process was carried out.

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| 0 | NaN | PLD US Equity | NaN | NaN | NaN | NaN | NaN | NaN |
| 1 | NaN | Last Price | Funds from Operations | Price to FFO Ratio | Adjusted Funds from Operations - Cash Flow | RSI 30 Day | EBITDA | Historical Market Cap |
| 2 | Dates | PX_LAST | CF_FFO | PX_TO_FFO_RATIO | CF_AFFO | RSI_30D | EBITDA | HISTORICAL_MARKET_CAP |
| 3 | 1/3/2000 | 19.8125 | NaN | NaN | NaN | 50.6613 | 36.158 | 1697.34 |
| 4 | 1/4/2000 | 19.5 | NaN | NaN | NaN | 47.5994 | 36.158 | 1697.34 |

| 0 | PLD | AMT | EQIX | WELL | SPG | PSA | O | DLR | CCI |
|---|---|---|---|---|---|---|---|---|---|
| 2000-01-04 | 19.5 | 29 | NaN | 15.3125 | 20.089 | 22.75 | 9.9259 | NaN | 30.5 |
| 2000-01-05 | 19.25 | 29.875 | NaN | 15.75 | 20.257 | 22.938 | 9.8654 | NaN | 30.0625 |
| 2000-01-06 | 19.625 | 29.563 | NaN | 16.5625 | 20.762 | 23.813 | 9.9864 | NaN | 29 |
| 2000-01-07 | 20 | 31.188 | NaN | 16.8125 | 21.66 | 24.125 | 10.168 | NaN | 30.5 |
| 2000-01-10 | 20.125 | 33.938 | NaN | 17.125 | 21.884 | 24.625 | 10.3496 | NaN | 31.9375 |

### Momentum Factor Construction

To build the momentum factor, the metrics used were quarterly price change and quarterly relative strength index (RSI). For quarterly price change, it uses price_df and calculates the percentage change in price for each quarter for each REIT, then builds a new data frame to store these values. For RSI, it is pulling 30 day trailing RSI for each REIT for each day. So, to get quarterly RSI values, it is taking the average RSI over the quarter and storing those values in a new dataframe. Now that it has built data frames that store quarterly price change and quarterly RSI for each REIT, these values are given scores relative to each other. First, they are ranked. Lowest price change gets the lowest rank and highest price change gets the highest rank. Then, these rankings are normalized on a scale from zero to one hundred. Again, lowest price change gets a zero and highest gets one hundred. This is done for both

quarterly RSI and quarterly price change. Then, the average between these two scores are taken to get a final momentum factor score. For this factor, a stock needs scores for price change and RSI in order to get a final momentum factor score. Meaning, if a stock has an NA value for RSI but not for price change, it will get an NA value for the final momentum score.

**Growth Factor Construction**

To build the growth factor, the metrics used were funds from operations (FFO), net income, operating income (EBIT), and EBITDA. A similar process to calculating quarterly price change was used for each of these metrics. To calculate the growth for these metrics, it calculates the percentage change in FFO, net income, EBIT, and EBITDA for each stock in each quarter. Then, these values are stored in their own data frame. Again, for each metric in each quarter, stocks are ranked by their growth. The highest growth gets a one hundred, the lowest growth gets a 0. Then, once we have scores for each of the four growth metrics, a growth factor score is calculated by taking the average between the four scores for FFO growth, net income growth, operating income growth, and EBITDA growth. Something that was done differently for this factor was how NA values were dealt with. Because there are four metrics used to calculate the growth score, it's fairly likely that a stock could have an NA value for one of the metrics. This would lead to a lot of stocks being left out of the portfolio for having just one NA value for a metric. To deal with this, the code calculates the average growth factor score based on the metrics that a stock has values for. So, if a stock has three of the four metrics, it will calculate the average growth factor score based on the three metrics it does have.

