



## Mean Reversion Basics (Intro)

### **Introduction**

Mean reversion theory, which suggests that deviations from the average price tend to revert back to the mean, is a fairly misunderstood market concept. The main reason for this is probably that mean reversion forces are not equally present in all financial markets. Some financial products tend to mean-revert, others are more likely to trend. Moreover, the same financial instrument may show a tendency towards mean-reversion in the short-term, yet a tendency towards trend-following in the longer-term. And finally, for the same financial instrument, mean-reversion forces have been shown to vary quite considerably from decade to decade. All this has led many traders to shy away from mean-reversion theory and gravitate towards more intuitive concepts such as *MA crossover trend-following* or *breakout patterns*. This is unfortunate because mean-reversion theory, when clearly understood, can highlight a number of very powerful and predictable quantitative biases and lay the foundation for some very profitable trading systems.

In Part 1 of this study we try to determine whether mean reversion has always been present in the US stock market. We will look at both *long-side* mean reversion (buying oversold conditions) and *short-side* mean reversion (shorting overbought conditions). In later studies, we will look at how the *size* and the *persistence* of the overbought/oversold condition tend to affect the market's tendency towards mean reversion.

### **Analysis - Mean-Reversion Long-Side**

In this first study we will test whether - over the past 50 years - a down day in the S&P500 was more likely followed by another down day (momentum or "continuation"), or whether a down day was more likely followed by an up day (reversion). Using a 1 day "mean price" (yesterday's close) is the simplest possible test to ascertain the presence of mean reversion forces, and will provide a baseline for further studies.

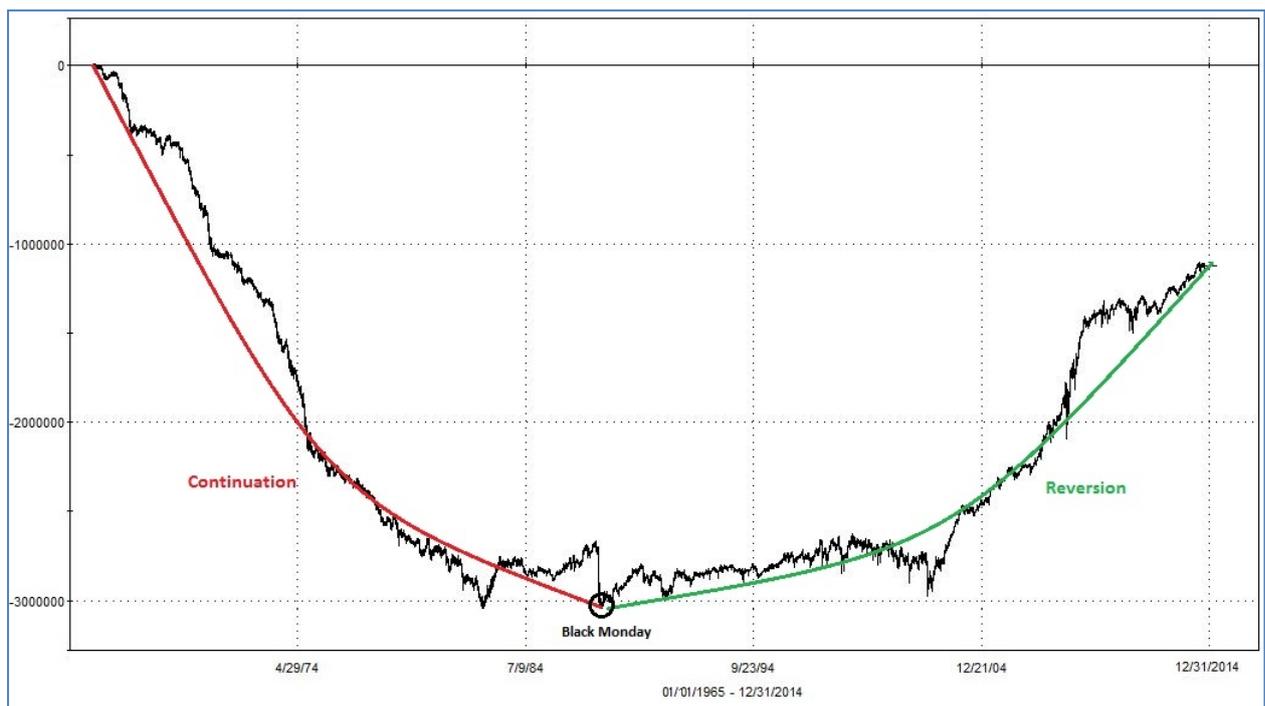
System data:

- Instrument: INX (S&P500 Index) from Jan 1st 1965 to Dec 31st 2014 (50 years)
- Capital per trade: US\$ 1,000,000 (no compounding)

System rules:

- Go long at the close of a down day
- Exit 1 day later

Below is the equity curve for our long-side system:





