

In this paper, we explore two questions:

1. Has price momentum continued to work since Jagadeesh/Titman published their paper in 1993?
2. Where is price momentum most effective and in what form?



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Almost a quarter of a century has passed since Jagadeesh/Titman (JT) published their famous 1993 paper “Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency,” which explored the price momentum anomaly. Given the 25-plus years of additional history, we have enough data to perform an out-of-sample test and see if their findings still hold. We discover they do, but less effective than during their test period. Then we delve into the many facets of price momentum to better understand about this anomaly. We learn a few things while analyzing different look-back periods, different holding periods, how momentum is constructed and how it is used.

Price momentum, which we will also refer to as momentum in this paper, has been a staple of investing circles for years. Long before “quants” began investing in stocks with momentum, investors analyzed stock price charts looking for price momentum. In fact, the strategy can be traced as far back as economist David Ricardo in the 1800s, who encouraged investors to cut their losses but let their profits run. Today, you can still see many approaches to momentum in the investment marketplace. It is not uncommon to hear an investor say, “this stock appears attractive, but look at the price chart, there is no support for it right now?” or “this stock has solid fundamentals and with its price starting to rise, time to buy.” In both cases, the investor is looking for an increasing (or not decreasing) stock price (i.e., price momentum) before they invest in a stock.

Beyond these simple investing rules, there has been a great deal of academic research on the price momentum anomaly from Kahneman to Fama and French. Fama and French’s paper is part of the extensive research exploring risk-based explanations for the phenomenon. Fama and French find price momentum to be one of four price risk factors alongside beta, value and size. In addition to risk-based explanations, many papers have been published exploring behavioral explanations for the anomaly. One of the leaders in the field of study called behavioral investing is Daniel Kahneman who made significant contributions studying investor psychology. Kahneman found two of the main behavioral biases behind price momentum are conservatism and herding. In conservatism, investors react slowly to new information and will respond to good news by continually building their stock position over time. As investors build their position, they will place greater pressure on the stock’s price, leading to a rising stock price – price momentum. In herding, investors see others invest in a security, making it appreciate, and join the “herd,” providing support for yet higher stock prices. It is similar to when people not involved in the investment/finance industry tout an asset class as a “sure thing” because of its performance. Price appreciation begets price appreciation.

In addition to the risk and behavioral based explanations, there have been many papers ranging from studying momentum beyond U.S. equities to studying different asset classes and different countries around the world. This paper is not looking to answer why the anomaly exists nor study different asset classes or countries. We focus solely on exploring different aspects of price momentum within U.S. equities.

Key Takaways:

1. Price Momentum has continued to work since Jagadeesh and Titman wrote their paper in 1993.
2. While the momentum effect for very short (one month) and very long (three-plus years) formation periods is negative, it is positive and strong in the intermediate formation period (from more than a month to a year).
3. The longer you would like to hold a momentum stock in your portfolio, the shorter the formation period you should use.
4. The momentum effect is stronger in the tails (Deciles > Quintiles).
5. The momentum effect is stronger in small cap stocks and growth stocks.
6. Refining your universe of stocks provides stronger risk-adjusted returns, primarily due to risk reduction.
7. Altering your measure of momentum to adjust for a stock’s beta or volatility adds value.
8. The momentum effect is stronger in shorting the lowest momentum stocks than buying the highest momentum stocks.

Data: For our analysis, we used stock price data for U.S. Companies from IDC between 1990 and 2017. We limited our universe to companies within the Russell 3000 Index. For company fundamental data, we combined quarterly financial statement data from Compustat, analyst forecast data from I/B/E/S, and security prices and returns from IDC.

Methodology: Our tests have many moving parts, including how the momentum characteristic is created to length of holding period. Unless noted in our analysis, assume that we use the most common definition of price momentum, which is the one-year price change of a stock excluding the most recent month, which we refer to as 2_12 (price change from the end of month 2 to the end of month 12). Also, unless stated otherwise, assume we are forming quintile spread portfolios on a monthly basis. This means every month we sort the universe stocks from high to low on the momentum measure tested and form a portfolio long the top 20% and short the bottom 20%. We then calculate this portfolio’s return over the next month to arrive at the quintile spread return, which refers to the spread between the return of the top quintile stocks and the bottom quintile stocks.

