NEWFOUND RESEARCH

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Diversifying the What, How, and When of Trend Following

April 2, 2018

SUMMARY

- Naïve and simple long/flat trend following approaches have demonstrated considerable consistency and success in U.S. equities.

- While there are many benefits to simplicity, an *overly* simplistic implementation can leave investors naked to unintended risks in the short run.

- We explore how investors can think about introducing greater diversification across the three axes of *what, how*, and *when* in effort to build a more robust tactical solution.

About Newfound Research

Founded in August 2008 Newfound Research is a quantitative asset management firm based in Boston, MA.

Investing at the intersection of quantitative and behavioral finance, Newfound Research is dedicated to helping investors achieve their long-term goals with research-driven, quantitatively-managed portfolios, while simultaneously acknowledging that the quality of the journey is just as important as the destination.

We work exclusively with financial advisors and institutions to help them manage the wealth of their clients through our suite of investment portfolios and mutual funds.

Portfolios Focused on Risk Management

Our strategies reflect our view that investing is not easy. Emotional decisions can derail even the best laid plan. Therefore, we believe that the optimal investment plan is, first and foremost, one that investors can stick with. Research shows that investors feel the pain of losses more than they feel the joy of gains. This is reflected in a deep desire to protect the capital that they have worked hard to accumulate. Accordingly, we seek to improve risk-adjusted returns and investor experience by prioritizing downside risk management and seeking to avoid large losses.

Our portfolios are available as separately managed accounts, through model manager platforms, and as mutual funds[1].

Multi-Manager Model Allocations

For investors looking to outsource their asset allocation and manager selection decisions, we offer our QuBe ("Quantitative Behavioral") portfolio series, a suite of strategically managed, behavior aware, hybrid active/passive portfolios offered with zero overlay fee[2].

Newfound was awarded 2016 ETF Strategist of the Year by ETF.com[3]

[1] See http://www.thinknewfoundfunds.com
[2] See http://www.thinknewfound.com/qube-managed-portfolios
[3] An ETF Strategist is a firm that builds portfolios primarily using exchange-traded funds.

In last week's commentary – *Protect & Participate: Managing Drawdowns with Trend Following* – we explored the basics of trend following and how a simple "long/flat" investing approach, when applied to U.S. equities, has historically demonstrated considerable ability to limit extreme drawdowns.[4]

While we always preach the benefits of simplicity, an evaluation of the "long run" can often overshadow many of the short-run risks that can materialize when a model is overly simplistic. Most strategies look good when plotted over a 100-year period in log-scale and drawn with a fat enough marker.

With trend following in particular, a naïve implementation can introduce uncompensated risk factors that, if left unattended, can lead to performance gremlins.

We should be clear, however, that left unattended, nothing could happen at all. You could get lucky. That's the funny thing about risk: sometimes it does not materialize and correcting for it can actually leave you worse off.

But hope is not a strategy and without a crystal ball at our disposal, we feel that managing uncompensated risks is critical for creating more consistent performance and aligning with investor expectations.

In light of this, the remainder of this commentary will be dedicated to exploring how we can tackle several of the uncompensated risks found in naïve implementations by using the three axes of diversification: what, how, and when.

The *What*: Asset Diversification

The first axis of diversification is "what," which encompasses the question, "what are we allocating across?"

As a tangent, we want to point out that there is a relationship between tactical asset allocation and underlying opportunities to diversify, which we wrote about in a prior commentary *Rising Correlations and Tactical Asset Allocation*.[5] The simple take is that when there are more opportunities for diversification, the accuracy hurdle rate that a tactical process has to overcome increases. While we won't address that concept explicitly here, we do think it is an important one to keep in mind.

Specifically as it relates to developing a robust trend following strategy, however, what we wish to discuss is "what are we generating signals on?"

A backtest of a naively implemented trend following approach on U.S. equities over the last century has been exceptionally effective. Perhaps deceivingly so. Consider the following cumulative excess return results from 12/1969 to present for a 12-1 month time-series momentum strategy.

