## Market Signals – Methodology

The recent past (since 2000), in particular, shows that the buy-and-hold strategy is not satisfactory for a good long-term capital investment. The examples of return for characteristic time periods of the S&P 500 market index, as well as the following chapter on the **duration of bull and bear markets**, demonstrate that there are local, long-term trends in stock markets, i.e. that there are bull and bear markets. Assuming these local trends, we model the stock market with an auto-regressive model of second order, an AR2-model. In contrast to an AR1-model, the AR2-model better describes the statistical properties of the observed local trends. By means of a Kalman filter we then calculate the trends of the logarithms of the weekly price changes. These are plotted for the S&P 500 market in the following diagrams.

For a trend above a threshold close to 0 (light blue line), the average price changes are positive and there is no need to exit the market. A trend falling below the "zero threshold" is an indication of the start of a bear market and therefore one should gradually exit the market. If the trend falls below the red line, the more aggressive strategy indicates a temporary re-entry into the market. All parameters (for the thresholds, as well as for the averaging times of the trends) are obtained by optimizing the yield of stock during a long time interval and by taking into account the transaction costs (0.5% assumed for all buy or sell transactions) and the risk-free interest yield (3% assumed). Because different time periods in the past result in small differences in the trend parameters, we indicate a bandwidth of trends. The trend that is optimal for the full time history from 1964 to 2009 (black curve) is also characterized by very few false alarms. However, since the averaging time scale is on the order of one year, all market signals possess an inertia that prevents a fast market re-entry after the end of a bear market.

