

Improved Moving Average (IMA) strategies

By Fotis Papailias and Dimitrios D. Thomakos

A modified version of, perhaps, the most widely used technical trading strategy – moving averages – is discussed in this article. The suggested approach combines cross-over “buy” signals and a dynamic threshold value which acts as a trailing stop. The trading behaviour and performance achieved using this modified strategy is different to the standard approach with results showing that, on average, the proposed modification increases the cumulative return and the Sharpe ratio of the investor while exhibiting smaller maximum drawdown and less of a drawdown duration than that obtained by using the standard moving average strategy.

This article explains how a “moving average dedicated investor” can obtain higher profits (possibly combined with smaller risk characteristics, such as lower standard deviation and lower drawdown) using an improved moving average methodology (henceforth IMA). We define a “moving average dedicated investor” as an individual who forms his or her strategy based on trading signals of price or moving average cross-overs by carefully selecting the moving average (henceforth MA) length (or lengths) via back-testing.

The modification we propose is simple, intuitive, has a probabilistic explanation (based on the notion of “return to the origin” in random walk parlance) and can be easily implemented. It consists of a rule that relates the current price of an asset with the price of the last “buy” signal issued by a moving average strategy (making this latter price a dynamic threshold) which then acts as a dynamic trailing stop (either stop-loss or stop-profit depending on the current position). For reasons of simplicity, we focus on the long-only approach. However, for short-sales analysis and/or a full mathematical discussion, we refer readers to our academic papers available on the website shown at the end of this article.

Improved Moving Average Methodology

Consider the standard $MA(k)$, where k denotes the length (or “look-back”

period), and the trading signals it produces. In the simple case of a price cross-over, the standard strategy is to open a long position if the current price is greater than the current value of the $MA(k)$ (“buy” signal) and, consequently, close a long position if the current price is below the value of the $MA(k)$ (“exit” signal).

Our $IMA(k)$ first opens a position using the entry signal from the standard $MA(k)$, and marks this as the (first) “entry” price. If, in the meantime, the standard MA exits a trade and then re-enters while the current price is higher than the entry price, the IMA stays put *but its entry price is renewed*; hence the new entry price acts as a “trailing stop” which has been dynamically updated.

In order for the IMA to close a long position there are two conditions:

1. The IMA exits a trade if the current price is below the last updated entry price, or
2. IMA exits a trade if the current price is below a percentage threshold of the last updated entry price. The threshold parameter must first be defined in percentage terms, i.e. $t\%$, and then the threshold price is given by $(1-t\%)$ times the last updated entry price. For example, if the last updated entry price is \$75 and our threshold parameter is $t=0.03$ or 3%, the relevant threshold of the last updated entry

price is $(1-0.03)*\$75=\72.75 . This has proved to be useful in practice since it reduces the sensitivity to short-term price changes and therefore to over-active trading during choppy markets (this concept is further discussed in the second example).

If the IMA exits the long trade (in one of the above ways), it then enters a trade again:

- a. If and only if the standard MA provides a new buy signal, or
- b. If the current price rises above the last updated entry price (while standard MA is still in the trade).

For illustration purposes we will discuss a step-by-step example using (1) and (a) of the above conditions when the market is bullish, i.e. the IMA exits a trade if and only if the current price is below the last updated entry price and, once out, IMA opens again a long position if the standard MA provides a new buy signal.

Figure 1 (opposite) presents the MA and IMA strategies based on a 200-day look back period. The bottom red line depicts the periods that an investor who follows the standard MA strategy is in a long position. Similarly the top green line depicts the relevant period that an investor who follows the IMA strategy is in a long position. The horizontal green dashed lines mark the updates of the entry price. We are using a one day delay so that our results mimic real life situations, i.e. if we observe a buy signal at time “t”, we open a long position at time “t+1”. In all our analysis we are using the daily adjusted closing prices¹.

- On 17-04-2003 the current closing price is \$89.56, above the 200-day moving average, which is \$88.39. Hence, the standard MA gives a buy signal and on 21-04-2003 the investor opens a long position at \$89.65. The IMA uses this as its initial entry signal and the investor who follows the IMA strategy opens a long position as well (the green dotted line depicts the entry price of the IMA).
- On 16-07-2004 the current price is \$110.71 and the current standard MA equals \$110.80. The standard MA

¹ Data collected from Yahoo Finance.