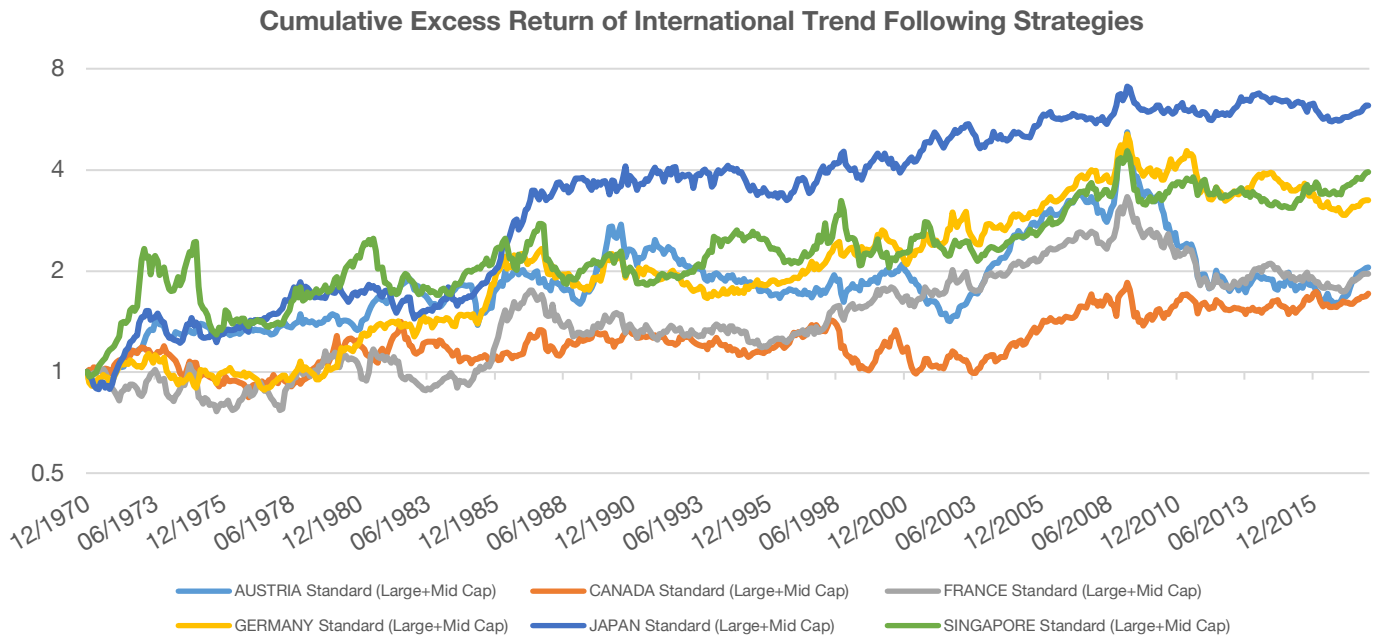
[4] https://blog.thinknewfound.com/2018/03/protect-participate-managing-drawdowns-with-trend-following/
[5] https://blog.thinknewfound.com/2016/10/rising-correlations-tactical-asset-allocation/

Source: Kenneth French Data Library. Calculations by Newfound Research. Past performance is not an indication of future returns. All performance information is backtested and hypothetical. Performance is gross of all fees, including manager fees, transaction costs, and taxes. Performance is net of withholding taxes. Performance assumes the reinvestment of all dividends. Benchmark is 50% U.S. equity index / 50% risk-free rate.

While the strategy exhibits a considerable amount of consistency, this need not be the case.

Backtests demonstrate that trend following has worked in a variety of international markets "over the long run," but the realized performance can be much more volatile than we have seen with U.S. equities. Below we plot the growth of $1 in standard 12-1 month time-series momentum strategies for a handful of randomly selected international equity markets minus their respective benchmark (50% equity / 50% cash).

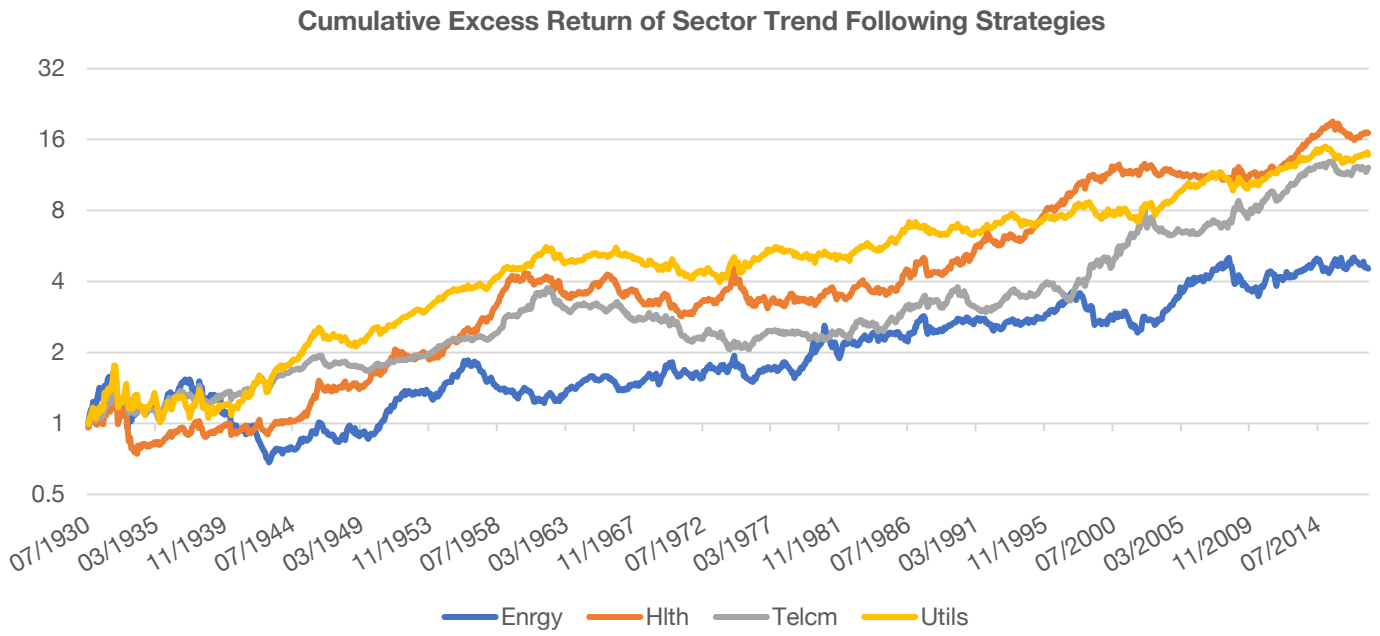
Note: Things can get a little whacky when working with international markets. You ultimately have to consider whose perspective you are investing from. Here, we assumed a U.S. investor that uses U.S. dollar-denominated foreign equity returns and invests in the U.S. risk-free rate. Note that this does, by construction, conflate currency trends with underlying trends in the equity indices themselves. We will concede that whether the appropriate measure of trend should be local-currency based or not is debatable. In this case, we do not think it affects our overall point.