Question #1

Has price momentum continued to work since Jagadeesh/Titman published their paper in 1993?

Exhibit 1 shows the performance of price momentum in the JT paper (1965-1989), as well as its performance since the paper’s testing period (1990-2016). As the dark blue bar in the chart below shows, stocks with high price momentum have continued to outperform stocks with low momentum by 7% per year. However, this is much less than the almost 20% spread during JT’s test period.

Next, we asked the question of how performance for momentum post-JT compared to performance pre-JT. We used Fama and French’s dataset on momentum which extends back to 1927 for this analysis. We found that momentum post-JT is comparable to pre-JT. From **Exhibit 2**, the post-JT time period is about 1% higher per year than the pre-JT time period. So, it looks like the efficacy of momentum peaked during the time period JT tested, only to revert back to the long run average after the paper. But as the analysis shows, momentum has been working for a very long time, almost 100 years.

Exhibit 1 – Price Momentum Annualized Performance: JT Test Period vs. Post JT-test Period

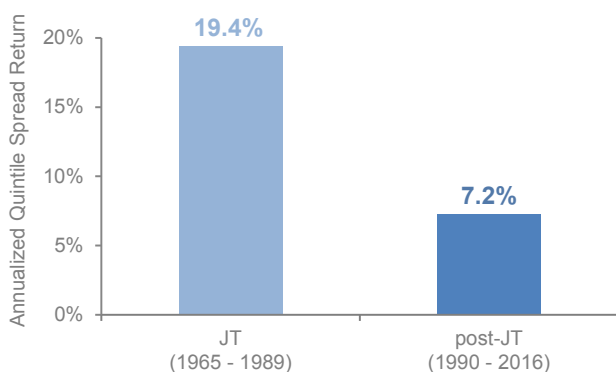
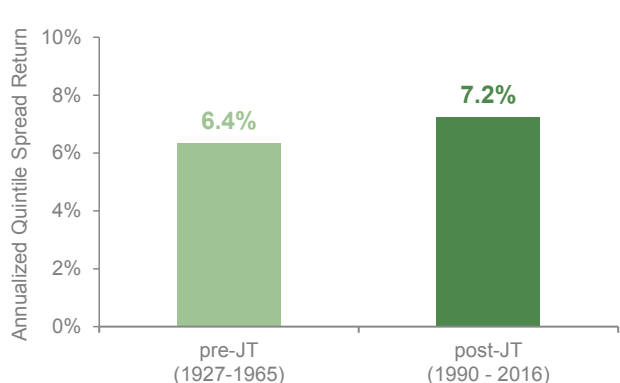


Exhibit 2 – Price Momentum Annualized Performance: Pre-JT Test Period vs. Post-JT Test Period



Question #2

Where is price momentum most effective, and in what form?

Given that the price momentum has continued to add value post-JT, we wanted to study the many facets of price momentum post-JT to discover where it is most effective. We break this part of the paper into seven sections, each focused on a different aspect of momentum:

Section 1: We review momentum over different formation periods. In addition to the traditional one-year formation period (2_12), we will look at the last month, six months, three years, etc.

Section 2: We analyze different holding periods. Most characteristic tests in the research literature are based on a one-month holding period, meaning that every month the portfolio is rebalanced. We extend this holding period analysis beyond a month to see how long the momentum effect lasts for stocks.

Section 3: We explore if momentum is more effective in the extreme tails (top and bottom deciles) than broader quintiles, which is most often cited in traditional research including JT's paper.

Section 4: We study momentum in different stock styles: large cap, small cap, growth, and value stocks.

Section 5: We research if momentum is most effective in smaller peer-like industry groupings or broad universes.

Section 6: We analyze different types of momentum (such as adjusting for a stock's beta or volatility).

Section 7: We look at the different sides of momentum. Is it better to buy the high momentum stocks, short the low momentum stocks, or do both?

