Actively Using Passive Sectors to Generate Alpha Using the VIX

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Abstract: A significant amount of academic research has documented momentum within and across broad sectors of the stock market as a means of generating alpha over a passive benchmark. However, few studies approach sector allocation from a mean reversion perspective using the Chicago Board of Exchange (CBOE) Volatility Index (VIX) as the trigger. We find that positioning into defensive sectors during periods of low volatility for the stock market, and into cyclical sectors during periods of high volatility produces significant long-term alpha. Using this framework, we backtest a dollar neutral strategy documenting return differentials, and create a modified S&P 500 Index that overweights and underweights cyclical and defensive sectors systematically based on VIX levels. Absolute and relative returns for a sector allocation strategy that uses VIX levels significantly outperforms a passive buy and hold approach by using mean reversion to generate alpha. We postulate that the approach likely works because of behavioral biases related to loss aversion and the disposition effect creating mispricings that are repeatable and exploitable during periods of extreme market stress.

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Introduction

The Efficient Market Hypothesis is at the core of all traditional arguments for buy and hold investing. Because this theory postulates that all information is known and factored immediately into price, active asset allocators and traders cannot possibly outperform or have any analytical edge[1]. A major assumption for the Efficient Market Hypothesis to hold, however, is that market participants are on average rational and do not exhibit behavioral biases that cause over or underreactions in current price. We know from numerous academic studies that this simply is not true.[2] Market participants exhibit clear patterns of irrational responses to already known data, allowing for exploitable opportunities and alpha generation through the identification of near-term activity driven by emotion.

Active traders and asset allocators inherently attempt to exploit repeatable human behavior to create a better risk-adjusted return profile for their portfolios. One well documented anomaly traders often focus on is momentum. Underreaction to positive news is often cited as the reason for why the momentum anomaly exists. Investors may be exposed to all data points that impact valuation, but the gradual diffusion of information, and hesitation to aggressively position bullishly into a particular segment of the market creates persistence in price movement and ultimately forms trends. Conversely, overreactions to all available information tend to present themselves during periods of heightened fear and risk of loss. Prospect theory[3] argues that individuals do not act rationally and value gains and losses differently, creating a bias towards loss aversion and a stronger emotional response to declining stock prices than advancing ones. Put simply, a dollar of loss is felt more strongly than a dollar of gain.

Fear of loss, rather than hope for gain, is where the most aggressive mispricing occurs when it comes to investing and is most felt during periods of heightened volatility for the stock market. Perceived risk during corrections and crashes often results in panic selling, usually at the wrong time, as loss aversion dictates actions more than any Efficient Market Hypothesis ever could. While it may be cliché to say that most investors tend to "sell bottoms," the reality is that there is ample evidence proving that market participants often act defensively after a decline in asset values has already taken place, selling winners and holding on to losers.[4]

Buy and hold index investors will argue that this is exactly why buy and hold works. If you don't care about near-term volatility, you don't risk selling at the wrong time, and as such are better off in the long-run. As investing legend Peter Lynch once said, "far more money has been lost by investors preparing for corrections, or trying to anticipate corrections, than has been lost in corrections themselves." However, this is only correct if the execution for preparing for a correction is wrong. It is the "preparation for a correction" that must be defined

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[1] See Malkeil (2003)

[2] See Philip and Torbey (2002)

[3] See Kahneman and Tversky (1979)

[4] See Barber (2011)

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properly. If Black Swans[5] are considered unpredictable and are the catalyst for severe losses in markets, then the objective for active managers shouldn't be to try to anticipate exactly when a correction or crash is set to take place. Rather, it would make more sense to position oneself defensively in case there is a volatility spike and collapse in markets while still maintaining beta exposure, and then increase that beta exposure at lower prices when overreactions create discounted buying opportunities.

Sector Momentum and Crashes

One of the most studied and well-known anomalies that counter the Efficient Market Hypothesis is the existence of momentum and autocorrelation in asset prices. Moskowitz and Grinblatt in 1999 documented the persistence of returns at the one-month interval[6] across stocks and notably on the sector and industry level, while other studies show that other asset classes also exhibit such patterns.[7] As sectors and industries advance, they tend to continue to advance because they already have, allowing active traders to take advantage of trends and price drift.

While momentum continues to be an observable and exploitable phenomenon, it certainly is not guaranteed, nor risk-free. Momentum as a factor for generating alpha is prone to periodic "momentum crashes" which can create "infrequent and persistent strings of negative returns. These momentum crashes are partially forecastable. They occur in panic states, following market declines when market volatility is high, and are contemporaneous with market rebounds. The low ex-ante expected returns in panic states are consistent with a conditional high premium attached to the option like payoffs of past losers."[8] Momentum studies when evaluating sector allocation strategies tend to not put the anomaly in the context of volatility and environments of heightening uncertainty for the stock market. The objective is not to buy low and sell high, but instead buy high and sell higher. Continuously chasing the best-performing sectors works until the inevitable volatility spike and crash takes places.

A different approach to sector positioning is to not consider momentum at all when over or underweighting against a benchmark's passive positioning. Sectors and industries may explain why momentum exists, but behavior explains why sectors get mispriced after volatility spikes. These volatility spikes may be unpredictable, but the mispricing that occurs in cyclical sectors following severe panic states for the stock market is the exact opportunity active traders should be focused on. Positioning defensively in advance of high volatility periods through lower beta sectors like Utilities, Consumer Staples, and Healthcare allows for protection prior to when unpredictable losses occur. As losses and volatility increase to unsustainable levels, the positioning out of defensive sectors into cyclical ones presents an

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[5] See Taleb (2007)

[6] See Moskowitz and Grinblatt (1999)

[7] See Luu and Yu (2012)

[8] See Daniel and Moskowitz (2015)