Source: MSCI. Calculations by Newfound Research. Past performance is not an indication of future returns. All performance information is backtested and hypothetical. Performance is gross of all fees, including manager fees, transaction costs, and taxes. Performance is net of withholding taxes. Performance assumes the reinvestment of all dividends. Benchmark is 50% respective equity index / 50% U.S. risk-free rate.

The question to ask ourselves, then, is, "Do we believe U.S. equities are special and naive trend following will continue to work exceptionally well, or was U.S. performance an unusual outlier?"

We are rarely inclined to believe that exceptional, outlier performance will continue. One approach to providing U.S. equity exposure while diversifying our investments is to use the individual sectors that comprise the index itself. Below we plot the cumulative excess returns of a simple 12-1 time-series momentum strategy applied to a random selection of underlying U.S. equity sectors.



Source: Kenneth French Data Library. Calculations by Newfound Research. Past performance is not an indication of future returns. All performance information is backtested and hypothetical. Performance is gross of all fees, including manager fees, transaction costs, and taxes. Performance is net of withholding taxes. Performance assumes the reinvestment of all dividends. Benchmark is 50% respective sector index / 50% U.S. risk-free rate.

While we can see that trend following was successful in generating excess returns, we can also see that *when* it was successful varies depending upon the sector in question. For example, Energy (blue) and Telecom (Grey) significantly diverge from one another in the late 1950s / early 1960s as well as in the late 1990s / early 2000s.

If we simply equally allocate across sector strategies, we end up with a cumulative excess return graph that is highly reminiscent of the of the results seen in the naïve U.S. equity strategy, but generated with far more internal diversification.

Source: Kenneth French Data Library. Calculations by Newfound Research. Past performance is not an indication of future returns. All performance information is backtested and hypothetical. Performance is gross of all fees, including manager fees, transaction costs, and taxes. Performance is net of withholding taxes. Performance assumes the reinvestment of all dividends.

A potential added benefit of this approach is that we are now afforded the flexibility to vary sector weights depending upon our objective. We could potentially incorporate other factors (e.g. value or momentum), enforce diversification limits, or even re-invest capital from sectors exhibiting negative trends back into those exhibiting positive trends.

The *How*: Process Diversification

The second axis of diversification is "how": the process in which decisions are made. This axis can be a bit of a rabbit hole: it can start with high-level questions such as, "value or momentum?" and then go deeper with, "which value measure are you using?" and then even more nuanced with questions such as, "cross-market or cross-industry measures?" Anecdotally, the diversification "bang for your buck" decreases as the questions get more nuanced.

With respect to trend following, the obvious question is, "how are you measuring the trend?"

One Signal to Rule Them All?

There are a number of ways investors can implement trend-following signals. Some popular methods include:

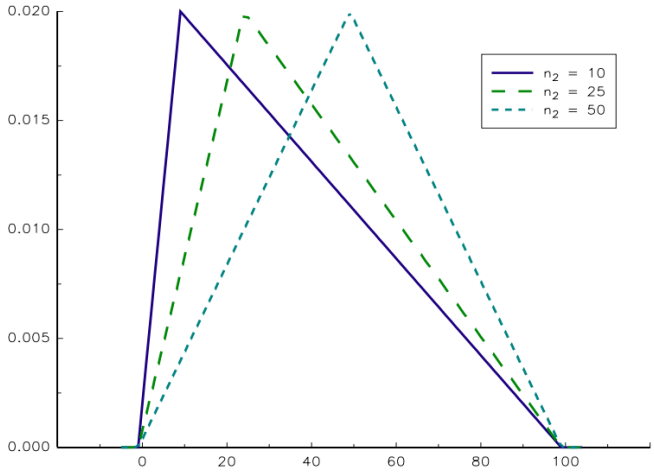
- Prior total returns ("time-series momentum")
- Price-minus-moving-average (e.g. price falls below the 200 day moving average)
- Moving-average double cross-over (e.g. the 50 day moving average crosses the 200 day moving average)
- Moving-average change-in-direction (e.g. the 200 day moving average slope turns positive or negative)

One question we often receive is, "is there one approach that is better than another?" Research over the last decade, however, actually shows that they are highly related approaches.

