Robust Testing for Bollinger Band, Moving Average and Relative Strength Index

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Abstract

We test whether the moving average indicator is profitable in trend following and compare the result with common momentum indicators such as Relative Strength Index (RSI) and Bollinger Band (BB). Our sample runs from January 1, 1963, through December 31. 2019. We test whether the signals generated are profitable and compare their success in timing the portfolios based on the previous year's volatility using the Center for Research in Security Prices (CRSP) data. We note the portfolios sorted by volatility to be trend following and use common entry points for timing them. We find all indicators to be more profitable than the Buy and Hold (BH). The moving average (MA) has the strongest return, while BB and RSI show positive return they do worse than the MA. The results hold across all portfolio deciles sorted by both size and volatility. The indicators for RSI and BB are robust to other specifications for entry and parameters. We also show price level analysis for both RSI and BB as well as a trailing three year analysis for the volatility deciles and moving average.

I. Introduction

We obtained daily price levels and returns of these ten portfolios from the Center for Research in Security Prices (CRSP). These portfolios were constructed from NYSE, AMEX, and NASDAQ stocks and stocks in the Center for Research in Security Prices (CRSP) and are assigned to a portfolio based on their annual standard deviation. The annual standard deviation is calculated as the standard deviation of daily returns within the prior year. An equally weighted price index will be computed daily for each portfolio. The portfolios are rebalanced each year based on the standard deviation of the previous year.

Covel's (2009) that trending markets are characteristic of higher highs and higher lows provide intuition for this rule. Higher highs and higher lows characterize an uptrend. In this type of environment, a trend-following strategy should be used. (Covel, 2009). Thus, buying around the oversold levels and riding the highs will produce profitable returns.

Typical strategies for trend following include a moving average crossover with price crossing over a short-term moving average. Han et al. (2013) test this study on the volatility sorted decile portfolios. They are confirming the ability of a moving average strategy to work well at times the portfolios. According to the definitions by Hayden (2003) and Bollinger (2001), a market of higher highs and higher lows would be traded differently than a market with a primarily sideways activity where prices range between typical highs and lows. Hayden (2003) and Bollinger (2001) develop a set of strategies for trading the Relative Strength Index (RSI) and Bollinger Bands (BB) on this type of market. Their definitions are consistent with the trend following ideas in Covel (2009). and thus, a moving average crossover would not fare well in a sideways market. We can test whether the volatility decile portfolios are trend following.

We employ an additional set of technical trading rules to the portfolios, namely the RSI and Bollinger Band outlined in Henry (1999) and Bollinger (2001). These indicators are typically thought of as oscillators which should be used for sideways markets. In technical trading circles, it is common to use these indicators for trend following by buying when the indicators reach their oversold levels (prices fall below the bottom of the band). As the market has upward momentum, prices will shoot higher as they deviate from the trend (unless a new, downward trend is starting).

A moving average first constructs the Bollinger Bands (see Bollinger 1991). A length of 20 is typical in Bollinger 1991. Then standard deviation bands are added above and below the band. They constructed by taking the standard deviation of the MA(20) and adding subtracting two times the value to the moving average.

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Covel (2009) discusses the trend following to be characterized by a series of higher highs and higher lows for an uptrend which is the case of the volatility decile portfolios of Han et al. (2013). Bollinger (1991) shows that the bands can ride the band's top when prices cross through the band from below, which is the signal we use.

Similar oscillators common in technical trading circles include the Relative Strength Index (RSI) and Stochastic (PK). The construction limits them to values between 0 and 100 with below 20 oversold and above 80 overbought.

John Henry (1993) notes that the RSI can be traded using a trend following strategy by buying when it is above oversold. He also notes that the RSI may push higher and higher when it reaches overbought (lower and lower for oversold). We employ this strategy to the volatility decile portfolios by buying when RSI crosses 20 from below and earning the return on the volatility decile portfolio. We earn the T-bill rate when it crosses back below 20 from above. The indicators all work at various levels below the midpoint of overbought and oversold, which Pring (2002) discussed as the cutoff for buy/sell signals. RSI 40 is standard in Hayden (2003).

Pring, 2002), Edwards and Magee (1948) observations on moving averages suggest that one should buy when prices revert to the moving average from above and touch the average. A mean-reverting signal is referred to for trend following markets.

Indicators that typically oscillate between highs and lows can predict tops and bottoms in sideways markets. (Hayden, 2003, Bollinger, 2001). Since our market comprises higher highs and higher lows, we test buying the dips when oscillators such as RSI and Bollinger Bands revert from their means. We suggest that stock prices are mean-reverting when sorted by volatility rather than following a random walk.

Fama and Blume (1966) define the weak form of market efficiency because past prices are already incorporated in the current price. Therefore any information in the past is already incorporated in the current price. The semi-strong form and super-string form are even more restrictive. They suggest that public and private information (semi-strong) and all information, including insider information (super strong), are already incorporated in the stock price. This study would have implications for the weak form of market efficiency.

This paper tests the busy signals of oversold regions for popular oscillators in literature and technical trading circles. The implications of these indicators suggest that markets are mean-reverting when in an uptrend and that the volatility decile portfolios may be better timed by buying the oversold regions of oscillators than using a moving average crossover.

Constructing a factor of moving averages scaled by price and finding different levels of the indicator is done in Zhou et al (2016) and Arvamov et al (2020) and done in Chung et al (2021). MA trend might be a better indicator than the standard MA definition for comparing to oscillators.

Future work would include combining several indicators in a genetic algorithm to time the portfolios and use neural networks to predict the tops and bottoms. Lo, Mamaysky and Wang (2000) suggested that future work include using technical indicators and optimizing a specific objective function. Optimizing indicators over Volatility Decile may be an appropriate study for this line of work. Or comparing the trend factor of MA to oscillators.

Our focus here is on uptrend stock prices that are mean-reverting. There are several indicators (including moving averages) that pick up on this behavior. We show that buying extreme oversold levels of oscillators (while in an uptrend) acts as a buy signal comparable to a moving average crossover. This type of buy signal has been outlined by Edwards and Magee (1948), Pring (2002), Covel (2009), Hayden (2003), and Bollinger (2001). It has not yet been adopted by academic literature. Thus, we introduce new ways to interpret several technical indicators common in technical trading circles for decades.

We use CRSP daily prices from the start of the year 1963 through the year ended 2019. We find the results in this paper hold outside of the sample for data before 1963, starting as early as 1925.

Daily prices are obtained, and then stocks are sorted into decile portfolios based on their previous year's annual volatility. We construct our technical indicators from these portfolios.

