USING VOLATILITY TO ENHANCE MOMENTUM STRATEGIES

A simple modification to the popular momentum strategy applied to international market indices produces highly profitable results in emerging market indices. High-volatility recent winners outperform low-volatility recent losers on an annualised basis by 17.4 per cent, with the strategy's long portfolio driving the superior performance. In contrast, applying the momentum/volatility strategy to developed market indices produces small but consistent improvements over the standard momentum approach.

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The momentum effect, originally described by Jegadeesh and Titman (1993), is characterised by a short-term return continuation of up to 12 months, whereby stocks that have had high returns in the recent past continue to have high returns in the near future and, similarly, stocks with low returns in the recent past repeat this performance in the near future. Classified as a major unresolved puzzle of capital markets, the momentum effect has sustained almost two decades of research. Although various risk-based and behavioural-based explanations for momentum have been offered, no explanation has achieved broad acceptance (Chan et al. 1996).

Previous momentum research has often considered other variables such as size, book-to-market, earnings and trading volume. In this paper, we consider whether volatility considerations can be used to improve on the profitability of the standard momentum approach. Momentum strategies buy securities with large returns in the recent past ('winners') and short securities with poor returns in the recent past ('losers'). Our approach is driven by two insights. First, average returns and volatilities are positively correlated at the level of international market indices. This means that indices with high volatility may be an advantage to the long side of the momentum strategy but may be a disadvantage to the short side of the momentum strategy. Thus, instead of simply buying winners and shorting losers, a better strategy may be to buy high–volatility winners and to short low–volatility losers. This is the strategy that we call the momentum/volatility strategy.

The second insight comes from an expression used by some stock market commentators and professionals at certain times that 'the market has climbed a wall of worry'. The expression means that the market has climbed over a period of time despite some intervening bad news. An implication is that the user regards such a market movement as having more than the usual strength. Perhaps indices that have 'climbed a wall of worry' will have stronger than usual momentum. We hypothesise that an index that has recently 'climbed a wall of worry' will have relatively high recent volatility, because it seems likely that any intervening bad news that was overcome will have at least produced extra volatility. Thus this insight also predicts that high-volatility winners will tend to have stronger momentum than winners in general.

Literature review

Volatility has long been a subject of interest to market participants and researchers. The consensus in the financial sector over many years has been that the volatility of the market has increased over time due to: (a) improvements in the speed and availability of financial information; (b) the increased importance of institutional investors; and (c) progress in the derivatives markets. Contrary to this popular belief, studies such as

Malkiel and Xu (1997, 1999), Schwert (1989), and Campbell et al. (2001) find that there has been no significant trend in total market volatility across many decades, but that the volatility of individual stocks has grown over time (Xu & Malkiel 2003).

There has also been research linking return predictability with past volatility of returns. Arena et al. (2005) have shown that stocks with high volatility display large momentum but also exhibit the quickest and largest reversals. Similarly, Wang and Xu (2009) have found that market volatility has significant predictive power for momentum especially in volatile down markets.

Malin and Bornholt (2010) use past volatility to explain an anomalous return produced by a 52-week high trading strategy.

Our present study differs from these past studies by employing a double-sorting method to investigate whether a momentum/volatility strategy is an improvement over the standard single-sorted momentum strategy.

Data and methodology

Monthly returns are derived from monthly prices with reinvested gross dividends of 44 Morgan Stanley Capital International (MSCI) indices downloaded from