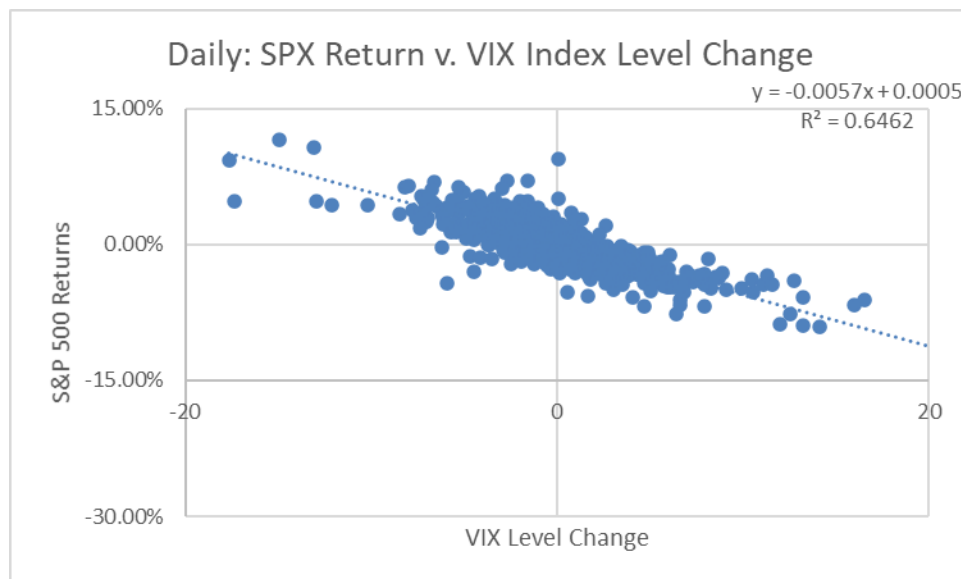Electronic copy available at: https://ssrn.com/abstract=3718824

opportunity to buy into panic and benefit from a return to normalcy, until the pattern repeats and defensive positioning during excessively low periods of volatility is warranted again.

Deconstructing the VIX

The CBOE Volatility Index, better known as the VIX, is an index designed to measure the market's expectations for volatility over the following 30 days. It does this using the CBOE's S&P 500 index derivatives contracts. Originally envisioned as a means of simply measuring volatility expectations using the S&P 100 index, the VIX has become the premier benchmark for U.S. stock market volatility. It is cited by numerous financial media outlets as the "fear index" and has spawned a number of tradable products using it as the underlying index, including exchange-traded funds (ETFs), exchange-traded notes (ETNs) and options contracts.[9]

Many traders and investment managers use the VIX as part of their decision-making processes. Historically, there has been a strong negative correlation between stock market performance and the VIX (see Chart 1). This is demonstrated by looking at daily returns in the S&P 500 index in relation to daily changes in the VIX.[10]

**Chart 1: Daily VIX and Stock Market Correlation**

Daily: SPX Return v. VIX Index Level Change

$y = -0.0057x + 0.0005$
$R^2 = 0.6462$

(scatter plot: S&P 500 Returns on vertical axis from -30.00% to 15.00%; VIX Level Change on horizontal axis from -20 to 20)

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[9] Chicago Board Options Exchange (CBOE). "CBOE Volatility Index - VIX White Paper." CBOE, http://www.cboe.com/micro/vix/vixwhite.pdf

[10] See Bhave (2018)

From 1990 through 2018, significant daily losses in the S&P 500 have been strongly linked to short-term spikes in the VIX. The same correlation also exists when viewing S&P 500 returns and VIX changes on a monthly basis as well (see Chart 2).

Chart 2: Monthly VIX and Stock Market Correlation

Monthly: SPX Return v. VIX Index Level Change

$y = -0.0067x + 0.0092$
$R^2 = 0.5328$
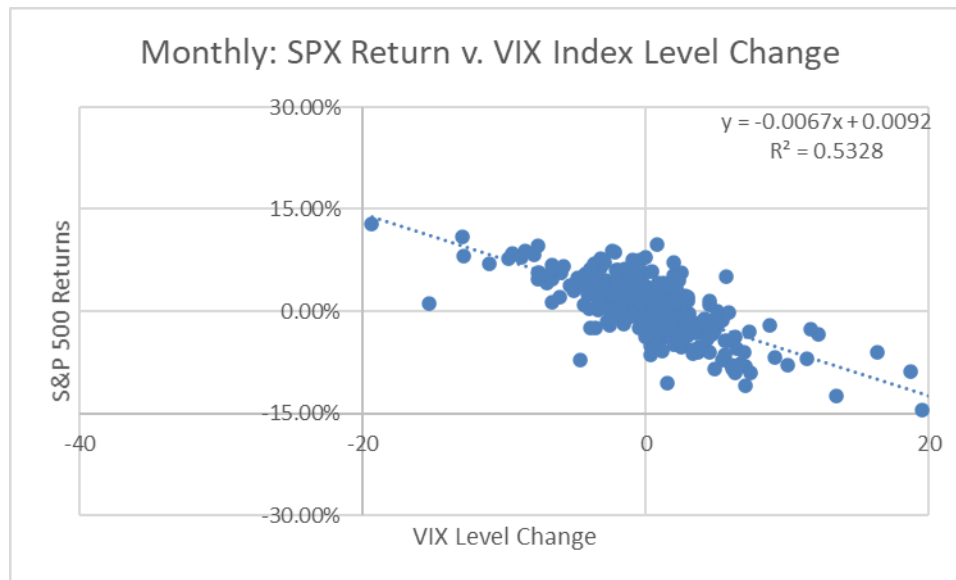
Which of the two factors is more causal in this relationship is unclear but loss aversion could be explanatory. Investors have a tendency to want to avoid losses more than generate gains. In practice, investors seeing sharp declines in financial markets often rush to sell before any further losses occur. The disposition effect[11] argues that investors sell their winners before their losers, and often times the winners before a VIX spike and decline in stocks are high beta/cyclical areas of the stock market. The overreaction takes places, and brings with it an anomaly to exploit, but not often. Volatility spikes and corrective environments for stocks, while painful, are relatively infrequent. VIX levels more often than not stay in a range of 12 to 24, and experience extremes at tails that are few and far between (see Chart 3).

Chart 3: Range of VIX Levels Historically

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[11] See Fogel and Berry (2006)

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Frequency of VIX Levels
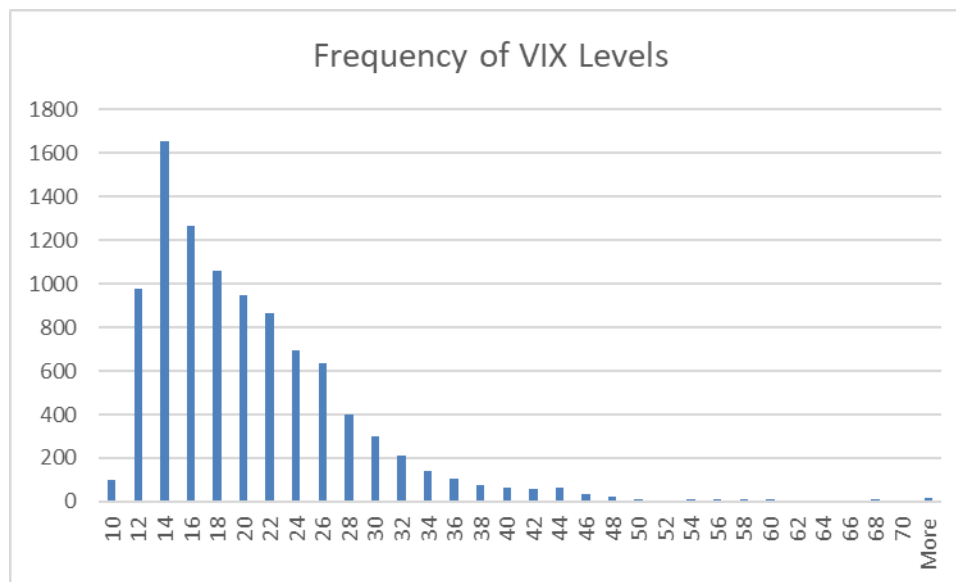
Sector Returns and VIX Levels