We also test the indicators on simulated geometric Brownian motion (random walk) stock prices. This is shown in the section 3.

To carry this out we use the Center for Research in Security Prices (CRSP) 1929-2019 and simulated a random walk by taking the mean and standard deviation of every stock file. We then follow the geometric Brownian motion procedure by estimating the next stock price based on the current stock price, the mean, and the standard deviation.

We take buy rules common in trend following. Following Henry (1994), Bollinger (2002) and Pring (2002). We see that buying oscillators which smooth out momentum indicators when they are oversold is similar to buying when prices touch the moving average from above which is a common buy rule in stock trading.

Typically investors stack several indicators on a chart at a time. They use the various buy and sell signals to create informed decisions.

We show a sample chart below of common indicators using the SPY from the last 6 months ending 08/31/2021 daily data from Barchart.com. We add the main indicators studied in this paper and mark the buy signals which we test rigorously.

The highlighted yellow regions denote buy signals. They are when prices fall below the bottom of the band, or touch the lower band (which would be falling below the lower band on a tighter standard deviation). We use a 20 period moving average and 2 standard deviations to construct the Bollinger band. The equations for this and our other indicators are in the following section.

We show the Relative Strength Index (RSI) with a standard time frame of 14 periods with an oversold region of 30 and overbought of 70. We see the buy signals when RSI falls below 40, and 50 (which is tested following the equations and are also common oversold areas used for RSI (See Henry 1994, Pring 2002 among many others).

Figure 1. S&P 500 last 6 months with BB and RSI

II. Data and Methodology

We obtained 10 volatility decile portfolios returns and prices from Center for Research in Security Prices (CRSP) from the start of the year 1963 through the year ended 2019. We chose the 1963-2019 period to match up with Fama-French factors. We find the results in this paper hold outside of the sample for data prior to 1963 starting as early as 1925. These portfolios were constructed from NYSE, AMEX and NASDAQ stocks and are assigned to a decile portfolio based on their annual standard deviation. The standard deviations are calculated as the standard deviation of daily returns within the prior year. Once the stocks are assigned a portfolio, we then compute daily an equally weighted price index for each portfolio. These portfolios are rebalanced annually based on the standard deviation of the previous year.

Next, we describe a series of momentum indicators we tested. For each indicator we specify a timing strategy that requires us to invest when the timing signal suggests to be in the portfolio, otherwise to invest in a 30-day treasury bill. In other words, the timing portfolio earns the portfolio rate of return each day it is in the market and the risk-free rate on all other days. We then compare the performance of the timing portfolio with the performance of a buy and hold volatility portfolio for the period. We present the excess returns where the excess returns are the returns of the timing portfolio minus the returns of the buy and hold strategy. We also report the accuracy of the timing portfolio. The rule is accurate on a given day if it chose the asset (the portfolio or the T-Bill) earning the higher return.

For completeness, we first examine the moving average strategy examined by Han et al (2013). This is the simple mean of the current close and the previous 9 trading days close, MA(10). The buy signal is triggered when the price crosses the MA(10) from below. When this happens we are in the market. We stay in the market until price crosses the MA(10) from above. We earn the t-bill rate of return until price crosses back above the MA(10). The moving average crossover is a momentum signal that indicates when prices cross above the moving average from below they will continue to rise.

The formal statement of the investment strategy is:

$$\mathrm{MA}_n = \frac{P_{\mathrm{close}} + P_{t-1} \ldots + P_{t-n-1}}{n} \tag{1}$$

The rule becomes:

$$\begin{cases} 1 & P_{t-1} > \mathrm{MA10}_{t-1} \\ 0 & P_{t-1} < \mathrm{MA10}_{t-1} \end{cases} \tag{2}$$

Where MA_n *is an n day* (*in our case* 10 *day*) *moving average of prices*; 1 *is* owning the decile portfolio and 0 is owning a risk-free asset.

The Relative Strength indicator, RSI, is another momentum indicator that examines the speed and the strength of recent price changes to determine whether the portfolio is overbought or undersold. We buy the volatility decile portfolios when RSI crosses 20 from below and continue to hold until it crosses 80 from below at which point, we sell the portfolio and earn the t-bill rate.

The second momentum strategy we tested is the Bollinger Band Indicator (BBAND). The indicator uses an upper band (UB), above a simple moving average, and below the simple moving average, a lower band (LB). The distance between the upper and lower band is determined by the moving standard deviation. To test this strategy we used a 10-day moving average and the upper band is determined by adding 2-standard deviations to the simple average and the lower band is set by subtracting 2-standard deviations from the moving average. We buy the volatility decile portfolios when the moving average is above the lower band and continue to hold until it crosses below the lower band at which point, we sell the portfolio and earn the t-bill rate. Formally, the investment strategy is presented below:

Bollinger Band Indicator

$$\text{BBAND} = \text{UB}, \text{LB}, \text{MA10} \tag{3}$$

$$\text{UB} = \text{MA}_{10} + 2\sigma \tag{4}$$

$$\text{LB} = \text{MA}_{10} - 2\sigma \tag{5}$$

σ *is the volatility of the* $MA10$

The rule becomes:

$$\begin{cases} 1 & P_{t-1} > LB_{t-1} \\ 0 & P_{t-1} < LB_{t-1} \end{cases} \tag{6}$$

The third momentum strategy we tested is Relative Strength Index (RSI). The indicator uses an oversold region typically below 20 (30, 40 and 50 are also commonly used in technical trading), a middle line (50), and an upper line 80 (50, 60 and 70 are also commonly used in technical trading). We buy the volatility decile portfolios when the RSI is above the oversold region and continue to hold until it crosses below the oversold region again at which point, we sell the portfolio and earn the t-bill rate. Formally, the investment strategy is presented below:

Relative Strength Index (RSI)

$$\text{RSI} = 100 - \left[\frac{100}{1 + \text{U}\bar{\Delta}\text{P}_{14}/\text{D}\bar{\Delta}\text{P}_{14}}\right] \tag{7}$$

$$\begin{aligned} \text{U}\bar{\Delta}\text{P}_{14} &= 14 \text{ Average of Upward Price Change over last 14 Periods} \\ \text{D}\bar{\Delta}\text{P}_{14} &= \text{Average of Downward Price Change over last 14 periods} \end{aligned} \tag{8}$$

$$\text{Upward Price Change} = \begin{cases} P_{\text{close}} & P_{\text{close}} > P_{t-1} \\ 0 & P_{\text{close}} < P_{t-1} \end{cases} \tag{9}$$

$$\text{Downward Price Change} = \begin{cases} P_{\text{close}} & P_{\text{close}} < P_{t-1} \\ 0 & P_{\text{close}} > P_{t-1} \end{cases} \tag{10}$$

∴ **Relative Strength Index**

The rule becomes:

$$\begin{cases} 1 & RSI_{t-1} > 40 \\ 0 & RSI_{t-1} < 40 \end{cases} \tag{11}$$

All of these indicators provide a robust test of additional technical indicators for timing the volatility decile portfolios. Indicators that have a positive MAP (the returns in excess of the buy and hold are greater than 0) are tested using the CAPM and Fama and French 3 Factor models. We also test these indicators on portfolios sorted by size. We report the CAPM and Fama and French alphas for size portfolios that have a positive MAP.