TABLE 1: Descriptive statistics

Panel A: Developed Countries					
Country	**Mean %**	**SD %**	**Country**	**Mean %**	**SD %**
Australia	1.04	7.08	Japan	0.98	6.29
Austria	0.99	6.75	Netherlands	1.16	5.63
Belgium	1.09	6.01	Norway	1.27	8.00
Canada	1.02	5.78	Singapore	1.31	8.41
Denmark	1.23	5.68	Spain	1.02	6.77
France	1.07	6.61	Sweden	1.38	7.06
Germany	1.03	6.36	Switzerland	1.08	5.35
Hong Kong	1.75	10.33	UK	1.04	6.49
Italy	0.78	7.42	USA	0.88	4.52
			AVERAGE	1.12	6.70
Panel B: Emerging Countries					
Country	**Mean %**	**SD %**	**Country**	**Mean %**	**SD %**
Argentina	2.59	15.81	Malaysia	1.10	8.49
Brazil	2.80	15.16	Mexico	2.10	9.24
Chile	1.78	7.10	Morocco	1.23	5.65
China	0.55	10.70	Pakistan	1.16	11.29
Colombia	1.86	9.44	Peru	2.00	9.55
Czech Republic	1.53	8.59	Philippines	1.00	9.32
Egypt	1.83	9.75	Poland	2.17	14.51
Hungary	1.82	11.10	Russia	2.69	16.52
India	1.27	9.05	South Africa	1.36	8.13
Indonesia	1.96	14.79	Sri Lanka	1.27	10.89
Israel	0.88	7.07	Taiwan	1.15	10.77
Jordan	0.47	5.35	Thailand	1.29	11.20
Korea	1.25	11.20	Turkey	2.31	16.95
			AVERAGE	1.59	10.68

Note: This table provides descriptive statistics for the returns data of the 18 MSCI Developed Markets and 26 MSCI Emerging Markets indices from their first available months (January 1970 at the earliest) until January 2011 obtained from Datastream. Mean refers to the average monthly returns. SD refers to the standard deviation of monthly returns.

Datastream. Returns are calculated in US dollar terms to facilitate the interpretation of results across markets. The timeframe for the study extends from January 1970 to January 2011. Table 1 lists all of the countries in the sample, together with the average monthly return and standard deviation of each index. To understand better the performance of indices in different global settings, the countries in Table 1 are classified into 18 Developed (Panel A) and 26 Emerging (Panel B) markets based on MSCI's own classification.

The new momentum/volatility trading strategy proposed in this paper double-sorts indices for the two cases (developed and emerging) using a measure of momentum as the first sort variable and a measure of volatility as the second sort variable. Since momentum studies commonly use past six-month returns to sort securities into portfolios, we adopt this practise for our first sort variable. For simplicity, we use the standard deviation of monthly returns over the same six months as our measure of volatility. The strategy is constructed by buying the portfolio that contains indices that have performed well over the past six months and that have also displayed relatively high volatility (high–volatility winners), and selling the portfolio that contains those indices that have performed poorly over the past six months with relatively low volatility (low–volatility losers).

Portfolios are formed for the developed and emerging markets separately using the same procedure for each. Based on past six-month returns, every month the Winner portfolio contains the 25 per cent of indices with the highest past six-month returns, and the Loser portfolio contains the 25 per cent of indices with the lowest past six-month returns. The standard single-sorted or pure momentum arbitrage portfolio is the Winner–Loser portfolio. The momentum/volatility portfolios are derived by splitting both the Winner and Loser portfolios based on recent volatility. That is, the high-volatility winner portfolio (denoted HvWinner) contains the 50 per cent of indices in the Winner portfolio with the highest standard deviation of monthly returns over the past six months. Similarly, the low-volatility loser portfolio (denoted LvLoser) contains the 50 per cent of indices in the Loser portfolio with the lowest standard deviation of monthly returns over the past six months. The momentum/volatility arbitrage portfolio is the HvWinner–LvLoser portfolio.

We calculate portfolio returns for holding periods of three, six, nine and 12 months. Following Balvers and Wu (2006), we allow a one-month gap between the end of the ranking period and the beginning of the holding period. We also employ Jegadeesh and Titman's (1993) overlapping portfolio method. This means that for a six-month holding period, for example, one-sixth of the portfolio is updated each month (see Jegadeesh and Titman (1993) for a fuller explanation of the overlapping portfolio approach).