Since high levels of market volatility, using the VIX as the benchmark, are closely tied to negative equity returns, we theorize that spikes in volatility could produce "buy low" opportunities in certain segments of the market. In Benjamin Graham's book, "The Intelligent Investor," the author discusses how investors should expect volatility when investing in equities and to use volatility to their advantage. He uses the example of "Mr. Market," a hypothetical investor who is overly emotional and reactive to prevailing sentiment instead of relying on the underlying fundamentals of any given security. Graham argues that during periods such as these, securities can become either overbought or oversold, thus, creating an opportunity for outperformance.[12]

We test this theory by examining the forward-looking returns of specific sectors of the market during various periods of market volatility, as measured by the VIX. In Tables 1 and 2, we use a rolling 14-trading day average for the VIX to smooth out some of the daily fluctuations and examine sector-level forward returns both 200 trading days and 500 trading days out into the future.[13]

Table 1: Sector Performance Following VIX Levels 200 Days Forward

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[12] See Graham (2006)

[13] 200- and 500-trading day periods are meant to roughly approximate 1-year and 2-year forward returns.

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Sector 200-Trading Day Forward Returns by Rolling 14-Day VIX
(1998 - Current)

VIX Range	Industrials	Consumer Staples	Financials	Consumer Discretionary	Materials	Energy	Healthcare	Technology	Utilities	S&P 500 Total Return
10-12	10.56%	5.21%	7.35%	9.36%	11.17%	11.28%	8.57%	14.04%	8.25%	9.90%
12-14	7.66%	7.28%	4.94%	7.96%	7.28%	1.46%	8.89%	11.88%	9.25%	8.03%
14-16	9.81%	8.73%	9.02%	9.01%	9.01%	6.92%	10.45%	12.09%	13.11%	9.82%
16-18	7.95%	8.17%	4.45%	9.76%	7.33%	8.15%	8.80%	7.68%	11.61%	7.67%
18-20	1.50%	4.62%	-0.99%	4.64%	2.90%	2.12%	3.61%	-0.40%	4.50%	2.08%
20-25	-1.48%	3.10%	-3.26%	1.02%	-0.12%	0.54%	0.03%	-10.12%	-0.41%	-0.33%
25-30	3.27%	4.52%	-0.53%	8.42%	4.91%	1.31%	1.06%	-5.22%	1.56%	2.88%
30-35	16.18%	8.33%	15.91%	20.83%	17.96%	9.66%	14.38%	15.72%	8.91%	14.94%
35-40	13.04%	6.55%	15.68%	17.82%	12.86%	8.99%	14.71%	21.09%	11.81%	18.36%
40-45	36.60%	22.09%	52.14%	42.80%	43.40%	26.54%	22.69%	40.52%	13.72%	32.03%
45-50	47.76%	25.60%	69.23%	55.90%	56.47%	30.72%	24.67%	50.48%	19.10%	40.14%

source: YCharts
note: the Sector Select SPDR ETFs are used to represent sectors

We find that cyclical sectors, such as Technology, Industrials, Materials and Consumer Discretionary, tend to outperform when investing during periods of high volatility while defensive sectors, such as Utilities, Consumer Staples and Healthcare tend to underperform. Conversely, there is a much less discernible trend when examining the starting points of low volatility.

In Table 2, we find similar results when examining 500-day forward returns.

Table 2: Sector Performance Following VIX Levels 500 Days Forward

Sector 500-Trading Day Forward Returns by Rolling 14-Day VIX
(1998 - Current)

VIX Range	Industrials	Consumer Staples	Financials	Consumer Discretionary	Materials	Energy	Healthcare	Technology	Utilities	S&P 500 Total Return
10-12	7.21%	12.54%	-7.02%	6.40%	8.66%	7.75%	9.58%	15.99%	18.19%	8.31%
12-14	15.93%	17.79%	10.16%	19.14%	16.12%	3.62%	20.06%	28.70%	22.19%	18.22%
14-16	21.26%	17.55%	18.16%	19.99%	19.34%	17.40%	22.19%	27.62%	25.24%	20.72%
16-18	24.60%	22.40%	20.95%	26.35%	20.53%	28.84%	28.74%	24.24%	28.66%	23.66%
18-20	16.84%	15.27%	13.98%	22.71%	15.62%	23.29%	18.75%	12.97%	18.94%	15.95%
20-25	8.45%	10.41%	4.86%	18.76%	11.86%	7.48%	12.45%	0.65%	5.49%	6.48%
25-30	9.80%	9.23%	0.75%	22.27%	16.29%	12.11%	11.78%	-1.18%	5.44%	6.03%
30-35	40.67%	23.19%	34.67%	46.99%	39.47%	40.71%	31.53%	28.37%	29.36%	33.21%
35-40	46.94%	23.40%	43.50%	50.07%	41.75%	46.78%	33.85%	40.40%	29.70%	39.82%
40-45	84.46%	40.66%	73.01%	93.05%	80.49%	66.03%	32.77%	69.29%	26.50%	57.83%
45-50	98.30%	43.93%	94.73%	108.90%	93.24%	71.41%	34.91%	80.25%	31.08%	69.19%

source: YCharts
note: the Sector Select SPDR ETFs are used to represent sectors

Again, the traditionally cyclical sectors deliver above-average performance during high volatility starting points while defensive sectors underperform. Forward-looking returns in low-to moderate-volatility periods yield only modest differences across sectors.

Given the more notable performance differences in high volatility periods, we theorize that by overweighting cyclical sectors and underweighting defensive sectors in these high

volatility periods, we can achieve significant alpha in comparison to the S&P 500 Index by waiting for such periods to take place and acting afterwards.

Sector Returns During Market Corrections

There is a generally held belief among investors that defensive and safe-haven assets, such as Treasury Bonds, Utilities, and Gold tend to outperform during times of market turmoil. We find that whether or not the economy is in recession, if there is a significant correction in equity prices and levels of volatility are elevated, this flight to quality into traditionally defensive sectors and out of cyclical areas does indeed occur. However, different sectors can experience greater impacts depending on the nature of the market environment at the time.

