Leverage for the Long Run

A Systematic Approach to Managing Risk and Magnifying Returns in Stocks

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Abstract: Using leverage to magnify performance is an idea that has enticed investors and traders throughout history. The critical question of when to employ leverage and when to reduce risk, though, is not often addressed. We establish that volatility is the enemy of leverage and that streaks in performance tend to be beneficial to using margin. The conditions under which higher returns would be achieved from using leverage, then, are low volatility environments that are more likely to experience consecutive positive returns. We find that Moving Averages are an effective way to identify such environments in a systematic fashion. When the broad U.S. equity market is above its Moving Average, stocks tend to exhibit lower than average volatility going forward, higher average daily performance, and longer streaks of positive returns. When below its Moving Average, the opposite tends to be true, as volatility often rises, average daily returns are lower, and streaks in positive returns become less frequent. Armed with this finding, we developed a strategy that employs leverage when the market is above its Moving Average and deleverages (moving to Treasury bills) when the market is below its Moving Average. This strategy shows better absolute and risk-adjusted returns than a comparable buy and hold unleveraged strategy as well as a constant leverage strategy. The results are robust to various leverage amounts, Moving Average time periods, and across multiple economic and financial market cycles.

Introduction

Using leverage to magnify performance is an idea that has enticed investors and traders throughout history. The concept is simple enough: borrowing funds allows you to buy more of an asset than with cash alone, multiplying the effect of any gains and losses. The critical question of when to employ leverage and when to reduce risk, though, is not often addressed. Under academic theory, one cannot develop a strategy to time the use of leverage due to market efficiency and the randomness of security prices.

We find strong evidence to the contrary. Security prices are non-random and tend to exhibit trends over time as well as volatility regimes under which leverage is more or less beneficial. As such, one can combine these two concepts to create a strategy that employs the use of leverage only during periods which have a higher probability of success. In doing so, one can achieve higher returns with less risk than a comparable buy and hold strategy. This is the primary focus of our paper: systematically determining environments favorable to leverage and developing a strategy to exploit them.

The idea that you can achieve a higher return with less risk stands in direct conflict with the Capital Asset Pricing Model (CAPM). Developed in the early-to-mid 1960s, the CAPM dictates that the expected return for a given security should be determined by its level of systematic risk, or Beta. A linear relationship is said to exist between Beta and return, which is represented in chart form as the Security Market Line (SML). The SML progresses linearly (up and to the right) whereby the higher the Beta, the higher the expected return.

Though still widely regarded as one of the key tenets of Finance, the CAPM has been challenged by a number of studies over the years. Empirical research has shown that anomalies such as the small firm effect, the value effect, and the momentum effect cannot be explained by the CAPM.[1]

The low volatility anomaly has also called into question the presumed absolute relationship between risk and return. Low volatility stocks have exhibited above market performance with lower than market Beta, opposing the risk/return laws of the CAPM.[2] Similarly perplexing is the tendency for high beta stocks to exhibit lower performance than predicted by their level of risk.[3]

In this paper, we put forward an additional factor that is unexplained by traditional Finance theory: the volatility and leverage anomaly that allows for long-run outperformance using leverage. Key to any study which counters efficient markets is understanding what allows for the anomaly to exist. We propose that the combination of structural and behavioral conservatism in the use of leverage brings with it inefficiencies which are not easily arbitraged away.

In addition to facing margin requirements, certain institutional investors such as pension plans, mutual funds, and endowments are simply unable to borrow money to invest beyond their portfolio's asset value based on stated mandates and regulatory requirements. For those institutional investors who do not face such restrictions, leverage brings with it a new set of risks, including "costs of margin calls, which can force borrowers to liquidate securities at adverse prices due to illiquidity; losses exceeding the capital invested; and the possibility of bankruptcy."[3] In the case of hedge funds, for example, the "fragile nature of the capital structure, combined with low market liquidity, creates a risk of coordinated redemptions among

[1] See Fama and French (1992).
[2] See Baker and Haugen (2012).
[3] See Blitz and Vliet (2007).
[3] See Jacobs and Levy (2012).

investors that severely limits hedge funds arbitrage capabilities. The risk of coordination motivates managers to behave conservatively [in their usage of maximum leverage]."[4]

Leverage aversion is also due to innate behavioral biases. The availability heuristic is a mental rule of thumb which argues that individuals will use the first immediate example that comes to mind when evaluating a topic, or making a decision. Often times, the most extreme negative events are the first things considered. The word leverage, or margin, makes most individuals immediately think of historically catastrophic events, loss, or the risk of ruin, creating a natural aversion to using borrowed money to generate excess returns. Some of the most prominent examples that come to mind include:

1) The 1929 stock market crash,

2) The 1987 stock market crash,

3) The 1998 Long-Term Capital Management blowup,

4) The 2007 Quant Quake,

5) The 2007-2009 Financial Crisis,

6) The 2015 stock market selloff (European sovereign debt crisis),

7) The 2018 "Volmageddon", and

8) The 2020 stock market crash

Leverage aversion is understandable given these traumatic events, but it is not "rational" as Finance theory assumes. In theory, when presented with the option to construct an unleveraged portfolio or a leveraged one, mean-variance optimization views the two as equal so long as the expected return and volatility of the two portfolios remains the same.[5] The fact that leverage is used becomes irrelevant, which means there should be no preference between the two portfolios. In practice, however, investors are more likely to avoid the leveraged portfolio despite having the same risk/return characteristics as the unleveraged one.

Prior studies on the use of leverage to enhance risk/return in a portfolio have primarily been centered on low beta stocks[6] and risk parity.[7] These studies suggest there are benefits to leveraging lower beta assets which investors, due to leverage aversion, are either unable or unwilling to do. To the best of our knowledge, however, there has not yet been a study using technical indicators which evaluates the potential timing benefits of using leverage purely on the stock market itself to not just increase absolute return, but also improve risk-adjusted performance.

In this paper, we propose that using widely-referenced Moving Average indicators for evaluating stock market trends can enhance absolute return and generate higher risk-adjusted performance beyond what the CAPM and Modern Portfolio Theory would argue is possible. To do this, however, we first need to dispel mistaken beliefs about leverage and Moving Averages independently to better understand exactly why a strategy which leverages or deleverages based on Moving Averages produces superior results over time.

[4] See Tolonen (2014).
[5] See Jacobs and Levy (2013).
[6] See Frazzini and Pedersen (2012).
[7] See Asness, Frazzini, and Pedersen (2012).

Volatility and the Importance of Path

While the availability heuristic leads us to think of leverage in terms of a constant source of significant risk, objective quantitative analysis can help us identify what actually causes leverage to result in loss, and under what conditions leverage is beneficial. In this paper, we focus on daily re-leveraging of the multiplier (ex: tracking 1.25x, 2x, or 3x the S&P 500 daily total return), which is the most commonly used time frame in leveraged mutual funds and Exchange Traded Funds (ETFs).[8]

One of the mistaken notions about daily re-leveraging is the idea that there is some form of natural decay. This is the belief that over time the cumulative returns from such rebalancing will end up moving towards zero or at the very least be considerably less than a constant buy and hold strategy. Going back to 1928, we find this is simply not the case.[9] While a daily releveraged buy and hold of the S&P 500 initially suffered from great losses going into and following the 1929 stock market crash (-99.9% for the 3x), over the long run it would have significantly outperformed the unleveraged strategy, by multiples in excess of the leverage factor.[10] We observe this in Table 1, where the 3x leveraged cumulative return since 1928 is an astonishing 681 times that of the unleveraged S&P 500.

Table 1: S&P 500 vs. Daily Leveraged S&P 500, Growth of $1 (October 1928 – December 2020)

Metric	S&P 500	S&P 500 1.25	S&P 500 2x	S&P 500 3x
Growth of $1	$4,059	$19,313	$591,035	$2,763,322
Multiple vs. Buy/Hold	1	5	146	681

There is no natural form of decay from leverage per se, as the long-run view illustrates. While we cannot conclude that the daily leveraged always outperforms in an upward trending market, the idea that leverage is only suitable for very short-term trading is false when looking at how daily leveraging can perform over long-term cycles. That is not to say that leverage is without risk, just that the source of that risk does not come from some inherent decay.

What does cause significant problems for constant leverage over time is volatility. Daily re-leveraging combined with high volatility creates compounding issues, often referred to as the "constant leverage trap."[11] When the path of returns is not trending but alternating back and forth between positive and negative returns (seesawing action), the act of re-leveraging is mathematically destructive. The reason: you are increasing exposure (leveraging from a higher level) after a gain and decreasing exposure (deleveraging from a lower level) after a loss, again and again. An example from recent history will make this point clearer.

In August 2011, the S&P 500 experienced extremely high volatility, where over a six-day period the annualized standard deviation was above 75%. The cumulative return for the S&P 500 over these six trading days was a positive 0.51%, but the levered returns fell far short of multiplying this return as we see in Table 2. Using 1.25x leverage, the total return was still positive but less than the unlevered return at 0.46%. When 2x and 3x leverage was applied, the cumulative returns actually turned negative even though the unlevered return was positive.

[8] The most popular of long-leveraged S&P 500 ETFs are the ProShares Ultra S&P500 (SSO) which tracks twice the daily return, and the ProShares UltraPro S&P500 (UPRO) which tracks 3x the return. The Direxion S&P 500 Bull 1.25X (PPSP) has been discontinued in 2018 due to decreasing popularity.

[9] Source: S&P 500 Total Return Index (Gross Dividends) data from Bloomberg.

[10] We assume no cost to using leverage in this section but will introduce an assumed cost in the strategy section.

[11] See Trainor Jr. (2011).

Table 2: S&P 500 vs. Daily Leveraged S&P 500 (August 8, 2011 – August 15, 2011)							
Index	**08/08/2011**	**08/09/2011**	**08/10/2011**	**08/11/2011**	**08/12/2011**	**08/15/2011**	**Cumulative Return**
S&P 500	-6.65%	4.74%	-4.37%	4.65%	0.53%	2.19%	**0.51%**
1.25x	-8.31%	5.93%	-5.47%	5.81%	0.66%	2.73%	**0.46%**
2x	-13.30%	9.49%	-8.75%	9.29%	1.06%	4.37%	**-0.14%**
3x	-19.95%	14.23%	-13.12%	13.94%	1.58%	6.56%	**-2.02%**

Why is this the case? After the 6.65% decline on August 8, instead of increasing leverage as would occur naturally from a decline in one's equity, leverage is reset to the lower asset base. Exposure is effectively being reduced ahead of the gain of 4.74% on August 9. Next, after the gain on August 9, instead of decreasing leverage as would occur naturally from an increase in one's equity, leverage is reset to the higher asset base. Exposure is now increasing ahead of the loss of 4.37% on August 10.