Results

Table 2 presents the results of the momentum/volatility strategies for the developed (Panel A) and emerging markets (Panel B) showing the average monthly returns of the short (LvLoser), long (HvWinner) and the arbitrage (HvWinner–LvLoser) portfolios, together with their associated t-values. To determine whether volatility enhances momentum, Table 2 also presents the Winner–Loser results of the pure momentum strategy in the final two rows of the table.

The momentum/volatility findings for developed markets in Panel A indicate that the long portfolio outperforms the short portfolio for each holding period, with the highest return of 0.86 per cent per month (t-value 3.68) for the six-month holding period. Comparing these results with the corresponding pure momentum results, we observe that the momentum/volatility profits are slightly larger for all holding periods.

Panel B of Table 2 presents the results for the two strategies applied in the emerging markets. For each holding period, the profits of the momentum/volatility strategy are greater than the momentum strategy, with the highest return of 1.45 per cent per month (t-value 2.87) being earned using a six-month holding period. This profit is almost double the pure momentum profit of 0.76 per cent per month (t-value 1.82) for the same period. The entries in Panel B for nine-month and 12-month holding periods also show substantially higher profits for the momentum/volatility strategy compared to the corresponding pure momentum strategy.

A feature of Table 2 is the remarkably high returns generated by the long portfolio that is composed of recent winners with high volatility. For example, with a six-month holding period, the HvWinner portfolio earns an average return of 1.51 per cent per month (t-value 5.08) in the developed markets case and earns 2.36 per cent per month (t-value 4.36) in the emerging markets case. Investors who do not wish to adopt a long/short strategy can derive very large returns by investing only in the long portfolio of this strategy.

Risk-adjustment analysis

An important issue in this research is the extent to which any profits survive risk-adjustment. This is addressed by employing an international two-factor model used by Balvers and Wu (2006):[1]

$$R_{p,t} - R_{f,t} = \alpha_p + \beta_{p,mkt}(R_{mkt,t} - R_{f,t}) + \beta_{p,vmg}VMG_t + \varepsilon_t \quad (1)$$

The dependent variable $R_{p,t}$ - $R_{f,t}$ is the monthly excess return of an equally weighted portfolio of interest, whether it is the long, short or arbitrage portfolio of a strategy, where Rp,t represents the monthly return of portfolio p at time t and Rf,t is the monthly risk-free rate at time t represented by the one-month US Treasury bill return.[2] The independent variables are as follows: $Rmkt,t$ - Rf,t corresponds to the excess return on the MSCI World market portfolio $Rmkt$ at time $t;$ $VMGt$ or the Value minus

TABLE 2: *Profitability of Momentum/Volatility and Momentum strategies*

Strategy	Portfolio	Panel A: Developed Markets				Panel B: Emerging Markets			
		Holding Months				Holding Months			
		3	6	9	12	3	6	9	12
Mom/Vol	LvLoser	0.75	0.66	0.69	0.79	1.33	0.91	0.95	1.09
		(3.03)	(2.77)	(3.00)	(3.54)	(2.78)	(2.01)	(2.18)	(2.55)
	HvWinner	1.45	1.51	1.41	1.23	2.05	2.36	2.18	1.89
		(4.64)	(5.08)	(4.88)	(4.38)	(3.71)	(4.36)	(4.03)	(3.56)
	HvWinner-LvLoser	0.70	0.86	0.73	0.45	0.72	1.45	1.23	0.79
		(2.71)	(3.68)	(3.44)	(2.34)	(1.31)	(2.87)	(2.57)	(1.75)
Mom	Winner-Loser	0.66	0.73	0.61	0.38	0.66	0.76	0.48	0.19
		(3.09)	(3.74)	(3.39)	(2.29)	(1.32)	(1.82)	(1.28)	(0.54)