Bruder, Dao, Richard, and Roncalli (2011) united moving-average-double-crossover strategies and time-series momentum by showing that cross-overs were really just an alternative weighting scheme for returns in time-series momentum.[6] To quote,

"The weighting of each return … forms a triangle, and the biggest weighting is given at the horizon of the smallest moving average. Therefore, depending on the horizon n2 of the shortest moving average, the indicator can be focused toward the current trend (if n2 is small) or toward past trends (if n2 is as large as n1/2 for instance)."

Figure 1: Window function $\mathcal{L}_i$ of moving average crossovers ($n_1 = 100$)



Marshall, Nguyen and Visaltanachoti (2012) proved that time-series momentum is related to moving-average-change-in-direction.[7] In fact, time-series momentum signals will not occur until the moving average changes direction. Therefore, signals from a price-minus-moving-average strategy are likely to occur before a change in signal from time-series momentum.

Levine and Pedersen (2015) showed that time-series momentum and moving average cross-overs are highly related.[8] It also found that time-series momentum and moving-average cross-over strategies perform similarly across 58 liquid futures and forward contracts.

Beekhuizen and Hallerbach (2015) also linked moving averages with returns, but further explored trend rules with

[6] Bruder, Benjamin and Dao, Tung-Lam and Richard, Jean-Charles and Roncalli, Thierry, Trend Filtering Methods for Momentum Strategies (December 1, 2011). Available at SSRN: http://ssrn.com/abstract=2289097

[7] Marshall, Ben R. and Nguyen, Nhut H. and Visaltanachoti, Nuttawat, Time-Series Momentum versus Moving Average Trading Rules (December 22, 2014). Available at SSRN: http://ssrn.com/abstract=2225551

[8] Levine, Ari and Pedersen, Lasse Heje, Which Trend Is Your Friend? (May 7, 2015). Financial Analysts Journal, vol. 72, no. 3 (May/June 2016). Available at SSRN: https://ssrn.com/abstract=2603731

skip periods and the popular MACD rule.[9] Using the implied link of moving averages and returns, it showed that the MACD is as much trend following as it is mean-reversion.

Zakamulin (2015) explored price-minus-moving-average, moving-average-double-crossover, and moving-average-change-of-direction technical trading rules and found that they can be interpreted as the computation of a weighted moving average of momentum rules with different lookback periods.[10]

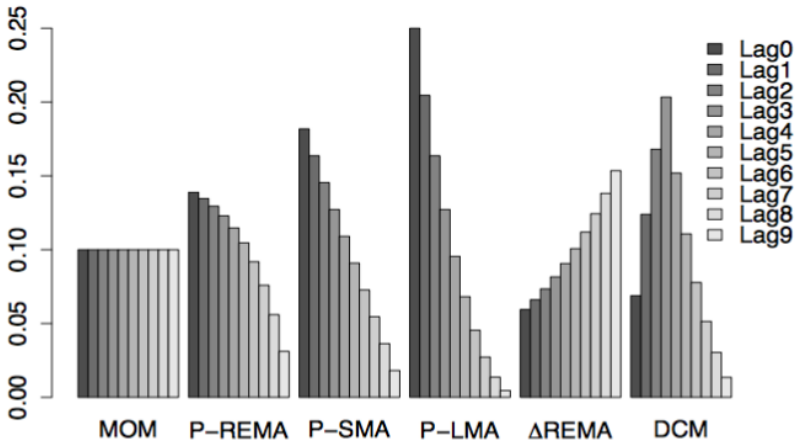


Figure 1: Weights of monthly price changes used for the computations of the technical trading indicators with $k = 10$. **MOM** denotes the Momentum rule. **P-REMA** denotes the Price-Minus-Reverse-Exponential-Moving-Average rule (with $\lambda = 0.8$). **P-SMA** denotes the Price-Minus-Simple-Moving-Average rule. **P-LMA** denotes the Price-Minus-Linear-Moving-Average rule. **ΔREMA** denotes the Reverse-Exponential-Moving-Average-Change-of-Direction rule (with $\lambda = 0.9$). **DCM** denotes the Double Crossover Method (based on using two exponential moving averages with $\lambda = 0.8$ and $s = 3$). **Lag**$(i-1)$ denotes the weight of the lag ΔP_{t-i}, where Lag0 denotes the most recent price change ΔP_{t-1} and Lag9 denotes the most oldest price change ΔP_{t-10}.

These studies are important because they help validate the approach of traditional price-based systems (e.g. moving averages) with the growing body of academic literature on time-series momentum.