Section 1

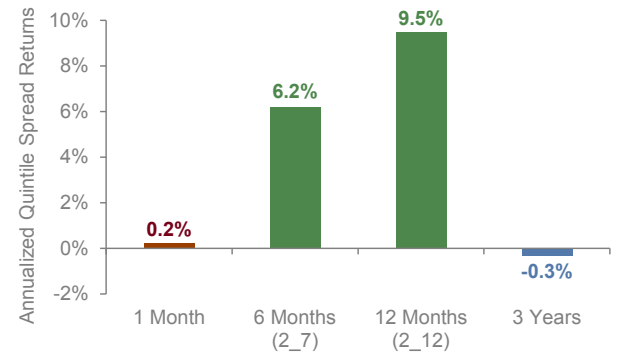
Price Momentum by Formation Period

Formation period refers to the period of time that momentum in the stock develops. For this section, we are exploring the following questions. As investors, should we buy/sell a stock with high/low momentum after its first month of strong appreciation or do we need to wait longer than a month for a momentum trend to solidify? And if we wait longer, maybe over a year for the momentum trend to form, is it too late and has the stock already greatly appreciated with little time left for further appreciation? Is there, instead, an intermediate time period where the momentum trend has become established with time to still earn future price appreciation? We find intermediate (6 to 12 months) momentum formation portfolios have the highest returns.

Momentum formation period has been greatly studied in the research literature. Most studies, including JT's paper, have analyzed 12-month price momentum (2_12). However, some authors have looked at shorter and longer formation periods. The consensus findings are that for very short price momentum (over the last month or less) and for very long price momentum (over the past three to five years) the returns for momentum actually revert. In other words, over a very short or very long timeframe, stocks with high price momentum have poor performance for the following month and stocks with low price momentum have strong performance for the following month.

Our findings are consistent with the existing research. Momentum is strongest for an intermediate-term formation period (6 to 12 months) and tends to be weak in a very short formation period (1 month) or long formation period (3 years). In **Exhibit 3**, the performance spread for stocks with intermediate-term momentum, represented by the green bars (less than one year but greater than a month), is strong on the order of 6% to 10% per year. However, when you look at the red bar or short-term momentum (less than a month), and blue bar or long-term momentum (greater than a year), the performance disappears. There definitely is a sweet spot for identifying momentum, the intermediate term. In the next section we expand our analysis of stocks with intermediate term momentum.

Exhibit 3 – Price Momentum Over Different Formation Periods: One-Month Forward Returns - Annualized



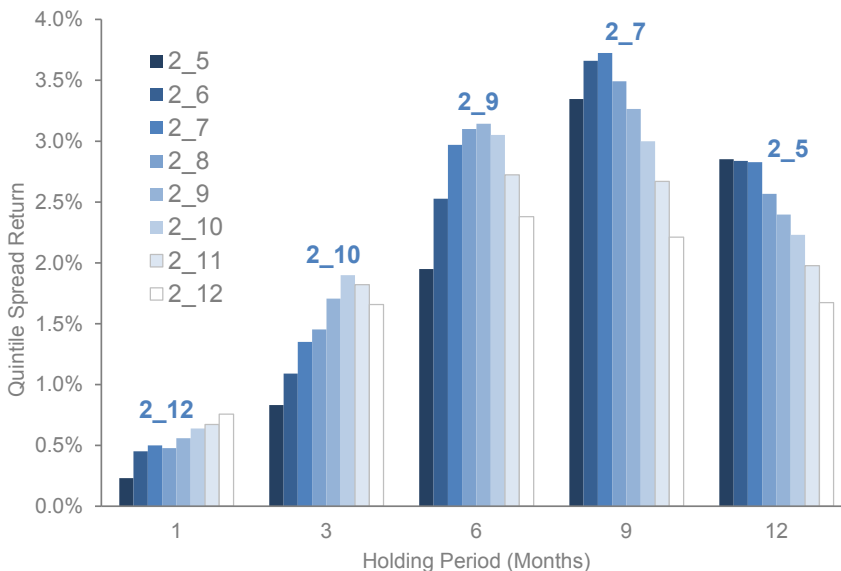
Section 2

Price Momentum by Holding Period

In this section, we continue to explore the trade-offs between investing in stocks just beginning a momentum trend versus those with more seasoned trends in place. We ask how long can we expect to earn above market returns from momentum stocks and does the answer depend on how long the stock’s momentum trend has already been in place? As we saw in the last section, if you wait too long for the trend to form, the stocks may have little room left to appreciate. Conversely, if you enter your position too early, the momentum trend may not have fully formed, leading to poor returns. This has implications for investors with different investment horizons (holding periods) and how they incorporate momentum stocks into their portfolios. Should they look for companies with more or less seasoned momentum?

