UNIVERSITY of York

Discussion Papers in Economics

No. 15/06

Size Matters: Tail Risk, Momentum and Trend Following in International Equity Portfolios

Andrew Clare, James Seaton, Peter N. Smith and Stephen Thomas

Department of Economics and Related Studies
University of York
Heslington
York, YO10 5DD

Size Matters: Tail Risk, Momentum and Trend Following in International Equity Portfolios

Andrew Clare*, James Seaton*, Peter N. Smith† and Stephen Thomas*

***Cass Business School, London**

†University of York, UK

This Version: May 2015

Abstract

We investigate the relationship between size and momentum across a wide range of international equity markets. A distinction is made between relative momentum where assets are ranked according to their performance against each other, and absolute momentum (or trend following) where assets are categorized according to whether they have recently exhibited positive, nominal return characteristics. We find only limited evidence for the outperformance of relative momentum portfolios. Trend following, however, is observed to be a very effective strategy over the study period delivering superior risk-adjusted returns across a range of size categories in both developed and emerging markets while not reversing the performance superiority of smaller firms. We also find, contrary to popular perception, that it is the mid cap-sector that dominates in emerging markets and suggest that this sector should be considered as the equivalent to developed economy small-cap investing.

Keywords: International equity markets, firm size, momentum, trend following, tail risk.

JEL codes: G0, G11, G15.

1. Introduction

In this paper we explore the small firm effect using MSCI style indices for both developed and emerging markets for the period since 1995, and show how overlaying relative momentum and trend following strategies can substantially enhance both absolute and risk-adjusted returns. For over 30 years the size effect has been well documented in the finance literature, starting with Banz (1981), Keim (1983), and others; the outperformance of small stocks relative to their large counterparts has been an accepted 'anomaly' in asset pricing. Indeed the "Small Minus Big" factor is a key component of the Fama and French (1992) three-factor model. Arguments can be made, in much the same way as the value-growth debate, that small firms have higher returns to compensate their owners for bearing additional risk compared to large firms. This might take the form of lower liquidity or less balance sheet strength for example. Alternatively, one can argue that the small firm effect is an anomaly that is mispriced by the market. A key finding in our study is that a mid-cap effect dominates in emerging markets.

Another anomaly within stock markets, and indeed asset classes generally, is that of momentum. The classic equity strategy highlighted by Jegadeesh and Titman (1993) involves buying the 'winners' over the past 6-12 months and selling the 'losers' over the same period. This is frequently referred to as cross-sectional momentum, or relative momentum by Antonacci (2012). Studies by Erb and Harvey (2006) and Miffre and Rallis (2007) demonstrate the effectiveness of this approach within commodity markets.

An alternative type of momentum investing is where one is interested only in the direction of prices or returns rather than how they fair against their peer group. This type of activity is known as trend following (other names include time series momentum and absolute momentum) and is frequently used by Commodity Trading Advisors (CTAs) (see Szakmary et al, 2010). As examples, trend following rules may use the current price relative to a moving average (Faber, 2007), or the length of time that excess returns have been positive over a range of timeframes (Hurst et al, 2012). The aim is always to trade in the direction of the prevailing price, i.e. when prices are rising long positions are taken and when prices are falling then cash or short positions are taken.

Evidence for the effectiveness of trend following strategies has been presented byFaber (2007), ap Gwilym et al (2010) and Moskowitz et al (2011), amongst others. Clare et al (2012) demonstrate that when relative momentum is compared to trend following it is the

latter that provides by far the more impressive investment performance enhancement for a variety of asset classes.

A few studies have considered combining relative momentum with other established equity strategies such as value. Asness (1997) observes that momentum is present in both value and growth stocks in the US but that the effect is larger in the latter. Similar results are observed by ap Gwilym et al (2009) in the UK when momentum is combined with dividend yield. Clare et al (2014) study a variety of international markets and find that trend following enhances the risk-adjusted returns of both value and growth companies, but particularly for the latter.

In this paper we seek to examine the relationship between size and momentum in an international context: We find that: the size effect exists across a large range of international markets, both developed and emerging; relative momentum provides small improvements in risk-adjusted performance compared to standard equal-weight portfolios although this has appeared to diminish in the last decade; trend following delivers substantial benefits in terms of considerably higher risk-adjusted returns and much lower maximum drawdowns; and finally that *combining* trend following with relative momentum leads to higher levels of return although there is little improvement in risk-adjusted performance compared to trend following alone.