Note: This table presents the average monthly percentage returns of the short, long and arbitrage portfolios of the momentum/volatility strategy (Mom/Vol). First, each month t, indices are ranked based on their six-month returns from month t-7 to t-1 month. The 25 per cent of indices with the largest past six-month returns are grouped in the Winner portfolio, while the 25% of indices with the smallest past six-month returns are grouped in the Loser portfolio. Within the Winner and Loser portfolios in each month t, indices are sorted based on their standard deviation of returns over the period from month t-7 to t-1. LvLoser represents the portfolio composed of the 50 per cent of indices in the Loser portfolio with the smallest standard deviations of return and HvWinner represents the portfolio composed of the 50 per cent of indices in the Winner portfolio with the largest standard deviations of return. These portfolios are equally weighted. The arbitrage portfolio HvWinner–LvLoser is to be held for three, six, nine or 12 months. The monthly return for each holding period comes from employing Jegadeesh and Titman's (1993) overlapping portfolio methodology. Winner–Loser refers to the corresponding pure momentum arbitrage portfolio. T-statistics are presented in parentheses.

TABLE 3: *Risk-adjusted Momentum/Volatility and Momentum profits*

Strategy	Portfolio	Panel A: Developed Markets			Panel B: Emerging Markets		
		Annualised Raw Ret.	α_p	Adj R²	Annualised Raw Ret.	α_p	Adj R²
Mom/Vol	LvLoser	0.079	-0.046	58.3%	0.109	-0.003	28.7%
			(-2.430)			(-0.055)	
	HvWinner	0.181	0.054	59.3%	0.283	0.211	17.5%
			(2.289)			(3.020)	
	HvWinner - LvLoser	0.103	0.099	1.0%	0.174	0.214	-0.9%
			(3.508)			(2.881)	
Mom	Winner - Loser	0.088	0.093	-0.1%	0.091	0.127	-0.3%
			(3.633)			(2.052)	

Note: This table presents the two-factor regression results for the momentum/volatility and the momentum strategies with six-month holding periods. Loser represents the portfolio composed of the 25 per cent of indices with the lowest past six-month returns and Winner represents the portfolio composed of the 25 per cent of indices with the highest past six-month returns. LvLoser represents the portfolio composed of the 50 per cent of indices in the Loser portfolio with the smallest past standard deviations of returns and HvWinner represents the portfolio composed of the 50 per cent of indices in the Winner portfolio with the largest past standard deviations of returns. The two-factor regression model is:

$$R_{p,t} - R_{f,t} = \alpha_p + \beta_{p,mkt}(R_{mkt,t} - R_{f,t}) + \beta_{p,vmg}VMG_t + \varepsilon_t$$

where Rmkt,t is the market factor represented by the return on the MSCI World market portfolio, Rf,t is the one-month US Treasury Bill return, and VMGt is the value-growth factor represented by the return on the MSCI World Value Index minus the return on the MSCI World Growth Index. Annualised Raw Ret. is the annualised unadjusted return for the respective portfolio. The t-statistics presented in parentheses are corrected for heteroskedasticity using the White (1980) test.

Growth factor is the return on the MSCI World Value Index minus the return on the MSCI World Growth Index at time *t*. These indices were downloaded from Datastream. The coefficients $\beta_{p,mkt}$ and $\beta_{p,vmg}$ are the regression loadings on the two factors, while the intercept α_p (or simply alpha) represents the risk-adjusted abnormal returns of the portfolios over the estimation period. If alpha is statistically significantly different from zero, then this is evidence of abnormal profits. The *t*-values corresponding to the regression coefficients are corrected for heteroskedasticity using the White (1980) test.

Pure momentum strategy profits are reversed within five years, whereas momentum/volatility profits are not reversed within five years. These differing post-holding period results (if confirmed in other settings) will challenge a number of existing momentum explanations.