We find they should change the type of momentum stocks they buy depending on their holding period. Specifically, we show that an investor with a shorter holding period should invest in stocks that have had momentum for longer, such as the last year, while an investor with a longer holding period should seek stocks with shorter momentum trends, such as the past six months. In addition to this main finding, we also discovered that once a stock begins its uptrend and shows momentum, it usually can continue this trend for 15 to 18 months before declining. It does not matter whether the stock has had momentum for the past six months or the past year, after about 15 months from the initial uptick, it will begin to lose its luster and decline. On to the analysis.

Exhibit 4 – Price Momentum by Formation Period and Holding Period



the initial uptick, it will begin to lose its luster and decline. On to the analysis.

Prior to this section, we have only considered how an investment would perform by holding the momentum portfolio for the next month. Now, we will consider performance over longer holding periods, such as the next quarter or year. **Exhibit 4** shows the quintile spread returns by holding period, with the bars representing different momentum formation periods (short to long). We highlight the formation period that has the strongest performance above each holding period.

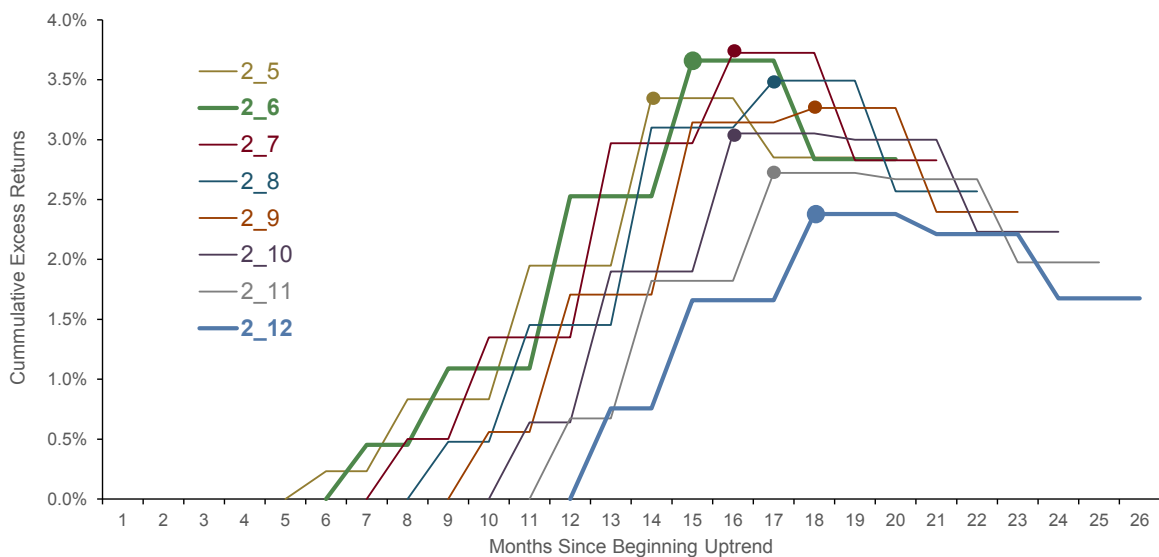
From this exhibit, you can quickly see that different momentum portfolios perform better for different holding periods. For shorter holding periods like one to three months, the longer momentum portfolios (lighter bars) have higher returns. For longer holding periods, the shorter momentum portfolios (dark bars) have higher returns. For instance, stocks with a long formation period, like one year (2_12), are the strongest performers if you continue to hold them for the next month, while they are one of the weakest performers if you hold the stocks for the next year. Stocks with a shorter formation period, like five months (2_5), are one of the weakest if you hold them for the next month, while the strongest if you hold them for the next year. As you move from left to right in Exhibit 4 shifting toward longer holding periods, the shorter formation periods (darker bars) have the best returns. In the end we find that the shorter the formation period used for momentum, the longer you should hold your stocks and vice versa.

We noticed an interesting pattern in Exhibit 4. Returns for stocks with momentum eventually peak and decline the longer you hold them. We find stocks have roughly a 15-month appreciation cycle from the start of their uptrend.

Exhibit 4a shows the cumulative performance of holding momentum stocks with different formation periods. In this exhibit, we start the holding period returns at the end of each portfolio's formation period. For a five-month formation period portfolio, we start the holding period returns at month five since the stocks have already appreciated for five months. For a six-month formation period, we start the holding period returns at month six and so on. This captures the fact that during the formation period the momentum stocks have already shown strong returns and we would like to see how much longer those strong returns can last. To do this we look at how long after their formation period do stocks continue the trend of above-market performance.