2. Momentum and Trend Following

2.1 Momentum

Momentum is one anomaly in the financial literature that has been demonstrated to offer some explanatory ability of future returns. Many studies, such as Jegadeesh and Titman (1993) and Grinblatt and Moskowitz (2004) have focussed on momentum at the individual stock level, whilst others such as Miffre and Rallis (2007) and Erb and Harvey (2006) have observed the effect in commodities. Asness et al (2012) find momentum effects within a wide variety of asset classes, whilst King et al (2002) use momentum as a means of allocating capital across asset groups.

Typical momentum strategies involve ranking assets based on their past return (often the previous twelve months) and then buying the winners and selling the losers. Ilmanen (2011)

argues that this is not the ideal approach and that investors would be better served by volatility weighting the past returns. Failing to do this leads to the most volatile assets spending a disproportionate amount of time in the highest and lowest momentum portfolios (see Asness et al, 2012).

2.2 Trend following

Trend following has been widely used in futures markets, particularly commodities, for many decades (see Ostgaard, 2008). Trading signals can be generated by a variety of methods such as moving average crossovers and breakouts with the aim to determine the trend in prices. Long positions are adopted when the trend is positive and short positions, or cash, are taken when the trend is negative. As trend following is generally rules-based it can aid investors since losses are mechanically cut short and winners left to run. This is frequently the reverse of investors' natural instincts. The return on cash is also an important factor either as collateral in futures or as the risk-off asset for long-only methods. Examples of the effectiveness of trend following are, amongst others, Szacmary et al (2010) and Hurst et al (2010) for commodities, and Wilcox and Crittenden (2005) and ap Gwilym et al (2010) for equity indices. Faber (2007) uses trend following as a means of tactical asset allocation and demonstrates that it is possible to form a portfolio that has equity-level returns with bond-level volatility. Ilmanen (2011) offers a variety of explanations as to why trend-following may have been successful historically, including investor underreaction to news and herding behaviour. Moskowitz et al (2011) refer to an equivalent of trend following as "time series momentum". They demonstrate that a variety of asset classes show persistence in returns for periods of 1-12 months.

2.3 Combining trend following and momentum

A few studies have sought to combine some of the strategies previously discussed. Faber (2010) uses momentum and trend following in equity sector investing in the United States. Antonacci (2012) uses momentum for trading between pairs of investments and then applies a quasi-trend following filter to ensure that the winners have exhibited positive returns. The risk-adjusted performance of these approaches has been a significant improvement on benchmark buy-and-hold portfolios. In a related study we extend these ideas to the multi-

asset context (Clare et al, 2012) and find that although adding a momentum filter increases the level of return compared to equal weighting, the momentum portfolios are prone to large drawdowns. By contrast they find that trend following filters produce higher Sharpe ratios than the momentum-based equivalents, higher Sharpe ratios and, crucially, much lower maximum drawdowns. Finally, Clare et al find that the higher returns achieved by adding the trend following filter cannot be explained by the Fama-French-Cahart four factor model.

3. Data, Methodology and Results

3.1 Data

In order to gauge the impact of both momentum and trend following on market cap investment strategies, we used MSCI Large, Mid and Small Cap indices for 20 developed and 12 developing economies. The developed economy equity indices were: Australia, Belgium, Canada, Denmark, Finland, France, Germany, Hong Kong, Ireland, Israel, Italy, Japan, Netherlands, Norway, Singapore, Spain, Sweden, Switzerland, United Kingdom and United States. The developing economy equity indices were: Australia, Belgium, Canada, Denmark, Finland, France, Germany, Hong Kong, Ireland, Israel, Italy, Japan, Netherlands, Norway, Singapore, Spain, Sweden, Switzerland, United Kingdom and United States. Monthly data for these price and total return indices begins from the end of May 1994 for the large and mid-cap indices and from the end of December 2000 for the small cap indices unless otherwise indicated. The final month for all data is May 2013.

3.2 Equally weighted long portfolios across markets and sizes

Table 1 shows the summary statistics for the large, mid and small-caps, and combinations of the three, over the study period. The results are presented in two periods: June 1995 - May 2013, the whole data period, and January 2002 - May 2013, the period that small caps are introduced[1]. All portfolios are equally-weighted and rebalanced monthly. Firstly, we note that over the whole period from 1995 in developed markets (see Table 1), large and mid-caps delivered essentially the same performance. In emerging markets mid-caps returned around 1% per annum more with slightly higher volatility. In the later period beginning 2002, however, mid-caps outperformed large caps by over 2% per annum for developed markets

[1] We use the first 12 months of data for momentum calculations in subsequent sections hence the somewhat later start than might be anticipated based on the data section.

and 3% per annum for emerging markets. Volatility was somewhat higher but not enough to diminish the relationship on a risk-adjusted basis. Small-caps delivered the highest risk-adjusted returns within developed markets with a Sharpe ratio of 0.5 over the shorter period compared to 0.31 for large cap and 0.41 for mid cap; however, there was no similar outperformance shown by emerging small-caps with the mid- cap sector offering the highest absolute and risk-adjusted returns, the Sharpe being 0.78, the highest among the strategies in Table 1.