In Table 3, we detail broad market and sector returns during five periods of significant equity market declines.[14]

Table 3: Sector Returns In Major Market Declines

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[14] To define sectors, we use the SPDR Select Sector ETFs (https://us.spdrs.com/en/product/view-all-low-cost-core?cid=0). The nine ETFs used were all launched on 12/16/98. Prior to 10/7/15, the financial sector included both Financials and Real Estate before Real Estate was spun off into its own sector. Prior to 6/18/18, the Technology and Consumer Discretionary sectors included Communication Services companies before Communication Services was spun off into its own sector.

	Recessionary Periods		Non-Recessionary Periods		
Start Date	3/24/2000	10/12/2007	4/29/2011	7/20/2015	9/20/2018
End Date	10/4/2002	3/6/2009	10/7/2011	2/11/2016	12/24/2018

	Recessionary Periods		Non-Recessionary Periods		
Avg. Daily VIX	25.2	32.8	26.1	19.5	19.7

Total Returns					
S&P 500	-45.8%	-54.7%	-14.4%	-13.0%	-19.4%
Utilities	-26.4%	-41.4%	2.8%	8.1%	-1.6%
Consumer Staples	0.6%	-28.0%	-3.2%	-0.2%	-10.5%
Healthcare	-18.2%	-37.1%	-8.5%	-17.1%	-13.9%
Financials	-19.3%	-81.7%	-27.2%	-21.8%	-22.2%
Materials	-15.5%	-56.0%	-23.0%	-16.8%	-21.5%
Energy	-20.3%	-48.9%	-23.8%	-23.4%	-27.2%
Industrials	-32.5%	-61.4%	-20.8%	-10.3%	-23.6%
Consumer Discretionary	-19.5%	-55.8%	-9.7%	-12.8%	-21.4%
Technology	-81.4%	-49.9%	-8.4%	-10.5%	-22.7%

Total Returns (relative to the S&P 500)					
S&P 500	--	--	--	--	--
Utilities	19.4%	13.4%	17.2%	21.0%	17.8%
Consumer Staples	46.4%	26.7%	11.2%	12.7%	8.9%
Healthcare	27.6%	17.7%	5.9%	-4.1%	5.5%
Financials	26.5%	-27.0%	-12.8%	-8.8%	-2.8%
Materials	30.3%	-1.3%	-8.6%	-3.9%	-2.1%
Energy	25.4%	5.8%	-9.3%	-10.4%	-7.8%
Industrials	13.3%	-6.7%	-6.4%	2.6%	-4.3%
Consumer Discretionary	26.3%	-1.1%	4.7%	0.2%	-2.0%
Technology	-35.6%	4.8%	6.0%	2.5%	-3.4%

The two recessionary periods were marked by severe underperformance in the sectors largely attributed to causing the recession. During the dot-com bubble, Technology was a massive underperformer. During the financial crisis, it was Financials that were the biggest losers. Outside of those two sectors in those recessions, we can conclude that defensive sectors, such as Utilities and Consumer Staples, outperformed the S&P 500, but the remaining sectors were inconsistent in their returns.

In the three non-recessionary periods measured, however, there are more distinct patterns of defensive and cyclical sector performance. We note that Utilities and Consumer Staples were strong outperformers and beat the S&P 500 by at least 9% in all measured periods. The more traditional economically-cyclical sectors, such as Financials, Materials, Energy and Industrials, underperformed in 11 of the 12 instances. The consumer-cyclical sectors, including Consumer Discretionary and Technology, produced mixed results but demonstrated the ability to beat the S&P 500 despite heightened market volatility.

From these results, we can establish that investors do tend to rotate into more conservative market sectors during periods of above-average market volatility that often

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correlate with meaningful declines in the value of equities. The clear beneficiaries of this defensive rotation are the Utilities and Consumer Staples sectors.

The Trigger

The above shows that when the VIX is at a particular level, certain sectors outperform in the subsequent 12-months. With this in mind, an optimal trigger level needs to be defined for when cyclical sectors are expected to outperform defensive sectors in the subsequent periods. An additional trigger is required for when one should switch positions from cyclical sectors to defensive sectors. To do this, Nelder-Mead optimization is performed over a learning period. There are two methods used to determine the learning periods applied. The first is a static period between January 1, 1999 to December 31, 2004. The second is a rolling 5-year period with the first period between January 1, 1999 to December 31, 2004. Subsequently, the oldest month is dropped and a new month is added, with the final rolling period being September 1, 2014 to August 31, 2019. This means that the trigger level will vary through time.

In addition to this, one could equally-weight their investment in cyclical and defensive sectors to create a cyclical and defensive index, or one can use the sector weightings of a passive benchmark such as the S&P 500 to reconstruct an index. Both possibilities were used in generating the optimal trigger.

In Table 4, and Charts 4 and 5, the results of the static and the rolling trigger levels for equally and sector weighted indices are shown.

Table 4: VIX Trigger Levels

Entry & Exit Levels - Static Training Period		
	Equally-Weighted	Sector-Weighted
Entry VIX Level	33	36
Exit VIX Level	12	12

Charts 4 and 5: Range of VIX Triggers

VIX Triggers (Equally Weighted)
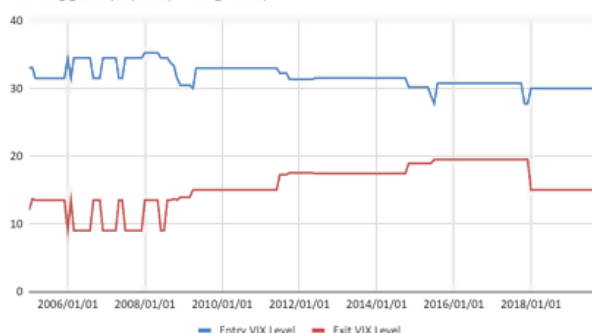
VIX Triggers (Sector-Weighted)

10
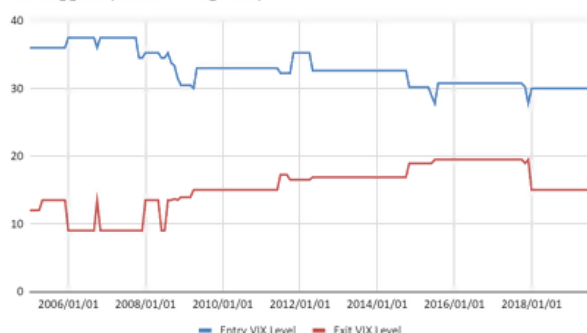
For both equally-weighted and sector-weighted indices, the difference between the initial entry trigger and exit trigger is very high. This gap closes through time, although it has widened again since 2018. This could be an indication that a more volatile market climate may lead to a greater differential in the trigger levels.