**Quality Factor Construction**

Because the original factors of earnings quality and financial strength were combined to create one quality factor, the metrics used are debt to EBITDA, debt to equity, interest coverage ratio, debt growth rate, and absolute percentage error between reported FFO and GAAP earnings. For debt to EBITDA, debt to equity, interest coverage ratio, and debt growth rate, these metrics were scored similarly to metrics for the previous factors. The stock with the lowest debt to EBITDA gets one hundred, the highest gets a zero. The same goes for debt to equity and debt growth rate. The stock with the highest interest coverage ratio gets one hundred, lowest gets a zero. To calculate the absolute percentage error between reported FFO and GAAP earnings, it calculates FFO using GAAP metrics for each quarter. The formula for FFO is Net Income + (Depreciation Expense + Amortization Expense + Losses on sale of property) - (Gains on sale of property + Interest Income). Then, it takes the absolute value of the reported FFO minus the calculated FFO divided by the calculated FFO times one hundred. Then it stores the absolute percentage error values in a new data frame where each stock is again ranked on this metric. The smallest percentage error gets one hundred and the largest percentage error gets a zero. It then takes the average of the scores for all these metrics to get to a final quality factor score. Like the growth factor score, the code calculates the average quality factor score based on the metrics that a stock has values for. So, if a stock has four of the five metrics, it will calculate the average growth factor score based on the four metrics it does have.

**Value Factor Construction**

For the value factor, the only metric used was price to FFO per share. Originally, it was supposed to include price to net asset value per share, but when this metric was pulled from bloomberg, it returned NA values for every REIT. Similar to the other metric score calculations, for each quarter, each stock is ranked on their price to FFO per share. The lowest value gets one hundred, the highest value gets a zero. Because price to FFO is the only metric being used, the value factor score is the same as the price to FFO score.

**Low Volatility Factor Construction**

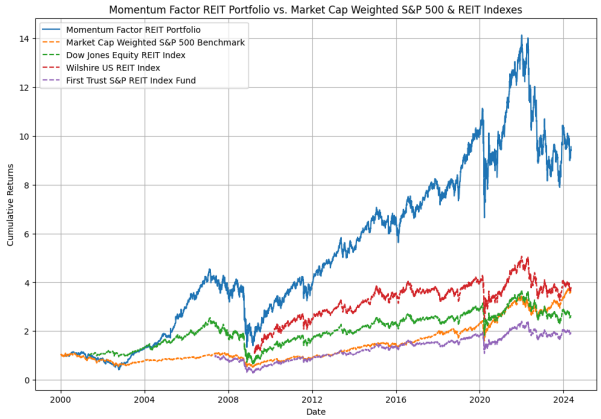
To build the volatility factor, we start with the daily returns data frame, which shows the daily return for each REIT since 2000. Then, this dataframe gets resampled on a quarterly basis, and it calculates the standard deviation of daily returns for each REIT for each quarter. Again, each REIT is then ranked and scored based on their volatility. Lowest volatility gets one hundred, highest volatility gets a zero.

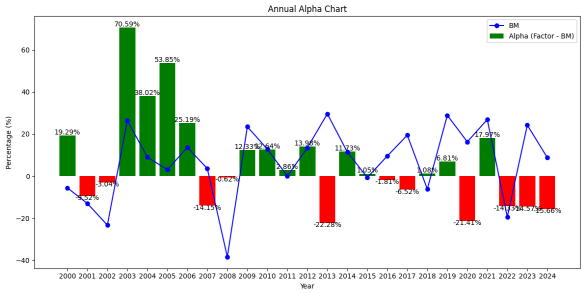
**Portfolio Construction**

After building data frames that hold scores for all five factors for each REIT in each quarter, it calculates a five factor score by taking the average of all the factor scores. With the final portfolio, a REIT has to have a score for all five factors or it will not be included in the portfolio. If it has any NA values for any of the individual factor scores, it will get an NA value for the five factor score and will not be included. This can be problematic as it leads to more stocks being dropped out of the asset pool as different factors are combined. This can lead to multi-factor portfolios that underperform when compared to individual factors. For each quarter, the portfolio reallocates into the ten REITs with the highest average five factor scores from the previous quarter. The ten stocks are equally weighted with no short position.