Over the whole period beginning 1995 the risk-adjusted performance of developed and emerging markets was very similar with Sharpe ratios of around 0.3. In the later period emerging markets outperformed considerably. Returns were some 10-11% per annum higher for emerging mid-caps than for the developed markets, albeit with volatility around one-fifth higher too. The maximum drawdowns for each strategy are the numbers usually associated with long only equity strategies with a very painful 60% plus commonplace; we note that any investors creating long-short strategies possibly with leverage may well have been wiped out, rendering the existence of many 'anomalies' questionable (Gray and Vogel, 2013).

3.3 Ranking by volatility adjusted returns for different size categories-relative momentum

We next consider the interaction of relative momentum and size. Following the method of Ilmanen (2011) we rank markets according to their prior 12-month return and then volatility-weight these by dividing by the standard deviation of returns over the same period. Portfolios are held for one-month and then recalculated with the momentum portfolio being the top quarter of available assets.

Table 2 reports that over the whole period returns for the momentum portfolio are around 2 to 3% p.a. higher for both large and mid-cap developed markets compared to all developed markets in Table 1 with similar volatility. Within emerging markets, however, the performance of large-cap momentum is very poor with an annual compound return of just 1.2% compared to about 11% for all markets. In the lower panel of Table 2 we see that mid-cap momentum for emerging markets has slightly higher risk-adjusted and absolute returns than all markets but the strategy of taking the highest momentum indices from the large and mid-cap combined emerging market universe is still below the base case scenario risk-adjusted return (in the lower panel, Table 1).

Over this shorter period in Table 2 we observe some benefits to relative momentum within developed small-caps but this is offset by underperformance within emerging small-caps with the mid-cap segment showing notable superior performance. There is little other evidence found to support the case for relative momentum during the second time frame. Sharpe ratios are very similar with or without momentum. It should be noted that the maximum drawdowns experienced by all of these portfolios are very severe. Every size category had to endure a maximum drawdown of at least 60% with some portfolios such as small-cap emerging suffering even deeper falls.

3.4 Overlaying trend-following on the equally-weighted size portfolios: does it help?

Thus far we have examined the relationship between relative momentum and size. We next consider the performance of trend following, or absolute momentum, in the same context. The concept of trend following is not new with Ostgaard (2008) providing a description of trend following activities that date back across several centuries. Hurst et al (2012) demonstrate that trend following has been a profitable strategy to adopt across equities, bonds, currencies and commodities as far back as 1902.

Following on from the work of Faber (2007), we will use a 10-month moving average[2] to define the trend. Specifically, if the current index price is above a simple 10-month moving average of the prices then a long position in the asset is adopted. If the current price is below the moving average then the asset is sold and a position in short-term treasury bills taken instead. The trend following rule is calculated at the end of each month and no short-selling is permitted.

Table 3 reports trend following results across the range of size portfolios. For the long period, we firstly note the substantial improvements in risk-adjusted returns compared to both the base case and the relative momentum equivalents. For developed markets, returns are around 2% per annum higher than the equally-weighted portfolios with volatilities around eight percentage points lower. Substantial outperformance is also observed within large and mid-cap emerging markets over the same period. A further benefit to the trend following approach is that maximum drawdowns are reduced from around 60% to close to 20% in all portfolios. Finally, we also find that portfolios become less negatively skewed. In the case of developed

[2] Faber (2007) and Clare et al (2012) report that moving average lengths between 6-12 months perform similarly across a range of asset classes.

markets these remain negative, however, the emerging markets and the portfolios containing both developed and emerging markets are both positive. This evidence is consistent with the findings of Koulajian and Czkwianianc (2010) for other managed futures and trend following strategies.

In the shorter period, for developed markets and the combination of all markets we observe the standard relationship of returns increasing as size decreases both with and without trend following. We again find that annualized returns are higher for developed markets using a trend following although the reverse is displayed for emerging markets. The consistent properties are the substantial reduction in both volatility and maximum drawdowns across all markets and all size categories. As a result the Sharpe ratios for all the trend following portfolios are considerably higher than their traditional buy-and-hold equivalents. As in the longer period, we also report a positive shift in skewness although the majority of portfolios remain mildly negative. The emerging market mid cap Sharpe ratio in Table 3, lower panel, is noticeably high at 1.28. Indeed, the mid cap Sharpe ratios are high for all our Tables/strategies, suggesting that emerging market mid cap behaves as developed country small cap.