III. Results

We use CRSP daily prices from the start of the year 1963 through the year ended 2019. We use the momentum indicator from Han, Yang and Zhou (2013) deemed MA(10). This is the simple mean of the current close and the previous 9 trading days close. The market in signal is triggered when the price crosses the MA(10) from below. We

stay in the market until the price crosses the MA(10) from above. We earn the t-bill rate of return until the price crosses back above the MA(10).

We annualize the returns by using 252 trading days. We also annualize the standard deviation of the returns by multiplying by the square root of 252.

Table 1 presents the results for the MA(10) rule in panels A through C. This updates the results of Han et al. (2013). Panel A provides the annualized average returns and annualized standard deviations for the buy and hold strategy for the decile volatility portfolios and for the high (decile 10) minus the low (decile 1). The average returns are, with the exceptions of deciles 7 and 8, an increasing function across the deciles ranging from 10.1% to 28.11%. Similarly, the MA timing portfolios are an increasing function across the deciles ranging from 14.2% to 32.82%. The timing portfolio returns are considerably higher than the buy and hold strategy and the standard deviations are only about two-thirds of the volatility decile portfolios. This is clearly reflected by Sharpe ratios in Panel B. Panel C shows the return difference between MA timing portfolios and the buy and hold portfolios (MAP). All of the returns in this panel are statistically significant. Showing an average excess return of 8.80 percent annualized. With a standard deviation of 15.33 percent. The success rate (fraction of trading days when the MA timing strategy timed well) of this strategy is about 55%, meaning 55% of the of time the strategy placed the investor in the higher earning asset (the portfolio or risk-free asset). Contrary to the suggestion of Mclean and Pontiff (2016) that such profitable studies on financial time series fall apart post-publication, these results held up well even after the results were published by Han et al. (2013).

Table 2 presents the results for the Relative Strength Indicator. When RSI is above 80% we sell the portfolio and invest in 30-day t-bills. We invest in the portfolio when RSI hits 20%. Panel A of Table 2 provides the average returns and standard deviations for the Relative Strength indicator timing portfolios and for the high (decile 10) minus the low (decile 1). The average returns across the portfolios range from 4.84% to 14.31%. The return difference between RSI timing portfolios and the buy and hold portfolios (MAP) (Panel B) is consistently negative across all deciles implying that RSI timing portfolio returns are not any better than the Buy and Hold strategy. Clearly, buy and hold strategy performs better than the RSI timing strategy across all portfolios. Less than 50% of the time this strategy placed the investor in the higher earning asset. This shows poor excess returns using the RSI as a timing tool.

Next, we present the results of Bollinger Band's timing strategy. We calculate the 20-day moving average (MA) prices each day using the last 20 days' closing prices including the current closing price, and 2 standard deviations above and below the MA denoted upper and lower bands respectively. We compare the lower band's price with the current price as the timing signal. If the current price is above the lower band, it is an in-the-market signal, and we will invest in the decile portfolios for the next trading day and we will be fully invested in the portfolio until the price exceeds the upper band at which point we sell the portfolio and invest in the 30-day risk-free T-bill for the next trading day. Table 3 has the results of this timing strategy. The average returns of this timing strategy are all positive but not better than the buy and hold strategy. The return difference between this timing strategy and the buy and hold portfolios (MAP) is negative across all deciles indicating that Bollinger Bands is not an effective timing tool.

Next, we present the results of MACD's timing strategy. We calculate the 12,26-day fast and slow moving averages that make up the MACD indicator. We then use a 9 day average of the difference of this indicator to compute the MACD signal line. We take a signal of 1 if the signal line prices each day using the last 14 days' average of up and down closing prices including the current closing price. The up closing price is recorded if the close is greater than the previous close. The down closing price is recorded if the close is lower than the previous close. RS is the ratio of the simple mean of the up closing price to the down closing price. RSI is 100-100/(1+RS). The value ranges from 0 to 100. If the RSI value is above 20 it is an in-the-market signal, and we will invest in the decile portfolios for the next trading day; otherwise it is an out-of-the-market signal, and we will invest in the 30-day risk-free T-bill for the next trading day. We use the 10 NYSE/AMEX volatility decile portfolios as the investment assets. We report the average return (Avg Ret). And the standard deviation (Std Dev) for the buy-and-hold benchmark decile portfolios (Panel A), the RSI timing decile portfolios (Panel B), and the RSI portfolios (MAP RSI) that are the differences between the RSI timing portfolios and the buy-and-hold portfolios (Panel C). The results are annualized and in percentages. We also report the annualized Sharpe ratio (Sratio) for the buy-and-hold portfolios and the MA timing portfolios, and we

report the success rate for the MAPs. The sample period if from January 1, 1963, to Dec. 31, 2018; t-statistics are in parentheses. ** and * indicate significance at the 1% and 5% levels, respectively. Other periods of 30, 40, and 50 may be used for an in the market signal but are not recorded.

Last, we present the results of OBV's timing strategy. We calculate the 12-day On Balance Volume (OBV) using the 5-day highest close and lowest close including the current close. We multiply 100 by the ratio of the difference of the current close and the lowest close to the difference of the highest close and the lowest close. This value scales between 0 and 100. If it is above 20 (oversold) it is an in-the-market signal, and we will invest in the decile portfolios for the next trading day; otherwise it is an out-of-the-market signal, and we will invest in the 30-day risk-free T-bill for the next trading day. We use the 10 NYSE/AMEX volatility decile portfolios as the investment assets. We report the average return (Avg Ret). And the standard deviation (Std Dev) for the buy-and-hold benchmark decile portfolios (Panel A), the %K timing decile portfolios (Panel B), and the %K portfolios (MAP %K) that are the differences between the %K timing portfolios and the buy-and-hold portfolios (Panel C). The results are annualized and in percentages. We also report the annualized Sharpe ratio (Sratio) for the buy-and-hold portfolios and the %K timing portfolios, and we report the success rate for the MAP %K. The sample period if from January 1, 1963, to Dec. 31, 2018; t-statistics are in parentheses. ** and * indicate significance at the 1% and 5% levels, respectively.