# Results

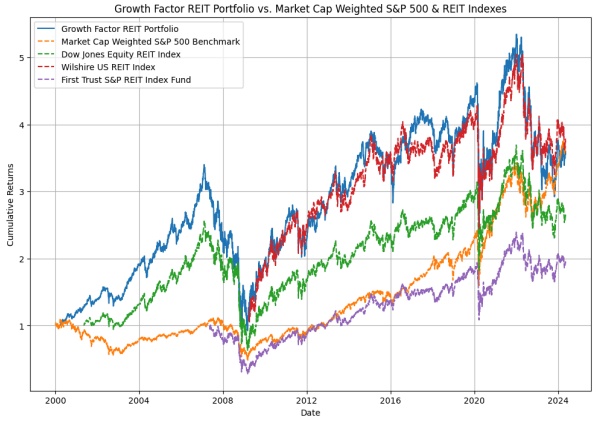
## Momentum Only Portfolio

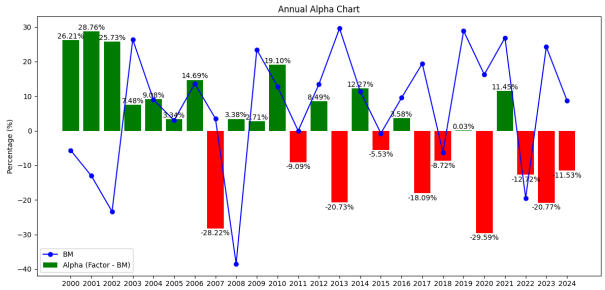



**Average Annual Return: 9.5%**
**Average Annual Volatility: 28%**
**Sharpe Ratio: 0.33**
**Max. Drawdown: -70%**
**Alpha: 3.9%**

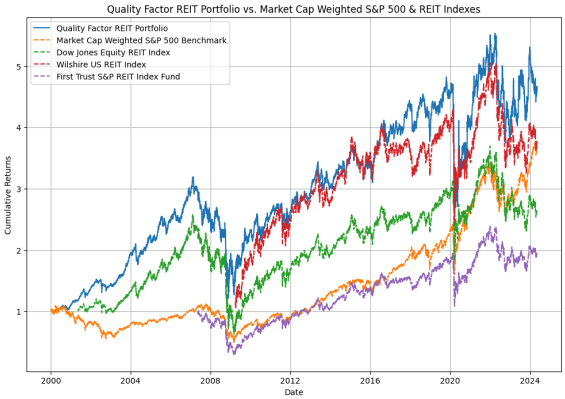
## Growth Only Portfolio

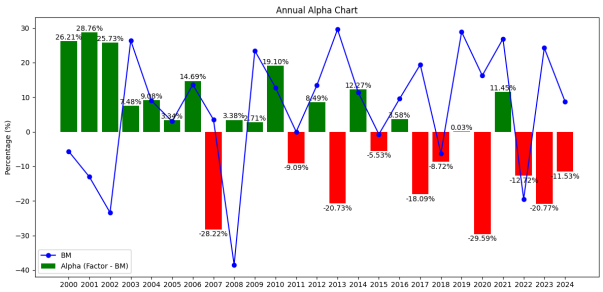


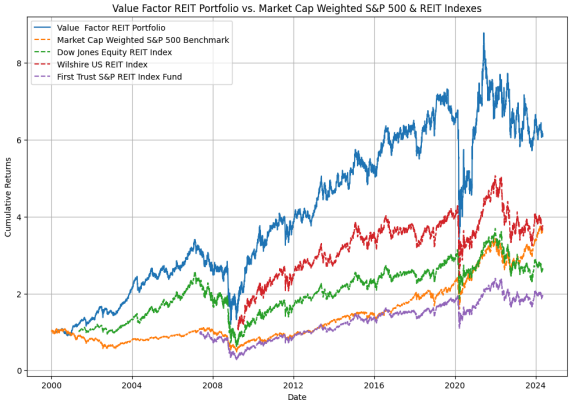

**Average Annual Return: 5.3%**
**Average Annual Volatility: 27%**
**Sharpe Ratio: 0.19**
**Max. Drawdown: -73%**
**Alpha: 0.0%**