3.5 Overlaying trend-following on volatility-adjusted ranked assets or, overlaying absolute momentum on relative momentum portfolios

Thus far, the evidence presented clearly favours trend following over relative momentum in giving high risk-adjusted returns. This is consistent with evidence presented by Antonacci (2013). To further test this, we now look at combining relative momentum with trend following. Portfolios are formed in the same fashion as Table 2; however, for a long position to be taken the trend must be positive for the asset using the rule described earlier. If the trend is not positive then the asset allocation is placed in cash instead.

Table 4 displays the results of the combination of the two types of momentum. Firstly we observe that the overall level of return is higher through this combination strategy than the equivalent returns from trend following alone (Table 3), relative momentum (Table 2), or equally weighted (Table 1). This is true of all size categories and particularly noticeable within developed markets. We also find though, that volatility is now higher than trend following alone and that this cancels out the increase in return such that Sharpe ratio levels are largely unchanged in aggregate. This supports the results of Clare et al (2012). In

addition to the higher volatility there is also an increase in the maximum drawdowns that most portfolios are forced to endure.

The evidence presented thus suggests that when relative momentum and trend following interact, it is the latter which is the dominant beneficial presence in terms of the investor's experience. We have seen that relative momentum added little in the way of portfolio gains across a range of markets and size categories. Trend following, by contrast, provided substantial benefits in terms of considerably reduced volatility, lower maximum drawdowns and less negatively skewed returns.

Further, and somewhat surprisingly, we see that for emerging markets it is the mid cap firms which offer the best risk adjusted returns-they are the 'small cap' equivalent of developed market companies.

3.6 The search for alpha

The properties of the investment strategies thus far are based upon unconditional returns. In this section of the paper we examine whether the excess returns can be explained by well-known, and widely employed risk factors. The lower parts of Tables 3 and 4 present alpha estimates and related t-values for the trend following portfolios and the trend following combined with momentum respectively. These are calculated for the full set of both developed and emerging size portfolios, and hence cover the shorter period. The alphas for each of the j investment strategies (α_j) were generated using expression (1):

$$ER_{jt} = \alpha_j + \beta_1 MKT_t + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 UMD_t + \varepsilon_{jt} \qquad (1)$$

where, ERj is the excess return on investment strategy j; MKT, SMB and HML represent Fama and French's three factors (market, size and value respectively); UMD is Carhart's momentum factor; and ϵ_{jt} is a white noise error term. We also show results for a 3-factor model where the factors are more recognisable as 'macro' factors, namely the Goldman Sachs' Commodity Index (GSCI), the return on the MSCI world equity index, and the return on the Barclays Aggregate Bond Index (BAR): all are expressed in excess of the US Treasury Bill rate. The Newey-West t-statistics are shown in brackets.

We see in Table 3 that the excess return for both the 4- and 3-factor models for developed countries rises monotonically as we progress from large to small portfolios, ranging from 0.579% to 0.997% per month. A similar pattern is seen for emerging countries, where the excess return rises from a low of 1.01% for large firms to a high of 1.38% per month for mid-size firms with a value of 1.31% for small firms. All of these numbers are highly statistically significant, with Newey-West t-values 2.89, 3.76 and 3.51, respectively. Clearly a very significant alpha remains even after the removal of factor components and it is highest for small firms in developed and for mid-size firms in emerging economies.

The lower section of Table 4 contains similar analysis but for size portfolios based on both trend following and the top quartile by prior performance (momentum).Here we again see strong, well-determined excess returns for all developed markets' size portfolios (ranging from a low of 0.658% to a high of 1.27% per month) and for emerging country portfolios the excess returns are well determined and highest for the mid-size firms, at 1.90% per month, whichever set of risk factors are used.

Both investment strategies analysing the absolute and relative trend interaction with size as an investing style give a powerful message that tail risk/drawdowns can be managed to give attractive Sharpe ratios and substantial alpha. As regards transactions' costs we note that recent work by Frazzinni et al (2012) has clearly shown, using a real data set from a large investor, that anomalies/styles such as value, growth and size survive transactions' costs with much greater room to spare than generally thought; the same cannot be said for reversal strategies. Further the switching of assets and moving to T-bills occurs relatively infrequently with one-way transactions taking place on average approximately every 7 months.

4. Conclusions

This paper has investigated the relationship between size and momentum across a range of developing and emerging international equity markets. We particularly make the distinction between relative momentum, where assets are ranked based on their prior volatility-adjusted returns, and trend following, where assets are categorized according to the direction of recent price moves.