Figure 1: MA example using a 200-day Moving Average

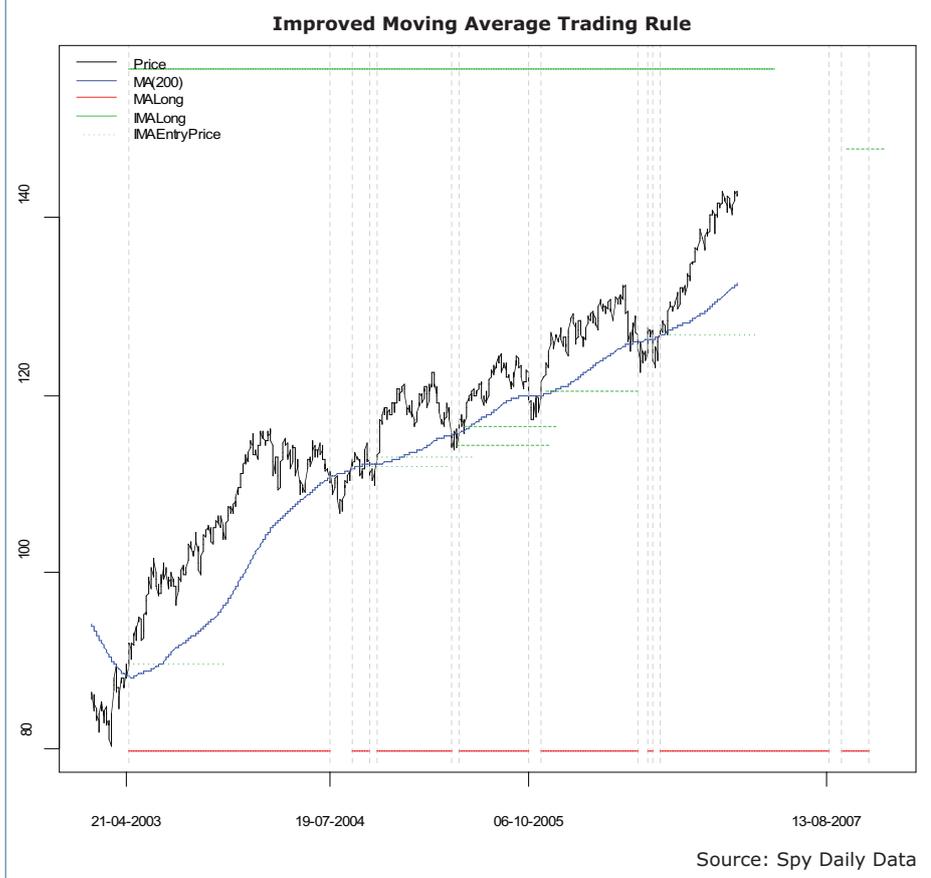


Table 1: Cumulative Return of the example described in Figure 1

Date	Price \$	Position	MA	Return	Position	IMA	Return
21-04-2003	89.65	Enter Long			Enter Long		
19-07-2004	110.24	Exit Long		22.97%	Long		
03-09-2004	112.12	Enter Long		Long			
14-10-2004	110.64	Exit Long		-1.32%	Long		
28-10-2004	113.22	Enter Long		Long			
18-04-2005	114.5	Exit Long		1.13%	Long		
03-05-2005	116.6	Enter Long		Long			
06-10-2005	119.2	Exit Long		2.23%	Long		
01-11-2005	120.49	Enter Long		Long			
08-06-2006	125.75	Exit Long		4.37%	Long		
30-06-2006	127.28	Enter Long		Long			
13-07-2006	124	Exit Long		-2.58%	Long		
26-07-2006	126.83	Enter Long		Long			
13-08-2007	145.23	Exit Long		14.51%	Long		
12-09-2007	147.87	Enter Long		Long			
08-11-2007	147.16	Exit Long		-0.48%	Long		
09-11-2007	145.14				Exit Long		61.90%
Cumulative Return			45.36%			61.90%	

provides a "sell" signal and the investor who follows the standard MA exits the trade on 19-07-2004 at \$110.24. The IMA stays put as the current price of \$110.80 is greater than its entry price of \$89.65.