The time frames we use are common for the indicators and are not optimized. We show robustness checks with different thresholds for the RSI, Stochastic, and Bollinger Band and determine the results are as good as, or better with these thresholds. We show results for the default parameters.

We then analyze the average returns, standard deviations, excess returns, sharpe ratio and success rate for the Relative Strength Index (RSI). We use the typical parameters in technical trading to analyze these. RSI 14, 20,80.

We test our indicators in an excess return format following Han et al (2013) where excess return is defined as the MAP (Moving Average Portfolio) where the indicator return is enacted by taking the dummy variable (1 in the market, 0 out of the market) multiplied by the market return for that day. When the indicator is out of the market it earns the risk free rate of return. Thus excess returns are earned by being out of the market on down (negative return) days. We summarize the excess returns for all portfolios.

We then try to explain the returns away using the CAPM and Fama and French 3 factor models. The excess returns we use are the returns in excess of the buy and hold strategy which is a little more aggressive than the typical Risk-Free rate of return. Noted that the market return is much higher than the risk-free rate. The models tell us whether the portfolios are generating returns by taking on excess risk.

Table 1

We calculate the 5-day Stochastic (PK) using the 5-day highest close and lowest close, including the current close. The indicator construction and rules are in the methodology. If it is above 20 (oversold), it is an in-the-market signal, and we will invest in the decile portfolios for the next trading day; otherwise, it is an out-of-the-market signal, and we will invest in the 30-day risk-free T-bill for the next trading day. We use the 10 NYSE/AMEX volatility decile portfolios as the investment assets. We report the average return (Avg Ret). And the standard deviation (Std Dev) for the buy-and-hold benchmark decile portfolios (Panel A), the PK timing decile portfolios (Panel B), and the PK portfolios (MAP PK) are the differences between the PK timing portfolios and the buy-and-hold portfolios (Panel C). The results are annualized and in percentages. We also report the annualized Sharpe ratio (Sratio) for the buy-and-hold portfolios and the PK timing portfolios, and we report the success rate for the MAP PK. The sample period is from January 1, 1963, to December 31, 2018. Y-statistics are in parentheses. ** and * indicate significance at the 1% and 5% levels, respectively. Other 30, 40, and 50 may be used for an in-the-market signal, and the MAPs are shown in the previous table.

	Panel A. Volatility Decile Portfolios				Panel B. BB (20) Timing Portfolios			Panel C. MAP BB	
Rank	Avg Ret	Avg Ret	Std Dev	Sratio	Avg Ret	Std Dev	Success	Std Dev	Sratio
Low	10.10 **	11.37**	6.23	106.37	1.27**	2.52	57.33	6.73	79.69
	(11.13)	(13.52)			(3.72)				
2	12.02 **	13.43**	8.79	98.90	1.41**	2.96	56.55	9.28	78.46
	(9.60)	(11.32)			(3.53)				
3	13.45 **	14.75**	10.79	92.82	1.30**	3.48	56.07	11.34	76.85
	(8.79)	(10.13)			(2.77)				
4	14.10 **	15.68**	12.50	87.55	1.58**	3.76	56.37	13.06	71.70
	(8.00)	(9.30)			(3.12)				
5	14.45 **	15.96**	14.15	79.33	1.52**	3.81	55.83	14.66	66.22
	(7.30)	(8.36)			(2.95)				
6	15.35 **	16.73**	15.18	79.01	1.38**	4.15	55.86	15.74	67.44
	(7.23)	(8.17)			(2.46)				
7	14.87 **	16.78**	16.48	73.10	1.92**	4.70	55.69	17.14	59.09
	(6.43)	(7.55)			(3.03)				
8	14.71 **	17.35**	17.88	70.58	2.64**	4.95	55.71	18.55	53.76
	(5.88)	(7.20)			(3.96)				
9	16.49 **	18.43**	18.82	72.75	1.94**	5.27	55.47	19.54	60.11
	(6.25)	(7.26)			(2.73)				
High	38.21 **	39.76**	19.91	175.85	1.55**	5.07	57.32	20.56	162.80
	(13.78)	(14.80)			(2.26)				
High-Low	28.11 **	28.39**	17.39	136.00	0.28	4.60	57.30	17.61	132.76
	(11.83)	(12.10)			(0.45)				

This table shows that the risk-adjusted returns are superior to the buy and hold with lower risk measured by standard deviation. MAPs show excess returns at each decile, and all the returns are statistically significant. PK is the most substantial result. It shows highly significant results and has returns that are much higher than the buy and hold.

This table shows that the risk-adjusted returns are superior to the buy and hold with lower risk measured by standard deviation. The MAPs show the excess returns at each decile. All the returns are statistically significant. The most accurate decile is the top decile with 57.98 percent accuracy. They were showing an average excess return of 8.80 percent annualized with a

This table shows that the risk-adjusted returns are superior to the buy and hold with lower risk measured by standard deviation. The MAPs show the excess returns at each decile. All the returns are statistically significant.

The results are lower than the MA10, but this suggests that the Bollinger Band can be used as a timing tool on the volatility decile portfolios. It is common in technical trading to combine several technical indicators. We explore the ability of the RSI and Stochastic to time the volatility decile portfolios in the following tables.

For the default parameter, the Bollinger Band has several success rates above 57, while the moving average of 10 only had one. Our average excess return is a bit lower; however, it is met by much lower volatility. We see similar Sharpe ratios in the triple digits.

Table 1 (b)

We calculate the 14-day relative strength index (RSI) prices each day using the last 14 days' average of up and down closing prices, including the current closing price. The up-closing price is recorded if the close is greater than the previous close. The down closing price is recorded if the close is lower than the previous close. RS is the ratio of the simple mean of the up-closing price to the down closing price. RSI is 100-100/(1+RS). The value ranges from 0 to 100. If the RSI value is above 20, it is an in-the-market signal, and we will invest in the decile portfolios for the next trading day; otherwise, it is an out-of-the-market signal, and we will invest in the 30-day risk-free T-bill for the next trading day. We use the 10 NYSE/AMEX volatility decile portfolios as the investment assets. We report the average return (Avg Ret). And the standard deviation (Std Dev) for the buy-and-hold benchmark decile portfolios (Panel A), the RSI timing decile portfolios (Panel B), and the RSI portfolios (MAP RSI) are the differences between the RSI timing portfolios and the buy-and-hold portfolios (Panel C). The results are annualized and in percentages. We also report the annualized Sharpe ratio (Sratio) for the buy-and-hold portfolios and the MA timing portfolios, and we report the success rate for the MAPs. The sample period is from January 1, 1963, to December 31, 2018; t-statistics are in parentheses. ** and * indicate significance at the 1% and 5% levels, respectively. Other periods of 30, 40, and 50 may be used for an in-the-market signal but are not recorded.