We find that the well-researched size effect has been present across a range of developed markets but not for emerging countries, particularly in the early part of the twenty-first

century. Small and mid-cap stocks have outperformed their large counterparts on both a risk-adjusted and unadjusted basis. The performance of equities over the period of study has been characterized by some periods of turbulence such as the Asian crisis in the late 1990s, the dot-com boom and bust and the housing boom and financial crisis that took place during the first decade of the new millennium. This activity was contemporaneous with substantial falls in equity prices with many of the buy-and-hold portfolios in this paper suffering drawdowns in excess of 50%.

When relative momentum was introduced we found that over the whole period there were some small risk-adjusted gains to be had. These appeared to diminish after 2001, however, when there became little difference with base case portfolios. The introduction of trend following, however, was observed to offer substantial benefits across all size categories and both developed and emerging markets. Annualized returns were typically slightly higher but the big gains were made in considerably lower volatility and maximum drawdowns compared to relative momentum and buy-and-hold portfolios. An additional property of trend following portfolios was that returns were found to be less negatively skewed.

Finally, we combined relative momentum and trend following strategies together. We observed that the level of return was higher than trend following alone but that this was accompanied by a commensurate increase in volatility such that risk-adjusted returns were, on aggregate, little changed. We thus conclude that trend following is the dominant momentum effect.

When we expose these unconditional returns to both macro/financial and Fama-French factors in the search for alpha we find that excess returns remain, especially for the small stock portfolios in developed and for mid-sized firms in emerging economies.

References

Antonacci, G., (2012). "Risk Premia Harvesting Through Dual Momentum", Portfolio Management Consultants.

Antonacci, G., (2013). "Absolute Momentum: A Simple Rule-Based Strategy and Universal Trend-Following Overlay", Portfolio Management Consultants.

Asness, C., (1997). “The Interaction Between Value and Momentum Strategies”, *Financial Analysts Journal*, 53, 29-36.

Asness, C., Moskowitz, T. and Pedersen, L.H., (2012). “Value and Momentum Everywhere”, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2174501

Banz, R. (1981). “The Relationship Between Market Value and Return of Common Stocks”, *Journal of Financial Economics*, 9, 3-18.

ap Gwilym, O., Clare, A., Seaton J., Thomas S., (2009). "Dividends and Momentum", *Journal of Investing*, 18, 42-49.

ap Gwilym O., Clare, A., Seaton, J. and Thomas, S., (2010). "Price and Momentum as Robust Tactical Approaches to Global Equity Investing", *Journal of Investing*, 19, 80-92.

Clare, A., Seaton, J., Smith P.N. and Thomas, S., (2012). "The Trend is Our Friend: Risk Parity, Momentum and Trend Following in Global Asset Allocation", Cass Business School working paper.

Clare, A., Seaton, J., Smith P.N. and Thomas, S., (2014). "International Value and Momentum", Cass Business School working paper.

Erb, C., and Harvey, C., (2006). "The Tactical and Strategic Value of Commodity Futures", *Financial Analysts Journal*, 62, 69-97.

Faber, M., (2007). “A Quantitative Approach to Tactical Asset Allocation”, *Journal of Investing*, 16, 69-79.

Faber M., (2010). “Relative Strength Strategies for Investing”, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1585517

Fama, F. and French, K. (1992). “The Cross Section of Expected Returns”, *Journal of Finance* 47, 427-465.

Frazzini, A., Israel, R. and Moskowitz, T., (2012). “Trading Costs of Asset Pricing Anomalies”, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2294498

Gray, W.R., and Vogel, J., “Using Maximum Drawdowns to Capture Tail Risk”, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2226689

Hurst, B., Ooi, Y.H. and Pedersen L., (2012). "A Century of Evidence on Trend Following Investing", AQR Capital Management working paper.

Keim, D.B., (1983). “Size-related anomalies and stock return seasonality: Further empirical evidence.” *Journal of Financial Economics* 12, 13-22.

King, M., Silver, O. and Guo, B., (2002). “Passive Momentum Asset Allocation”, *Journal of Wealth Management*, 5, 34-41.

Koulajian, N. and Czkwianianc (2010). "Black Box Trend Following - Lifting the Veil", Quest Partners LLC.

Ilmanen A., (2011). *Expected Returns*. John Wiley & Sons.

Jegadeesh, N. and Titman, S. (1993). “Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency”, *Journal of Finance* 48, 65-91.

Miffre, J., Rallis, G., (2007), "Momentum Strategies in Commodity Futures Markets", *Journal of Banking & Finance*, 31, 1863-1886.

