TREND FOLLOWING: A PERSISTENT MARKET ANOMALY

In this note we present a study of trend following using two centuries of data. We find that trend following is a persistent market anomaly with highly significant performance over this long back-test. We also present a combined portfolio of a trend following investment and a standard basket of equities and bonds. We conclude that trend following is a valuable contribution to any portfolio manager's toolbox[1].

Introduction

The efficient market hypothesis (EMH) is one of the most discussed and (frequently) controversial ideas in economics. Any investor with long-term experience in investing will bear witness to the fact that market inefficiencies, if they exist, are weak. The EMH does not make it impossible for individuals to make money - it instead makes it impossible to make easy money by arbitraging mispriced instruments; the mispricing needs to cover the costs of trading for the market to be considered inefficient. The so-called "free lunch", it states, does not exist; therefore an investor must assume risk in order to generate a return beyond that of the risk-free rate. A proponent of the EMH would say one cannot "beat the market", meaning one cannot pick and choose financial instruments that outperform others on a risk adjusted basis, as all information is already fully encompassed in the price of these instruments. That same proponent would also state it is impossible for an asset manager or hedge fund to isolate a market anomaly and systematically and repeatedly extract money from the market based on mispricing opportunities. The existence of successful hedge funds, asset managers or stock pickers may simply be a statistical fluke and hence not inconsistent with the EMH. In this note, however, we present a study of a long-term, high capacity, persistent market anomaly: trend following. We find the effect to be weak, but highly statistically significant in generating consistent positive returns over two centuries.

Trend following or momentum strategies are well known in the hedge fund industry, and Commodity Trading Advisors (CTAs) have exploited such effects for many years. The CTA industry now commands (as of Q4, 2014) no less than $317bn[2], representing around 13% of the total assets of the hedge fund industry, and accounting for several percent of the daily activity of futures markets. Many authors (including the authors of this note) have already investigated the trend effect on a wide range of assets and have convincingly established its statistical significance in the last few decades. This note extends the time horizon even further, to 200 years, as far in the past as we have been able to go in terms of data. We find that the effect has been remarkably steady over two centuries, which is a testament to the stability of the approach.

This note is structured as follows. First we explain how to build a trend forecast, and then briefly describe the data used in this study. We subsequently describe the results of the back-test and show how it can be combined with a more traditional basket of stocks and bonds. Finally, we demonstrate the "long volatility" property of trend following which makes it an (even more) attractive addition to most traditional portfolios.

How to capture a trend

What is trend following? A rising price tends to continue to rise and a falling price continues to fall. In technical terms, price returns are said to be auto-correlated. Futures are instruments which are operationally as easy to buy and profit from a rising price as they are to sell and profit from a falling price. It is for this reason that the CTA industry was built up around the futures markets. The identification of a trend in a time-series of prices is visually straightforward. Take, for example, the price time-series in Figure 1 which is from a small part of the S&P 500 history. One can easily identify periods of uptrends and periods of down-trends. How do we identify these patterns in a systematic way? There are many different ways to do this, but for the purpose of this note we prefer to stay simple. We are therefore using a moving average crossover technique[3]. In Figure 1 we have overlaid moving averages of the prices on top of the price time-series. When the price moves above the 100-day Simple Moving Average (SMA) of the price we buy (upward trend) and when the price moves below the 100-day SMA of the price we sell.

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[1] This short note is a condensed version of our paper "Two centuries of trend following" published in the Journal of Investment Strategies, 3, 41-61 (2014). We invite the reader to consult the long version for a more detailed discussion of the subject and an extensive bibliography of references.

[2] Source: BarclayHedge

[3] Similar to that described in
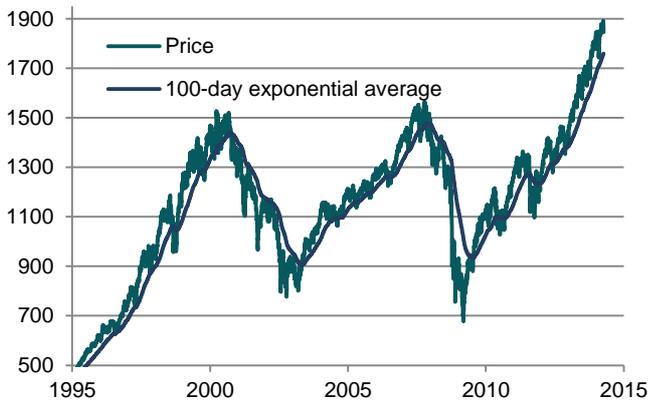http://en.wikipedia.org/wiki/Trend_following

Figure 1: A plot for the case of the S&P 500 showing the price time-series and a moving average of the price superimposed. The forecast is positive (buy) when the price is above the moving average and negative (sell) when it is below.