The more leverage that is applied, the more pernicious the constant leverage trap. This is why the 3x leveraged S&P 500 performs worse than the 2x leveraged and the 2x leveraged performs worse than 1.25x leveraged. Additionally, the higher the volatility in the path of returns, the more harmful such compounding issues become, as we will see in the next example.

High volatility and seesawing action are the enemies of leverage while low volatility and streaks in performance are its friends. We can see this clearly in Table 3. With the same unleveraged cumulative return of 19.41%, the four paths illustrated have different leveraged returns. In both Path 1 and Path 2, the S&P 500 is positive for six consecutive days, but the lower volatility Path 1 achieves a higher return. Both Path 1 and Path 2 perform better than the leverage multiplier as the constant re-leveraging benefits from compounding. The opposite is true in Path 3 and Path 4, which have alternating positive and negative returns during the first five days. These paths fall directly into the constant leverage trap and the highest volatility Path 4 is hurt the most when leverage is applied. Lower volatility path 1 and 2 deliver superior returns due to lower volatility regime

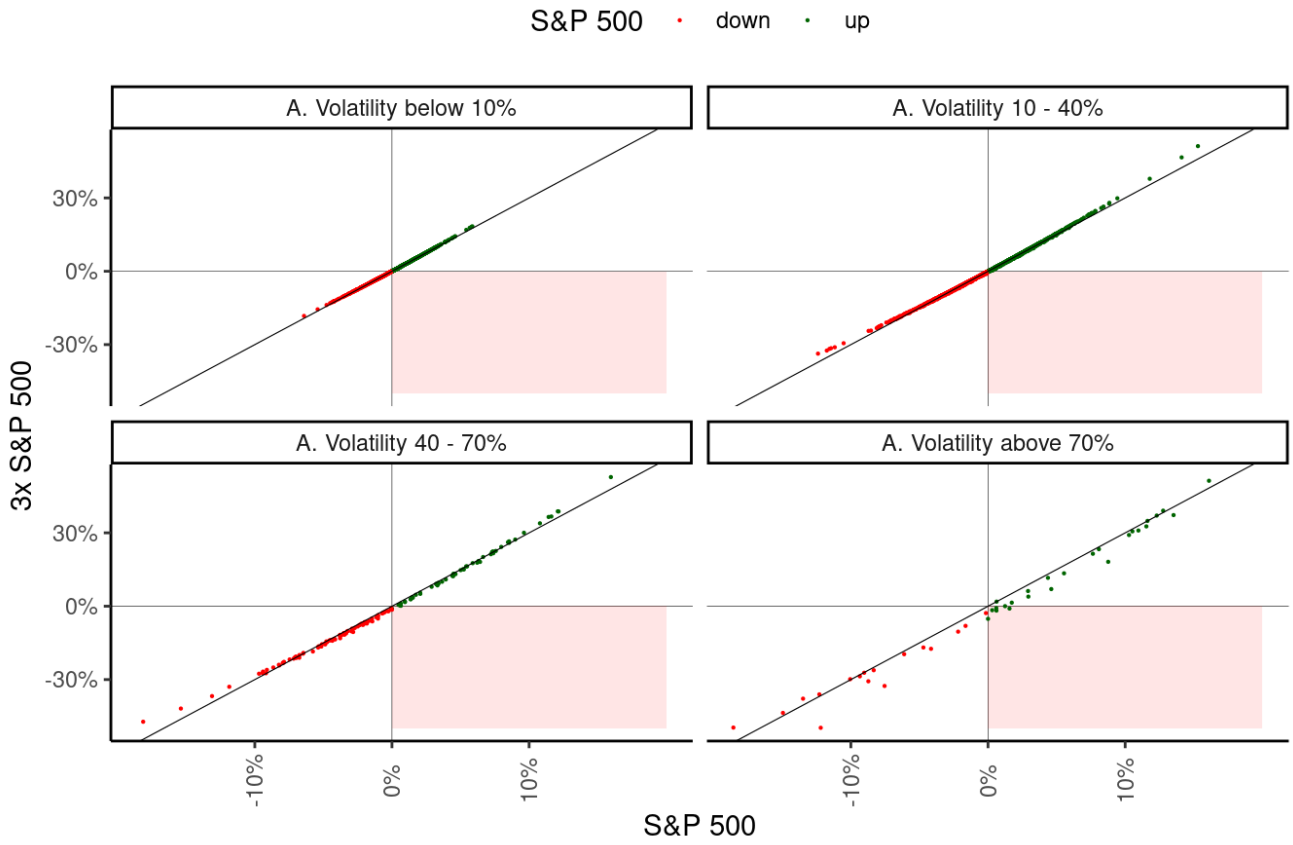
Table 3: S&P 500 vs. Daily Leveraged S&P 500 - Path Dependency, Volatility and Leverage								
S&P 500	**Day 1**	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**Day 6**	**Cumulative Return**	**Annualized Volatility**
Path 1	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	19.41%	0.00%
Path 2	2.00%	4.00%	2.00%	4.00%	2.00%	4.03%	19.41%	17.48%
Path 3	7.00%	-7.00%	7.00%	-7.00%	7.00%	12.70%	19.41%	131.21%
Path 4	14.00%	-14.00%	14.00%	-14.00%	14.00%	8.97%	19.41%	221.40%
2x S&P 500	**Day 1**	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**Day 6**	**Cumulative Return**	**Multiple of 1x**
Path 1	6.00%	6.00%	6.00%	6.00%	6.00%	6.00%	41.85%	2.16
Path 2	4.00%	8.00%	4.00%	8.00%	4.00%	8.06%	41.78%	2.15
Path 3	14.00%	-14.00%	14.00%	-14.00%	14.00%	25.40%	37.41%	1.93
Path 4	28.00%	-28.00%	28.00%	-28.00%	28.00%	17.95%	28.23%	1.45
3x S&P 500	**Day 1**	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**Day 6**	**Cumulative Return**	**Multiple of 1x**
Path 1	9.00%	9.00%	9.00%	9.00%	9.00%	9.00%	67.71%	3.49
Path 2	6.00%	12.00%	6.00%	12.00%	6.00%	12.09%	67.46%	3.48
Path 3	21.00%	-21.00%	21.00%	-21.00%	21.00%	38.10%	52.69%	2.71
Path 4	42.00%	-42.00%	42.00%	-42.00%	42.00%	26.92%	22.25%	1.15

The conclusion drawn from the fictitious return paths can be confirmed when looking at historical returns in the S&P 500. In weeks with low volatility (annualized below 10%), the compounded performance of the

3x daily leveraged approach largely follows the 3x of the weekly performance. This can be seen in Chart 1, where the return observations mostly lay on the diagonal with slope 3. For volatilities between 10 and 40%, still most observations lay on the diagonal, or in the extremes even above, meaning that the 3x leveraged path outperformed the unleveraged index by more than the leverage factor in up-weeks and less than the leverage factor in down-weeks. Therefore, below 40% volatility is the sweet spot for being daily-leveraged.

In weeks with volatility over 40%, many weekly 3x leveraged returns fall below the diagonal, meaning that they start to systematically underperform. In the volatility above 70% bin, this underperformance is yet amplified. Some positive returning weeks in the S&P 500 translate into negative performing weeks in the 3x leveraged, i.e. falling in the red-highlighted lower-right square in Chart 1. One of these extreme weeks has already been shown in Table 2.

Chart 1: Weekly Returns of the S&P 500 vs. 3x Leveraged



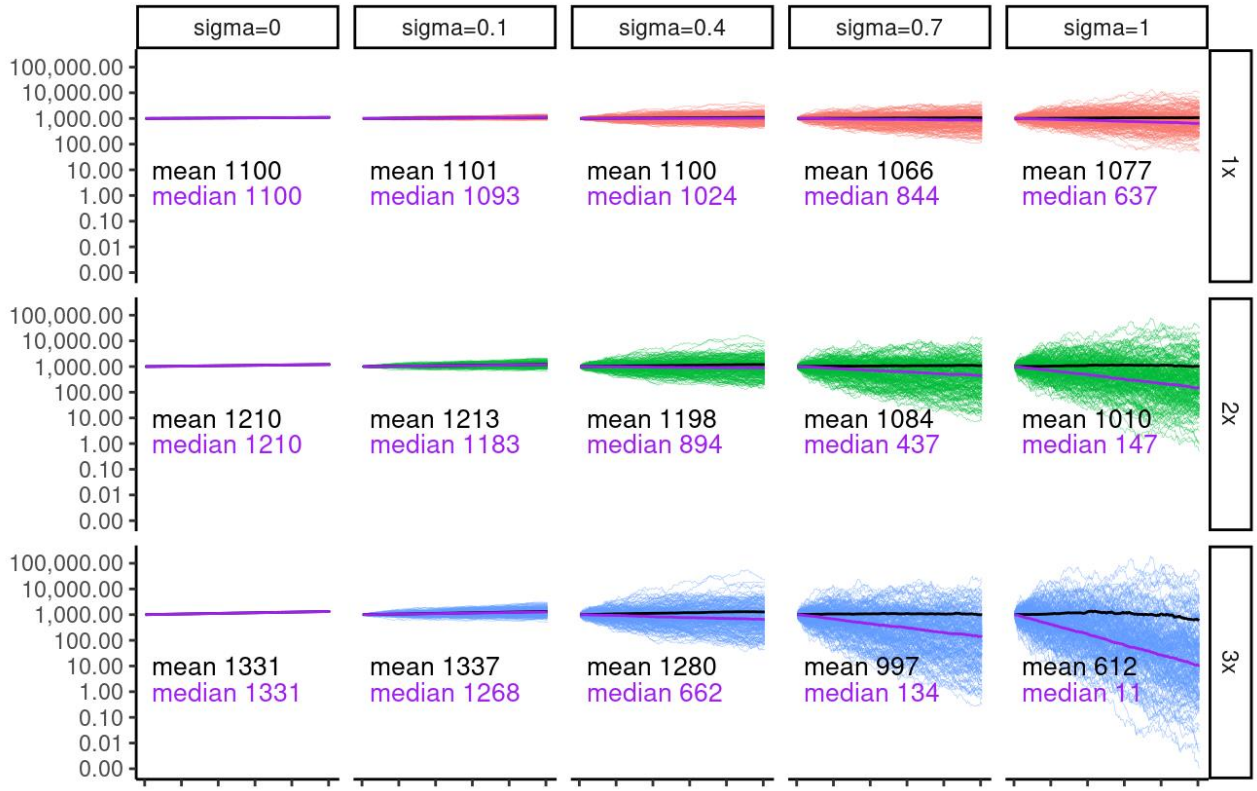
From the stylized facts, we see that while volatility hurts leverage, the relationship is non-linear, i.e. low volatility (below 40%) does not lead to much decay and is even beneficial to leveraged performance, while extreme volatility has a highly negative impact. Demonstrating this further are simulated normally-distributed returns over 252 trading days with each[11] simulation at five different volatility levels (0%, 10%, 40%, 70%, and 100%), and a mean of 10% (upward trend in the market). The results are shown in Chart 2.