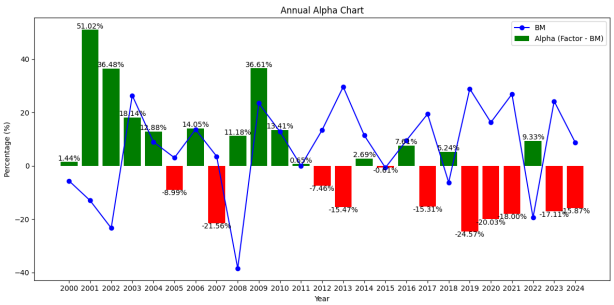
## Quality Only Portfolio




## Value Only Portfolio

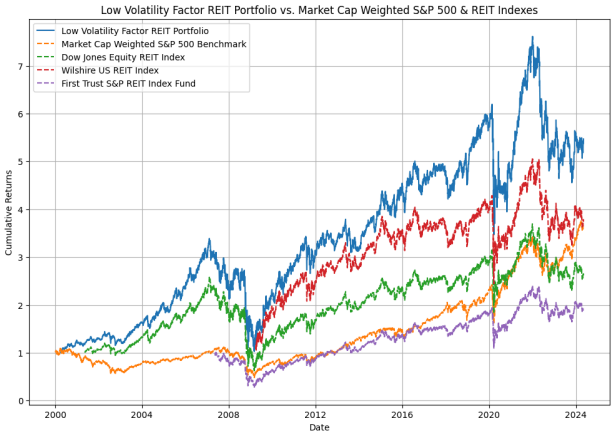


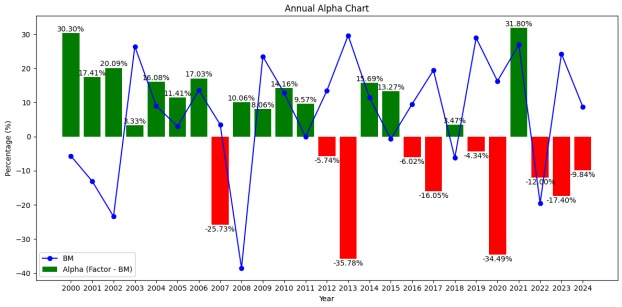



**Average Annual Return: 6.3%**
**Average Annual Volatility: 22%**
**Sharpe Ratio: 0.28**
**Max. Drawdown: -62%**
**Alpha: 0.8%**

**Average Annual Return: 7.5%**
**Average Annual Volatility: 26%**
**Sharpe Ratio: 0.29**
**Max. Drawdown: -65%**
**Alpha: 2.0%**

## Low Volatility Only Portfolio




**Average Annual Return: 7.0%**
**Average Annual Volatility: 28%**
**Sharpe Ratio: 0.25**
**Max. Drawdown: -69%**
**Alpha: 1.5%**

## Metrics for S&P Benchmark & other REIT Indexes

### S&P 500

**Average Annual Return: 5.5%**
**Average Annual Volatility: 19.5%**
**Sharpe Ratio: 0.28**
**Max. Drawdown: -56%**
**Alpha: 0.0%**

### Dow Jones Equity REIT Index

**Average Annual Return: 4.3%**
**Average Annual Volatility: 28%**
**Sharpe Ratio: 0.15**
**Max. Drawdown: -75%**
**Alpha: -1.2%**

### Wilshire US REIT Index (Starts in 2009)

**Average Annual Return: 9.1%**
**Average Annual Volatility: 25%**
**Sharpe Ratio: 0.37**
**Max. Drawdown: -43%**
**Alpha: -1.2%**

### First Trust S&P REIT Index Fund (Starts in 2007)

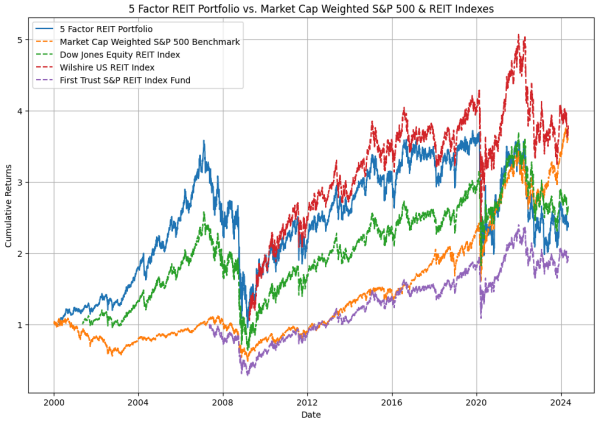
**Average Annual Return: 3.9%**
**Average Annual Volatility: 29%**
**Sharpe Ratio: 0.13**
**Max. Drawdown: -72%**
**Alpha: -1.5%**