Also of note is that we buy and sell a quantity of futures such that we achieve constant risk throughout the back-test. The notional positions are adjusted to achieve this, by scaling positions inversely to the estimated current level of volatility in the market[4]. This style of risk management is standard in the CTA industry. One can see the effect of this in Figure 2 where we show the time-series of S&P 500 returns before and after the "risk management" procedure. One notices that the volatility of the time-series after adjustment is satisfactorily constant over the whole history, unlike a constant dollar investment.
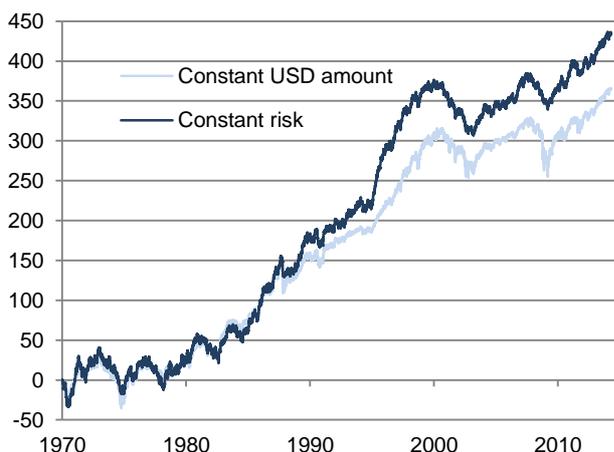

Figure 2: A long-term time-series for the S&P 500 showing the effect of normalising positions inversely with forecast volatility. The volatility of the resulting time-series is seen to be more constant, and the drawdowns through crisis periods less pronounced.

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[4] For those more mathematically minded readers, positions are proportional to 1/volatility

The back-test instruments

One aim of this note is to show that trend following is a statistically significant effect over a long horizon, and that it is universal across asset classes. While diversification of instruments is an important contributor to the success of any CTA, the purpose of this paper is to back-test the trend over a very long history; hence, we voluntarily limit ourselves to the contracts for which a long dataset is available. This makes the inclusion of emerging markets more difficult. Therefore, for indices, bonds and currencies, we only consider the following seven countries: Australia, Canada, Germany, Japan, Switzerland, the United Kingdom and the United States. We believe the results of this section would only be improved by the choice of a wider pool.

We also need to select a pool of commodities. In order to have a well-balanced pool, we chose the following seven representative contracts: Crude Oil, Natural Gas, Corn, Wheat, Sugar, Live Cattle and Copper.

In summary, we have assembled a pool of seven commodity contracts, seven 10-year bond contracts, seven stock index contracts and six currency contracts. All the data used in the current paper comes from GFD (Global Financial Data, www.globalfinancialdata.com). The starting dates of the time-series are shown in Table 1. It is worth noting that currencies cannot be extended back beyond 1973 due to the Bretton Woods agreement and the gold standard that was used prior to that date, effectively rendering the exchange rates fixed.