	Panel B. RSI (14) Timing Portfolios			Panel C. MAP RSI		
Rank	Avg Ret	Std Dev	Sratio	Avg Ret	Std Dev	Success
Low	11.52**	5.65	120.02	1.42**	3.65	56.84
	(15.11)			(2.88)		
2	13.66**	8.51	104.94	1.64**	3.70	56.73
	(11.91)			(3.29)		
3	15.14**	10.28	101.13	1.68**	4.77	56.64
	(10.91)			(2.61)		
4	15.73**	11.87	92.62	1.63*	5.44	55.86
	(9.82)			(2.22)		
5	15.79	13.55	81.58	1.35	5.59	55.34
	(8.64)			(1.78)		
6	16.81**	14.59	82.73	1.46	5.89	55.64
	(8.54)			(1.84)		
7	16.88**	15.94	76.19	2.01**	6.30	55.63
	(7.85)			(2.37)		
8	17.91**	17.18	76.67	3.20**	6.98	55.45
	(7.73)			(3.40)		
9	18.94**	17.89	79.40	2.45**	7.86	55.28
	(7.85)			(2.31)		
High	38.25**	19.05	175.95	0.04	7.74	56.64
	(14.89)			(0.04)		
High-Low	26.74	17.28	127.30	(1.38)	7.39	55.93

This table shows that the risk-adjusted returns are superior to the buy and hold with lower risk measured by standard deviation. The RSI is significant at all levels except for the 5th and 6th deciles, high and high minus low. Results are mixed for excess returns using the RSI as a timing tool.

This indicator has similar results as the above two indicators; however, the excess returns are lower and insignificant in the top decile. The success rate is above 55 percent for all the deciles, which is like the above results. Thus, we have a positive expectation for these portfolios. The 20 thresholds may be too constricting, which is why we don't see better results. The robustness check excess returns may show better results because 20 could be too low of a threshold for buying. Prices may revert far above 20 and never hit the threshold. They could also, at times, be using 20 to correct to a new trend. Henry (1999) suggests this.

Table 1 (c)

We calculate the 10-day moving average (MA) prices each day using the last ten days' closing prices, including the current closing price, and compare the MA price with the current price as the timing signal. If the current price is above the MA price, it is an in-the-market signal, and we will invest in the decile portfolios for the next trading day; otherwise, it is an out-of-the-market signal, and we will invest in the 30-day risk-free T-bill for the next trading day. We use the 10 NYSE/AMEX volatility decile portfolios as the investment assets. We report the average return (Avg Ret). And the standard deviation (Std Dev) for the buy-and-hold benchmark decile portfolios (Panel A), the MA timing decile portfolios (Panel B), and the MA portfolios (MAPs) are the differences between the MA timing portfolios and the buy-and-hold portfolios (Panel C). The results are annualized and in percentages. We also report the annualized Sharpe ratio (Sratio) for the buy-and-hold portfolios and the MA timing portfolios, and we report the success rate for the MAPs. The sample period is from January 1, 1963, to December 31, 2019; t-statistics are in parentheses. ** and * indicate significance at the 1% and 5% levels, respectively.

	Panel B. MA (10) Timing Portfolios			Panel C. MAP MA		
Rank	Avg Ret	Std Dev	Sratio	Avg Ret	Std Dev	Success
Low	14.20 **	3.78	250.65	4.10 **	5.55	56.82
	(27.88)			(5.48)		
2	15.41 **	5.75	185.62	3.39 **	7.28	55.21
	(19.78)			(3.45)		
3	17.52 **	6.86	186.43	4.07 **	9.02	54.77
	(18.94)			(3.34)		
4	18.90 **	7.94	178.42	4.80**	10.35	55.01
	(17.65)			(3.44)		
5	19.90 **	8.98	168.80	5.46 **	11.56	54.64
	(16.42)			(3.50)		
6	21.59 **	9.76	172.63	6.25 **	12.31	55.44
	(16.39)			(3.76)		
7	21.71 **	10.70	158.67	6.84 **	13.37	55.43
	15.05			(3.80)		
8	25.90 **	11.63	181.98	11.19 **	14.40	55.90
	(16.51)			(5.76)		
9	28.10 **	12.28	190.26	11.62 **	15.14	56.10
	(16.96)			(5.69)		
High	47.01 **	13.60	310.88	8.80 **	15.33	57.98
	(25.63)			(4.26)		
High-Low	32.82 **	12.89	217.78	4.70 **	13.31	54.09
	(18.87)			(2.62)		

Table 2 (a)

Table 2 reports the alphas, betas, and adjusted R^2 of the regressions of the MAPs formed from the 14-day RSI timing strategy on the market factor (Panel A) and the Fama-French (1993) 3 factors (Panel B), respectively. The alphas are annualized and in percentages. The sample period is from January 1, 1963, to December 31, 2018.

	Panel a. CAPM			Panel B. Fama-French				
Rank	α	βmkt	R^2 %	α	βmkt	βsmb	βhml	R^2 %
Low	1.85**	(0.07)**	9.27	2.00**	(0.07)**	(0.02)**	(0.02)**	9.71
	(3.95)	(-37.63)		(4.27)	(-38.48)	(-5.36)	(-6.09)	
2	2.11**	(0.08)**	10.36	2.05**	(0.07)**	(0.02)**	0.02	10.75
	(4.46)	(-40.01)		(4.34)	(-38.31)	(-5.44)	(6.05)	
3	2.33**	(0.11)**	12.05	2.23**	(0.10)**	(0.01)**	0.03**	12.28
	(3.86)	(-43.57)		(3.69)	(-41.45)	(-2.49)	(5.81)	
4	2.38**	(0.12)**	12.53	2.38**	(0.12)**	(0.05)**	0.02**	13.10
	(3.47)	(-44.54)		(3.47)	(-43.48)	(-8.75)	(4.45)	
5	2.10**	(0.12)**	11.87	2.11**	(0.12)**	(0.06)**	0.03**	12.82
	(2.96)	(-43.19)		(3.00)	(-42.40)	(-11.48)	(5.23)	
6	2.22**	(0.12)**	10.87	2.18**	(0.12)**	(0.08)**	0.05**	12.34
	(2.96)	(-41.11)		(2.92)	(-40.07)	(-13.28)	(8.15)	
7	2.81**	(0.13)**	10.50	2.66**	(0.13)**	(0.08)**	0.07**	12.33
	(3.50)	(-40.31)		(3.34)	(-38.63)	(-13.14)	(11.51)	
8	4.04**	(0.14)**	9.58	4.06**	(0.14)**	(0.13)**	0.07**	12.46
	(4.52)	(-38.31)		(4.60)	(-38.08)	(-19.64)	(9.38)	
9	3.48**	(0.17)**	11.16	3.59**	(0.17)**	(0.13)**	0.05**	13.28
	(3.48)	(-41.71)		(3.63)	(-41.75)	(-17.70)	(6.07)	
High	0.92	(0.14)	8.42	0.98	(0.15)	(0.13)	0.06	10.66
	(0.93)	(0.07)**		(1.02)**	(0.07)**	(0.11)**	0.08**	
High-Low	(-0.94)	(-18.31)		(-1.04)	(-17.60)	(-14.89)	(9.81)	