- On 02-09-2004 the current price is \$112.58 and the standard MA value is \$111.67. The standard MA provides a buy signal and the investor opens a long position on 03-09-2004 at \$112.12. The IMA entry price is,

therefore, updated to \$112.12. Now, the investor who follows the IMA strategy (who is still long) will exit the trade if and only if the current price falls below the new updated entry price of \$112.12.

- The above procedure is repeated through the years 2004 - 2007. During this period of rising prices the standard MA enters and exits trades and the IMA entry price is updated. In 2007 prices fall sharply. After staying long during the period of rising prices, the IMA captures the change in trend as a result of the dynamically updated trailing stop.
- On 11-09-2007 the investor who follows the standard MA is not in a position and the current price is \$147.49. The standard MA is equal to \$146.13, so the standard MA signal gives a "buy". The investor opens a long position on 12-09-2007 at \$147.87. As analysed above, the entry price of the IMA is updated to \$147.87 and the investor who follows the IMA strategy will close the position if and only if the price falls below the level of \$147.87.
- Indeed, on 07-11-2007 the current price is \$147.91 and the standard MA is \$148.37. Hence the standard MA strategy provides a "sell" signal and the investor exits the trade on 08-11-2007 at \$147.16. On 11-08-2007-11 with the current price being equal to \$147.16, IMA provides an exit signal due to the fact that the current price fell below the last updated entry price of \$147.87, hence the investor who follows the IMA strategy closes the position on 09-11-2007 at \$145.14.

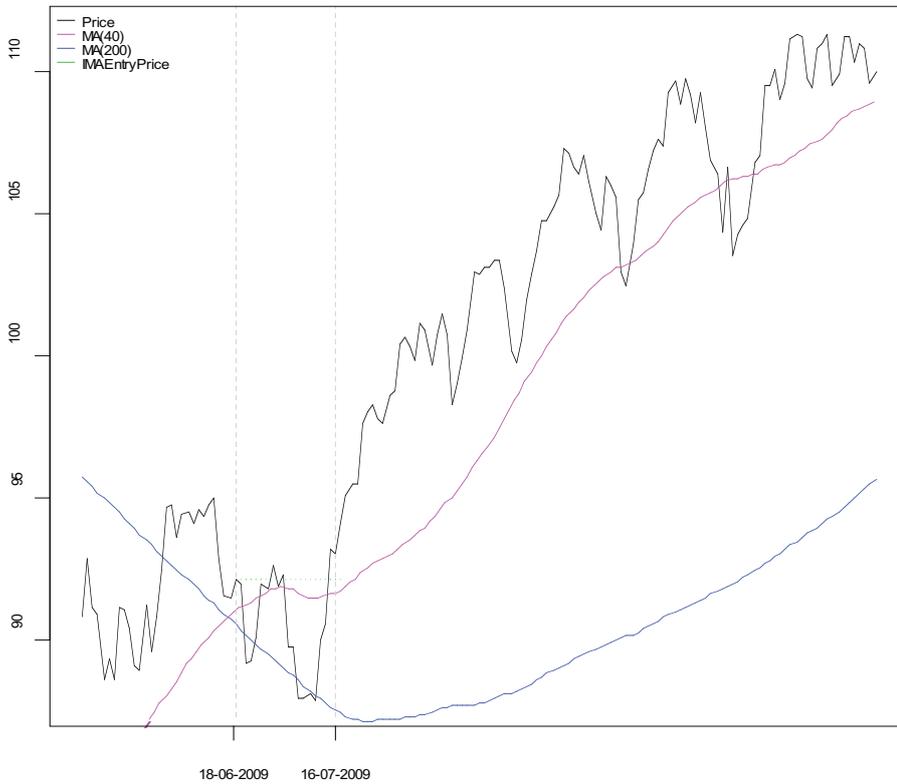
By the above analysis we obtain the following trades from Table 1.

In this example the IMA might look like it behaves as a buy and hold strategy, however this is due to (i) the strong trending behaviour of the market and (ii) the large MA length being used. Another aspect that is illustrated in Figure 1 is the IMA's ability to capture cyclical price behaviour and wait until the right moment when the cycle pattern is broken to exit the position.

Figure 2 presents an example of IMA exit signals using MA cross-overs.

Figure 2. IMA Example using a 20-day Moving Average

Improved Moving Average Trading Rule



Source: Spy Daily Data

Assume that an investor trades using signals of short and long moving average cross-overs with lengths of 40- and 200-days. Initially, the investor is out of the market.