[11] The Monte Carlo simulation uses 3,000 annual return paths for each volatility level, which results in 3.78 million random runs.

At low volatility levels, the decay is minimal, while at higher volatilities (above 40%), a daily leveraged strategy is very likely to lose over the course of a year.

Chart 2: Decay in Simulated Normally-Distributed Returns over 252 Days

Growth of initial $10,000, assuming an expected return of 10% and volatility sigma.



Notably, the chance of losing is higher than the chance of winning, as the mean is pushed up by fewer highly beneficial return paths. What is not captured in the simulations is empirically observed positive autocorrelation in daily returns, i.e. several up-days in a row, which leads to yet better performances at low-volatilities (see in Chart 6 that follows later).

Yet trending markets are paramount and volatility and streakiness are related as we will show in the next section. The reason for this in our view is behavioral. High volatility environments tend to be characterized by investor overreaction which is more prone to back-and-forth market movement. In contrast, low volatility environments are more consistent with investor underreaction which in turn results in more streaks or consecutive up days. The autocorrelation exhibited by stocks in low volatility regimes is an important precondition for leveraged strategies to perform well in, as streaks present themselves and leverage best takes advantage of them.[12] As we have shown in this section looking at only six trading days, different return scenarios can have a large impact on how cumulative returns look. As such, during considerably longer stretches of time than those illustrated here, path dependency and volatility only heightens the disparity among path scenarios.

[12] As referenced in Grinblatt and Moskowitz (2000), autocorrelation across various horizons is well documented throughout academic literature looking at market momentum and trend persistence.

The conclusion here is that the popular belief that leveraging results in decay over time is a myth, as performance over time has nothing to do with time itself, but rather: 1) the behavior of the underlying asset in its overall trend, 2) the path of daily returns (streaks versus seesawing action), and 3) whether the regime under which leverage is utilized is high or low volatility. Given that higher volatility is the enemy of leverage precisely because of the constant leverage trap, we next examine a systematic way of identifying lower volatility regimes with higher streak potential.

The Trend is Your [Downside Protection] Friend

While smoothing out a data series in statistics may not seem like anything groundbreaking, in the world of investing not a day goes by where the market's Moving Average isn't referenced. The first analysis of Moving Averages in the stock market dates all the way back to 1930.[13] In their seminal work, "Technical Analysis of Stock Trends," Edwards and Magee refer to the Moving Average as a "fascinating tool" that "has real value in showing the trend of an irregular series of figures (like a fluctuating market) more clearly."[14] They go on to define "uptrends" as periods when the price "remains above the Moving Average Line" and "downtrends" as periods when the price "remains below the Moving Average." As the saying goes, the trend is your friend until it ends, and Moving Averages are among the most popular ways of systematically identifying whether stocks are in an uptrend, or downtrend.[15]

Despite the popular notion that Moving Averages can help an investor make more money by participating in an uptrend, empirical testing suggests this view is not entirely accurate. A trading rule which buys the S&P 500 Index above its 200-day Moving Average and sells the S&P 500 Index (rotating into 3-month Treasury bills) below its 200-day Moving Average illustrates this point. If Moving Averages were about upside returns, they should have resulted in significant outperformance during powerful bull markets like those experienced in the 1990s, 2002 through 2007, and 2009 through 2018.[16]

As shown in Table 4, however, using a simple 200-day Moving Average strategy in these uptrending, Bull Market periods underperforms a buy and hold approach. This analysis assumes no cost to execute.

The differential between the two increases once commissions, slippage, and taxes are incorporated, suggesting the Moving Average strategy in practice would likely significantly underperform.

Table 4: S&P 500 vs. S&P 500 200-day Moving Average Rotation (Selected Bull Markets)

Bull Markets	Cumulative Return	
Time Period	**S&P 500**	**200-day MA Rotation**
Oct 12, 1990 - Jul 17, 1998	390.3%	303.1%
Oct 10, 2002 - Oct 09, 2007	120.6%	42.9%
Mar 10, 2009 - Sep 20, 2018	428.8%	164.4%
Mar 24, 2020 - Dec 31, 2020	70.2%	26.9%

[13] See Gartley (1930).

[14] See Edwards, Magee and Bassetti (2007).

[15] While there are various types of Moving Average (Simple, Exponential, Weighted, etc.), we limit our focus in this paper to the simplest and most frequently used form: the Simple Moving Average. A Simple n-day Moving Average is the unweighted mean of the prior n days. We use daily closing prices of the total return series to calculate the Moving Average for the S&P 500.

[16] All data and analysis presented is total return, inclusive of dividends and interest payments. Source for Treasury bill data: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.

If it's not about outperforming on the upside, what is the true value using Moving Averages to "follow the trend?" As Jeremy Siegel notes in "Stocks for the Long Run," the "major gain of the [Moving Average] timing strategy is a reduction in risk."[17] We can see this in Table 5 which shows how the same strategy performed during Bear Market periods. The outperformance here is substantial, indicating that the Moving Average is more about downside protection than upside participation.

Table 5: S&P 500 vs. S&P 500 200-day Moving Average Rotation (Selected Bear Markets)		
Bear Markets	**Cumulative Return**	
Time Period	**S&P 500**	**200-day MA Rotation**
Sep 16, 1929 - Jun 01, 1932	-86.0%	-14.7%
Mar 24, 2000 - Oct 09, 2002	-47.4%	-12.7%
Oct 09, 2007 - Mar 09, 2009	-54.9%	-9.1%
Feb 19, 2020 - Mar 23, 2020	-33.5%	-16.9%

A Non-Random Walk Down Wall Street

Beyond being an effective risk management tool, Moving Averages also provide important clues about stock market behavior. If stock prices moved in a "random walk" as was asserted by Samuelson and others, trends would not persist and there would be no differentiation in behavior above and below Moving Averages.[18] We find that is not the case, affirming the work of Lo and MacKinlay in a "NonRandom Walk Down Wall Street."[19]

Chart 3 shows the annualized volatility of the S&P 500 Index above and below various popular Moving Average time periods, going back to October 1928. As confirmed by Monte Carlo simulations, irrespective of which Moving Average interval is used, the underlying finding remains the same: when stocks trade below their Moving Average, volatility going forward is considerably higher than when stocks trade above their Moving Average.[20]

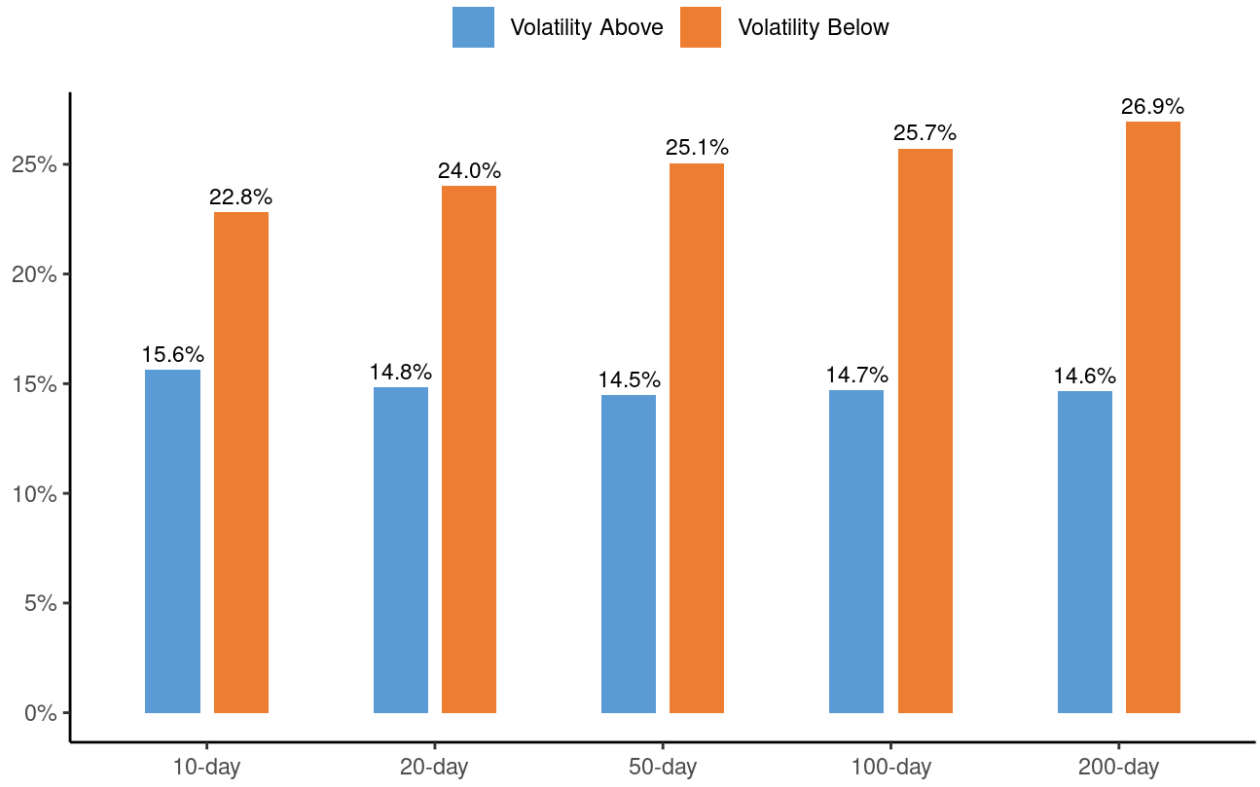
[17] See Siegel (1998). See also Faber (2006) which notes a similar finding when Moving Average timing is applied to Tactical Asset Allocation.