This table shows the remaining alpha is still positive and significant at all deciles except for the high decile after using the market factor and the Fama and French 3-Factors. The Market, SMB, and HML factors are all adverse in explaining the excess returns, except for the HML in the top decile. We explore RSI in the following table.

Table 2 (b)

Table 2 reports the alphas, betas, and adjusted R^2 of the regressions of the MAPs formed from the 20-day BB timing strategy on the market factor (Panel A) and on the Fama-French (1993) 3 factors (Panel B), respectively. The alphas are annualized and in percentages. The sample period is from January 1, 1963, to December 31, 2018.

	Panel a. CAPM			Panel B. Fama-French				
Rank	α	βmkt	R^2 %	α	βmkt	βsmb	βhml	R^2 %
Low	1.44**	(0.03)**	4.10	1.44**	(0.03)**	0.00	0.00	4.12
	(4.40)	(-24.36)		(4.33)	(-23.28)	(-1.46)	(-1.11)	
2	1.70**	(0.05)**	5.95	1.81**	(0.05)**	0.00	(0.02)**	6.33
	(4.37)	(-29.59)		(4.66)	(-30.42)	(0.38)	(-7.74)	
3	1.66**	(0.06)**	7.06	1.76**	(0.06)**	(0.00)**	(0.02)**	7.25
	(3.67)	(-32.44)		(3.88)	(-32.73)	(-0.02)	(-5.53)	
4	1.96**	(0.06)**	6.57	2.11**	(0.07)**	(0.01)**	(0.03)**	6.92
	(4.00)	(-31.21)		(4.31)	(-32.14)	(-3.44)	(-6.40)	
5	1.88**	(0.06)**	5.96	2.02**	(0.06)**	(0.02)**	(0.02)**	6.33
	(3.77)	(-29.61)		(4.05)	(-30.40)	(-6.19)	(-4.05)	
6	1.77**	(0.06)**	5.84	1.95**	(0.07)**	(0.04)**	(0.02)**	6.49
	(3.26)	(-29.31)		(3.59)	(-30.44)	(-8.87)	(-4.00)	
7	2.38**	(0.08)**	6.31	2.58**	(0.08)**	(0.05)**	(0.02)**	7.04
	(-3.88)	(-30.54)		(4.22)	(-31.68)	(-9.68)	(-3.69)	
8	3.10**	(0.07)**	5.51	3.25**	(0.08)**	(0.06)**	(0.00)	6.36
	(4.77)	(-28.44)		(5.02)	(-29.12)	(-11.21)	(-0.38)	
9	2.40**	(0.07)**	4.90	2.53**	(0.08)**	(0.07)**	(0.01)	5.97
	(3.46)	(-26.74)		(3.67)	(-27.29)	(-12.57)	(1.27)	
High	1.93**	(0.06)**	3.78	2.02**	(0.07)**	(0.05)**	0.01	4.38
	(2.88)	(-23.35)		(3.02)	(-23.58)	(-9.35)	(1.13)	
High-Low	0.47	(0.03)**		0.58	(0.03)	(0.05)**	0.00**	
	(0.75)	(-12.24)		(0.94)	(0.63)	(-10.97)	(-13.06)	

The BB Timing shows significant positive returns at every decile except for the high-low in both sorts.

Table 2 (c)

Table 2 reports the alphas, betas, and adjusted R^2 of the regressions of the MAPs formed from the 10-day MA timing strategy on the market factor (Panel A) and the Fama-French (1993) 3 factors (Panel B), respectively. The alphas are annualized and in percentages. The sample period is from January 1, 1963, to December 31, 2018.

	Panel a. CAPM			Panel B. Fama-French				
Rank	α	βmkt	R^2 %	α	βmkt	βsmb	βhml	R^2 %
Low	5.23**	(0.18)**	26.90	5.41**	(0.19)**	(0.04)**	(0.02)**	27.29
	(8.16)	(-71.38)		(8.47)	(-71.24)	(-7.35)	(-4.04)	
2	5.24**	(0.30)**	42.07	5.71**	(0.31)**	(0.08)**	(0.06)**	43.30
	(7.01)	(-100.26)		(7.72)	(-102.16)	(-13.71)	(-9.96)	
3	6.54**	(0.40)**	49.29	7.21**	(0.42)**	(0.11)**	(0.08)**	50.86
	(7.55)	(-116.00)		(8.44)	(-118.98)	(-16.55)	(-12.20)	
4	7.72**	(0.48)**	52.00	8.68**	(0.50)**	(0.17)**	(0.11)**	54.65
	(7.98)	(-122.46)		(9.21)	(-128.23)	(-23.65)	(-14.66)	
5	8.75**	(0.54)**	52.83	10.02**	(0.57)**	(0.25)**	(0.14)**	56.96
	(8.16)	(-124.51)		(9.78)	(-133.82)	(-31.45)	(-16.90)	
6	9.71**	(0.56)**	51.49	11.03**	(0.60)**	(0.31)**	(0.12)**	56.36
	(8.39)	(-121.22)		(10.04)	(-131.16)	(-36.21)	(-13.48)	
7	10.54**	(0.60)	49.84	12.03**	(0.64)**	(0.37)**	(0.12)**	55.73
	(8.25)	(-117.28)		(10.02)	(-128.55)	(-40.41)	(-12.48)	
8	15.09**	(0.64)**	47.93	16.61**	(0.67)**	(0.45)**	(0.08)**	54.85
	(10.76)	(-112.88)		(12.71)	(-124.60)	(-44.93)	(-7.98)	
9	15.59 **	(0.65) **	44.98	17.12**	(0.69)**	(0.52)**	(0.05)**	53.09
	(10.29)	(-106.37)		(12.23)	(-118.39)	(-48.48)	(-4.36)	
High	12.26**	(0.56)**	33.28	13.89**	(0.60)**	(0.55)**	(0.05)**	42.07
	(7.26)	(-83.09)		(8.81)	(-92.72)	(-45.38)	(-4.26)	
High-Low	7.04**	(0.38)**		8.47**	(0.42)**	(0.51)**	(0.03)**	
	(4.38)	(-59.00)		(5.64)	(-66.98)	(-2.75)	(-44.48)	