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The first graph shows the trends over the full time series from 1964 until 2009.
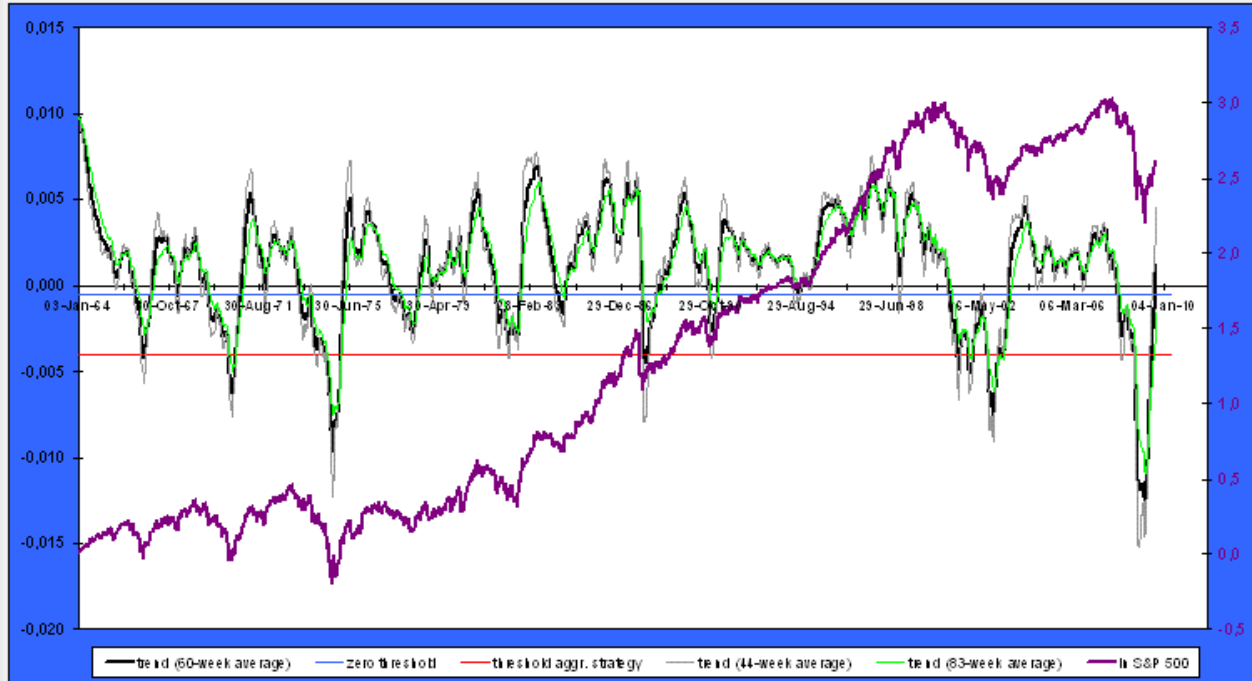
Purple curve with right-hand scale: logarithm of the S&P 500 on a weekly basis in the period Jan. 1964 until Aug. 2009
Red line with left-hand scale: threshold for the more aggressive strategy
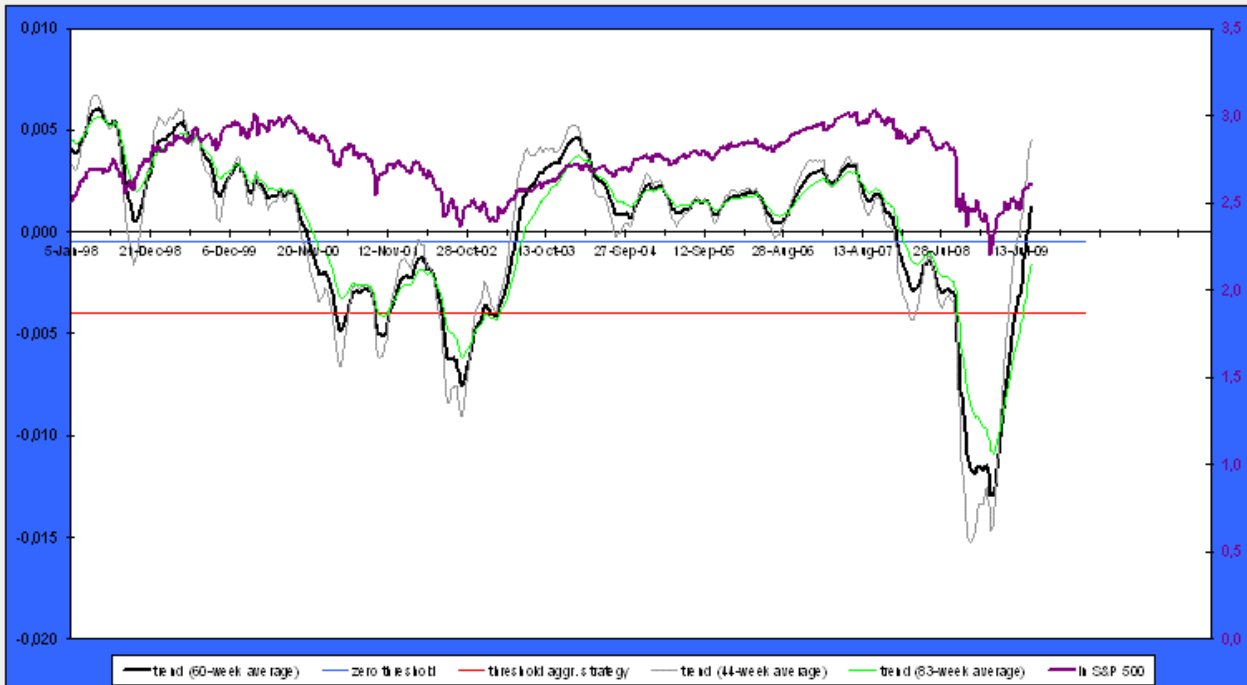*Light blue line with left-hand scale:* "zero threshold" for the conservative strategy
Black curve with left-hand scale: trend of the Kalman filter using 60-week average
Grey curve with left-hand scale: lower boundary of the trend width (trend of the Kalman filter using 44-week average)
Light green curve with left-hand scale: upper boundary of the trend width (trend of the Kalman filter using 83-week average)

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The second graph magnifies the time interval from January 1998 until August 2009. This is an example where our method shows its strengths. Both bear markets in this interval were detected in time. The time interval for the first market exit was from end of October to end of December 2000. Market re-entry with the conservative strategy was between May and June 2003. The time interval for the second market exit was from beginning of January to mid of February 2008. The conservative strategy gave a market re-entry signal between June and September 2009. In both cases, the conservative strategy missed the strong price increase in the early phase of market recovery, but unlike the more successful aggressive strategy, did not suffer from large temporary losses.