[18] See Samuelson (1965).

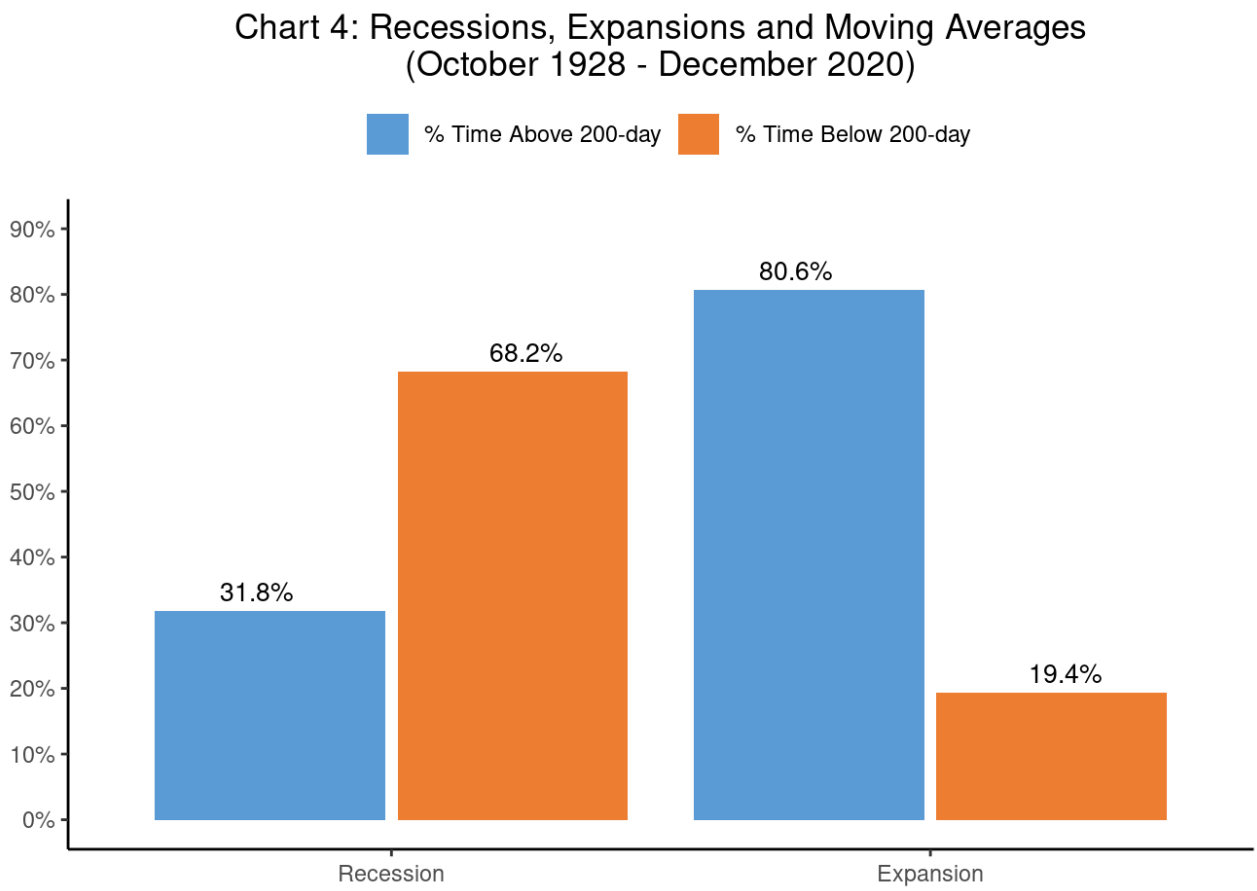
[19] See Lo and MacKinlay (2002).

[20] We observe a similar phenomenon in other markets, including Small Cap stocks, Commodities and High Yield Bonds. The Russell 2000 Index has an annualized volatility of 14.8% above its 200-day moving average versus 28.6% below it (1979-2020). The Bloomberg Commodity Index has an annualized volatility of 13.9% above its 200-day Moving Average versus 15.2% below it (1994-2020). The Bloomberg Barclays US Corporate High Yield Index has an annualized volatility of 3.6% above its 200-day Moving average versus 8.5% below it (1998-2020).

Chart 3: S&P 500 Annualized Volatility Above/Below Moving Averages
(October 1928 - December 2020)

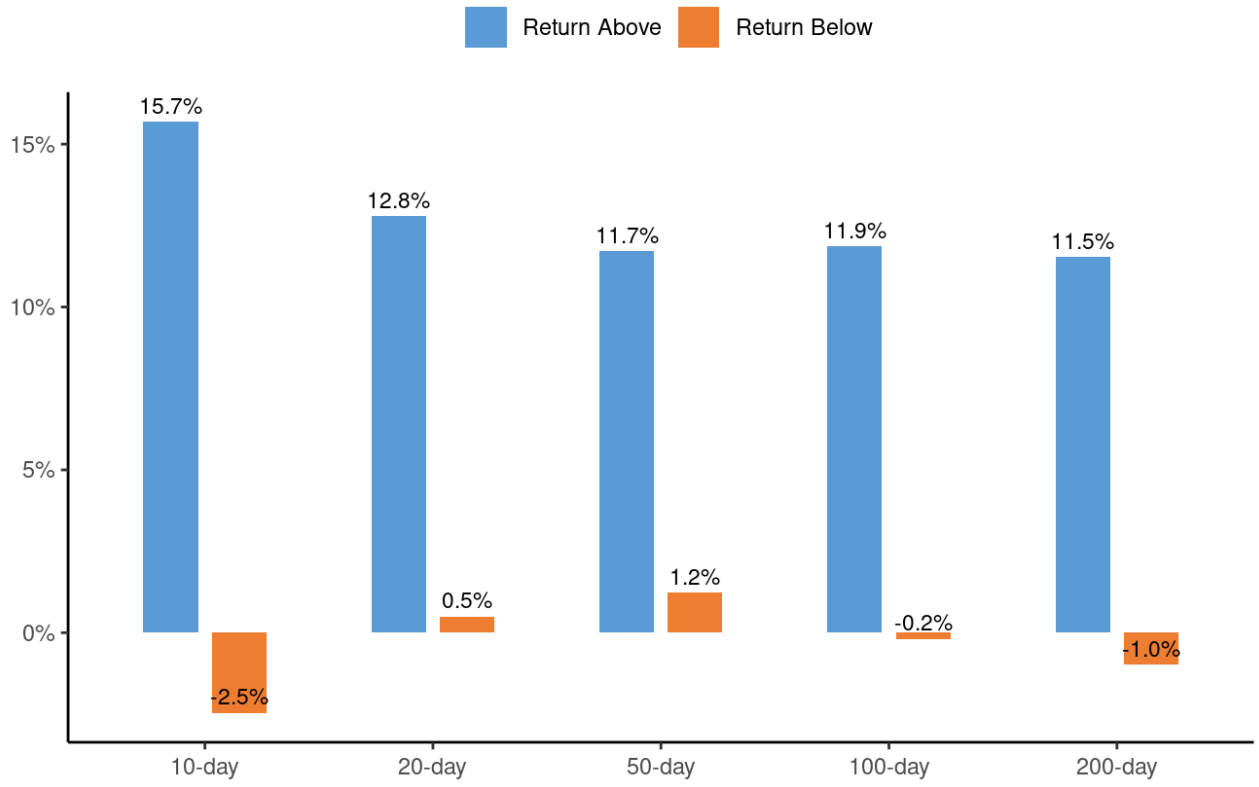


We propose that there is a fundamental underpinning to this stark differentiation in behavior. Since 1928, the U.S. economy has experienced 15 recessions, spending approximately 18% of the time in contraction. In Chart 4, we see that during these recessionary periods, the S&P 500 has traded below its 200-day Moving Average 68.2% of the time versus only 19.4% of the time during expansions. Meanwhile, during expansionary periods the S&P 500 has traded above its 200-day Moving Average 80.6% of the time versus only 31.8% of the time in recession. The uncertainty in growth and inflation expectations that coincides with periods of economic weakness is in our view what leads to investor overreaction and increased beta volatility.



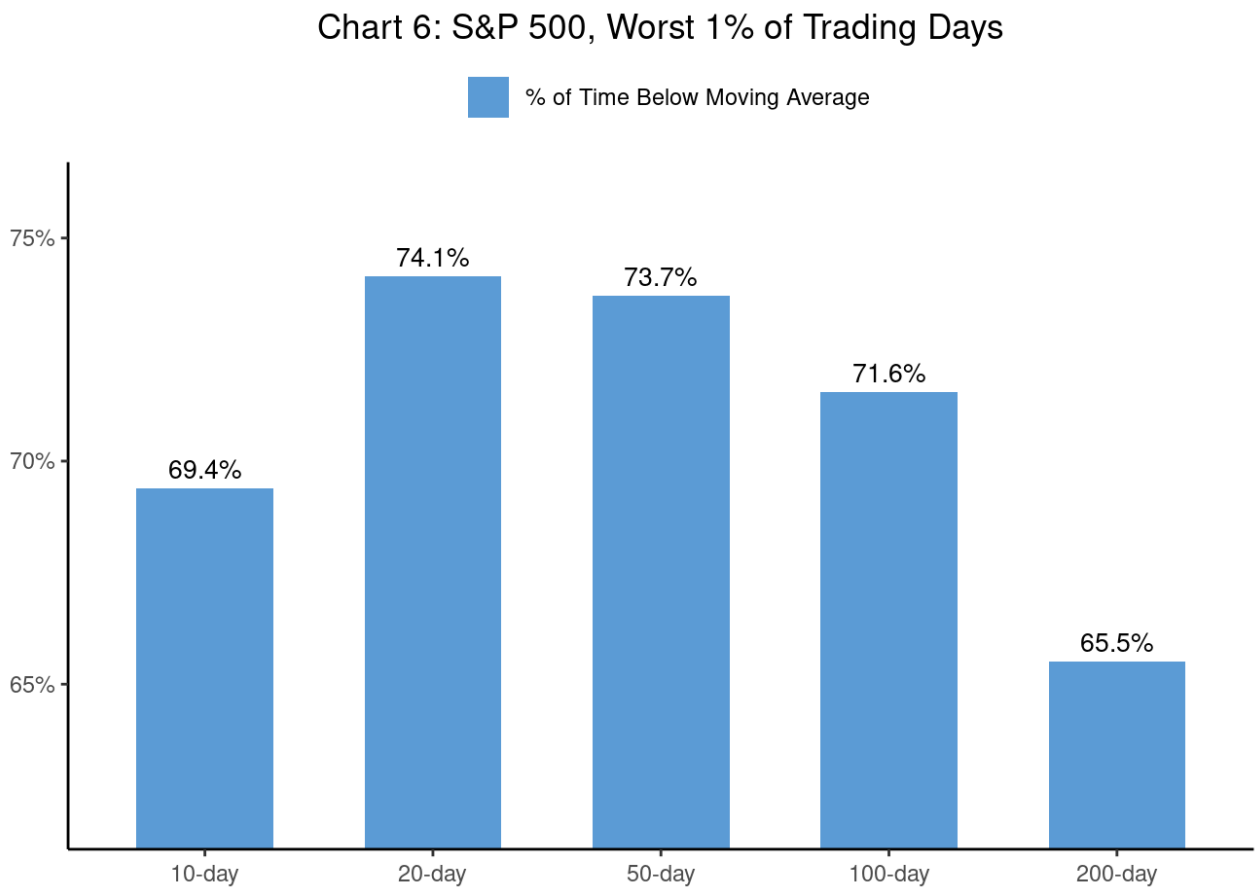
This is important because high volatility and uncertainty have not typically been constructive for equity markets. We can observe this tendency in Chart 5 which shows the significant disparity in S&P 500 returns between periods when it is above and below various Moving Averages.