This table shows the remaining alpha is still positive and significant at all deciles after using the market factor and the Fama and French 3-Factors. The Market, SMB, and HML factors are all adverse in explaining the excess returns. We explore the remaining indicators in the following tables.

We change the analysis of these indicators to time the portfolios sorted on size, which is a value-weighted portfolio instead of equally weighted. We know that equally weighting may overstate the emphasis of small stocks in the analysis. What we expect to see is that the technical indicators can time the size sorted portfolios. That size acts as a volatility decile portfolio with the highest volatility in the small stocks.

Table 3. Size Decile Portfolios

We report the average returns (Avg Ret) and the Fama-French (1993) alphas (FF) of the MAPs when they are constructed with 10 NYSE/AMEX/NASDAQ value-weighted market cap decile portfolios by using MA10, RSI, and Stochastic (%k) respectively. The results are annualized and in percentages. The sample period is from January 1, 1963, to December 31, 2018.

	MAP(RSI)		MAP(BB)		MAP(MA)	
Rank	Avg Ret	FF α	Avg Ret	FF α	Avg Ret	FF α
Large	0.77	0.41**	0.64**	0.88**	0.88	1.90**
	(0.54)	(4.48)	(2.69)	(3.82)	(0.47)	(4.39)
2	3.79**	3.32**	0.71**	0.95**	3.88**	3.34**
	(2.32)	(8.10)	(3.14)	(4.36)	(2.37)	(8.06)
3	6.20**	4.14**	0.72**	0.93**	6.27**	4.43**
	(3.67)	(10.45)	(3.32)	(4.46)	(3.71)	(10.40)
4	6.68**	4.36**	0.56**	0.79**	6.78**	4.63***
	(4.00)	(10.90)	(2.48)	(3.62)	(4.06)	(11.03)
5	7.71**	4.58**	0.95**	1.16**	7.77**	4.95**
	(4.78)	(11.88)	(4.47)	(5.67)	(4.82)	(11.89)
6	9.67**	4.91**	0.93**	1.15**	9.68**	5.60**
	(6.29)	(13.63)	(4.37)	(5.58)	(6.30)	(13.72)
7	10.82**	5.19**	0.90**	1.10**	10.80**	5.61**
	(7.94)	(14.49)	(4.48)	(5.68)	(7.94)	(14.51)
8	10.58**	5.17**	0.86**	1.00**	10.49**	5.24**
	(8.55)	(14.23)	(4.72)	(5.67)	(8.50)	(14.16)
9	10.05**	4.86**	0.79**	0.93**	9.96**	5.02**
	(8.26)	(13.49)	(4.60)	(5.59)	(8.22)	(13.43)
Small	9.18**	4.15**	0.56**	0.70**	9.10**	4.93**
	(6.10)	(10.56)	(3.00)	(3.82)	(6.09)	(10.66)
Small-Large	8.37**	3.00**	(0.09)	(0.21)	8.27**	2.95**
	(5.65)	(5.46)	(-0.33)	(-0.77)	(5.58)	(5.38)

From the table we see that RSI does comparable to the MA at size deciles. This is interesting because RSI does not beat the MA on the volatility sort. PK does a little better in all deciles. More notably is the large stock decile. The MA does the worst (a little under one percent) in the large stock decile while PK does nearly 5 percent. Percent R does better than the MA indicator at the Large-9 decile.

Robustness to alternate specifications.

We discuss various entry thresholds for our indicators below. We show the default settings in the main tables of the paper. They are not necessarily the best results but the more common ones.

Additional levels for entry and exit (as discussed above) are commong for technical trading. We show the excess returns in the tables below with the standard deviations and accuracy.

Table 4. RSI Threshold Levels

	RSI 30			RSI 40			RSI 50		
Panel A.	AVRet	Sdret	ACC	AVRet	Sdret	ACC	AVRet	Sdret	ACC
1	2.29	4.55	57.01	1.43	5.62	54.73	1.43	5.62	54.73
2	1.75	5.26	56.53	0.29	7.29	53.59	0.29	7.29	53.59
3	2.61	6.21	56.52	1.26	9.17	53.70	1.26	9.17	53.70
4	2.43	7.23	56.00	1.73	10.50	53.98	1.73	10.50	53.98
5	3.93	7.78	55.63	3.26	11.70	54.40	3.26	11.70	54.40
6	3.55	8.17	55.78	2.44	12.59	54.29	2.44	12.59	54.29
7	3.89	8.91	56.22	3.87	13.60	54.44	3.87	13.60	54.44
8	6.17	10.13	55.98	7.68	14.77	54.91	7.68	14.77	54.91
9	5.70	10.45	55.92	7.35	15.45	54.98	7.35	15.45	54.98
10	1.96	11.03	57.08	3.93	15.71	56.53	3.93	15.71	56.53
hml	(0.33)	9.89	50.78	2.50	13.64	54.60	2.50	13.64	54.60

Table 5. BB Threshold Levels

	BB 2 10			BB 1 20			BB 1 10		
Panel C.	AVRet	Sdret	ACC	AVRet	Sdret	ACC	AVRet	Sdret	ACC
1	1.35	3.25	57.62	3.73	4.92	57.59	5.08	4.69	59.11
2	1.44	3.51	56.57	3.38	6.14	56.76	4.60	5.89	57.14
3	1.49	4.84	56.21	5.11	7.64	56.64	5.82	7.28	57.26
4	1.41	5.51	56.15	4.41	8.74	56.26	5.49	8.13	56.57
5	2.56	6.07	56.00	6.17	9.58	56.30	7.67	9.25	56.78
6	2.91	6.21	55.95	6.52	10.33	56.71	7.35	9.66	57.20
7	2.84	6.73	55.89	7.47	11.17	56.71	9.88	10.72	57.50
8	4.02	7.04	55.64	10.30	12.25	56.66	11.34	11.49	57.22
9	3.40	7.21	55.56	10.38	12.79	57.01	12.10	12.04	57.38
10	3.00	7.58	57.59	9.51	12.85	58.72	9.89	12.03	59.19
hml	1.65	7.01	48.66	5.78	11.19	53.38	4.81	10.73	54.21

BB 1,10 shows some promise for excess returns so does BB 1,20.