Purple curve with right-hand scale: logarithm of the S&P 500 on a weekly basis in the interval Jan. 1998 until Aug. 2009
Red line with left-hand scale: threshold for the more aggressive strategy
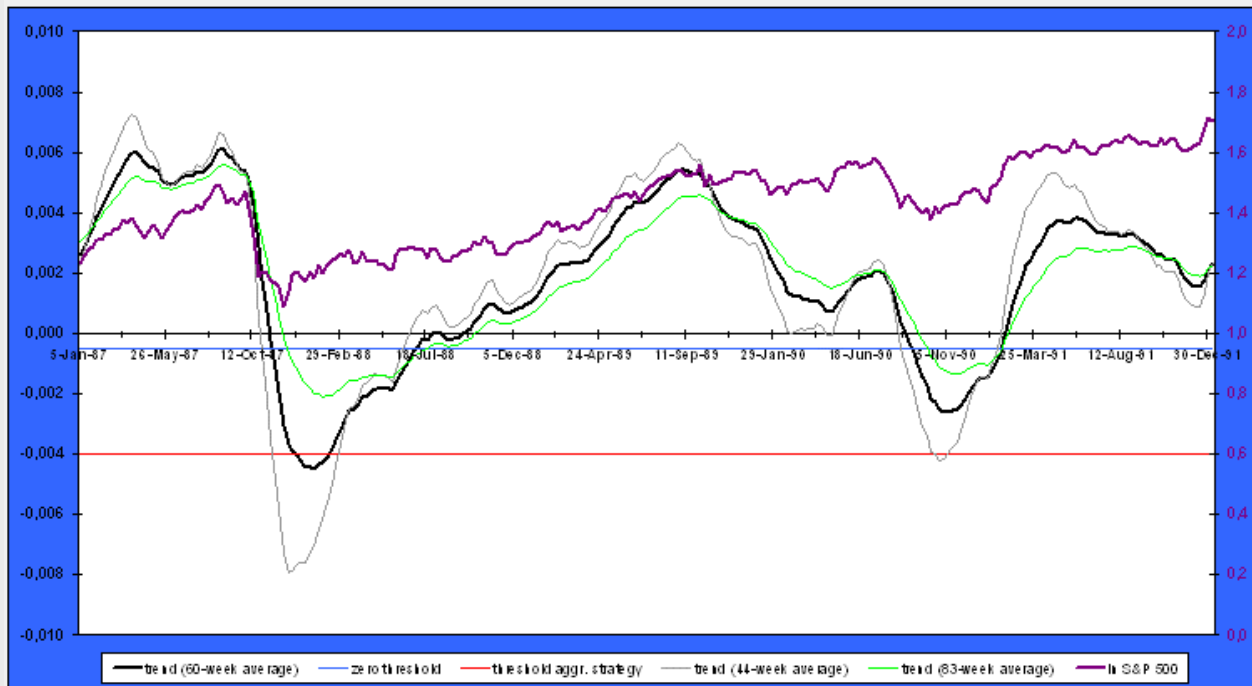*Light blue line with left-hand scale:* "zero threshold" for the conservative strategy
Black curve with left-hand scale: trend of the Kalman filter using 60-week average
Grey curve with left-hand scale: lower boundary of the trend width (trend of the Kalman filter using 44-week average)
Light green curve with left-hand scale: upper boundary of the trend width (trend of the Kalman filter using 83-week average)

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The third graph magnifies the time interval from January 1987 until January 1992. It is an example where our methodology does not work, because the time period over which the trend is averaged is longer than the market correction lasts. Both the October 1987 crash and the short price drop of 17% between July and October 1990, with their fast recoveries, were detected too late. Market exit occurred after the worst had already happened. While the aggressive strategy fully participated in the fast recovery after the 1987 crash, the conservative strategy missed a large part of it.

Purple curve with right-hand scale: logarithm of the S&P 500 on a weekly basis in the interval Jan. 1987 until Dec. 1991
Red line with left-hand scale: threshold for the more aggressive strategy
Light blue line with left-hand scale: "zero threshold" for the conservative strategy
Black curve with left-hand scale: trend of the Kalman filter using 60-week average
Grey curve with left-hand scale: lower boundary of the trend width (trend of the Kalman filter using 44-week average)
*Light green curve with left-hand scale:* upper boundary of the trend width (trend of the Kalman filter using 83-week average)

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Duration of Bull and Bear Markets

Another means of detecting long lasting bear markets is to take advantage of the different mean life spans of bull and bear markets. The analysis of the full time history of the S&P 500 index from 1964 to 2009 shows that bear markets have a mean duration of 80 ± 45 weeks, whereas bull markets have a mean duration of 125 ± 73 weeks. In bull market phases, the average annual return was +27%, however the annual return in bear market phases was -24%. Also the volatilities show significant differences: in bull market phases the volatility was 13%, while the volatility of bear market phases was 20%.