Moskowitz, T., Ooi, Y.H., Pedersen, L., (2011). "Time Series Momentum", University of Chicago working paper.

Ostgaard, S. (2008)."On the Nature of Trend Following", Last Atlantis Capital Management.

Szakmary, A., Shen, Q., and Sharma, S., (2010). "Trend-Following Trading Strategies in Commodity Futures: A Re-Examination", *Journal of Banking and Finance*, 34, 409-426.

Wilcox, C. and Crittenden, E., (2005). “Does Trend Following Work on Stocks?”, Blackstar Funds Working Paper.

Table 1: Equity index summary statistics

This table presents summary statistics for equally-weighted combinations of the large, mid and small-cap indices and combinations of these three, over the study period.

	Developed Markets					Emerging Markets					All Markets				
	Large	Mid	Small	Large & Mid	All	Large	Mid	Small	Large & Mid	All	Large	Mid	Small	Large & Mid	All
June 1995-May 2013															
Annualized Return (%)	8.62	8.69	-	8.68	-	10.07	11.11	-	10.64	-	9.53	9.99	-	9.79	-
Annualized Volatility (%)	18.63	19.17	-	18.76	-	26.16	27.48	-	26.64	-	20.37	21.19	-	20.67	-
Sharpe Ratio	0.31	0.31	-	0.32	-	0.28	0.30	-	0.30	-	0.33	0.34	-	0.34	-
Maximum Drawdown (%)	58.40	60.89	-	59.64	-	62.86	67.04	-	64.96	-	58.16	61.19	-	59.69	-
Skew	-0.79	-0.88	-	-0.85	-	-0.47	-0.47	-	-0.48	-	-0.71	-0.75	-	-0.73	-
Jan 2002-May 2013															
Annualized Return (%)	7.72	10.17	12.97	8.96	10.32	17.99	21.22	19.79	19.63	19.73	11.61	14.38	15.63	13.00	13.90
Annualized Volatility (%)	19.87	20.98	22.80	20.33	21.02	23.30	25.15	25.86	24.11	24.56	20.62	21.93	23.47	21.21	21.86
Sharpe Ratio	0.31	0.41	0.50	0.36	0.42	0.70	0.78	0.70	0.75	0.74	0.49	0.58	0.60	0.54	0.56
Maximum Drawdown (%)	58.40	60.89	63.81	59.64	61.05	57.96	62.63	66.34	60.04	62.14	58.16	61.19	64.39	59.69	61.29
Skew	-0.82	-0.94	-0.82	-0.90	-0.89	-0.70	-0.77	-0.81	-0.75	-0.80	-0.82	-0.93	-0.87	-0.88	-0.90

Table 2: Relative Momentum

Markets are ranked according to their prior 12-month return and then volatility-weighted by dividing by the standard deviation of returns over the same period. Portfolios are held for one-month and then recalculated with the momentum portfolio being the top quarter of available assets. The 4 Factor Alpha is the alpha coefficient from a 4 US Factor Fama-French model where the factors are the return to the CRSP value-weighted market portfolio in excess of the Treasury bill rate (RMRF), the small minus big (SMB) factor that is long the smallest half of firms and short the largest half of firms, the high minus low (HML) book-to-market value factor and an up minus down (UMD) momentum factor. The 3 Factor World Alpha is the alpha coefficient from a 3 factor broad world factor model where the factors are the return to the Goldman Sachs Commodity Market Index (GSCI); the return on the MSCI world equity market index (MSCI); the return on the Barclays Aggregate Bond Index (BAR), each in excess of the US Treasury bill rate. Newey-West t-statistics are shown in brackets.