- On 17-06-2009 the 40-day SMA crosses above the 200-day SMA providing a "buy" signal and the investor opens a long position. The IMA uses this as its entry price and provides a "buy" signal as well. The investor opens the position on 18-06-2009 at \$92.22.

- On 19-06-2009, the current price is \$92.04 below the last updated entry price, hence the IMA gives an exit signal. The IMA will enter again using one of the ways described in the previous section, i.e. IMA will either stay out of the market for a large period waiting for the standard MA to exit and re-enter in order to update its entry price (entry condition [a]), or, given that the MA is still in the market will enter again when the current price rises above the entry price (entry condition [b]). This indeed happens on

29-06-2009 when the current price is \$92.7, hence the investor who follows the IMA strategy opens a long position again on 30-06-2009.

- However, on 30-6-2009 the current price drops to \$91.95 so the IMA gives another exit signal.
- On 15-07-2009 the current price rises once again above the entry price at \$93.26 and the investor enters in a long position on 16-07-2009.

Using the IMA without incorporating some additional threshold to trigger exit decisions might lead to unsuccessful trades like those described above – especially in times when the market is bearish and volatile. This can be avoided using a threshold percentage of the last updated entry price as described in the beginning of this article. Indeed, using a 3% threshold so that the IMA will trigger an exit signal if the current price is below 1-0.03 of the entry price.

In Table 2 we see that the 3% threshold price is never below the entry price of \$92.22 and hence the sensitivity to sudden short-term changes in prices is eliminated.

Performance results and combined usage

In the last part of this article we discuss some back-testing results on "SPY", which tracks the S&P 500 index. We do so since a frequent criticism of the IMA approach is that it does not always improve the relevant standard MA approach. This is true – but no strategy can be totally fool-proof! We are looking for an improvement that performs well on average, across combinations of MA methods and look-back periods.

However, as noted earlier, we are proponents of fully back-testing different MAs (simple, weighted, exponential etc.) using different lengths and varying periods in order to find the combination that provides the most desired result on average. Our claim then is that one will find an IMA approach that, if followed, will give the investor better returns on balance than a standard MA approach. We refer the interested reader to our website to see full details as to how one can avoid the curse of data mining. We stress that the example that follows is for illustrating the potential of the method. Let us then continue by focusing on a

Table 2. IMA using a threshold price exit signal.

Date	Price \$	Price \$ (3% Threshold)	IMA Position	IMA - a Position	IMA - b Position
18-06-2009	92.22		Open Long	Open Long	Open Long
19-06-2009	92.04	89.28	Long	Long	Long
22-06-2009	89.28	86.6	Long	Close Long	Long
29-06-2009	92.7	89.92	Long		Long
30-06-2009	91.95	89.19	Long	Open Long	Long
01-07-2009	92.33	89.56	Long	Close Long	Long
15-07-2009	93.26	90.46	Long		Long
16-07-2009	93.11	90.32	Long	Open Long	Long

Notes: IMA-a denotes the IMA using entry condition(a), IMA-b C denotes the IMA using entry condition(b).

period where the market was going down, that is from 01-10-2007 to 01-02-2009 and a buy and hold or the standard MA suffered losses. We expect that the IMA will suffer losses too, but not always. If we look carefully at Table 3, we observe that the IMA-a (which is using condition (a) to determine an entry) and IMA-b (which is using way (b)) provide lower cumulative losses compared to the standard approach and the buy and hold. If we try different MA lengths and different MA rules, we then see that if the IMA-a cross-over of the exponential MA (20, 50) is followed, the investor achieves a no-loss position.

The next best option is the IMA-b (50) of the exponential MA where the cumulative return is -5.5%. Both these qualitative results are extremely important as they stress the fact that there was an IMA that would have kept the investor in the market -alive- in a difficult period.

Furthermore, if the investor kept on following the IMA-b(50) during the subsequent years after the crisis (i.e. 01-02-2009 to 04-03-2012), we see in Table 4, that it is the most profitable strategy after the buy and hold. This outcome is important as it stresses the

fact that the IMA is not a result of data-mining. By carefully selecting an IMA strategy and following it, the investor suffers minimum losses during the crisis and a large return when the market is bullish. Furthermore, IMA-b(50) provides a drawdown which is one of the lowest among all strategies and it is one and a half times less compared to the drawdown of the buy and hold.