Results by decade are shown below:

S&P500 Index: 1-Day Mean-Reversion (Long-Side)				
Period	Trades (down days)	Win Rate	Win/Loss Ratio	Profit Factor
1965-1974	1210	40.33%	0.81	0.55
1975-1984	1225	46.86%	0.95	0.84
1985-1994	1160	53.53%	0.86	1.00
1995-2004	1183	59.09%	0.95	1.08
2005-2014	1126	58.53%	0.91	1.30

The results highlight that, from 1965 to 1987 or so, the US stock market had a clear statistical tendency to follow-through after a down day. In fact, during that period, down days were followed by further down days approximately 56% of the time. So buying into market dips would most likely have been a losing strategy during the period.

This tendency towards directional continuation in the US stock market changed quite markedly towards the latter part of the 1980's. In fact, the lowest point of the equity curve above occurred on a very specific day: namely October 19th 1987, also known as "Black Monday".

This inflection point is very noticeable on the equity curve above, and over the past 30 years we have witnessed mean-reversion forces increasingly exert their strength during short-term market selloffs. Over the past 3 decades, down days have tended to be followed by up days 57% of the time, giving long-side mean-reversion systems a distinct edge over follow-through strategies.

There are many possible reasons for this radical change in short-term price arbitrage, from follow-through to reversion. Following the crash of 1987, the SEC put into place a number of failsafe systems to try to prevent the market from experiencing further unruly collapses. Arguably, these measures have helped support the market during oversold periods, although the many "black swan" events of the past 15 years may well put this theory into question.

More likely, it is the dramatic increase in the number of market participants and associated trading volumes over the past 5 decades that have served to stabilize prices, at least over the short-term. Moreover, high-frequency trading systems and sophisticated algorithmic bots have been developed to quickly recognize oversold markets and buy into them, thus nudging prices back up. And finally, the increased ability for both private and institutional investors to sell short has also - somewhat ironically - helped stabilize falling prices, since short-sellers are incentivized to buy into falling markets to cover their winning positions.

Possibly the main take-away from this study is that market forces do indeed change over time. Sometimes for reasons that are clearly understood (legal/regulatory, trading volumes, etc), sometimes for reasons that are more obscure.

## **Analysis - Mean-Reversion Short-Side**

In this second study we will look at whether - over the past 50 years - an up day in the S&P500 has tended to be followed by another up day (momentum), or whether an up day has tended to be followed by a down day (reversion). Like in the previous study, we will use yesterday's close as the simplest expression of "mean price" to test the presence of mean reversion forces.

System data:

- Instrument: INX (S&P500 Index) from Jan 1st 1965 to Dec 31st 2014 (50 years)
- Capital per trade: US\$ 1,000,000 (no compounding)

System rules:

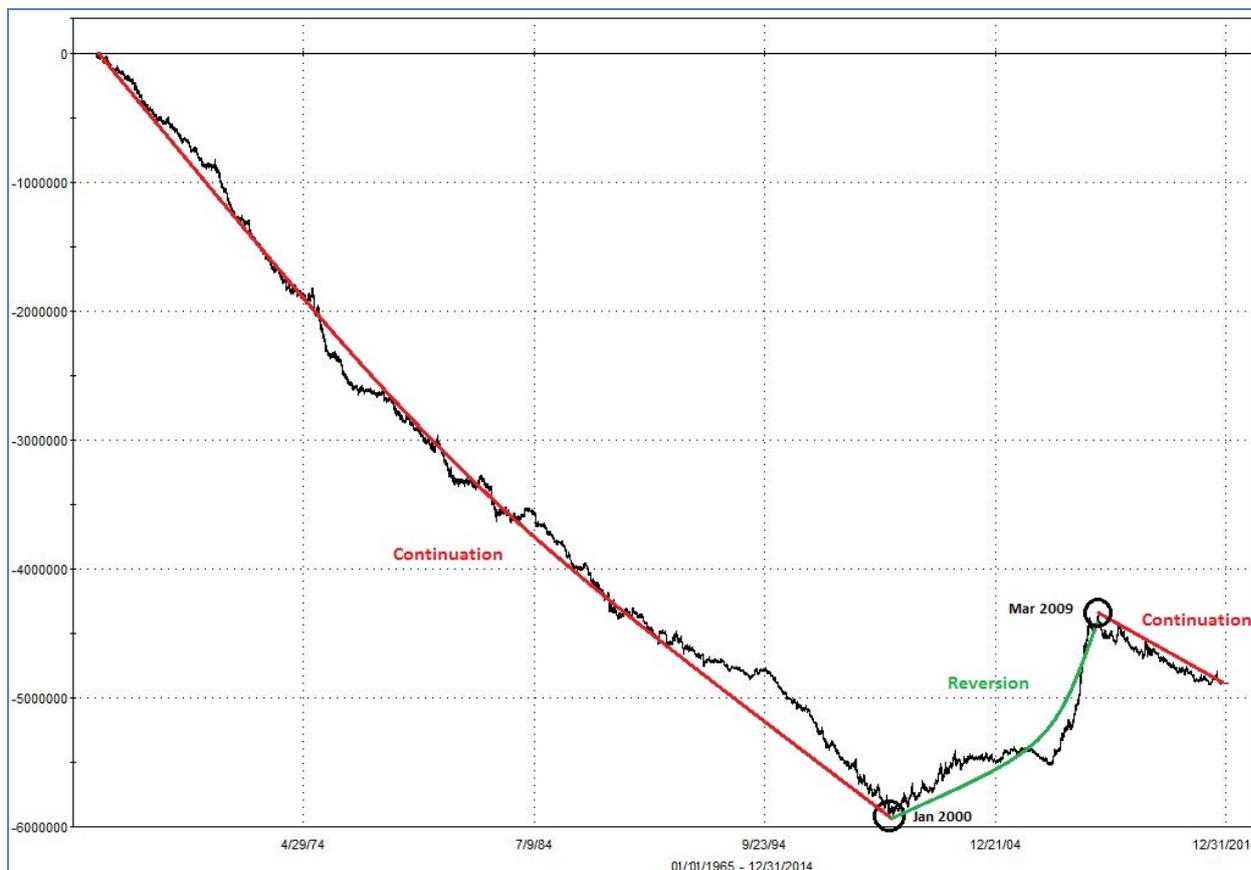
- Go short at the close of an up day
- Exit 1 day later