You could take any of these thresholds in the table above to recreate the tables below or generate timing signals. The best signal is BB(1,10), where 1 denotes the standard deviation and 10 denotes the moving average period. We show more common or default indicator settings in the main tables.

We show the MAPs for these technical rules below. We can see that they are much better than the MA10 and are shared among indicators used in technical trading. The added advantage of these new indicators for volatility decile portfolios is that they have areas for overbought and oversold, which moving averages don't have. We obtain similar but different signals than the MA10. Despite tweaking the Average Moving Length, we cannot get results as good as the results shown in the table below. These are by changing the thresholds on the standard parameters. Changing the parameter length may yield different results.

The above analysis suggests that the indicators used may be compared to the MA. The return of the Stochastic (PK) indicator is seemingly more significant than the MA. The robustness check of the RSI 40,50 and Bollinger Band (1,10) and (1,20) seems to

do better than having broader volatility for the band (i.e., 2,10 and 2,20) than the standard time frame results we show in the tables. BB (1,10) and BB (1,20) are slightly better than the MA, along with PK(5) 40 and PK(5) 50. The advantage is that the MA can only change length while the BB and PK can both change in length and entry signal. Looking at how far away price is to the MA might better relate the MA to these other indicators. We suggest that different parameters for these indicators may have a better timing ability than the MA and are commonly used in practice alongside it. Additional useful indicators in asset pricing studies.

Price Analysis

Table 6. BB and RSI levels and returns

BB	ret	sigma	RSI	ret	sigma
sigma	5.91	0.30	***OVERSOLD***	**-2.74**	**0.18**
+	1.85	0.16	*40.00*	-1.14	0.16
MA10	0.35	0.12	*50.00*	0.32	0.14
-	-1.00	0.10	*60.00*	1.46	0.14
sigma	**-5.91**	**0.21**	*OVERBOUGHT*	2.99	0.14

The table shows the BB has positive return when above the MA10. The return is greatest when it comes towards the upper band. The returns are negative when price is at low levels near the lower band.

The RSI has high returns near overbought and low returns near oversold.

Table 7. Summary Statistics RSI

	Mean	Std Dev	T (p)
RSI20	*0.43*	0.19	693.15
ret	*0.21*	0.20	0.00

Table 7a. Summary Statistics Bollinger Band

	Mean	Std Dev	T (p)
BB(LB)	*1.58*	0.58	2000.00
ret	*0.21*	0.70	0.00

We break our sample into price levels. $1-$25, $26-$50, $50+. We look at the summary statistics inside this.

Table 8. Price Level Analysis

	Bollinger Band		*RSI*		Buy and Hold	
Prc	**Mean**	**Std Dev**	**Mean**	**Std Dev**	**Mean**	**Std Dev**
$1-$25	179.9%	65.81%	45.0%	76.72%	17.5%	79.28%
$26-$50	104.0%	30.96%	38.3%	36.38%	28.6%	37.38%

>$50	97.8%	32.83%	41.6%	36.48%	34.5%	37.14%

We control for maximum draw down using 20 day rolling windows over the first peak to next trough.

Table 9. Maximum Drawdown Full Sample

	Max DD	Sigma
RSI	*51.88%*	23.81%
Bollinger B	*19.39%*	*14.67%*
BH	*79.53%*	26.24%

Table 10 t-test

	t-test	
	In Sample (1926-1950)	*Out of Sample (1950-2021)*
Bollinger B	262.1428	1.2+e03
RSI	113.58	463.28

Table 11 in sample and out of sample analysis.

Trailing 3 year Sample Analysis

We break the sample in to the three years prior to the publication by Han et al (2014) and three years after the publication. Leaving one year for the market to adjust. We find that the results hold both in and out of sample.

	In Sample (1926-1950)			*Out of Sample (1950-2021)*		
	Return	**Std Dev**	**Sharpe**	**Return**	**Std Dev**	**Sharpe**
Bollinger B	134.80%	43.66%	3.04	142.65%	43.82%	3.21
RSI	44.22%	72.67%	0.58	42.64%	67.03%	0.61
Buy Hold	26.32%	74.76%	0.33	20.55%	69.97%	0.27

All Decile	2012-2015	2015-2018
MAT	5.73%	7.97%
Wret	5.90%	5.74%

We see a slight improvement after the one year period leading through 12/31/2018. This provides a guide for indicating the indicators will still work after the article was published, in contrast to McLean and Pontiff (2016) which states that excess return studies fall apart post publication.

Decile 10	2012-2015	2015-2018
MAT	22.92%	19.15%
Wret	14.74%	8.89%

For Decile 10 we see that the results are similar between both of the periods prior to publication and after publication. We see from the above results that the MA10 is one of the strongest indicators and we expect that the other indicators would hold similarly.

IV. Conclusion

We can see that technical indicators common in technical trading circles can be used to time the volatility decile portfolios. The primary buy and sell signals are buying when indicators rebound from oversold and selling when they reach new oversold levels. The intuition behind the success of this rule is following Covel (2009) that trending markets are characteristic of higher highs and higher lows. Thus, buying around the oversold levels and riding the highs will produce profitable returns.

We can conclude that additional indicators such as the Relative Strength Index, Bollinger Bands, and Stochastic %k can be used to time the volatility decile portfolios. From a practical perspective, fund managers who hold many securities for clients could sort their portfolios by risk and use these types of indicators to enter and exit the market daily.

There isn't a one-size-fits-all technical indicator, and it is common to stack many on a chart.

We take to buy and sell signals when the indicators show that the price deviates from the trend. In practice, this would be done when many indicators make signals at a similar time. Chartists use their eyes to distinguish signals from noise which makes the scientific study of it difficult.

Future work would include combining several indicators in a genetic algorithm to time the portfolios and use neural networks to predict the tops and bottoms. We see from the excess returns that the indicators here, in some cases, perform much better than the moving average of 10. However, not in all circumstances.

Stochastic performs similar to the MA while BB and RSI both beat the buy and hold. It might be faster to pick up on changes and maybe more valuable and flexible than the MA, given its construction is based on other price properties such as high and low other than just the close. We usually see RSI or BB studied in the literature. PK is not often mentioned.

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