What we find is very interesting. No matter what formation period is used, a stock which exhibited momentum continues its momentum about 14-18 months from the beginning of their uptrend. For instance, stocks that have been exhibiting momentum for 12 months (2_12 highlighted in blue) tend to have strong returns for another six months, peaking at 18 months. Stocks which have been exhibiting momentum for six months (2_6 highlighted in green) tend to have strong returns for another nine months, peaking 15 months since their initial price increase.

Exhibit 4a – Price Momentum by Formation Period and Holding Period



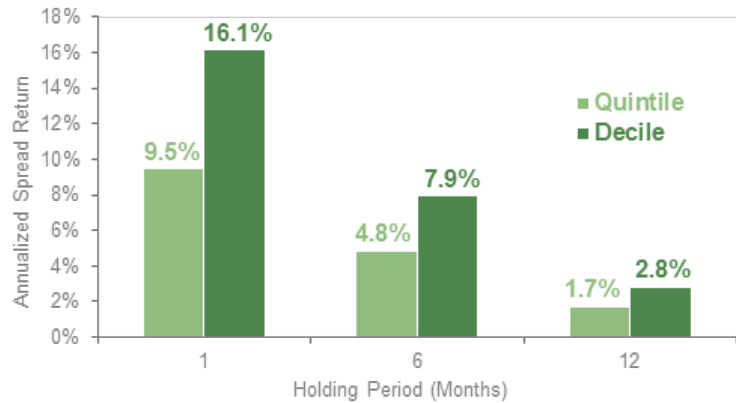
Section 3 Price Momentum Tail Analysis

So far in this paper we have only been testing portfolios that are created by investing in the top-quintile (20%) highest momentum stocks and shorting the bottom quintile (20%) of momentum stocks. We refer to this as a quintile spread portfolio, as the portfolio’s return depends on the spread between the highest 20% and lowest 20% stocks. But what if we decided to not invest in the top/bottom 20% of stocks but a more refined, concentrated group of stocks like the top/bottom 10%. Is it better to invest in a broader diversified group of stocks with a strong tilt toward momentum or a more concentrated group of stocks with a very strong tilt toward momentum?

We find a more concentrated group of higher momentum stocks has better performance. As Exhibit 5 displays, whether you look at a one year (2_12) or a six month (2_7) formation period, the more extreme decile stocks have nearly twice the efficacy as the top/bottom quintile stocks. If you hold the stock for the next month, the return spread for the top/bottom decile momentum stocks has an annualized

return of over 16% or almost twice the 9% annualized return of the quintile spread. The same is true if you choose to hold your portfolio for six months (decile spread return of 7.9% vs quintile of 4.8%) or for twelve months (3.0% for decile vs 1.5% for quintile). We also looked at six-month formation periods (2_7) and found similar results. There is a larger momentum effect in stocks with stronger momentum.

Exhibit 5 – One-Year Price Momentum: Decile vs. Quintile Spreads

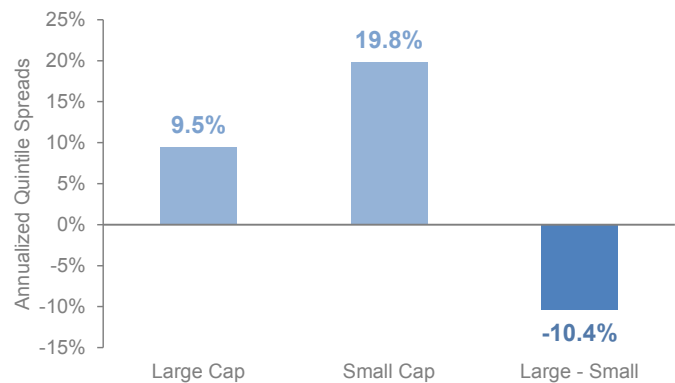


Section 4 Price Momentum by Style

In this section we turn our analysis to the following questions: For what types of stocks is momentum the most effective? Is the momentum effect stronger for riskier stocks (small companies or growth companies) or more conservative stocks (large companies or value companies)? Do investors who invest in risky stocks look for momentum before they invest, or do more conservative investors choose momentum stocks? We found that the momentum effect is stronger for the riskier segments of the equity market. The effect is much stronger in small cap stocks than in large cap stocks and stronger in growth stocks than in value stocks.