Trading Strategies

To determine whether one could use the VIX as a sector allocation tool, three different trading strategies are created. The first, dollar-neutral, is where, when the entry trigger level is reached, one goes 100% long the cyclical index and 100% short the defensive index, with this reversed when the exit trigger level is reached. The second, sector-rotation, is where, when the entry trigger level is reached, one rotates fully into the cyclical index and out of the defensive index, with this reversed when the exit trigger level is reached. Finally, the sector overweight and underweight strategy increases the cyclical index weight by 5% of its respective S&P level when the entry trigger level is met, reducing the defensive index weight by 5%, and inverting this when the exit level is met. These trading strategies are implemented using both equally and sector weighted cyclical and defensive indices and using a static and rolling training period for optimization. To mirror the actual returns that one would generate, the SPDR sector ETFs are used.

Dollar-Neutral Strategy

The dollar-neutral strategy is one where the pure alpha of differential returns based on a VIX trigger level can be discerned. Because it is dollar-neutral, the returns would be expected to be lower, but this should also be met with lower risk, meaning higher risk-adjusted returns are possible. The different performance metrics for the 4 variants of the strategy are calculated in Table 5 below.

Table 5: Dollar Neutral Returns

	Equally-Weighted (Static Training)	Sector-Weighted (Static Training)	Equally-Weighted (Rolling Training)	Sector-Weighted (Rolling Training)	S&P 500
Return (Annualized)	3.34%	3.89%	5.82%	5.54%	8.92%
Risk (Annualized)	11.25%	10.40%	11.23%	10.39%	16.47%
Risk-Adjusted Return	0.30	0.37	0.52	0.53	0.54
Maximum Drawdown	-33.94%	-31.98%	-31.84%	-30.81%	-55.25%
Upside Capture (%)	9.71%	10.29%	-7.43%	-2.49%	
Downside Capture (%)	7.21%	7.29%	-14.11%	-8.40%	

There are two clear findings that can be drawn from the above. The first is that the dollar-neutral strategy has lower risk compared to the S&P 500. The second is that the choice of learning method to generate the VIX trigger levels leads to significantly different return.

Across all variants, the portfolio is long the defensive index and short the cyclical index until mid-2008, when there is a switch across to cyclical stocks. There is also a move towards

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the defensive index in 2012 lasting to 2016 across all variants. However, there are clear differences between the different training methods used and the sector plays. In the equally-weighted trading strategy using a static training period, there are fewer switches across indices compared to the rolling training period. This lack of switching is most likely the reason for the relative underperformance as the cyclical or defensive indices are held on for too long a period. The opposite occurs with the sector-weighted indices, with a static training period leading to many more switches. In this case, this would lead to underperformance as the defensive or cyclical index is traded out before the returns have been fully realized. This also explains the upside capture being negative, and downside capture being more negative, as the strategy is more often exposed to shorting high beta cyclical sectors that perform strongly in bull markets until the VIX spike occurs.

Finally, the performances through time are decomposed to determine the times where the strategy performs and the times it does not. These performances are graphed in Charts 6 and 7 below.[15]

Charts 6 and 7: Dollar Neutral Versus S&P 500 (Static)
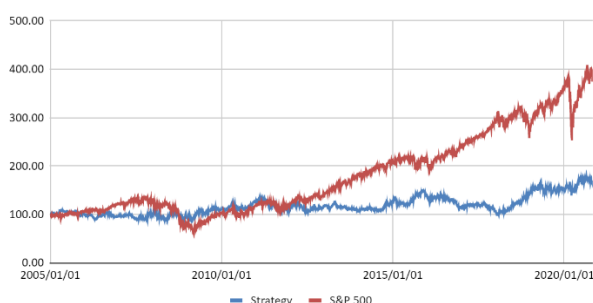
Equally-Weighted (Static Training) Dollar Neutral Strategy vs S&P 500 Returns — Sector-Weighted (Static Training) Dollar Neutral Strategy vs S&P 500 Returns
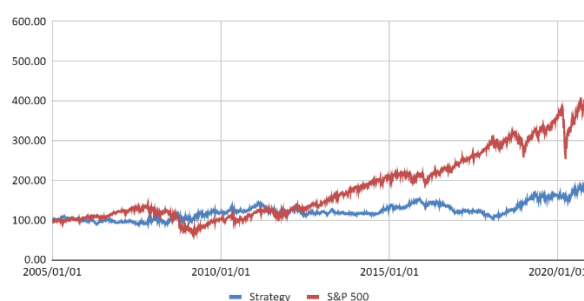
Using a static training period to optimize the VIX levels leads to fairly flat performance through time, irrespective of the weighting methodology used. There is clear alpha generated in 2008, as the strategies are long defensive stocks and short cyclical stocks, and again in 2016. However, that alpha is slowly eroded through time. One anomaly is that the equally-weighted portfolio, using this training method, is long cyclical stocks and short defensive stocks from 2019 - the only variant of the strategy that is. As such, it is receiving some negative alpha due to market conditions during that evaluation period.

Unlike the returns created using the static training period generated VIX trigger levels, the returns created using the rolling training period generated VIX trigger levels show a clear upward trend (see Charts 8 and 9). Both variants remain flat through the subprime crisis and then generate alpha as cyclical stocks rebound. The performance then flattens from 2012 to 2015 as a defensive play is held; however, this then yields positive performance during the

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[15] In all backtesting that follows, we start in a defensive position at the beginning of 2005 because the exit trigger level was reached at 12/16/2004 and it didn't hit the entry level at the point we started.

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volatility of the 2015 market. This erodes during the subsequent market run but is made up during the changed market conditions where defensive stocks are outperforming.