	Developed Markets					Emerging Markets					All Markets				
	Large	Mid	Small	Large & Mid	All	Large	Mid	Small	Large & Mid	All	Large	Mid	Small	Large & Mid	All
June 1995-May 2013: Top Quarter															
Annualized Return (%)	11.06	10.83	-	11.22	-	1.18	10.47	-	8.67	-	10.97	14.66	-	12.52	-
Annualized Volatility (%)	19.35	19.83	-	19.15	-	29.46	31.17	-	28.40	-	21.01	21.51	-	20.83	-
Sharpe Ratio (2.77%)	0.43	0.41	-	0.44	-	-0.05	0.25	-	0.21	-	0.39	0.55	-	0.47	-
Maximum Drawdown (%)	60.28	64.85	-	60.62	-	77.46	73.93	-	69.47	-	64.97	67.91	-	66.48	-
Skew	-0.59	-1.09	-	-0.88	-	-0.41	-0.59	-	-0.63	-	-0.73	-1.05	-	-0.94	-
Jan 2002-May 2013: Top Quarter															
Annualized Return (%)	6.89	11.47	15.18	9.54	11.07	11.64	22.57	18.03	18.63	19.28	9.45	18.43	16.74	13.59	14.70
Annualized Volatility (%)	19.33	21.56	23.06	20.11	20.85	26.31	26.42	29.38	25.30	25.47	21.31	23.25	25.15	22.14	22.63
Sharpe Ratio (1.58%)	0.27	0.46	0.59	0.40	0.46	0.38	0.79	0.56	0.67	0.69	0.37	0.72	0.60	0.54	0.58
Maximum Drawdown (%)	60.28	64.85	68.69	60.62	63.83	69.73	69.96	80.18	69.47	71.06	64.97	67.91	71.50	66.48	68.02
Skew	-0.85	-1.22	-0.92	-1.06	-1.08	-0.47	-1.03	-1.28	-1.01	-0.95	-0.96	-1.21	-1.00	-1.07	-1.15
4 Factor Alpha	0.252	0.545	0.757	0.407	0.494	0.594	1.42	1.19	1.11	1.19	0.430	1.09	0.966	0.730	0.808
Newey-West t-stat	(0.91)	(1.61)	(1.89)	(1.36)	(1.47)	(1.00)	(2.13)	(1.74)	(1.83)	(2.01)	(1.01)	(2.71)	(1.82)	(1.57)	(1.68)
3 Factor World Alpha	0.211	0.560	0.835	0.405	0.520	0.693	1.46	1.16	1.18	1.20	0.455	1.10	0.991	0.752	0.825
Newey-West t-stat	(1.15)	(2.40)	(2.68)	(2.20)	(2.36)	(1.46)	(2.60)	(2.06)	(2.41)	(2.57)	(1.51)	(3.02)	(2.46)	(2.24)	(2.36)

Table 3: Trend Following

Trend following portfolios are formed as follows: if the current index price is above a simple 10-month moving average of the prices then a long position in the asset is adopted. If the current price is below the moving average then the asset is sold and a position in short-term US treasury bills taken instead. The trend following rule is calculated at the end of each month and no short-selling is permitted. The 4 Factor Alpha is the alpha coefficient from a 4 US Factor Fama-French model where the factors are the return to the CRSP value-weighted market portfolio in excess of the Treasury bill rate (RMRF), the small minus big (SMB) factor that is long the smallest half of firms and short the largest half of firms, the high minus low (HML) book-to-market value factor and an up minus down (UMD) momentum factor. The 3 Factor World Alpha is the alpha coefficient from a 3 factor broad world factor model where the factors are the return to the Goldman Sachs Commodity Market Index (GSCI); the return on the MSCI world equity market index (MSCI); the return on the Barclays Aggregate Bond Index (BAR), each in excess of the US Treasury bill rate. Newey-West t-statistics are shown in brackets.

	Developed Markets					Emerging Markets					All Markets				
	Large	Mid	Small	Large & Mid	All	Large	Mid	Small	Large & Mid	All	Large	Mid	Small	Large & Mid	All
June 1995-May 2013															
Annualized Return (%)	10.38	10.85	-	10.64	-	11.88	15.14	-	13.54	-	11.14	12.66	-	11.92	-
Annualized Volatility (%)	10.38	10.25	-	10.09	-	14.85	14.99	-	14.67	-	11.10	11.02	-	10.92	-
Sharpe Ratio (2.77%)	0.73	0.79	-	0.78	-	0.61	0.82	-	0.73	-	0.75	0.90	-	0.84	-
Maximum Drawdown (%)	19.32	18.78	-	17.18	-	20.67	20.20	-	18.42	-	18.73	14.95	-	16.71	-
Skew	-0.34	-0.29	-	-0.26	-	1.08	0.67	-	0.89	-	0.26	0.17	-	0.25	-
Jan 2002-May 2013															
Annualized Return (%)	9.36	12.16	15.05	10.77	12.21	15.29	20.73	19.60	18.01	18.56	11.66	15.42	16.87	13.54	14.66
Annualized Volatility (%)	10.10	10.91	12.32	10.33	10.83	14.87	14.99	14.96	14.73	14.69	11.24	11.71	12.49	11.36	11.64
Sharpe Ratio (1.58%)	0.77	0.97	1.09	0.89	0.98	0.92	1.28	1.20	1.12	1.16	0.90	1.18	1.22	1.05	1.12
Maximum Drawdown (%)	19.32	15.00	21.23	17.18	18.55	17.82	20.20	20.13	18.42	18.94	18.73	14.95	19.08	16.71	17.51
Skew	-0.18	-0.32	-0.15	-0.20	-0.19	0.15	0.03	-0.28	0.06	-0.06	-0.05	-0.15	-0.25	-0.08	-0.15
4 Factor Alpha	0.581	0.737	0.908	0.659	0.742	0.989	1.38	1.29	1.18	1.22	0.73	0.978	1.05	0.856	0.921
Newey-West t-stat	(2.18)	(2.52)	(2.94)	(2.39)	(2.62)	(2.55)	(3.29)	(3.09)	(2.97)	(3.04)	(2.47)	(3.09)	(3.20)	(2.81)	(2.97)
3 Factor World Alpha	0.579	0.770	0.997	0.675	0.782	1.01	1.38	1.31	1.20	1.24	0.74	1.00	1.11	0.871	0.952
Newey-West t-stat	(2.59)	(3.21)	(3.37)	(2.96)	(3.19)	(2.89)	(3.76)	(3.51)	(3.38)	(3.47)	(2.91)	(3.78)	(3.72)	(3.39)	(3.56)