Exhibit 6 shows that large cap stocks (Russell 1000 Index) annualized quintile spread returns were close to 10%, which is excellent, but much less than the 20% annualized returns for small cap stocks (Russell 2000 Index).

Exhibit 6 – One-Year Price Momentum: Large Cap Stocks vs. Small Cap Stocks



As **Exhibit 7** shows, the momentum effect is stronger for small cap stocks than it is for large cap stocks across different formation and holding periods as well. As you move from left to right in Exhibit 7, you can see the difference for one-month, six-month and 12-month holding periods. Across the board, the momentum effect is stronger for small cap stocks.

Next, we find that the momentum effect is stronger for growth (Russell 1000 Growth Index) stocks than for value (Russell 1000 Value Index) stocks. **Exhibit 8** shows that the quintile spread annualized returns for growth stocks are almost 4% higher than for value stocks (11.1% vs 7.4%). And as **Exhibit 9** shows, this difference is present for shorter formation periods and longer holding periods. Like we saw with small cap stocks, across the board the momentum effect is stronger for growth stocks.

In both cases (small and growth stocks), there is stronger efficacy for price momentum in these riskier segments of the stock market, which begs the question, do risk-taking investors play momentum more than conservative investors? This is an interesting question and would make a terrific topic for future research.

Exhibit 7 – Price Momentum: Small Cap vs. Large Cap Stocks

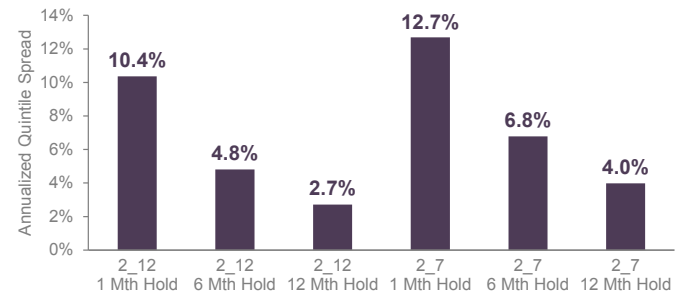


Exhibit 8 – One-Year Price Momentum: Growth vs. Value Stocks: Annualized One-Month Holding Period

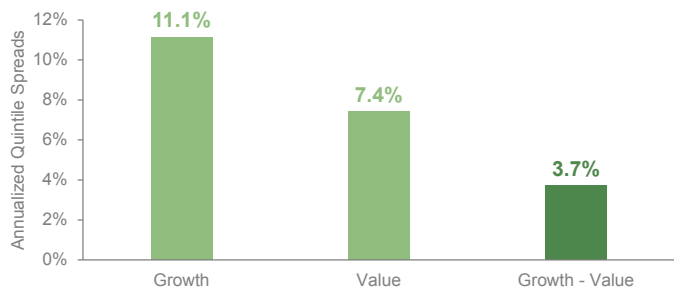
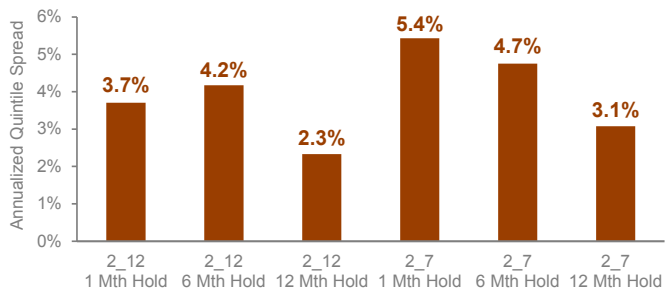


Exhibit 9 – Price Momentum: Growth vs. Value Stocks



Section 5

Price Momentum at a Broad Base or More Refined Peer Group

In this section, we compare performance of momentum stocks within a broad universe of stocks or within narrowly defined industries. If you are investing in momentum by finding the highest momentum stocks from your entire universe, you will tend to get industry or sector tilts, so momentum will have both a stock and industry effect. For example, say technology stocks far outperform any other sector over the last year, then the strongest momentum stocks will be predominantly technology stocks, leading to portfolios concentrated in this sector. On the other hand, if you combine the highest momentum stocks in the technology sector with the highest momentum stocks in each of the other sectors (or industries or even more refined groups), then your final portfolio will be well-balanced across different stock groupings. For this analysis, we look at stock momentum efficacy across the GIC schema, using their two-digit sector, four-digit industry group, six-digit industry and eight-digit sub-industry classifications.