Charts 8 and 9: Dollar Neutral Versus S&P 500 (Rolling)

Equally-Weighted (Rolling Training) Dollar Neutral Strategy vs S&P 500 Returns

Sector-Weighted (Rolling Training) Dollar Neutral Strategy vs S&P 500 Returns
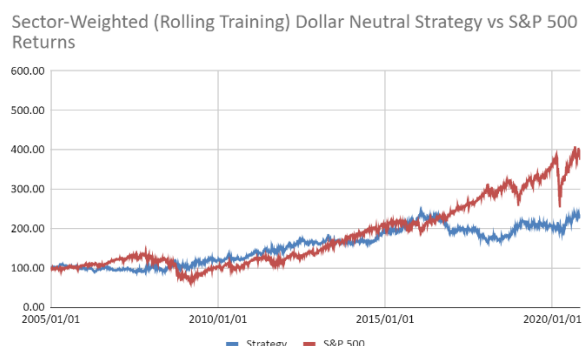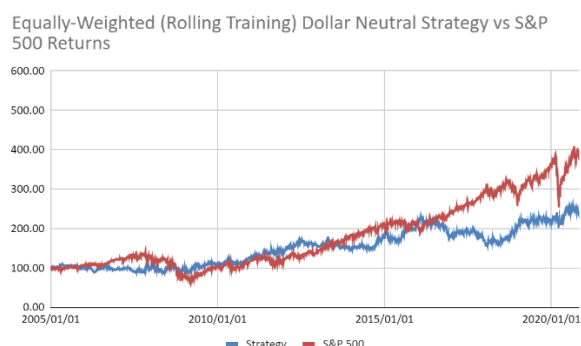
All-In Sector Rotation Strategy

The sector rotation strategy allocates 100% to either the cyclical index or the defensive index. Unlike the dollar-neutral strategy, the performance of the strategy is also dependent on the movement of the market as it always has beta exposure (see Table 6). The performances of the four variants of the strategy are tabulated below.

Table 6: All-In Rotation Strategy Returns

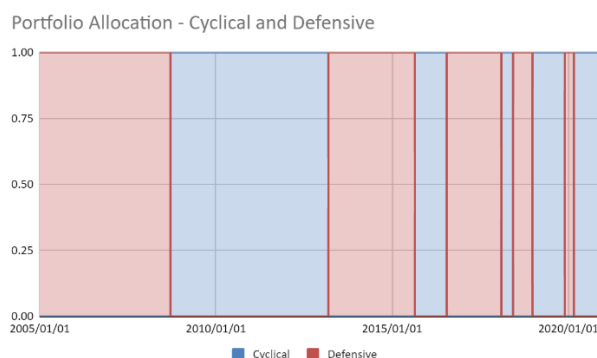|	Equally-Weighted (Static Training)	Sector-Weighted (Static Training)	Equally-Weighted (Rolling Training)	Sector-Weighted (Rolling Training)	S&P 500
Return (Annualized)	10.63%	11.06%	12.04%	12.00%	8.92%
Risk (Annualized)	17.60%	17.65%	16.96%	17.12%	16.47%
Risk-Adjusted Return	0.60	0.63	0.71	0.70	0.54
Maximum Drawdown	-54.54%	-52.51%	-54.54%	-52.51%	-55.25%
Upside Capture (%)	96.07%	97.77%	88.24%	91.53%	
Downside Capture (%)	94.14%	95.54%	84.34%	87.91%	

The absolute and risk-adjusted returns for all four variants exceeds that of buying and holding the S&P 500. The annualized risks are greater than the buy-and-hold strategy, but the maximum drawdowns are roughly the same. Across the variants, using a rolling training period to optimize the VIX trigger levels yields greater absolute and risk-adjusted returns. While no strategy is able to "keep up" with the S&P 500 fully, given upside capture ratios that are less than 100%, this is countered by downside captures being less than upside capture. Alpha, it appears, comes not from being up more with the strategy, but rather by being down less prior to the volatility spike and decline in equities.

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The below graphs (see Charts 10-13) show the rotation across cyclical and defensive indices through time. As the triggers are the same as the dollar-neutral strategy, the rotations occur at the same time. However, because it is a full sector rotation, these weights remain 100% until the next switch.

Charts 10 and 11: Sector Rotation Allocation (Equally-Weighted)
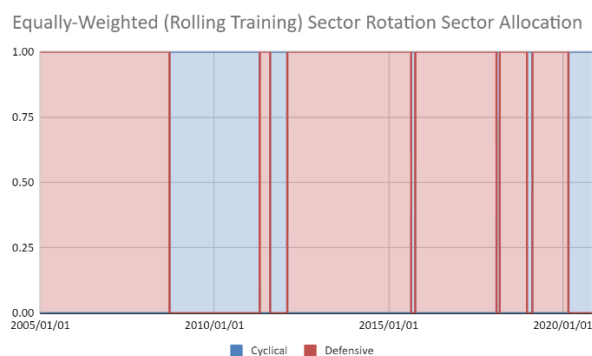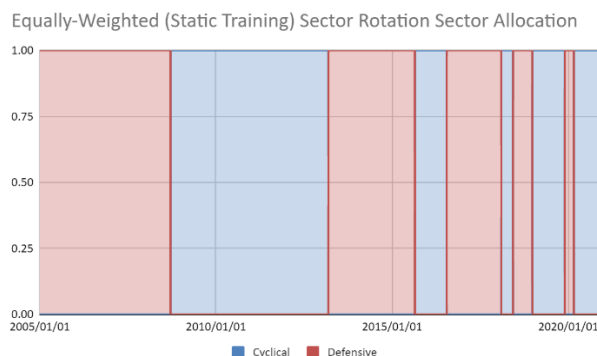
**Charts 12 and 13: Sector Rotation Allocation (Sector-Weighted)**
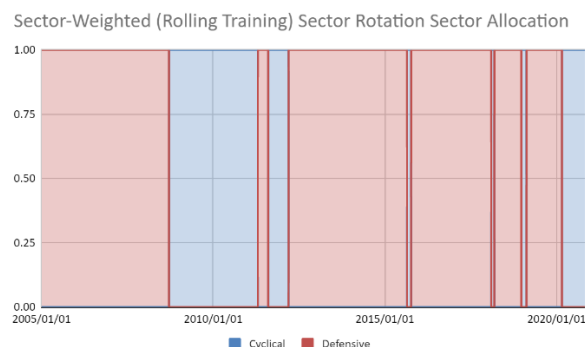
The same underlying themes are seen here. There is movement from defensive to cyclical sectors during the subprime crisis. In most of the subsequent periods, defensive stocks are held barring a few short periods where they are rotated into cyclical stocks.

Finally, the performances through time are decomposed to determine the times where the strategy performs and the times it does not. These performances are graphed in Charts 14-17 below.