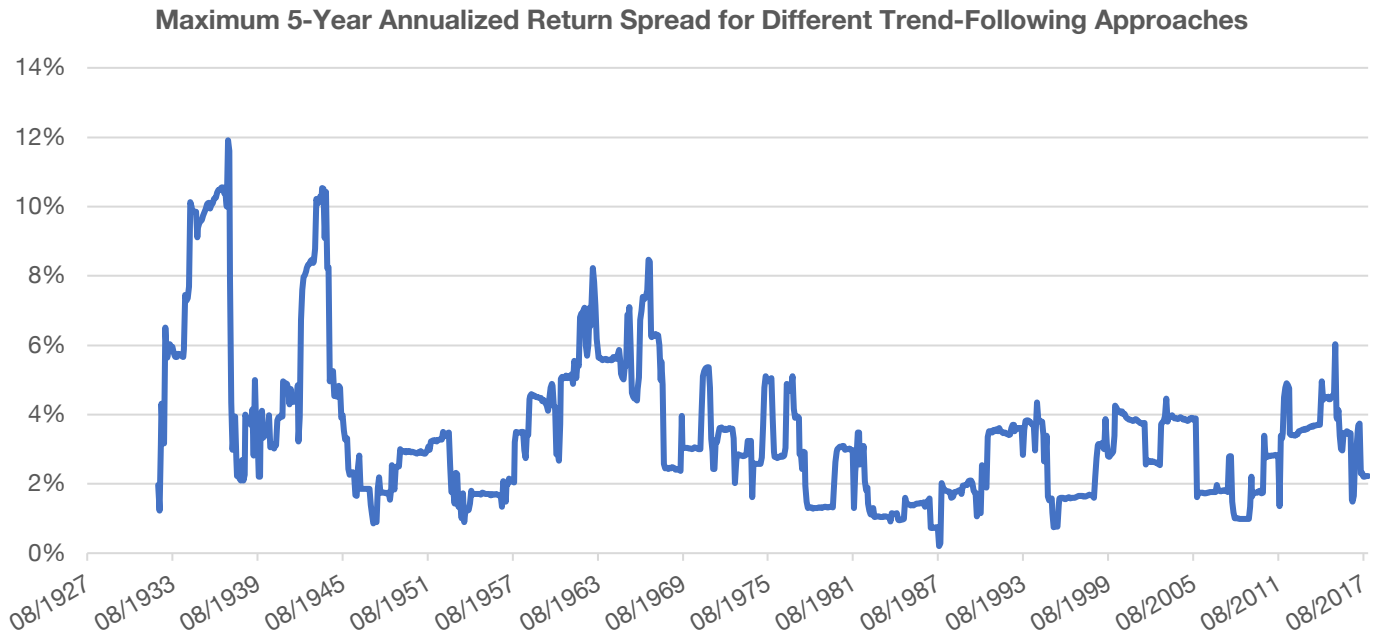
The other interpretation, however, is that all of the approaches are simply a different way of trying to tap into the same underlying factor. The realized difference in their results, then, will likely have to do more with the inefficiencies in capturing

[9] Beekhuizen, Paul and Hallerbach, Winfried G., Uncovering Trend Rules (May 11, 2015). Available at SSRN: http://ssrn.com/abstract=2604942

[10] Zakamulin, Valeriy, Market Timing with Moving Averages: Anatomy and Performance of Trading Rules (May 13, 2015). Available at SSRN: http://ssrn.com/abstract=2585056

that factor and which specific environments a given approach may underperform. For example, below we plot the maximum return difference over rolling 5-year periods between four different trend following approaches: (1) moving-average change-in-direction (12-month), (2) moving-average double-crossover (3-month / 12-month), (3) price-minus-moving-average (12-month), and (4) time-series momentum (12-1 month).

We can see that during certain periods, the spread between approaches can exceed several hundred basis points. In fact, the long-term average spread was 348 basis points ("bps") and the median was 306 bps. What is perhaps more astounding is that no approach was a consistent winner or loser: relative performance was highly time-varying. In fact, when ranked 1-to-4 based on prior 5-year realized returns, the average long-term ranks of the strategies were 2.09, 2.67, 2.4, and 2.79 respectively, indicating that no strategy was a clear perpetual winner or loser.



Source: Kenneth French Data Library. Calculations by Newfound Research. Past performance is not an indication of future returns. All performance information is backtested and hypothetical. Performance is gross of all fees, including manager fees, transaction costs, and taxes. Performance assumes the reinvestment of all dividends.

Without the ability to forecast which model will do best and when, model choice represents an uncompensated risk that we bear as a manager. Using multiple methods, then, is likely a prudent course of action.