Sector	Start date
Currencies	1973
Commodities	1800
Bonds	1918
Indices	1800

Table 1: Starting dates of the price time-series for each sector

In order to extend our time-series to 200 years, we have used spot or underlying prices. These prices have the disadvantage that they need to be "financed". We believe that the inclusion of these financing terms make little difference to the overall performance. This is illustrated in Figure 3, which shows that applying the trend to fully financed futures and unfinanced spot time-series gives comparable results.
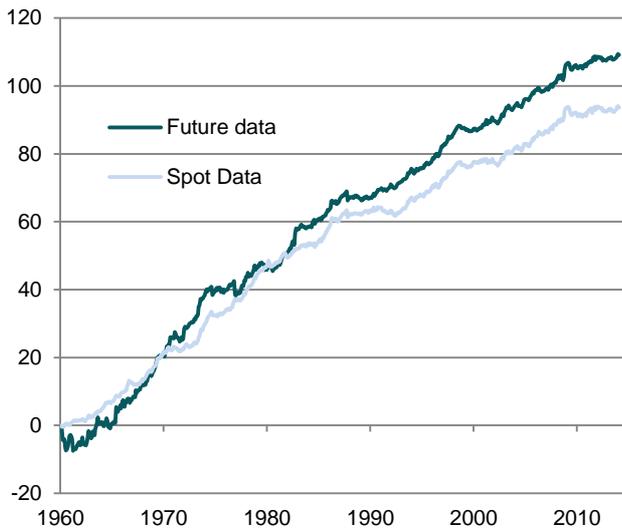
Figure 3: Trend on spot and on futures prices. The agreement since the late 1960s is very good (during this period the number of traded contracts is significant).
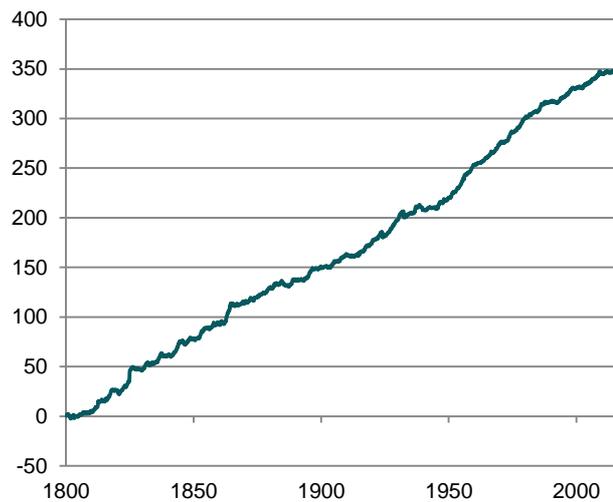

Figure 4: Aggregate performance of the trend on all sectors. The Sharpe Ratio over this 200-year history is 0.72. See Journal of Investment Strategies, 3, 41-61 (2014) for more details.

The back-test results

Figure 4 shows the results of applying the trend following strategy to the full 200-year back-test. The resulting Sharpe Ratio[5] is 0.72, a "10 sigma"' effect. It is worth just taking a moment to think precisely what that means. Let us take a random number generator, distributed as a bell-shaped normal distribution with a zero mean and use it as a fictitious daily return generator. If we sum these returns, then we end up with a fictitious strategy back-test. This "strategy" should have flat performance on average but any one single realisation can fluctuate up or down based on pure chance. If we were to generate 10^{23} such 200-year "random walks"' (i.e. a hundred thousand times more than the number of grains of sand on the earth) we would expect to obtain, through good fortune, only one that had a Sharpe Ratio as good as we have from trend following.

One can further test the significance and robustness of the result by looking at how performance is distributed across asset classes and time periods. Table 2 shows that the performance for equity indices, interest rates, commodities and currencies independently is consistently positive. Table 3 shows that the performance for each 50 year window of the 200 years is also consistently positive.

In summary, while the back-test reveals a low Sharpe Ratio strategy, testing over 200 years adds significance to the result, giving a strategy which has a single chance in approximately 10^{23} of being selected randomly.

Sector	Sharpe Ratio
Currencies	0.47
Commodities	0.28
Bonds	0.4
Indices	0.7

Table 2: Sharpe Ratios of individual sectors

Period	Sharpe Ratio
1800-1850	0.60
1850-1900	0.57
1900-1950	0.81
>1950	0.99

Table 3: Sharpe Ratios over sub-periods of 50 years

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[5] Sharpe ratios in this note are computed assuming no transaction costs (trading fees and impact costs).

Trend following in combination with equity and fixed income portfolios

It is, of course, interesting to know what the accretive value of the trend following strategy is to a portfolio of stocks or bonds. In order to study this point, we have used several benchmark strategies - namely: the S&P 500 Index (Bloomberg ticker - SPX), the MSCI World Index (Bloomberg ticker - MXWO), the J.P.Morgan Global Aggregate Bond Index (Bloomberg ticker - JGAGGUSD) and the S&P Balanced Equity and Bond Index - Moderate (Bloomberg ticker - SPBXMI) - and measured their performance in combination with the trend following strategy presented in this paper. This strategy has a constant risk due to the way we construct the back-test (see above). We have in each case similarly normalised the time-series of each benchmark strategy such that the risk remains constant through the lifetime of the strategy[6]. We first measure the Sharpe Ratio of each benchmark as well as its correlation with the trend following strategy. These figures are provided in Table 4. The combination of a Sharpe Ratio of a similar level to those of the benchmark strategies with a reasonably de-correlated return stream indicates that combining each with trend following will produce an improvement in the aggregate Sharpe Ratio. Table 5 shows that the Sharpe Ratio of the equal weighted combination of each benchmark (individually) with trend following is an improvement over the original.