Charts 14 and 15: All-In Sector Rotation Strategy Versus S&P 500 (Static)

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Equally-Weighted (Static Training) Sector Rotation Strategy vs S&P 500 Returns
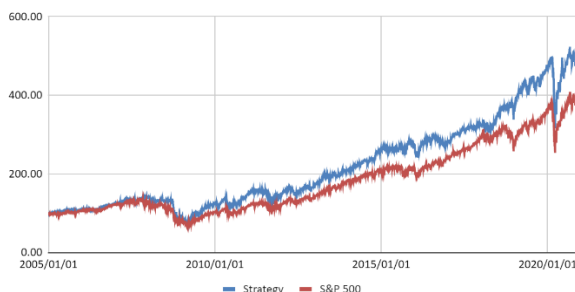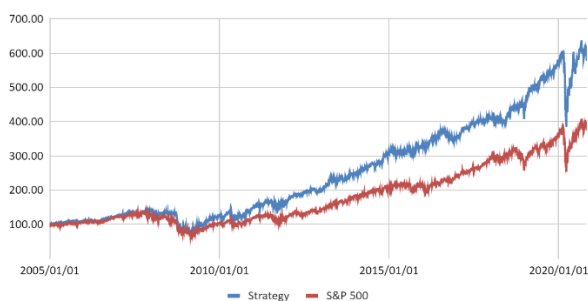

Sector-Weighted (Static Training) Sector Rotation Strategy vs S&P 500 Returns
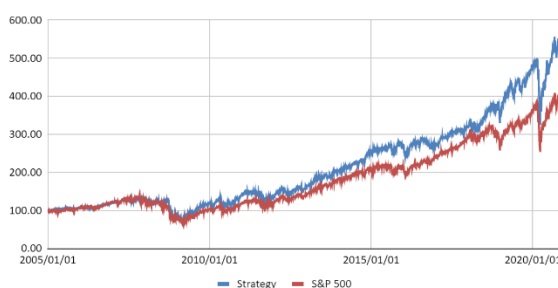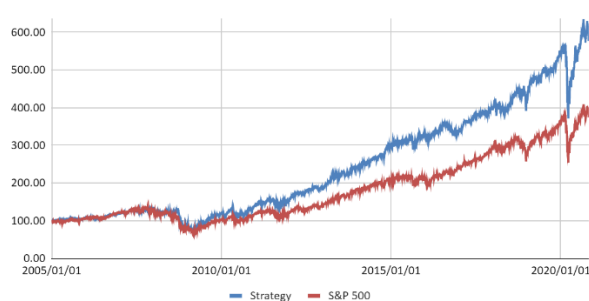
Using the static training period generated VIX trigger levels, the equally-weighted and sector-weighted strategies outperform the S&P 500 buy-and-hold strategy across most time periods (see Charts 14 and 15). As defensive stocks are held until mid-2008, the strategies outperform the buy-and-hold strategy, before they switch into cyclical stocks and have similar negative returns. However, in the period after, they recover quicker, leading to outperformance compared to the buy-and-hold strategy. This outperformance continues across time, with there being particularly strong performances in 2019.

Charts 16 and 17: All-In Sector Rotation Strategy Versus S&P 500 (Rolling)

Equally-Weighted (Rolling Training) Sector Rotation Strategy vs S&P 500 Returns

Sector-Weighted (Rolling Training) Sector Rotation Strategy vs S&P 500 Returns

Much like the strategies derived from the static training period generated VIX trigger levels, the strategies derived from the rolling training period generated VIX trigger levels also outperform a buy-and-hold strategy in most market conditions (see Charts 16 and 17). However, the magnitude of outperformance in these variants is greater than in the preceding variants.

Active Overweighting/Underweighting Sectors

While the sector rotation strategy is a possible trading strategy, it is more likely that one would overweight or underweight cyclical or defensive sectors based on the VIX trigger level rather than do an all-in approach. In this trading strategy (see Table 7), when the VIX entry trigger level is reached, cyclical sectors are overweighted by 5% and defensive stocks underweighted by 5%, with the inverse occurring when the VIX exit trigger level is reached.
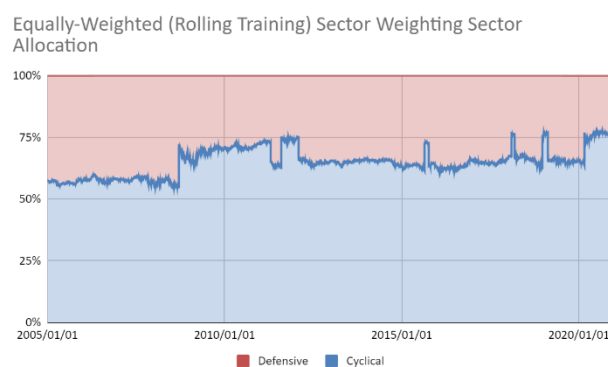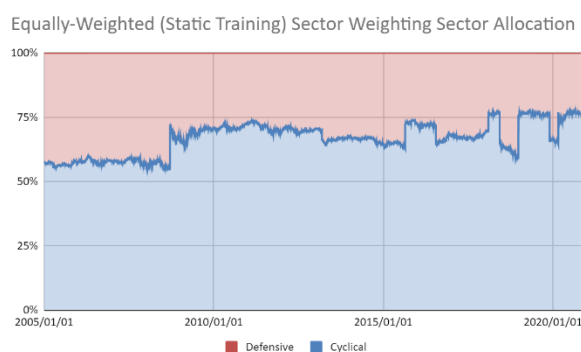
15

Table 7: Active Overweighting/Underweighting Strategy Returns

	Equally-Weighted (Static Training)	Sector-Weighted (Static Training)	Equally-Weighted (Rolling Training)	Sector-Weighted (Rolling Training)	S&P 500
Return (Annualized)	9.34%	9.80%	9.40%	9.81%	8.92%
Risk (Annualized)	16.07%	16.14%	16.02%	16.11%	16.47%
Risk-Adjusted Return	0.58	0.61	0.59	0.61	0.54
Maximum Drawdown	-51.41%	-51.82%	-51.41%	-51.82%	-55.25%
Upside Capture (%)	96.87%	97.92%	96.30%	97.49%	
Downside Capture (%)	96.22%	96.91%	95.54%	96.44%	

As per the sector rotation strategies, the sector overweight/underweight strategies outperform an S&P 500 buy-and-hold strategy in both absolute and risk-adjusted returns. The annualized risk is also lower, as is the maximum drawdown. Using a rolling training period to generate the VIX trigger levels compared to using a static training period to generate the VIX trigger levels leads to marginally higher absolute and risk-adjusted returns.

The allocations to the different sectors are derived from the same triggers used earlier. However, as they are cognizant of the market weightings as a whole, at most 50% of the strategy is allocated to defensive stocks and at most 75% allocated to cyclical stocks (see Charts 18-21 below). This brings them closer in line to the market as a whole through time.