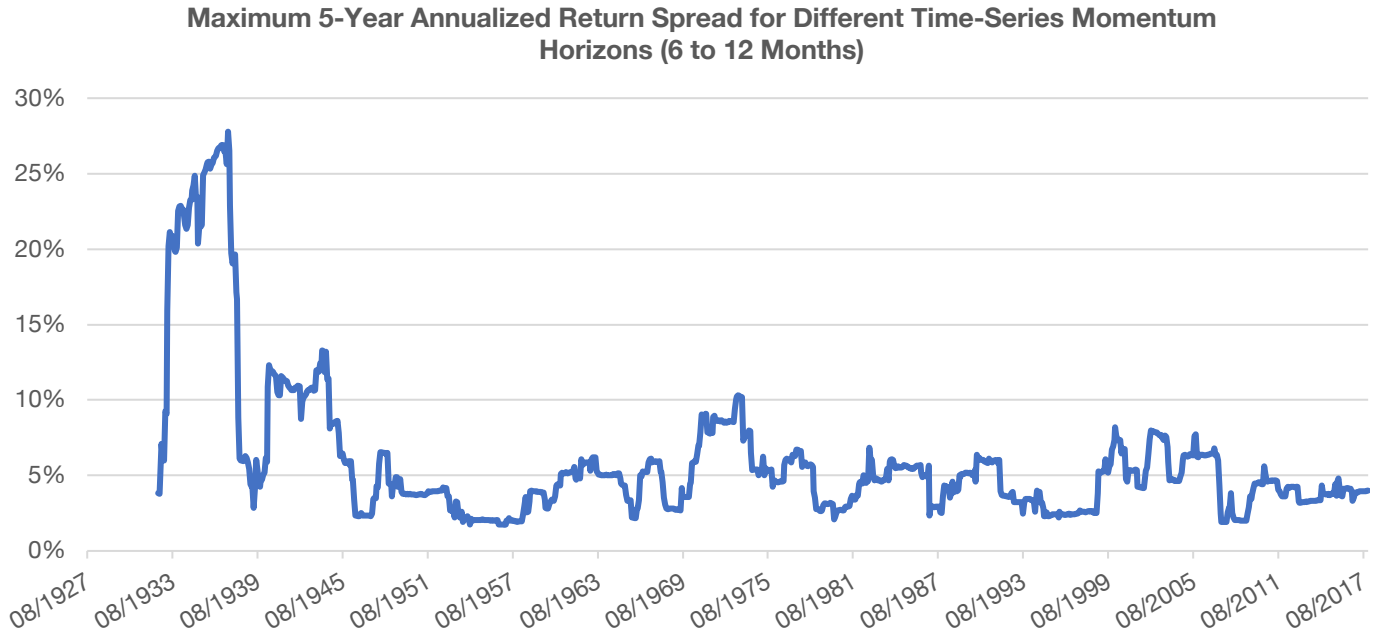
Identifying the Magic Parameter

The academic and empirical evidence for trend following (and, generally, momentum) tends to support a formation ("lookback") period of 6-to-12 months. Often we see moving averages used that align with this time horizon as well.

Intuition is that shorter horizons tend to react to market changes more quickly since new information represents a larger proportion of the data used to derive the signal. For example, in a 6-month momentum measure a new monthly data point represents 16.6% of the data, whereas it only represents 8.3% of a 12-month moving average.

A longer horizon, therefore, is likely to be more "stable" and therefore less susceptible to whipsaw.

Which particular horizon achieves the best performance, then, will likely be highly regime dependent. To get a sense of this, we ran six time-series momentum strategies, with look-back periods ranging from 6-months to 12-months. Again, we plot the spread between the best and worst performing strategies over rolling 5-year periods.



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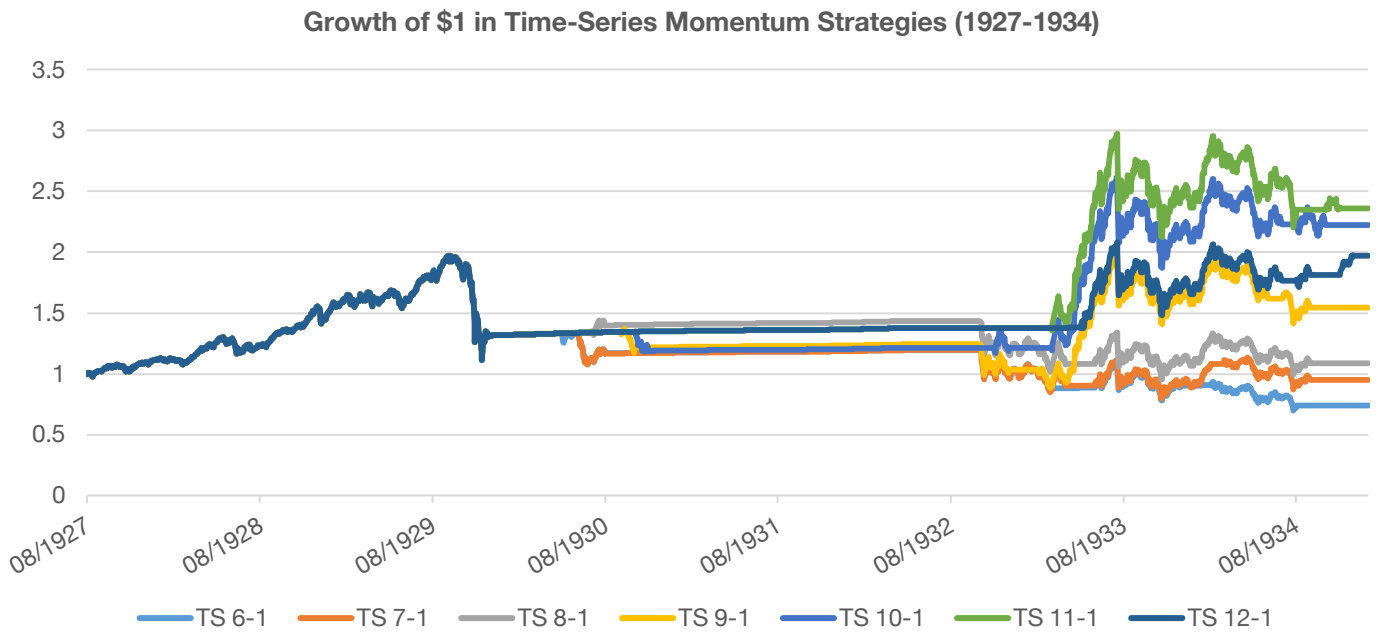
Ignoring the Great Depression for a moment, we can see that 5-year annualized returns between parameterizations frequently deviate by more than 500 bps. If we dig under the hood, we again see that the optimal parameterization is highly regime dependent.