**Individual Factor Portfolio Analysis**

Looking at the performance of the individual factor portfolios, there are some common trends. They all provide good returns, with each portfolio except for growth having a higher average annual return than the S&P benchmark. However, all these portfolios are more volatile than the S&P benchmark and have larger maximum drawdowns. This could be due to several factors. The first being the number of assets in the portfolio. There are only ten stocks in the portfolio at any given time which reduces the diversification of the portfolio. Having more stocks in the portfolio spreads out risk across more assets. If one performs poorly, it has a smaller impact on the portfolio. The next reason for the high volatility is simply due to the nature of the asset class. REITs are generally more volatile than other asset classes like equities and bonds. Finally, individual factor returns are known to be highly cyclical. They are sensitive to macroeconomic conditions and have periods where they underperform the market. It's also important to realize that there is no diversification among different asset classes with these portfolios. Because of this, all the available REITs are highly correlated with each other. So, when a recession comes, it doesn't matter if the portfolio is made up of the most undervalued, lowest volatility stocks. The portfolio is going to mimic what is going on in the broader real estate market. That is why most of the portfolios have large maximum drawdowns. This can be observed with the five individual factors above. During the 2008 Financial Crisis and COVID, these factors underperformed the market. I think it's also important to note that every one of the individual factor portfolios outperformed the Dow Jones Equity REIT Index, a market capitalization weighted index that measures the performance of REITs.

**Multi-Factor REIT Portfolios**

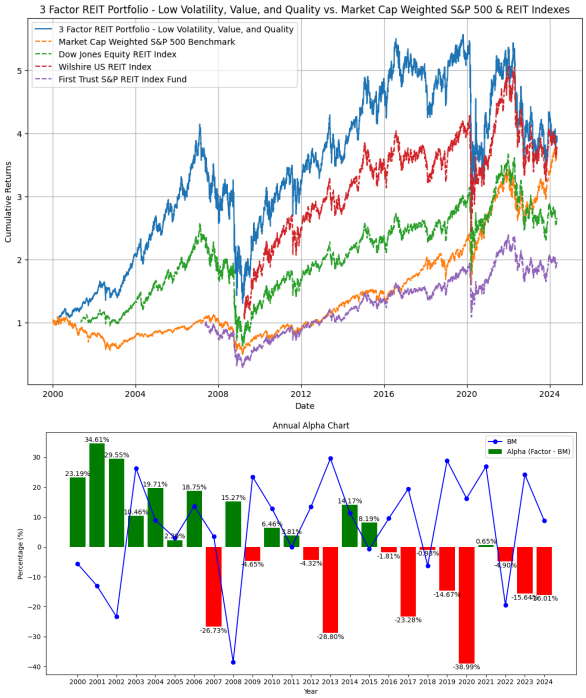
When we use all the available factors, it creates a portfolio that underperforms all the other individual factor portfolios. That is why it's important to understand the various effects that combining factors can have on a portfolio. When selecting which factors to combine, it's necessary to take into account their historical risk, correlation with other factors, and performance during different business cycles. Starting with value, it generally has historical risk comparable to the market. It has low correlation with momentum, quality, and low volatility, and it is pro-cyclical, meaning it performs well during periods of high economic growth, inflation, and when interest rates are rising. Momentum has similar risk to the market, low correlation with value, quality, and low volatility, and it is pro-cyclical. Quality has lower risk than the market, low correlation with value and momentum, and it is defensive, meaning that it performs well during recessions. Growth has similar risk to the market, low correlation with quality and low volatility, and is pro-cyclical. Instead of combining all of the factors, they can be selected based on the goals of an individual investor. A more defensive portfolio can be created by




**Average Annual Return: 3.6%**
**Average Annual Volatility: 29%**
**Sharpe Ratio: 0.12**
**Max. Drawdown: -73%**
**Alpha: -1.9%**