Charts 18 and 19: Defensive/Cyclical Weighting Through Time (Equally-Weighted)
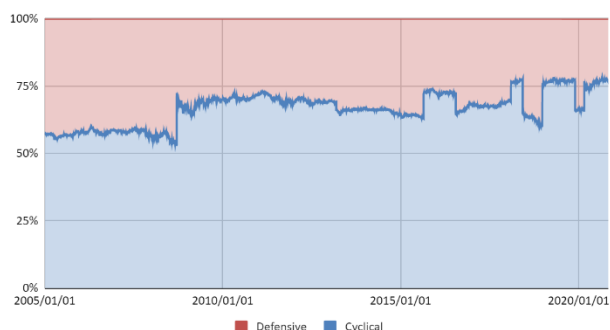

Charts 20 and 21: Defensive/Cyclical Weighting Through Time (Sector-Weighted)

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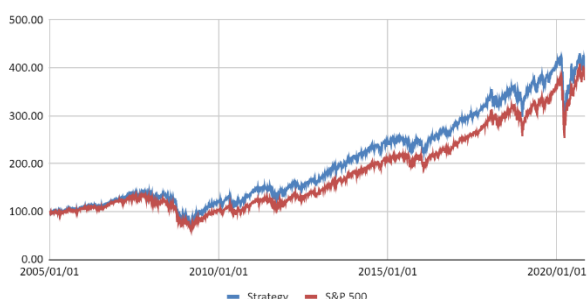Equally-Weighted (Rolling Training) Sector Weighting Sector Allocation
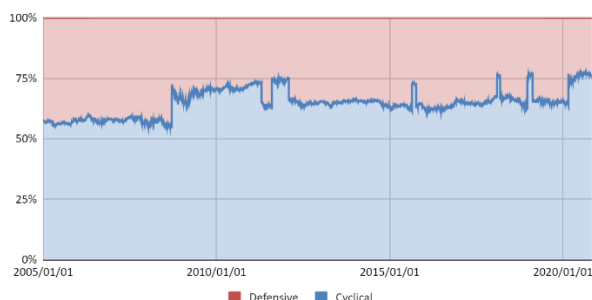
Cyclical and Defensive Weightings through Time

Finally, the performances through time are decomposed to determine the times where the strategy performs and the times it does not (see Charts 22-25). These performances are graphed below.

Charts 22 and 23: Active Overweighting/Underweighting Versus S&P 500 (Static)

Equally-Weighted (Static Training) Sector Weighting Strategy vs S&P 500 Returns
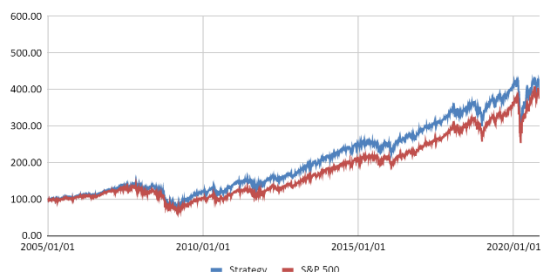

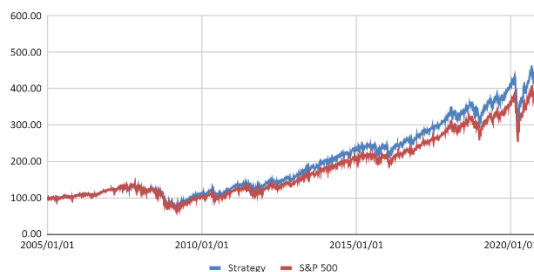Sector-Weighted (Static Training) Sector Weighting Strategy vs S&P 500 Returns
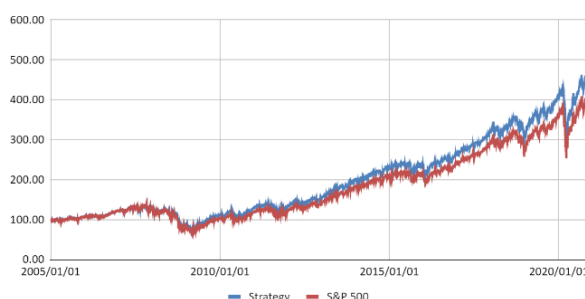
Charts 24 and 25: Active Overweighting/Underweighting Versus S&P 500 (Rolling)

Equally-Weighted (Rolling Training) Sector Weighting Strategy vs S&P 500 Returns

Sector-Weighted (Rolling Training) Sector Weighting Strategy vs S&P 500 Returns

Due to the sector allocations being more in line with the S&P weightings, the magnitude of over or underperformance is much lower than in the previous strategy. However, it is clear that, across all four variants, this trading strategy outperforms a buy-and-hold strategy in

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almost all market conditions with relative sector weighting being between a minimal band of plus or minus 500 basis points.

Why It Works

Is this simply a function of mean reversion, whereby cyclical sectors following VIX spikes suffer steeper losses than are justified, in turn creating an exploitable opportunity relative to defensive stocks after the spike has occurred? Perhaps. Volatility is inherently mean-reverting. A VIX spike can't persist forever and stay elevated for a particularly long period of time as that would imply a near-permanent bear market and decline in equities to zero.

A more behavioral explanation, however relates to how cyclical sectors, which tend to have higher sensitivity to bull market factors, behave prior to a corrective environment for stocks. If cyclical areas of the market tend to go up more and are the "winners" of investor portfolios, then the disposition effect means that when volatility accelerates, those winners are the first to be sold as the relative underperformers up to that point are held. The overreaction to losses and preferred method of selling winners first creates a mispricing and misallocation effect that can be potentially arbitraged for active investors and traders afterwards.

The challenge of course with such an approach to sector allocation is being defensive waiting for those levels to present a buy low opportunity in cyclicals. This can be quite challenging from an implementation standpoint, as it implies not being aggressively positioned in areas that could go up at a faster pace than the averages if the positioning is defensive throughout, preparing for the unknown timing of a correction that could take time to present itself.

The fact that all variations of the strategy have an up capture that is less than 100% because of defensive positioning would likely test the patience of investors implementing such an approach. Fear of missing out on a strong bull market can be a strong reason to not be defensive throughout. Yet, that is exactly why the strategy outperforms.

This intuitively makes sense. Being defensive in advance of a correction means the portfolio is up less during an extended bull run when investor complacency is taking place and performance momentum defines investor allocation decisions. When the volatility spike occurs, it is this defensiveness that saves the portfolio from the overreaction on the downside that occurs primarily in cyclicals.

Conclusion

While momentum is often touted as the ideal anomaly to take advantage of using sectors to express an active bet on continued performance, we find that an approach which waits for momentum to crash with a VIX spike allows for an ideal setup to buy low and sell high when investor overreactions take place. We test various methodologies and strategies, all of which come to the same conclusion around using extreme VIX levels as trigger points to determine how aggressive or defensive to get with sector allocations. While one can never know the exact moment an extreme period of volatility and collapse in stocks takes place, one

can be confident that it is worth being defensive before it happens. After it does, going full speed ahead when all is clear becomes the preferred way of positioning a portfolio until another extreme is reached. Mean reversion using the VIX to overweight or underweight sectors ultimately outperforms the mean of a passive strategy.

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