For example, coming out of the Great Depression, the longer-length strategies seemed to perform best. From 8/1927 to 12/1934, an 11-1 time-series momentum strategy returned 136% while a 6-1 time-series momentum strategy returned -25%. Same philosophy; very different performance.

Conversely, from 12/1951 to 12/1971, the 6-1 strategy returned 723% while the 11-1 strategy returned 361%.

Once again, without evidence that we can time our parameter choice, we end up bearing unnecessary parameterization risk, and diversification is a prudent action.



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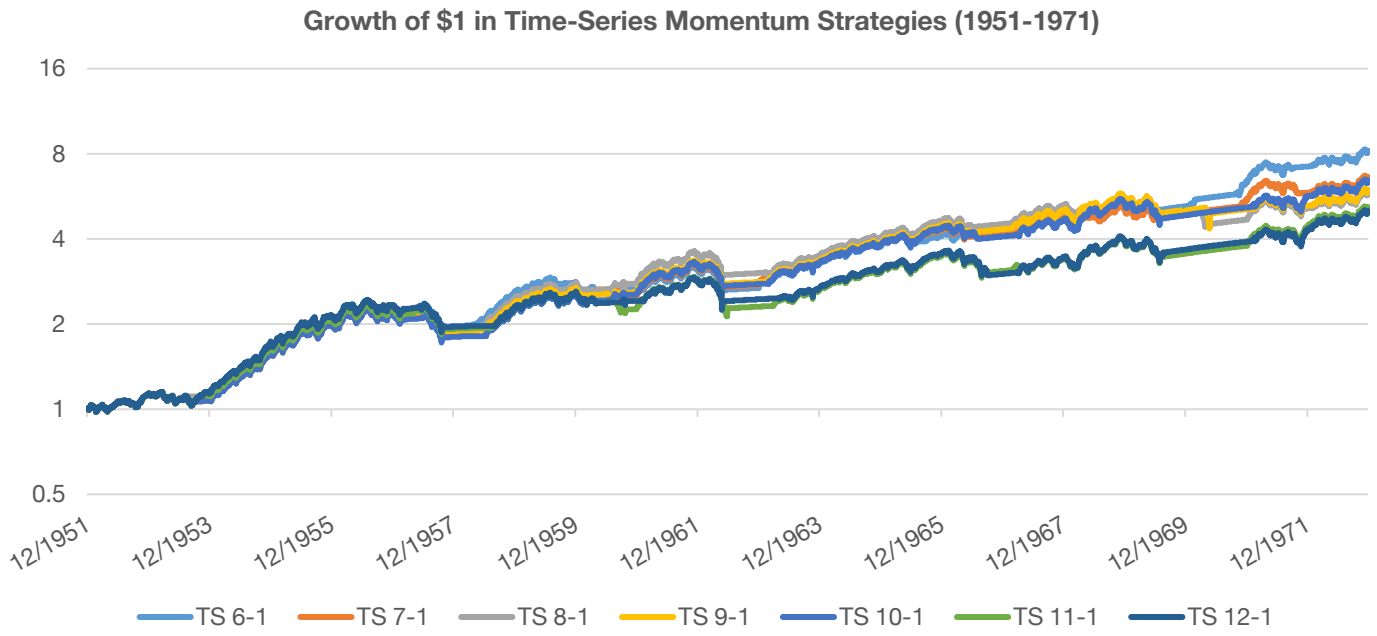

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The *When*: Timing Luck

Long-time readers of our commentary will be familiar with this topic. For those unfamiliar, we recommend a quick glance over our commentary *Quantifying Timing Luck* (specifically, the section *What is "Timing Luck"?)*.[11]