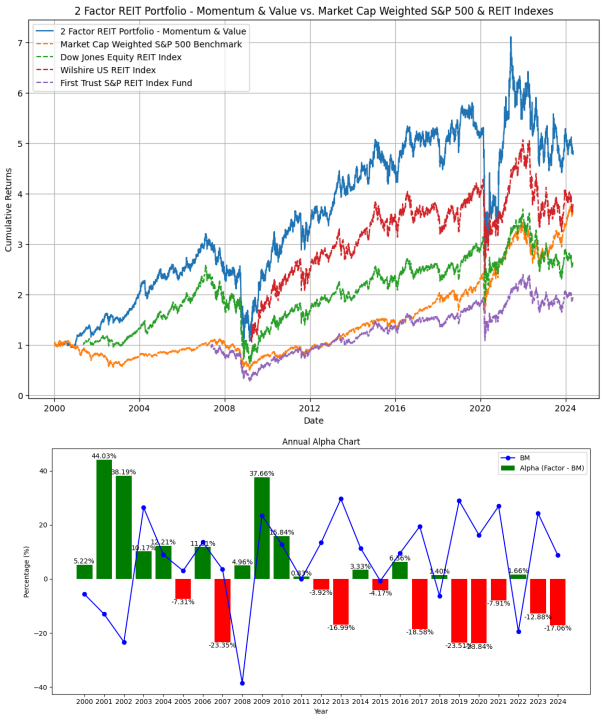
combining low volatility, value, and quality. This portfolio would yield moderate return with lower risk. A more dynamic portfolio can be created by combining momentum and value. This is a more aggressive allocation that would yield higher returns and higher risk. A balanced allocation would be something in between defensive and dynamic. For example, It might consist of value, momentum, low volatility, and quality.

**Defensive Allocation - Low Volatility, Value, & Quality**



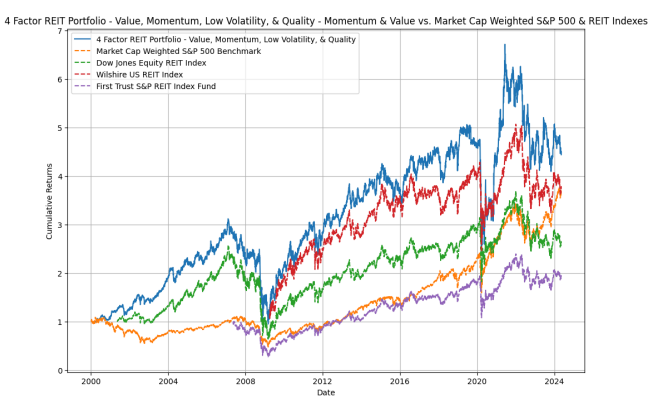

**Average Annual Return: 5.6%**
**Average Annual Volatility: 27%**
**Sharpe Ratio: 0.20**
**Max. Drawdown: -68%**
**Alpha: 0.1%**

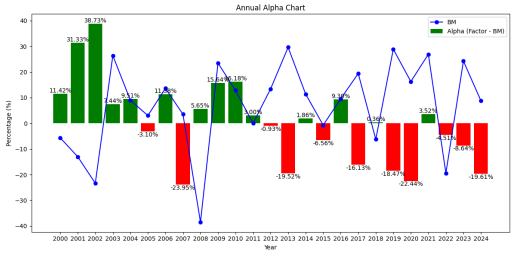
**Dynamic Allocation - Momentum & Value**




**Average Annual Return: 6.5%**
**Average Annual Volatility: 27%**
**Sharpe Ratio: 0.24**
**Max. Drawdown: -68%**
**Alpha: 0.9%**

**Balanced Allocation - Value, Momentum, Low Volatility, & Quality**




**Average Annual Return: 6.2%**
**Average Annual Volatility: 27%**
**Sharpe Ratio: 0.23**
**Max. Drawdown: -69%**
**Alpha: 0.6%**

## Future Improvements

Although all of the individual and most of the multi-factor portfolios outperformed the other REIT indexes, there is still room to improve this strategy. Starting with the data collection, one of the biggest challenges faced was missing data. Even though data is being collected from bloomberg, there were still many metrics that returned NA for certain stocks at certain times. Most of the missing values came from the small cap stocks. This is problematic because the strategy depends on finding small stocks that get overlooked. But, if a stock doesn't have the data available, it gets overlooked by the code and gets left out of the portfolio. This creates problems when building multi-factor portfolios as well. If a stock has an NA value for any of the factor scores being combined, this will lead to it getting left out of the portfolio. So if there was a stock that was very influential in the performance of the momentum portfolio, but it didn't have a score for value, it would get left out of the dynamic allocation portfolio. This creates distortions in the performance of the multi-factor portfolios. To solve this problem, data would need to be collected from a different source to ensure that there are values for each metric for each stock in each quarter.

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