And not only that: among all the strategies considered, in all combinations presented in Table 4, we can see that the IMA approach provides, on average, lower drawdowns and that,

Table 3. IMA Evaluation: 01-10-2007 to 01-02-2009. Notes: Sharpe is calculated using the annualised average return and standard deviation of returns, MAC denotes the MA Cross-Over, IMA-a C denotes the IMA using entry condition (a) Cross-Over, IMA-b C denotes the IMA using entry condition (b) Cross-Over.

	Simple MA (20, 50)				Simple MA (20, 100)			
	Sharpe	Cumulative	Drawdown	Duration	Sharpe	Cumulative	Drawdown	Duration
Standard MA(20)	-1.384	-0.235	0.242	285	-1.384	-0.235	0.242	285
Standard MA(50)	-2.260	-0.203	0.211	276	-0.651	-0.046	0.064	177
Standard MAC	-1.207	-0.196	0.252	177	-1.020	-0.072	0.083	177
IMA-a(20)	-1.161	-0.194	0.229	285	-0.726	-0.125	0.182	177
IMA-a(50)	-1.299	-0.139	0.147	285	-1.600	-0.016	0.016	197
IMA-a C	-0.549	-0.050	0.095	177	-0.982	-0.020	0.020	186
IMA-b(20)	-1.700	-0.244	0.252	285	-1.243	-0.180	0.189	177
IMA-b(50)	-1.301	-0.095	0.110	177	-1.338	-0.052	0.054	197
IMA-b C	-0.549	-0.050	0.095	177	-1.418	-0.042	0.042	186
	Weighted MA (20, 50)				Weighted MA (20, 100)			
	Sharpe	Cumulative	Drawdown	Duration	Sharpe	Cumulative	Drawdown	Duration
Standard MA(20)	-1.405	-0.273	0.280	285	-1.405	-0.273	0.280	285
Standard MA(50)	-1.702	-0.213	0.220	284	-0.089	-0.008	0.047	177
Standard MAC	-0.744	-0.120	0.165	276	-0.271	-0.022	0.064	177
IMA-a(20)	-0.814	-0.165	0.202	285	-0.428	-0.095	0.152	177
IMA-a(50)	-1.284	-0.155	0.164	285	-0.089	-0.008	0.047	177
IMA-a C	-0.931	-0.030	0.045	276	-1.110	-0.006	0.006	197
IMA-b(20)	-1.459	-0.262	0.269	285	-1.079	-0.199	0.205	235
IMA-b(50)	-1.059	-0.128	0.137	284	-0.089	-0.008	0.047	177
IMA-b C	-0.649	-0.069	0.088	177	-0.419	-0.022	0.040	177
	Exponential MA (20, 50)				Exponential MA (20, 100)			
	Sharpe	Cumulative	Drawdown	Duration	Sharpe	Cumulative	Drawdown	Duration
Standard MA(20)	-2.111	-0.344	0.351	285	-2.111	-0.344	0.351	285
Standard MA(50)	-1.040	-0.077	0.101	177	-1.248	-0.048	0.050	192
Standard MAC	-0.131	-0.011	0.064	177	-0.257	-0.011	0.038	177
IMA-a(20)	-1.404	-0.245	0.255	177	-1.349	-0.232	0.255	177
IMA-a(50)	-1.191	-0.094	0.106	285	-1.229	-0.046	0.057	177
IMA-a C	0.154	0.007	0.038	177	-1.394	-0.039	0.042	177
IMA-b(20)	-1.842	-0.300	0.307	285	-1.662	-0.272	0.279	177
IMA-b(50)	-0.764	-0.055	0.100	177	-0.875	-0.029	0.041	177
IMA-b C	-0.159	-0.013	0.052	177	-0.901	-0.020	0.025	177
Buy and Hold								
	Sharpe	Cumulative	Drawdown	Duration				
Buy & Hold	-1.041	-0.463	0.518	330				

Table 4. IMA Evaluation: 01-02-2009 to 04-03-2012. Notes: Sharpe is calculated using the annualised average return and standard deviation of returns, MAC denotes the MA Cross-Over, IMA-a C denotes the IMA using entry condition (a) Cross-Over, IMA-b C denotes the IMA using entry condition (b) Cross-Over.