Table 4: Trend Following and Momentum

This table shows the results of the combination of the two types of momentum simultaneously. The 4 Factor Alpha is the alpha coefficient from a 4 US Factor Fama-French model where the factors are the return to the CRSP value-weighted market portfolio in excess of the Treasury bill rate (RMRF), the small minus big (SMB) factor that is long the smallest half of firms and short the largest half of firms, the high minus low (HML) book-to-market value factor and an up minus down (UMD) momentum factor. The 3 Factor World Alpha is the alpha coefficient from a 3 factor broad world factor model where the factors are the return to the Goldman Sachs Commodity Market Index (GSCI); the return on the MSCI world equity market index (MSCI); the return on the Barclays Aggregate Bond Index (BAR), each in excess of the US Treasury bill rate. Newey-West t-statistics are shown in brackets.

	Developed Markets					Emerging Markets					All Markets				
	Large	Mid	Small	Large & Mid	All	Large	Mid	Small	Large & Mid	All	Large	Mid	Small	Large & Mid	All
June 1995-May 2013: Top Quarter															
Annualized Return (%)	14.79	12.97	-	13.80	-	9.37	15.07	-	14.43	-	14.15	17.49	-	15.47	-
Annualized Volatility (%)	14.91	14.30	-	14.16	-	22.91	25.24	-	21.63	-	15.90	15.90	-	15.47	-
Sharpe Ratio (2.77%)	0.81	0.71	-	0.78	-	0.29	0.49	-	0.54	-	0.72	0.93	-	0.82	-
Maximum Drawdown (%)	26.11	35.31	-	29.15	-	55.44	58.52	-	49.77	-	25.05	32.08	-	25.96	-
Skew	0.21	-0.37	-	-0.13	-	0.36	-0.18	-	0.10	-	-0.02	-0.28	-	-0.18	-
Jan 2002-May 2013: Top Quarter															
Annualized Return (%)	10.93	15.16	19.08	12.81	14.82	17.27	28.29	22.91	24.53	24.40	13.39	22.78	20.57	17.79	18.86
Annualized Volatility (%)	13.30	14.26	14.60	13.57	13.27	21.45	21.60	22.17	19.93	19.87	15.34	15.88	16.15	15.36	15.20
Sharpe Ratio (1.58%)	0.70	0.95	1.20	0.83	1.00	0.73	1.24	0.96	1.15	1.15	0.77	1.34	1.18	1.06	1.14
Maximum Drawdown (%)	19.97	21.70	23.21	20.98	19.34	28.36	35.19	39.93	29.21	29.70	22.53	26.06	24.81	25.09	24.09
Skew	0.22	-0.43	-0.27	-0.21	-0.36	0.23	-0.11	-0.69	-0.09	-0.32	-0.02	-0.16	-0.45	-0.09	-0.25
4 Factor Alpha	0.684	0.951	1.16	0.779	0.897	1.15	1.90	1.55	1.64	1.64	0.840	1.49	1.31	1.15	1.20
Newey-West t-stat	(2.23)	(2.58)	(3.42)	(2.25)	(2.70)	(2.18)	(3.13)	(2.45)	(3.19)	(3.18)	(2.25)	(3.67)	(3.01)	(2.98)	(3.04)
3 Factor World Alpha	0.658	0.955	1.27	0.779	0.937	1.18	1.90	1.55	1.66	1.64	0.849	1.49	1.35	1.15	1.22
Newey-West t-stat	(2.58)	(3.18)	(4.07)	(2.81)	(3.35)	(2.36)	(3.30)	(2.63)	(3.36)	(3.39)	(2.56)	(4.03)	(3.53)	(3.36)	(3.48)