Table 3 presents the annualised regression alphas for the momentum/volatility portfolios with six-month holding periods, together with the associated *t*-statistics and adjusted *R*-squared values. The results for the corresponding pure momentum strategy's Winner–Loser portfolio are also displayed. Table 3 also reports the annualised average raw return of each portfolio so that the impact of the risk adjustment can be assessed.

The developed markets results in Panel A indicate that the momentum/volatility strategy's profitability survives the risk-adjustment process. The risk-adjusted return of the arbitrage portfolio (HvWinner – LvLoser) remains significant at 9.9 per cent per year (*t*-value 3.508) with only a fraction of the unadjusted 10.3 per cent profits explained by the model. As might be expected from the raw results for developed markets discussed in the previous section, the risk-adjusted profit of 9.9 per cent for the momentum/volatility strategy is only marginally larger than the pure momentum profit of 9.3 per cent. Panel A also shows that both the long and the short portfolios contribute to the overall profitability of the strategy, displaying significant risk-adjusted returns of 5.4 per cent per year (*t*-value 2.289) and -4.6 per cent per year (*t*-value -2.43), respectively.

The risk-adjusted momentum/volatility results in Panel B for the emerging markets are dramatic. The arbitrage portfolio's large unadjusted profit of 17.4 per cent per year produces an alpha of 21.4 per cent (*t*-value 2.881). This alpha is much larger than the alpha of 12.7 per cent (*t*-value 2.052) generated by the pure momentum strategy. If we consider the component portfolios of the momentum/volatility strategy, we see that the short portfolio (LvLoser) has an insignificant alpha of –0.3 per cent (*t*-value –0.055). In contrast, the long portfolio (HvWinner) has a remarkably large alpha of 21.1 per cent (*t*-value 3.02). Since this alpha is almost the same as the momentum/volatility strategy's alpha of 21.4 per cent, investors can effectively capture the momentum/volatility alpha with a long-only strategy of buying high-volatility recent winners.

In this paper we have linked momentum to risk by using past volatility to improve on the momentum strategy. Although the profits of the momentum/volatility strategy survive risk-adjustment by the two-factor model, the possibility remains that a risk-based explanation of momentum may eventually prove successful based on a different model. Cooper et al. (2004) show that average momentum profits are positive only following periods with positive market returns. This result suggests a possible role for risk in explaining momentum. In contrast, Griffin et al. (2003) show that business cycle risk cannot explain momentum.

While many attempts to explain the momentum anomaly have appeared in the literature, neither risk-based nor behavioural explanations seem convincing at this stage (Jegadeesh & Titman 2001). While space constraints preclude us from reporting detailed post-holding period results, we can summarise our findings as follows. Pure momentum strategy profits are reversed within five years, whereas momentum/volatility profits are not reversed within five years. These differing post-holding period results (if confirmed in other settings) will challenge a number of existing momentum explanations. Given that our momentum/volatility portfolios are components of pure momentum portfolios, perhaps momentum is a composite phenomenon requiring different explanations for different components.

Discussion and Conclusion

This study has examined whether momentum strategies applied to international indices can be improved by taking into account each index's recent volatility. Our study answers this question in the affirmative. While the momentum/volatility strategy produces only small improvements over pure momentum in the developed markets case, the new strategy performs remarkably well when applied to emerging markets. For emerging markets, high-volatility recent winners outperform low-volatility recent losers on an average annualised basis by 17.4 per cent. In contrast, the long portfolio of the pure momentum strategy for emerging markets outperform the short portfolio by 9.1 per cent.

In addition, high-volatility winners earn an average annualised return of 28.3 per cent and an alpha of 21.1 per cent in emerging markets. While these anomalous results are of direct interest to practitioners, they also suggest opportunities for future research into whether stock-level and industry-level momentum strategies could be enhanced by taking past volatility into account.∎

Notes

1. A size factor is not needed in this context because the MSCI indices include only large liquid stocks.

2. This is the Ibbotson and Associates Inc. one-month T-bill rate which was downloaded from Kenneth French's website: http://www.mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.

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