	Simple MA (20, 50)				Simple MA (20, 100)			
	Sharpe	Cumulative	Drawdown	Duration	Sharpe	Cumulative	Drawdown	Duration
Standard MA(20)	0.626	0.249	0.160	260	0.551	0.193	0.160	260
Standard MA(50)	0.897	0.407	0.129	173	0.688	0.263	0.175	212
Standard MAC	0.280	0.099	0.254	248	0.688	0.285	0.225	212
IMA-a(20)	0.489	0.150	0.102	428	0.456	0.129	0.102	428
IMA-a(50)	1.021	0.440	0.088	170	0.706	0.171	0.105	205
IMA-a C	0.254	0.056	0.116	245	0.494	0.119	0.087	212
IMA-b(20)	0.522	0.191	0.139	260	0.487	0.158	0.139	260
IMA-b(50)	0.777	0.334	0.141	260	0.786	0.285	0.147	212
IMA-b C	0.394	0.140	0.156	270	0.934	0.338	0.116	212
	Weighted MA (20, 50)				Weighted MA (20, 100)			
	Sharpe	Cumulative	Drawdown	Duration	Sharpe	Cumulative	Drawdown	Duration
Standard MA(20)	0.716	0.291	0.163	260	0.603	0.213	0.163	260
Standard MA(50)	0.769	0.335	0.133	260	0.774	0.303	0.150	260
Standard MAC	0.560	0.233	0.177	260	0.637	0.262	0.173	321
IMA-a(20)	1.080	0.481	0.104	188	0.985	0.378	0.104	188
IMA-a(50)	0.727	0.287	0.140	451	0.910	0.340	0.115	469
IMA-a C	-0.007	-0.006	0.098	469	-0.233	-0.041	0.121	469
IMA-b(20)	0.874	0.361	0.115	260	0.772	0.275	0.115	260
IMA-b(50)	0.864	0.372	0.106	240	0.981	0.397	0.150	253
IMA-b C	0.573	0.223	0.163	260	0.705	0.256	0.152	266
	Exponential MA (20, 50)				Exponential MA (20, 100)			
	Sharpe	Cumulative	Drawdown	Duration	Sharpe	Cumulative	Drawdown	Duration
Standard MA(20)	0.658	0.267	0.191	260	0.544	0.187	0.191	260
Standard MA(50)	1.000	0.474	0.133	249	0.845	0.346	0.140	212
Standard MAC	0.821	0.392	0.151	212	0.471	0.175	0.271	212
IMA-a(20)	0.894	0.327	0.098	222	1.224	0.452	0.098	118
IMA-a(50)	0.801	0.303	0.104	464	0.908	0.237	0.082	180
IMA-a C	0.357	0.065	0.087	382	0.687	0.153	0.071	212
IMA-b(20)	0.861	0.356	0.129	258	0.859	0.308	0.129	258
IMA-b(50)	1.049	0.492	0.149	239	0.879	0.339	0.140	212
IMA-b C	0.922	0.432	0.110	212	0.893	0.345	0.128	212
	Buy and Hold							
	Sharpe	Cumulative	Drawdown	Duration				
Buy & Hold	0.868	0.663	0.218	203				

out of the five cases with a Sharpe ratio greater than one, four are using the IMA approach while only one uses the standard approach.

Conclusions

In this article we have presented a review of our academic research on an improved moving average methodology, which can be easily – and we think profitably – used by market practitioners. Our modification is based on an updated threshold value which is defined by the time-varying “buy” signals of the standard cross-over strategy and acts as

a dynamic trailing stop. This implies a different behaviour and performance for the modified strategy compared to the standard one and we find that, on average, the modification improves trading performance by a wide margin across a number of evaluation measures.

In theory, the dynamic trailing stop as introduced here could be possibly applied to any technical rule that provides trading signals. However, we have not tested this yet and our underlying theory justifies its usefulness when used with moving averages.

An investor interested in using this approach for trading would do well to perform some extensive back-testing in order to choose the IMA that has the best average performance across different evaluation periods (which should include bear markets). The IMA methodology will not, in fact it cannot, always provide better results against the standard MA, but there will always be one or more combinations where the IMA will be the most profitable: in our research we clearly document it is on average more profitable, the more you use it the higher the chances that it will be the best performer – and here lies its strength.