Exhibit 10 – Price Momentum (2 to 12) by Stock Grouping: Returns and Risk

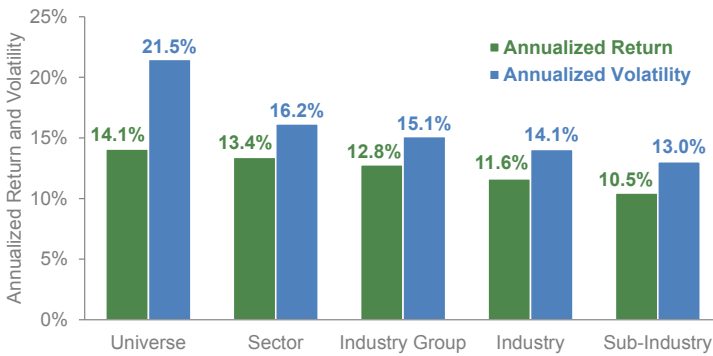
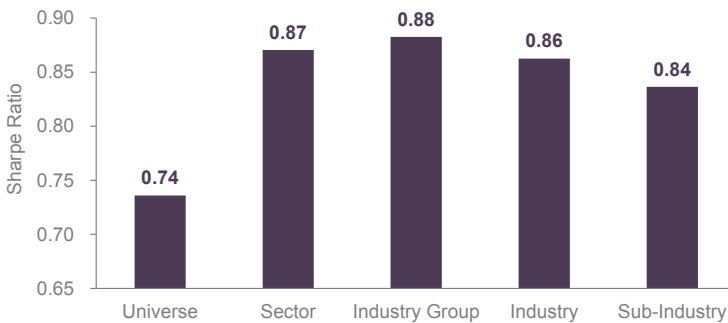


Exhibit 11 – Price momentum (2 to 12) by Stock Grouping: Risk Reward or Sharpe Ratio



We find that it does make sense to find momentum amongst more refined groupings, but more to reduce risk than enhance returns. In **Exhibit 10**, the returns are displayed by the green bars. The more refined the stock groupings, the lower the returns for momentum. The universe, sector and industry group levels are all pretty consistent, returning around 13-14% annualized. However, segmenting at the industry level costs you about a 1.5% and at the sub-industry level closer to 2.5% per year.

The blue bars show the risk or volatility of the returns for the momentum anomaly using different stock groupings. You immediately see that momentum at the universe level is by far the most risky approach. The annualized volatility of the returns for this strategy is almost 22%, far surpassing the sector volatility of 16%. In fact, as you refine the groupings, you reduce risk: industry group momentum returns have a 15% volatility, industry is 14%, and sub-industry are the least volatile at 13%.

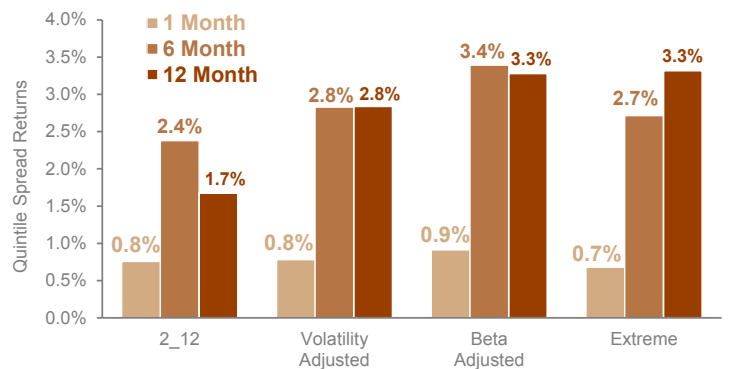
In the end, the best risk-reward from the momentum strategy is not at the universe level due to the elevated risk, nor at the sub-industry level due to the poorer returns, but at a grouping in the middle. As **Exhibit 11** shows, some refinement can go a long way, with the industry group level having the strongest Sharpe ratio (a common risk-reward metric, measuring return divided by volatility).