The logarithm (ln) of the US S&P 500 index, as a function of time (in weeks) (January 1964 to January 2010), with its bull markets (blue), bear markets (red) and not classifiable segments (black)
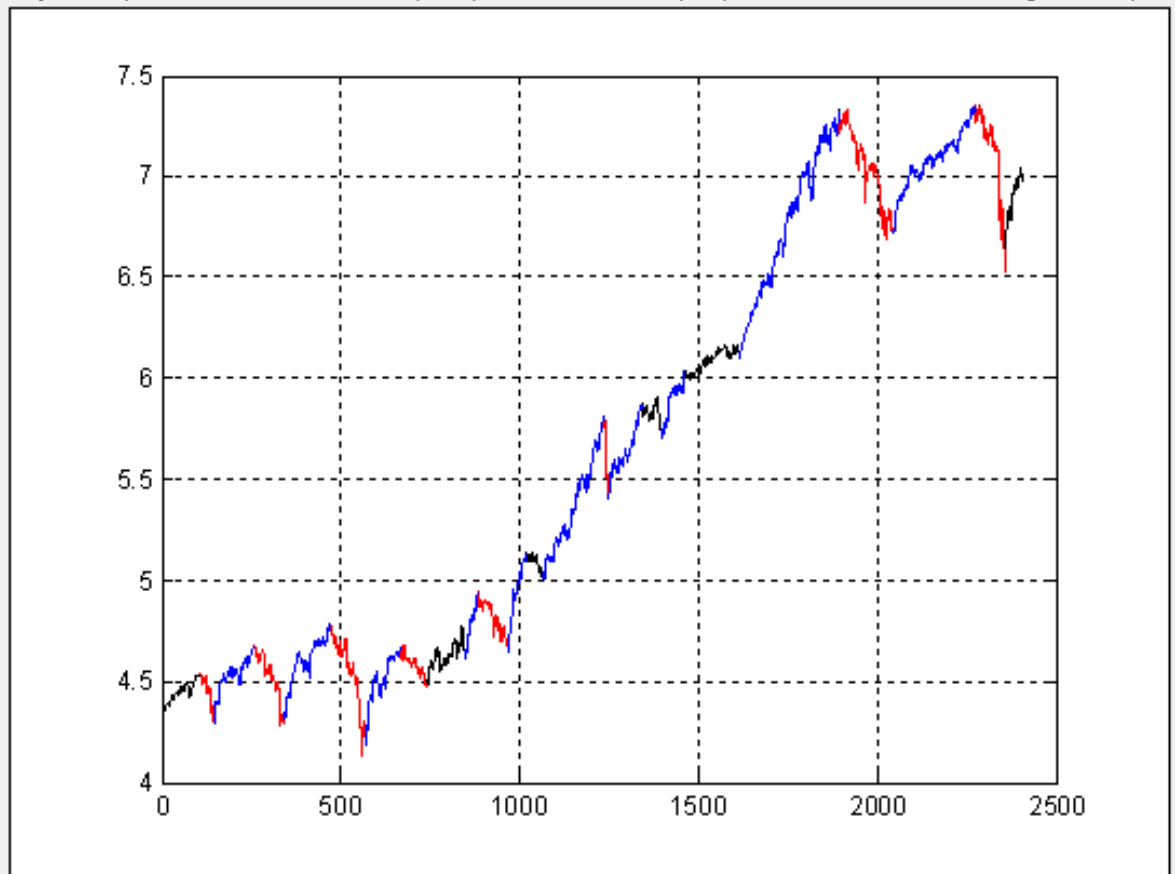
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Duration of Bull and Bear Markets

The second graph shows the life span and the corresponding average annual return for the bull markets identified in the period January 1964 to October 2007. The longer a bull market lasted, the lower its mean annual return was over its life span. Very short bull markets had high mean annual returns, 64% and 77% for the two shortest bull markets!