Chart 5: S&P 500 Annualized Excess Return Above/Below Moving Averages
(October 1928 - December 2020)

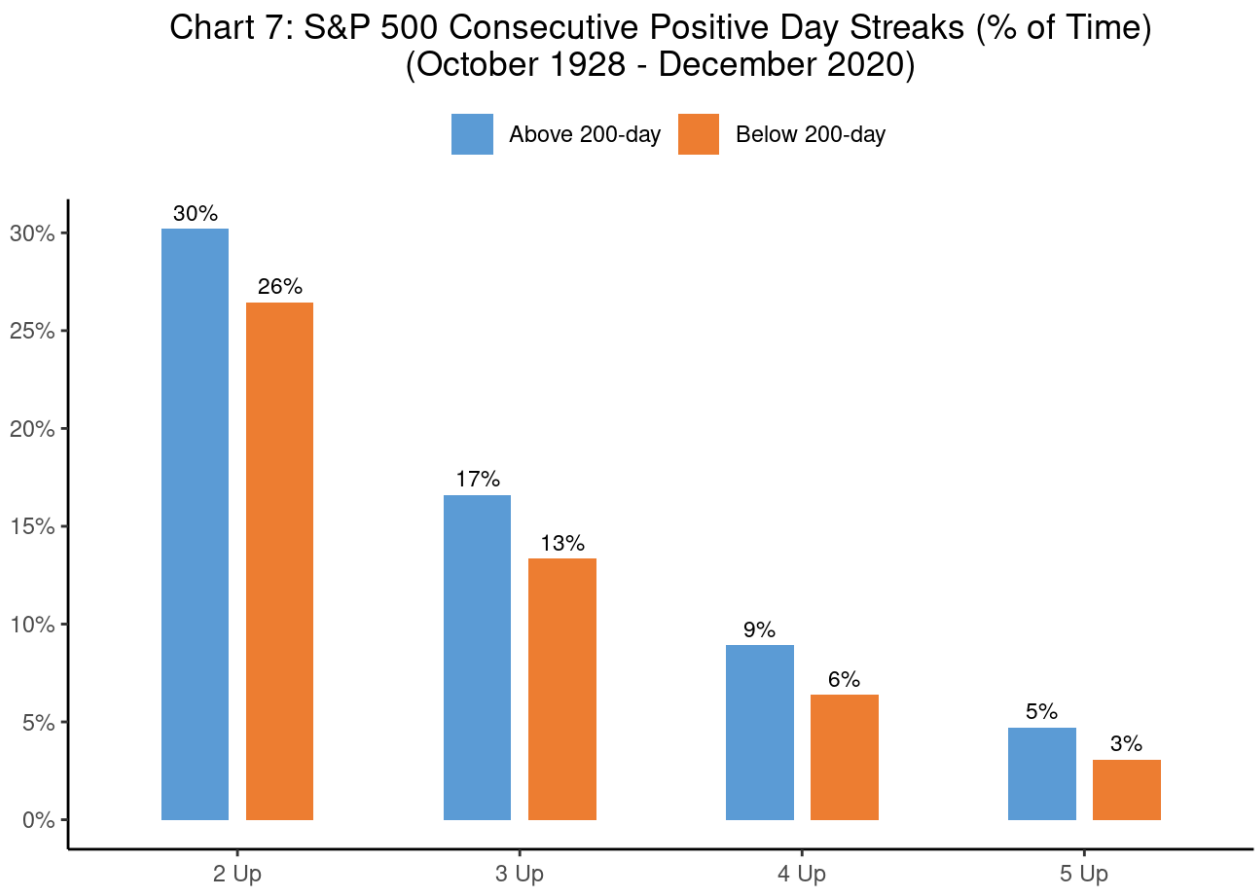


Viewing the Moving Average as a volatility indicator more so than a trend identifier helps explain how Moving Average strategies can underperform in strong equity bull markets. If the market is in an unrelenting up phase, a decline below the Moving Average results in a sell trigger which ends up being a false positive, resulting in missing out on subsequent returns for that moment in time. Over the course of a full economic and market cycle, however, where uptrends are interrupted by periods of higher volatility, the Moving Average can help limit equity exposure to environments which most favor return generation. The key component to exploiting the Moving Average in strategy form is less about being exposed to equities above it, but rather in avoiding higher equity volatility below it.

More so than that, Moving Averages can help investors mitigate the potential for loss aversion to result in sub-optimal portfolio decision making. Chart 6 shows that historically, the worst 1% of trading days have occurred far more often than not below the Moving Average. Included in this list are the two worst days in market history: October 19th in 1987 and October 28th in 1929. Entering both of these historic days, the market was already trading below all of its major Moving Averages (10-day through 200-day). While not of use for true buy and hold investors with an infinite time horizon, to the extent that Moving Averages can help sidestep such extreme down days, the power of the indicator remains in mitigating downside more so than participating in the upside.



Extreme down days are consistent with investor fear and overreaction, while gradual movements higher are characterized by investor underreaction which is well documented in academic literature related to behavioral finance. Important to this dynamic is the likelihood of consecutive up days depending on whether the market is above or below its Moving Average. Chart 7 illustrates that the S&P 500 is more likely to experience consecutive up days when it is above its Moving Average than below it.



This suggests that we should view the stock market as not simply being in a trend when above the Moving Average, but rather in an environment which favors lower volatility and higher potential for consecutive positive returns. These are the two characteristics which are of critical importance for a strategy which utilizes leverage.

The Leverage Rotation Strategy

We have established that leverage performs best when in a low volatility environment with a higher probability of positive performance streaks. By extension, it performs worst during periods of extreme volatility and choppier asset class behavior.

With this knowledge, our systematic Leverage Rotation Strategy ("LRS") is as follows:

> *When the S&P 500 Index closes above its Moving Average, rotate into the S&P 500 and use leverage to magnify returns.*
>
> *When the S&P 500 Index closes below its Moving Average, rotate into Treasury bills to manage risk.*

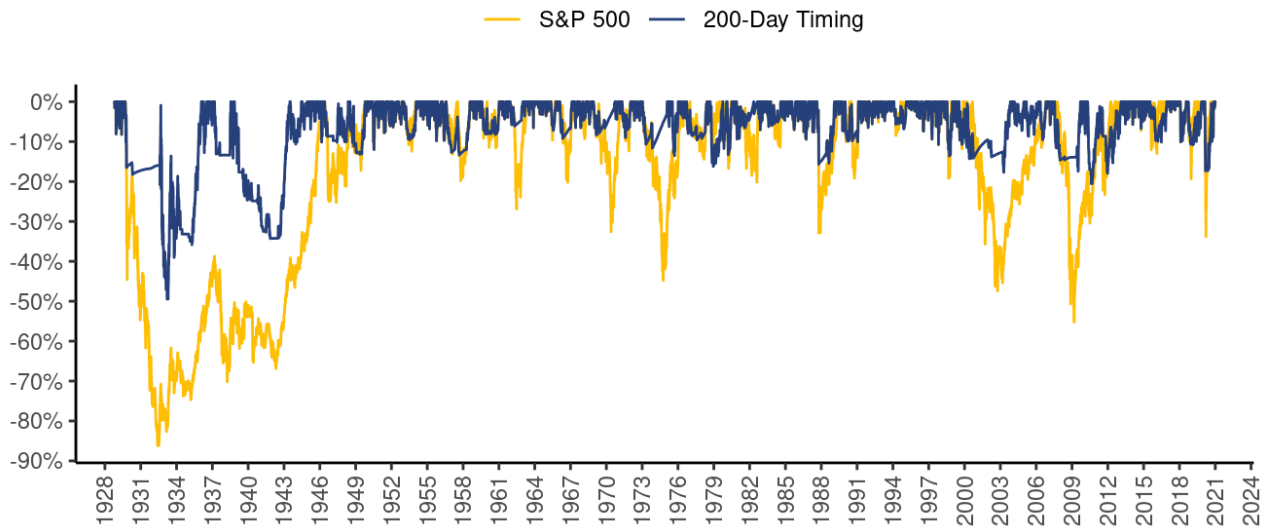
Before illustrating the results of the LRS, it is important to examine how an unleveraged timing strategy based on the Moving Averages alone performs going back to 1928. The data is summarized in Table 6. Note that the Moving Average rule results in higher risk-adjusted performance and lower drawdowns versus buy and hold, generating significant positive alpha in all Moving Average periods examined (10 through 200-day).