Section 6 Types of Price Momentum

In this section, we change the calculation of a stock’s momentum by adjusting for the stock’s volatility or beta as well as finding stock-specific relative momentum. One of the issues with the standard definition of momentum is that stocks with higher volatility or higher beta will have a better chance of being the highest or lowest momentum stocks. For instance, stocks with higher volatility will either have very strong returns or very weak returns, hence higher volatility. So these stocks will tend to either have high momentum or low momentum, with fewer observations in the middle. Likewise stocks with a higher beta will have a better chance of being in the top decile/quintile during strong markets and a better chance of being in the bottom decile/quintile during weak markets. In both cases, high volatility and high beta stocks will be overrepresented in the momentum anomaly portfolios. We can compensate for this overrepresentation bias by adjusting for a stock’s volatility or beta to arrive at a more “pure” measure of momentum.

In this section, we adjust momentum for beta and volatility as well as analyze another measure, extreme momentum, which is the z-score of the stock’s 2_12 momentum relative to its last three years. As **Exhibit 12** displays, some of the adjustments to momentum do make it more effective, especially over longer holding periods. Adjusting for either Beta or volatility, which we refer to as more “pure” momentum, adds value over all holding periods. Over a six to twelve month period these adjustment add roughly 1-2% to momentum’s quintile spreads.

Exhibit 12 – Price momentum and its derivatives



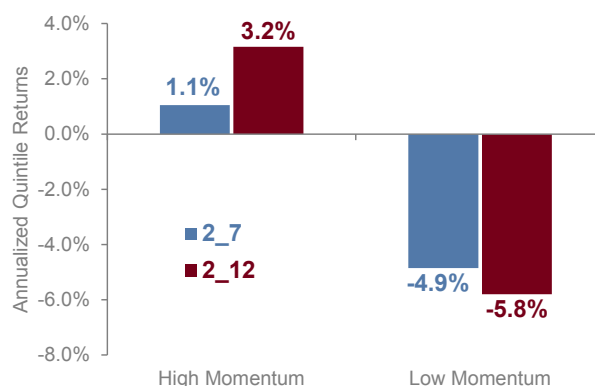
Section 7

Betting on Winning Stocks, Against Losing Stocks or Both

Most research papers test a characteristic by forming portfolios of long stocks with the highest values and short stocks with the lowest values. In general, research tests create portfolios buying the highest valued stocks, shorting the lowest valued stocks and calculating the return for this portfolio over the next month. Then next month they do the same thing, forming another portfolio in the same manner and seeing how it performs over the following month. This approach is commonly referred to as spread returns or the spread you earn between your longs and shorts. What we do not know with this type of test is where your spread return is coming from. It doesn't answer if the returns are coming from the stocks you go long or stocks you short. So as an investor, we don't know how much performance we may lose if we can't or are not willing to short stocks. We find that while there is value to doing both, shorting the low momentum stocks adds more value.

During a one-month holding period, the high-momentum stocks outperform less than the low-momentum stocks underperform. For instance, you can see in **Exhibit 13**, of the 9% quintile spread return for 2_12 (red bars), going long the winners generates 3% of the 9% spread while shorting the losers generates 6% of the spread.

Exhibit 13 – Price momentum annualized 1-month holding period returns: high vs. low momentum



Conclusion

In this paper we took a fresh look at price momentum. First, we extended Jagadeesh/Titman's seminal paper on price momentum and tested how the momentum anomaly has performed out of sample or since their paper was published. We found that the anomaly, while not as strong, is still alive and well. Second, we looked to better understand the anomaly. We confirmed prior research that momentum works best if you use an intermediate formation period. This fit with our finding that once a stock begins its momentum trend, it will generally appreciate for 15 months. We then discovered that momentum was more effective in the riskier segments of the market, such as small cap and growth stocks. This begs the question: do riskier investors tend to focus more on momentum than conservative investors? Furthermore, we found an investor can get better risk-adjusted returns by looking for momentum within sectors or industry groups. Next, it is important to consider looking for more "pure" momentum in stocks (i.e., adjusted for beta, volatility or both) when selecting stocks. Finally, we discovered that shorting the low momentum stocks provides better alpha than buying the high momentum stocks. In conclusion, the momentum effect is still alive and well, but there are many interesting nuances to the anomaly.

Disclosure

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