More importantly, besides increasing the cumulative return, it does so without increasing the risk-reward ratio: the modified strategy exhibits, on average, smaller maximum drawdown and smaller drawdown duration and in many cases a higher Sharpe ratio. These quantities are important to the investor: large drawdowns are catastrophic since they wipe out a large part of the invested capital making it difficult, if not impossible, for someone to return to the markets. We hope that the IMA approach will help anyone that is interested in this type of technical trading.

This article is a non-technical overview of the main ideas from two of our research papers "An Improved Moving Average Technical Trading Rule" and "An Improved Moving Average Technical Trading Rule II: Can we obtain performance improvements with short sales?", both available on our website at <http://www.quantf.com>, where additional results and discussion, as well as freely available R-Code can be found. We would like to thank Bob Fulks and Kent Russell for suggestions on the methodology. We are also indebted to the editor, Deborah Owen, for her help and patience in the preparation of this article.

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SAVE THE DATE!

The 2012 Annual Dinner
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**Guest speaker will be city expert,
David Buik from BGC Partners**

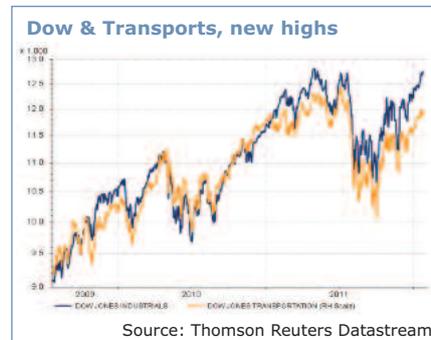
Details will follow shortly

Equity outlook

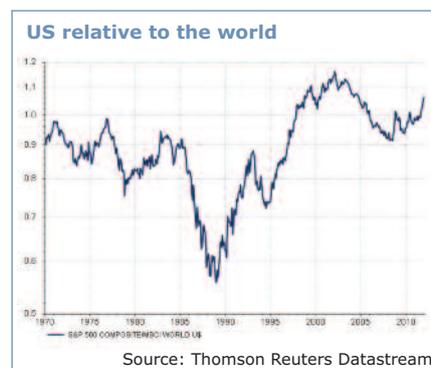
By Nicola Merrell

Over the last few months of 2011 the US positively diverged away from the rest of the global equity markets, culminating in a Dow Theory Buy Signal. Most readers will agree that this is a bullish signal for US equities and one not to be argued with. An overall bullish tone is set, especially in the US.

In a way, the most impressive feel to the rally has been the breadth and the clear, well defined leadership in the US. We expect this strength to filter through into global equities generally although the US has definitely led the way; decent outperformance shown here for the S&P Composite.



Clear, sustainable market trends are generally those driven by lots of stocks (good breadth – new highs by the advance-decline in the US of late) and clear sector relative trends. The beauty of relative trends is that they show consistent buying (or selling) of stocks despite any day-to-day gyrations in the underlying market. US industrial out-performance has led the way (and continues to do so) and subsequently Europe has started to follow suit.

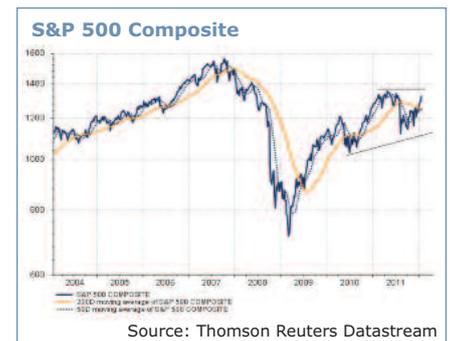


Overall, we feel that there is a need for new leadership as the broader European markets still lag behind. An eventual break higher in Europe, whilst not obvious early in the year would open the

way to a period of catch up and steep moves higher.



Looking forward, there are a few long term levels which need to be broken to extend the uptrend further. Firstly on an absolute level, the S&P resistance at 1371 was critical – the break through this level has confounded the naysayers who were sceptical about the strength of the rally. Once 1400 is cleared, it is easy to consider levels towards 1440.



We also feel that bank sectors globally are likely to participate in any bullish periods in the market. The long term relative trends are starting to be reversed and, of course, a gathering of pace could trigger substantial outperformance.

Overall we are looking for gains in 2012, as long as the sector trends continue to gather pace.

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