Table 6: Unleveraged Buy and Hold versus Unleveraged Moving Average Timing (October 1928 – December 2020)						
Metric	**S&P 500**	**10-Day**	**20-Day**	**50-Day**	**100-Day**	**200-Day**
Annual Return	9.4%	11.7%	10.4%	10.2%	10.7%	10.9%
Annual Volatility	18.9%	12.0%	11.6%	11.6%	12.1%	12.4%
Sharpe Ratio	0.32	0.68	0.6	0.58	0.59	0.59
Sortino Ratio	0.57	1.07	0.93	0.89	0.91	0.9
Max Drawdown	-86.2%	-49.5%	-46.6%	-46.6%	-46.5%	-49.5%
Beta	1	0.4	0.38	0.38	0.41	0.43
Annual Alpha	0.0%	5.3%	5.4%	5.2%	6.4%	5.7%
Avg Trades/Year	0	38	26	15	10	5

The key finding here is not about absolute return but risk-adjusted performance. To further illustrate this point, the Moving Average rule beats buy-and-hold in absolute performance in only 49% of rolling 3-year periods.[21] This is due to the fact that Moving Averages can whipsaw market participants in sideways or trendless periods. However, the true value here is in terms of risk-adjusted outperformance, where the Moving Average rule generates positive alpha in 69% of rolling 3-year periods.[22]

This is of critical importance because of the unspoken flaw in buy and hold: that almost nobody holds through large drawdowns. Chart 8 illustrates drawdowns since 1928 in the S&P 500 (yellow line) and the 200-day timing strategy (blue line). During all large Bear Markets, the 200-day strategy significantly truncates the downside. This is the major value in the Moving Average: minimizing risk and increasing the likelihood of sticking with a strategy over time.

Chart 8: S&P 500 vs. 200-Day Timing, Rolling Drawdown



[21] Average of outperformance using 10-day, 20-day, 50-day, 100-day and 200-day Moving Averages.

[22] Average of rolling alpha using 10-day, 20-day, 50-day, 100-day and 200-day Moving Averages.

While unleveraged strategies using the Moving Average as a timing indicator suggest one can achieve similar returns to buy-and-hold over time but with less volatility and drawdown, the question of how to generate higher returns using the market itself can only be answered with leverage.

From October 1928 through December 2020, a buy and hold strategy using leverage (with a 1% annual expense) significantly outperforms the unleveraged strategy. There is no free lunch here, though, as the annualized volatility is multiples of the unlevered index, leading to inferior risk-adjusted performance and larger drawdowns (see Table 7).

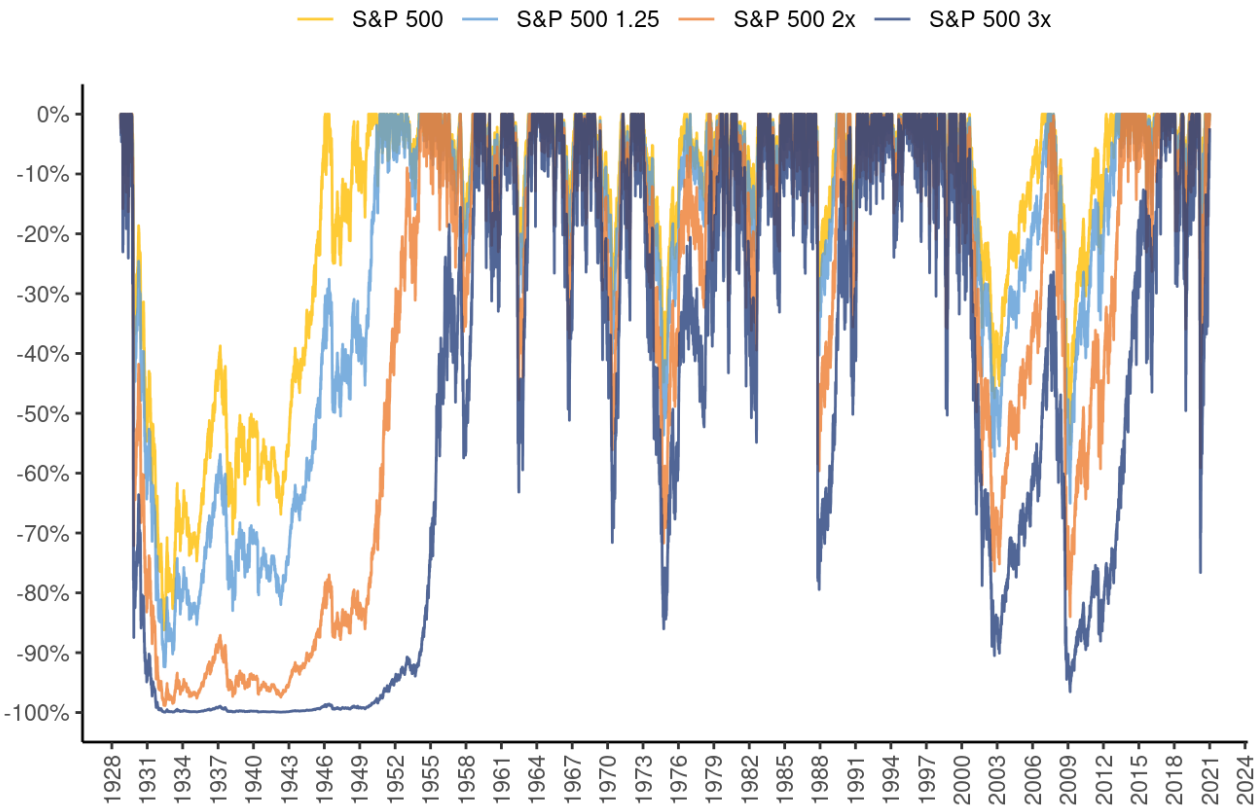
Table 7: Unleveraged Buy and Hold versus Leveraged Buy and Hold

Metric	S&P 500	S&P 500 1.25	S&P 500 2x	S&P 500 3x
Annual Return	9.5%	10.2%	14.4%	16.3%
Annual Volatility	18.9%	23.6%	37.8%	56.7%
Sharpe Ratio	0.32	0.29	0.29	0.22
Sortino Ratio	0.57	0.56	0.66	0.71
Max Drawdown	-86.2%	-92.4%	-98.8%	-99.9%
Beta	1	1.25	2	3
Annual Alpha (weekly)[22]	0.0%	-1.1%	-1.5%	-2.4%

While an annualized return of 16.3% for the 3x strategy sounds irresistible, the reality is that few would have stuck with a return path that incurred multiple 50+% drawdowns over time (see our discussion in the later Part "Risk of Ruin"). Leveraged buy and hold, then, only magnifies that major flaw of buy and hold. We can this more clearly in Chart 9.

[22] The alpha computed on daily returns is naturally zero, however various compounding periods generally lead to negative alphas of different amplitude. The alpha on weekly performances is reported here. The beta also deviates from the leverage factor, and one generally ends up with a lower beta than the leverage factor over the long run. On a weekly basis, the beta deviation is small.

Chart 9: S&P 500 vs. Leveraged S&P 500, Rolling Drawdown



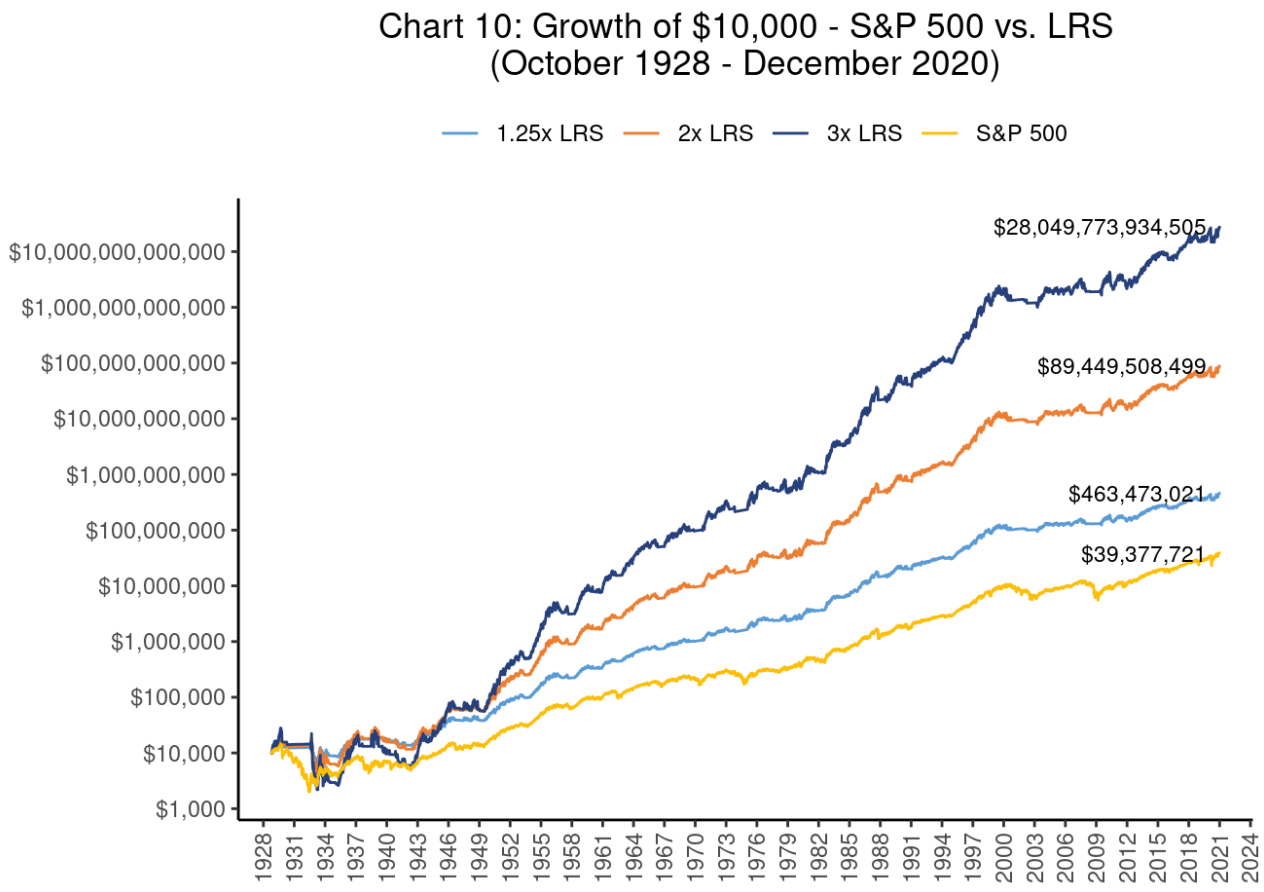
Alternatively, by implementing the Leverage Rotation Strategy, we can harness the power of leverage while increasing the odds of an investor sticking to the strategy over time. Although shorter Moving Average periods achieve similarly strong results, we will narrow our focus here to the 200-day Moving Average as it incurs the fewest transaction costs (average of 5 rotations per year) and is most applicable in time frame to both traders and investors. We will also assume for the purposes of this section a leverage fee of 1% per year, which approximates the current expense ratio for the largest leveraged ETFs.[23]

As shown in Table 8, as compared to a buy and hold of the S&P 500 and leveraged buy and hold, the LRS achieves: 1) improved absolute returns, 2) lower annualized volatility, 3) improved risk-adjusted returns (higher Sharpe/Sortino), 4) lower maximum drawdowns, 5) reduced Beta, and 6) significant positive alpha.