Results by decade are shown below:

S&P500 Index: 1-Day Mean-Reversion (Short-Side)				
Period	Trades (up days)	Win Rate	Win/Loss Ratio	Profit Factor
1965-1974	1267	38.28	0.84	0.53
1975-1984	1285	44.67	0.83	0.68
1985-1994	1356	45.75	0.89	0.75
1995-2004	1330	47.37	0.97	0.87
2005-2014	1386	47.69	1.23	1.13



Below is the equity curve for our short system:



The results for the short-side test are somewhat similar to those of the long-side test. As we can see from the equity curve above, systematically shorting an up day during the period 1965-2000 would have been a very unprofitable strategy. The fundamental reason for this undoubtedly lies in the stock market's defacto long bias. The S&P500 rose 2,200% between 1965 and 2015, corresponding to a compounded average increase of 6.36% per annum. In these conditions short-sellers are fighting a very strong head-wind which is likely to render the bulk of short-side mean-reversion systems unprofitable under "normal" market conditions.

The short-side equity curve also features an inflection point, this time centred around January 2000. This of course corresponds to the end of the internet bubble and the beginning of the 3 year bear market that followed. It therefore makes intuitive sense that short-side mean-reversion would have expressed itself during the 2000-2003 period, but less that it continued to do so during the recovery years of 2004-2008. We also note that the multi-year boom that followed the market crash of 2008/2009 has again favoured long-side follow-through over short-side mean-reversion.

Probably the main finding here is that short-side mean-reversion forces have also evolved considerably over the past 5 decades. Going short - under just about any market condition - would have been a fool's errand from 1965 to 2000. Since then however, certain periods have proven more profitable for short-sellers. But clearly, strongly trending bull markets will always make things more challenging for the short-seller than range-bound or bearish markets.

## **Summary**

The key findings are:

- Long-side mean-reversion has not been consistently prevalent in the US stock market over the past 50 years. In the 1960's, 1970's and much of the 1980's, down days tended to be followed by more down days. This was the heyday of runaway markets, where trading edges were most easily found in trend-following strategies. Mean-reversion forces started exerting their strength in the late 1980's. There are a number of likely reasons for this, including increased volumes, algo trading, short-selling, etc. The end result is that the US stock market has now become considerably more prone to correct short-term oversold prices rather than follow-through on them, giving long-side mean-reversion systems a distinct statistical edge.



# *The Mechanical Trader*

- Short-side mean-reversion was essentially non-existent in the US stock market from 1965 to 2000. The main reason for this is likely to lie in the stock market's built-in "inflationary" long bias: prices tend to rise over time, making shorting (at least as seen here in its simplest form) statistically unprofitable in the long-run. This is particularly true during sustained bull-runs. During more choppy or bearish market conditions, however, some short-side mean-reversion systems may well prove profitable, as seen during the 2000-2008 period. It should also be noted that, as per long-side systems, the advent of increased trading volumes and high-frequency trading have also played a role in reining in runaway prices, be they in oversold or overbought territory.
- The most important finding of this paper is that markets do indeed change over time, so traders searching for absolute truths - that span different markets and different timeframes - will tend to be disappointed. Only through long-term quantitative analysis can a trader hope to follow the evolution of the market and keep his trading edges current and intact.