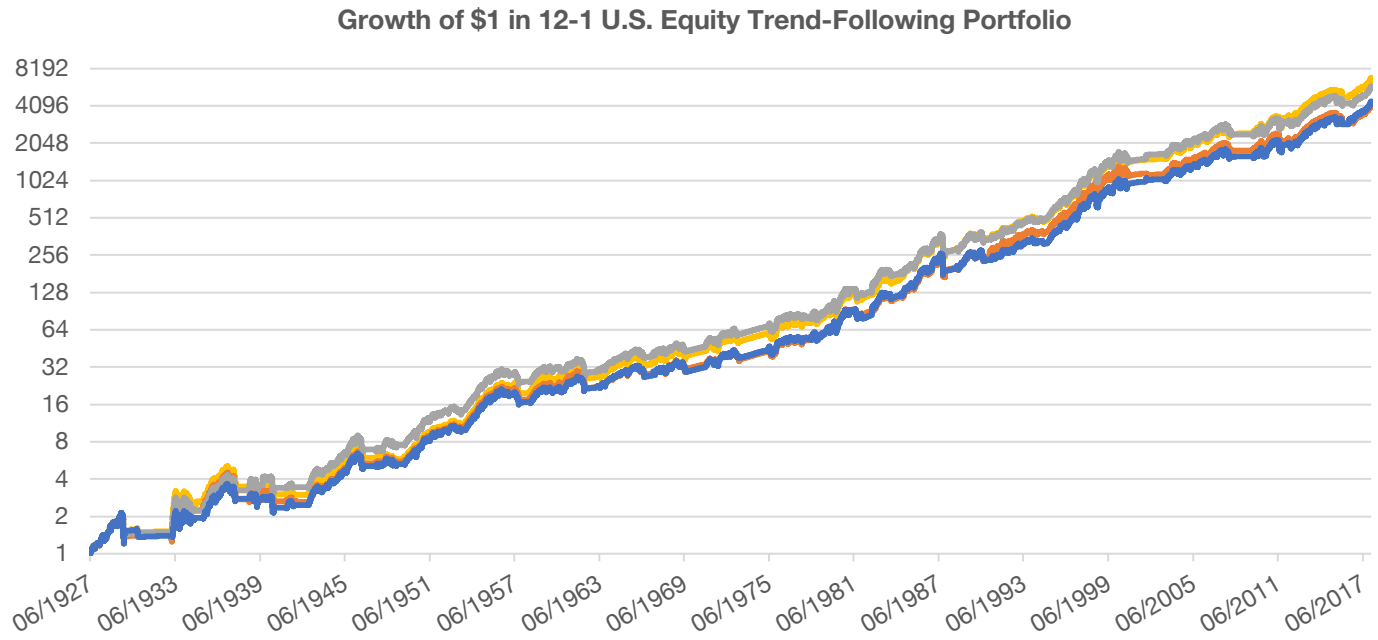
The simple description of the problem is that investment strategies can be affected by the investment opportunities they see at the point at which they rebalance. For example, if we rebalance our tactical strategies at the end of each month, our results will be subject to what our signals say at that point. We can easily imagine two scenarios where this might work against us:

1. Our signals identify no change and we remain invested; the market sells off dramatically over the next month.

2. The market sells off dramatically prior to our rebalance, causing us to move to cash. After we trade, the market rebounds significantly, causing us to miss out on potential gains.

[11] https://blog.thinknewfound.com/2018/01/quantifying-timing-luck/

As it turns out, these are not insignificant risks. Below we plot four identically managed tactical strategies that each rebalance on a different week of the month. While one of the strategies turned $1 into $4,139 another turned it into $6,797. That is not an insignificant difference.



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Fortunately, the cure for this problem is simple: diversification. Instead of picking a week to rebalance on, we can allocate to multiple variations of the strategy, each rebalancing at a different point in time. One variation may rebalance on the 1st week of the month, another on the 2nd week, et cetera. This technique is called "overlapping portfolios" or "tranching" and we have proven in past commentaries that it can dramatically reduce the impact that timing luck can have on realized results.

Conclusion

Basic, naïve implementations of long/flat trend following exhibit considerable robustness and consistency over the long run when applied to U.S. equities. The short run, however, is a different story. While simple implementations can help ensure that we avoid overfitting our models to historical data, it can also leave us exposed to a number of unintended bets and uncompensated risks.

Instead of adding more complexity, we believe that the simple solution to combat these risks is *diversification*.

Specifically, we explore diversification across three axes.

The first axis is "what" and represents "what we invest across." We saw that while trend following worked well on U.S. equities, the approach had less consistency when applied to international indices. Instead of presuming that the U.S. represents a unique candidate for this type of strategy, we explored a sector-based implementation that may allow for greater internal diversification.

The second axis is "how" and captures "how we implement the strategy." There are a variety of approaches practitioners use to measure and identify trends, and each comes with its own pros and cons. We explore four popular methods and find that none consistently reigns supreme, indicating once again that diversification of process is likely a prudent approach.

Similarly, when it comes to parameterizing these models, we find that a range of lookback periods are successful in the long run, but have varying performance in the short run. A prudent solution once again, is diversification.

The final axis is "when" and represents "when we rebalance our portfolio." Long-time readers recognize this topic as one we frequently write about: timing luck. We demonstrate that merely shifting what week of the month we rebalance on can have considerable long-term effects. Again, as an uncompensated risk, we would argue that it is best diversified away.

While a naïve trend following process is easy to implement, we believe that a robust one requires thinking along the many dimensions of risk and asking ourselves which risks are worth bearing (hopefully those that are compensated) and which risks we should seek to hedge or diversify away.

Corey Hoffstein & Justin Sibears

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Investing at the intersection of quantitative and behavioral finance, Newfound Research is dedicated to helping clients achieve their long-term goals with research-driven, quantitatively-managed portfolios, while simultaneously acknowledging that the quality of the journey is just as important as the destination.

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