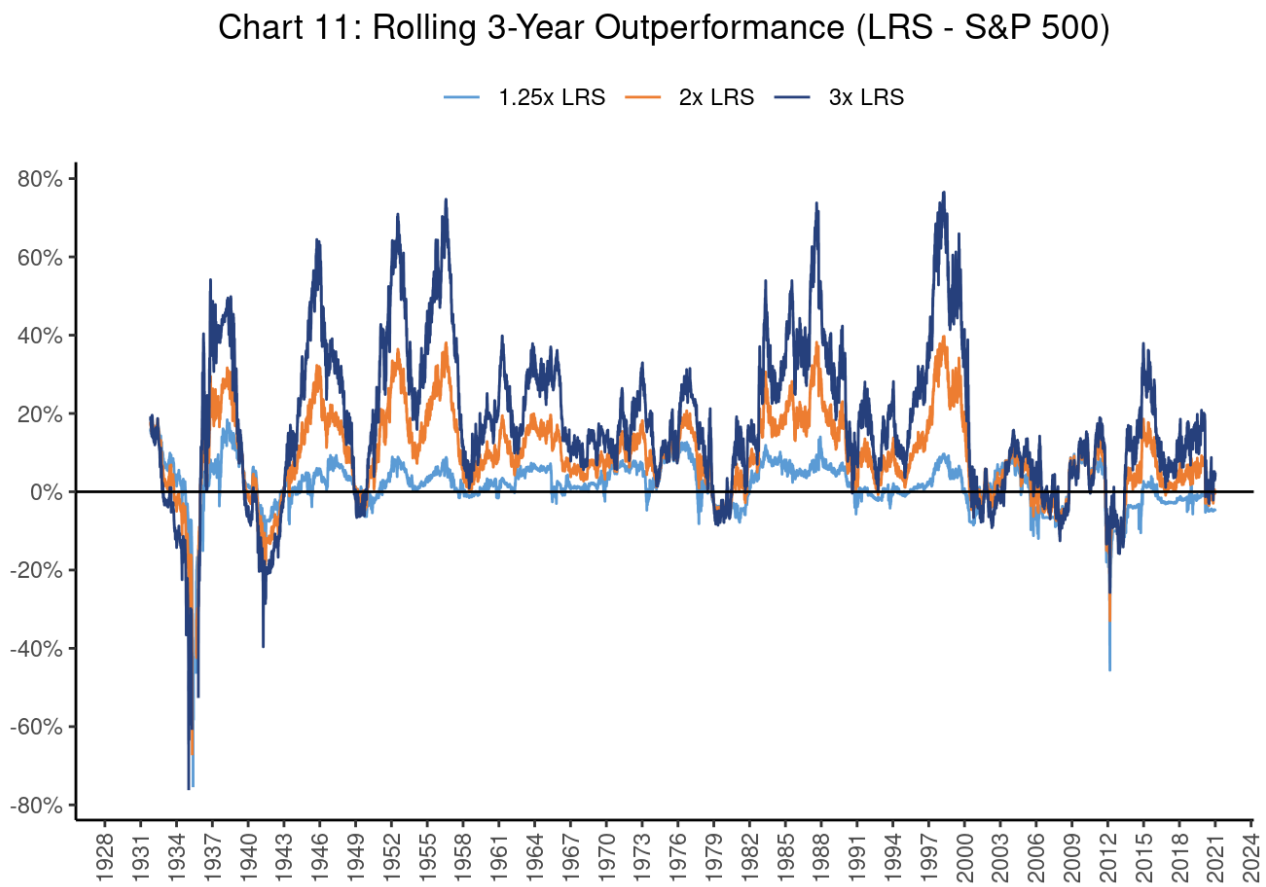
[23] As of 2021, the largest leveraged S&P 500 ETF has an expense ratio of 0.95%.

Table 8: Unleveraged Buy and Hold versus Leveraged Rotation Strategies (Oct 1928 – Dec 2020)							
Metric	**S&P 500**	**S&P 1.25x**	**S&P 2x**	**S&P 3x**	**S&P 1.25x (200-d LRS)**	**S&P 2x (200-d LRS)**	**S&P 3x (200-d LRS)**
Annual Return	9.4%	10.2%	14.3%	16.2%	12.4%	19.0%	26.7%
Annual Volatility	18.9%	23.6%	37.8%	56.7%	15.5%	24.9%	37.3%
Sharpe Ratio	0.32	0.28	0.28	0.22	0.57	0.61	0.61
Sortino Ratio	0.57	0.56	0.65	0.71	0.89	0.99	1.05
Max Drawdown	-86.2%	-92.4%	-98.8%	-99.9%	-59.0%	-78.7%	-92.2%
Beta	1	1.25	2	3	0.54	0.86	1.3
Annual Alpha	0.0%	-1.0%	-1.0%	-1.0%	6.4%	11.0%	17.5%
Avg Trades/Year	0	0	0	0	5	5	5

Chart 10 displays the growth of $10,000 from October 1928 through December 2020. A buy and hold of the S&P 500 grows to over $39 million while the 1.25x, 2x and 3x LRS grow to over $463 million, $89 billion and $28 trillion respectively.



In Chart 11, we see that this outperformance is consistent over time and through multiple economic and financial market cycles. On average, the LRS outperforms the S&P 500 in 80% of rolling 3-year periods.



We also see in Table 9 that during the four worst bear markets in U.S. history, all of the Leverage Rotation Strategies have a lower maximum drawdowns than an unleveraged buy and hold of the S&P 500.

Table 9: Maximum Drawdown during Bear Markets, S&P 500 vs. LRS

Peak	Trough	S&P 500	1.25x LRS	2x LRS	3x LRS
09/17/1929	01/06/1932	-86.2%	-22.9%	-35.3%	-49.6%
12/01/1973	03/10/1974	-44.8%	-15.4%	-25.1%	-36.6%
05/09/2000	09/10/2002	-47.4%	-9.4%	-17.5%	-27.3%
10/10/2007	09/03/2009	-55.2%	-13.4%	-21.3%	-31.1%
02/20/2020	03/23/2020	-33.8%	-21.3%	-32.1%	-44.7%

Another way to view the power of minimizing drawdowns is in the time it takes to reach new highs after a Bear Market. If we look at the worst Bear Markets in history, the LRS reaches new highs ahead of buy and hold in every example, from 1.25x through 3x. After peaking in September 1929, a buy and hold of the S&P 500 did not reach new highs until 1946, while the 1.25x and 2x LRS reached new highs ten years earlier, in 1936. Using constant leverage, the 3x S&P 500 without a rotation strategy reached new highs after both the 2000-02 and 2007-09 Bear Markets only in December 2016 respectively in October 2014 (see Table 10), illustrating the strong need for timing leverage in different volatility regimes. Unlike in previous corrections, after the low in March 2020, the LRS took longer to catch up to previous heights, avoiding much of the volatility of 2020. The 2020 volatilities of all LRS were about half the volatilities of their buy and hold counterparts, at the cost of slightly reduced returns (the 2x S&P 500 gained +22.6% at an

annualized volatility of 68.9% versus the 2x LRS +16.9% at 34.2% volatility, and the 3x +12.5% at 103.3% volatility versus the 3x LRS +21% at 51.3% volatility).

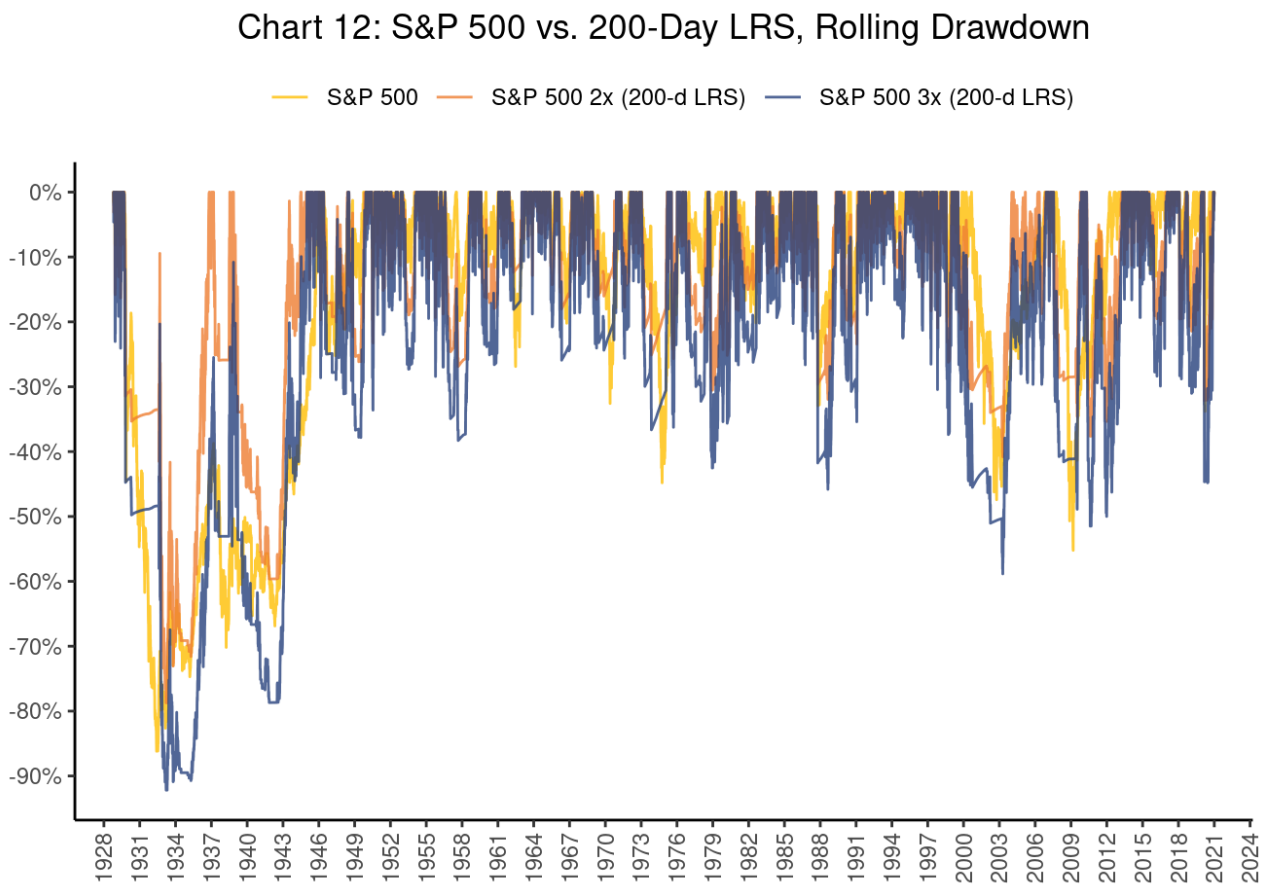
Table 10: Bear Markets and New High Dates, S&P 500 vs. LRS					
Worst 4 Bear Markets	New Highs By				
Bear Market Period	Bull Market Peak	S&P 500	S&P 1.25x	S&P 2x	S&P 3x
1929-32 (Buy and Hold)	09/16/1929	01/28/1946	09/18/1950	03/18/1954	10/07/1958
1929-32 (200-day LRS)	09/16/1929	01/31/1936	04/02/1936	10/30/1936	01/08/1945
1973-74 (Buy and Hold)	01/11/1973	07/09/1976	12/31/1976	08/04/1978	08/10/1979
1973-74 (200-day LRS)	01/11/1973	02/05/1975	02/13/1975	03/04/1975	03/17/1975
2000-02 (Buy and Hold)	03/24/2000	10/23/2006	04/20/2007	08/01/2013	12/08/2016
2000-02 (200-day LRS)	03/24/2000	11/03/2003	12/18/2003	01/05/2004	01/21/2004
2007-09 (Buy and Hold)	10/09/2007	04/02/2012	02/08/2013	08/01/2013	10/31/2014
2007-09 (200-day LRS)	10/09/2007	08/21/2009	08/21/2009	09/08/2009	09/10/2009
2020 (Buy and Hold)	02/19/2020	08/10/2020	08/24/2020	09/02/2020	N/A
2020 (200-day LRS)	02/19/2020	11/16/2020	11/16/2020	12/01/2020	12/04/2020