Benchmark	Sharpe Ratio	Correlation with trend (%)
S&P 500	0.63	7
MSCI World Equity	0.48	8
J. P. Morgan Fixed Income	0.91	19
S&P Balanced	1.05	12

Table 4: Sharpe Ratios of the different benchmarks together with the measured correlation vs. the trend following strategy presented, since 1990

We next apply a Markowitz optimisation[7] on a portfolio of equity, fixed income and trend following. We use the MSCI world index and the J. P. Morgan

Fixed Income index in combination with trend following to produce the combined strategy shown in Figure 5. The Sharpe Ratio of this strategy is measured to be 1.2 - greater than any single component. The weights determined by the Markowitz procedure are provided in Table 6.
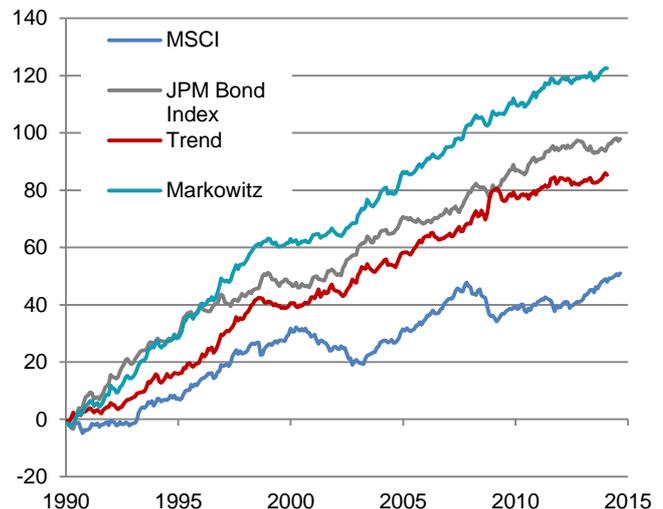

Figure 5: The result of "optimally" combining our trend following strategy with the J. P. Morgan bond index and the MSCI world equity index

Benchmark used	Sharpe Ratio of combination
S&P 500	0.99
MSCI World Equity	0.87
J. P. Morgan Fixed Income	1.05
S&P Balanced	1.15

Table 5: Sharpe Ratios of an equally weighted combination of the benchmarks with the trend following strategy. In each case the combination gives a better Sharpe than the original benchmark.

We also highlight that trend following generally exhibits the property of being "long volatility" in that it tends to deliver positive performance during times of stress. If a crisis persists, then, necessarily, trends develop. Any trend following system will naturally take advantage of these and outperform. Table 7 shows the return of the trend following strategy for various periods of market stress, aligned with the return of the S&P 500 for comparison. In all but two cases, the trend following strategy is positive over the stress periods. This provides a degree of comfort to a long only portfolio manager.

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[6] We do this again by buying and selling a quantity of the benchmark which is inversely proportional to the measured volatility of that benchmark.

[7] A mathematical procedure that finds the optimal weights amongst strategies, given the returns of each and the correlations amongst them.

Strategy	Portfolio weight (% of total)
Trend Following	40
J. P. Morgan Fixed Income	35.3
MSCI World Equity	24.7

Table 6: "Optimal" weights chosen by a Markowitz procedure to combine trend following, the J.P.Morgan Fixed Income index and the MSCI World Equity Index, to produce the resulting highest Sharpe Ratio combination.

Event	Date	S&P 500 (%)	Trend following (%)
87 crash	Oct-Nov 87	-28.4	-3
Lehman collapse	Aug-Nov 08	-24.5	5.9
Euro crisis	May-Sep 11	-17	2.1
Mexico crisis	Dec 81 – Feb 82	-10.5	2.3
2nd Gulf War	Dec 02 - Mar 03	-10.2	3.9
Sub Prime crisis	Nov 07 - Feb 08	-10.2	2.5
Russian crisis	Aug-Sep 98	-9.25	-0.3
9/11	Sep 01	-8.2	1.5

Table 7: Table of recent examples of market stress.

Conclusion

This brief note shows that a simple trend following strategy applied to a pool of liquid futures delivers a system with a modest, though highly significant, positive Sharpe Ratio. The strategy's stability, across both asset classes and time periods, adds to the significance of the result. We have also demonstrated that trend following can be used to great effect in combination with a more traditional portfolio made up of stocks and bonds, with Sharpe Ratio improvements seen in each case. An optimally chosen weighting scheme was shown to increase the Sharpe Ratio considerably.

Trend following, by its nature, also exhibits a favourable relationship with market stress. Examining the worst historical periods of market crisis, trend following is seen to be generally positive and anti-correlated to the S&P 500.

In short, we have demonstrated that trend following is a useful addition to any traditional portfolio mixing stocks and bonds.

Important disclosures