Mean annual returns of historical bull markets (January 1964 to October 2007) of the US S&P 500 index plus the corresponding curve fit, as a function of life span (in weeks)
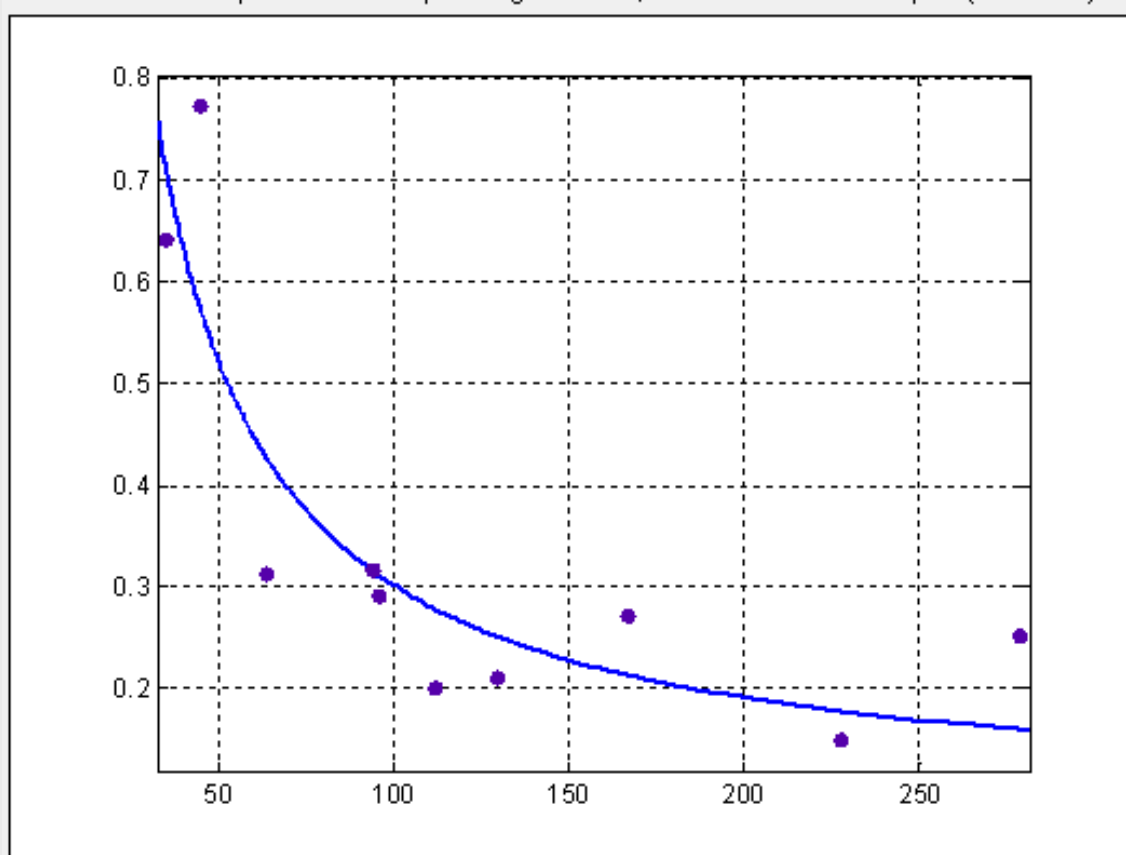
The combination of bull market life spans with our market signals is of additional use in the analysis of a current bull market. Its life span and its mean annual return up to now mark a point in the diagram. If the bull market has already persisted for several years and if, in addition, the trend approaches the "zero threshold", one has to be extra cautious. If the bull market is still young and the mean annual return achieved so far is very high, it is probable that either its growth rate will decrease or the bull market will not last very long.

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Regional and Sector Indices

The methodology for the S&P 500 market index can be applied to other regional as well as sector specific indices.

Regional indices: Although all world market indices go through bull and bear market phases in a similar way, the bull and bear markets may end at different times, within a range of a few months. In addition to the US S&P 500 market, which is the lead market for most world market indices, and therefore is of special importance, we have analyzed three other indices: the German DAX, the Japanese Nikkei, and the Chinese Hang Seng index, the last of which is becoming more and more important.

Sector indices: It is observed that different industries tend to peak at different times during the phases of an economic cycle. Investors can use sector rotation to take advantage of this.

Stock market cycle (black curve) and economic cycle (red curve)

1: Financials	4: Basic industry	7: Consumer non-cyclicals
2: Technology	5: Energy	8: Utilities
3: Capital goods	6: Health	9: Consumer cyclicals