Risk of Ruin

Leverage bears the risk of substantial loss and possible total ruin. As was shown in Table 7, following a buy-and-hold strategy using daily leverage resulted in a maximum drawdown in April 1942 of -99.9% for the 3x and -98.8% for the 2x. An investment of $10,000 using the 3x buy-and-hold at the all-time-heigh in September 1929 would have dropped to just $5.74 by 1942, a theoretical amount, as an investor would most probably have given up long before reaching that. Only by January 1960 the 3x investment would have recovered to the initial $10,000 (which required an incredible gain of 174,037%), and by December 2020 the value would reach $3,6 billion, outperforming the unleveraged by more than the leverage factor..If an investor abandons a strategy given a loss that exceeds his drawdown tolerance, this strategy fails, even if in hindsight massive gains were to come. For many investors, the down tolerance might be related to the initial investment, e.g. -50%, -70%, or -90%. Once below, the investor abandons, and any chance of recovery disappears.

Logically, the chance of running into ruin is the highest when investing at all-time-height, just before a correction. This is even amplified when applying leverage just before a correction. This is what is seen in the drawdowns in Chart 9. The 3x leveraged S&P 500 fell below -90% from October 1930 to March 1954, in October 2002, and October 2007 to August 2008. Other major drawdowns occurred in 1974 (-86%), and 1987 (-79%), as seen in the introduction, mainly driven by the high volatility effect.

The proposed Moving Average based LRS aims to avoid the extreme corrections, i.e. reducing the drawdowns. The 3x LRS has extreme drawdowns similar to the unleveraged S&P 500, while the 2x LRS generally shows maximum drawdowns not exceeding the S&P 500. This is seen in Chart 12 (and in Tables 9 and 10).



Modern Day Implementation

Going back to 1928, executing the Leverage Rotation Strategy as outlined would have been hampered by higher transaction costs, increased slippage, and higher costs of leverage. In today's market, all of these issues have been minimized. Transaction costs and slippage are considerably less and the cost of leverage has decreased substantially, and most importantly, one is not required to re-leverage daily manually, as there are daily-leveraged products available. Currently, the lowest cost and most efficient way to replicate the strategies discussed in this paper (for most investors) are through S&P 500 leveraged ETFs.

The results for the 200-Day Moving Average LRS using leveraged ETFs (2x SSO and 3x UPRO) are given in Tables 11 and 12. Different than discussed, we hold cash during risk-off periods (and not a T-Bill tracking product, e.g. the 1-3 Month Treasury ETF "BIL").

The performance figures are slightly below the theoretical computed performances using the S&P 500 index total returns, likely due to a negative leverage premium (performance lag) in the leveraged ETFs. Still and as argued before, all metrics show a clear risk-adjusted improvement over a buy-and-hold leveraged strategy.

Table 11: Unleveraged Buy and Hold versus Leveraged Rotation Strategies using Leveraged ETFs (Jul 2006 – Dec 2020)					
Metric	**S&P 500**	**S&P 500 2x**	**SSO**	**S&P 500 2x (200-d LRS)**	**SSO (200-d LRS)**
Annual Return	10.1%	15.1%	13.2%	14.6%	13.2%
Annual Volatility	20.5%	41.0%	39.9%	23.6%	23.4%
Sharpe Ratio	0.44	0.34	0.3	0.57	0.52
Sortino Ratio	0.73	0.73	0.68	0.89	0.81
Max Drawdown	-55.2%	-83.9%	-84.7%	-37.6%	-37.5%
Beta	1	2	1.94	0.66	0.65
Annual Alpha	0.0%	-1.0%	-1.0%	11.6%	11.0%

Table 11: Unleveraged Buy and Hold versus Leveraged Rotation Strategies using Leveraged ETFs (Jul 2009 – Dec 2020)									
Metric	**S&P 500**	**S&P 500 2x**	**SSO**	**S&P 500 3x**	**UPRO**	**S&P 500 2x (200-d LRS)**	**SSO (200-d LRS)**	**S&P 500 3x (200-d LRS)**	**UPRO (200-d LRS)**
Annual Return	15.3%	27.7%	26.4%	38.3%	35.4%	18.4%	17.4%	26.3%	24.2%
Annual Volatility	17.5%	34.9%	34.6%	52.4%	51.9%	24.7%	24.5%	37.1%	36.8%
Sharpe Ratio	0.85	0.77	0.75	0.72	0.67	0.72	0.68	0.69	0.64
Sortino Ratio	1.23	1.21	1.17	1.23	1.17	1.07	1.02	1.1	1.03
Max Drawdown	-33.8%	-59.1%	-59.3%	-76.6%	-76.8%	-37.6%	-37.5%	-51.5%	-51.2%
Beta	1	2	1.98	3	2.96	1	0.99	1.5	1.48
Annual Alpha	0.0%	-1.0%	-1.2%	-1.0%	-1.6%	5.4%	5.1%	8.7%	8.0%

Conclusion

Since 1928, the highest source of real returns in any asset class by far has come from the stock market. This is true in spite of the Great Depression of 1929 through 1933 and in spite of the 13 recessions thereafter. Through wars, disasters and political turmoil, stocks have been the best vehicle to not only keep up with inflation but far surpass it.

The tremendous wealth generation from stocks over this period, averaging over 9% annualized returns, makes a buy and hold strategy of the S&P 500 extremely difficult to beat. Beyond this, the Efficient Market Hypothesis maintains that it is impossible to consistently outperform the market while Random Walk theory asserts using technical indicators is futile. Finally, the CAPM states that the only way to achieve a higher return is to take more risk.

We challenge each of these theories in this paper. First, we illustrate that Moving Averages and trends contain important information about future volatility and the propensity for streaks in performance. Next, we show that using Moving Averages to time the market achieves a similar to higher return with less risk.

Lastly, we show Leverage Rotation Strategies which use a systematic rule to consistently outperform the market over time.

The key to this outperformance is understanding the conditions that help and hurt leverage in the long term. We show that it is higher volatility and seesawing market action which is most harmful to leverage. On the other hand, low volatility periods with positive streaks in performance are most helpful. Moving Averages are one way of systematically identifying these conditions. When the stock market is in an uptrend (above its Moving Average), conditions favor leverage as volatility declines and there are more positive streaks in performance. When the stock market is in a downtrend (below its Moving Average), the opposite is true as volatility tends to rise.

Moving Averages are used in this paper as they are simple signals for upcoming market volatility. Besides other Moving Average periods than the 200-Days discussed in this paper, other Risk-On/Risk-Off signals might be applied. In our "2014 Charles H. Dow Award" winning paper "An Intermarket Approach to Beta Rotation," we look at relative 4-week rolling returns of Utilities sector versus the broad market, a leading signal for market corrections, but also volatility spikes. In our "2014 Wagner Award, 3rd Place" winning "An Intermarket Approach to Tactical Risk Rotation," relative short to long Treasury index returns are used to predict bullish versus bearish markets (incepted by spikes in the yield spreads). Lastly, in the "2015 NAAIM Founders Award" winning paper "Lumber: Worth Its Weight in Gold Offense and Defense in Active Portfolio Management", we find that the Lumber/Gold return ratio is a strong leading indicator for market stress and heightened volatility. As market corrections, volatility, and High Yield spreads come hand-in-hand, a wide variety of such signals could be used. The described mechanism that volatility hurts leverage is what matters the most.

We find that being exposed to equities with leverage in an uptrend and rotating into risk-free Treasury bills in a downtrend leads to significant outperformance over time. For investors and traders seeking a destination with higher returns who are willing to take more risk at the right time, systematic leverage for the long run is one way of moving there, on average.

Further Research

While outside the scope of this paper, our conclusions have important implications for further areas of research. These include: 1) timing of leverage in asset classes outside of equities, 2) determining if volatility predictors in one asset class can be used to time leverage in another, and 3) determining if other technical indicators which are predictors of volatility yield similar results. We look forward to exploring these issues in upcoming papers.

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