The impact of leverage on risk management.

The leverage effect[1] is often synonymous with the highest potential performance, and simultaneously with a significant increase in risk, which may lead to ruination. In this study, we will determine whether these preconceived notions are correct, and confirm whether the leverage effect is always synonymous with an increase in risk. We will specifically study the leverage effect of futures contracts, which does not involve any borrowing costs.

Having studied the volatility of the CAC40 and the Bund (a German 10-year bond), we will examine various statistics in relation to a portfolio with notional positions in CAC futures contracts and Bund futures contracts. Secondly, we will look at the same portfolio with a different allocation. Each portfolio will be examined from the point of view of the leverage effect and the risk it entails in terms of volatility[2] and, above all, drawdown[3]. Finally, we will compare the CAC40 with a leverage of 1 with an alpha CTA (see the "Trend Following" study, November 2014).

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Markets and volatility

Volatility varies across markets and, to a greater extent, across asset classes. We are going to look at dispersion levels in 2 markets, representing 2 different asset classes: CAC40 futures and Bund futures. The calculated volatility is annualised volatility over a rolling 1-year period. Market data is daily and covers the period from 05/04/1990 to 27/10/2014.

Products	Bloomberg Code	Exchange	Asset class
CAC40	CF1 Index	Euronext	Equity Index
Euro-Bund	RX1 Comdty	Eurex	Bond

Source: Seven Capital

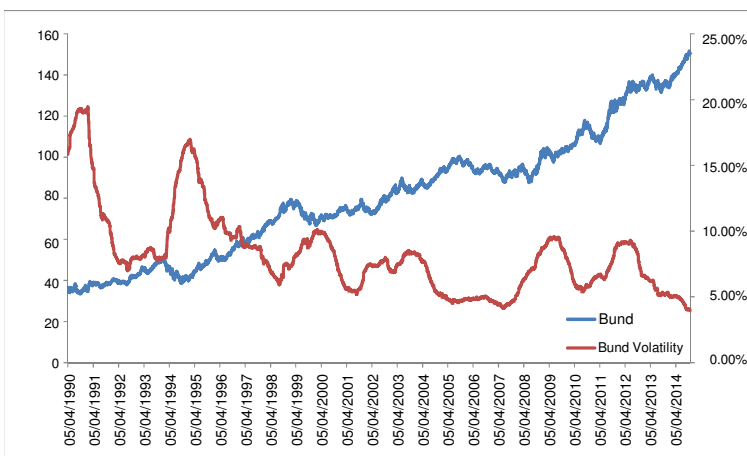*Figure 1*

CAC40 prices and CAC40 volatility
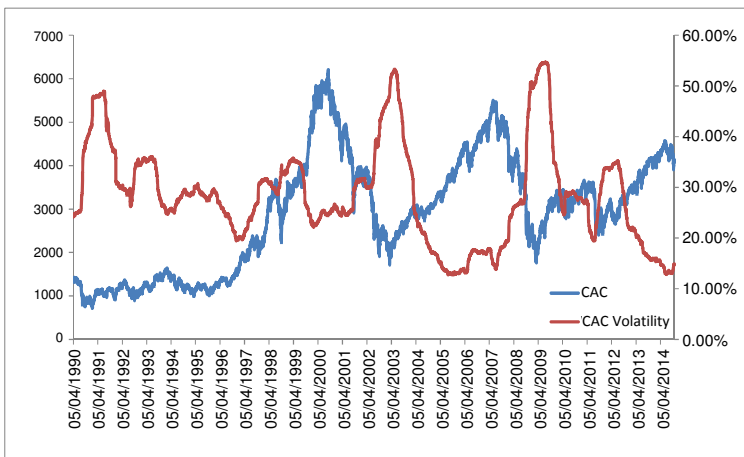
Source: Seven Capital

Graph 1

Over the period as a whole, the CAC40 has a volatility of 29.96%, with rolling volatility fluctuating between 12.78% and 54.68%. It is interesting to note, even though it is not the subject of this study, that volatility tends to peak during a slump in the market. We can also see that volatility tends to increase during market downturns and decrease as markets rise.

### Bund prices and Bund volatility (on Bund price)

Source: Seven Capital

Graph 2

Over the period as a whole, the Bund (the equivalent of a German 10-year bond) has a volatility of 8.44% with rolling volatility fluctuating between 3.96% and 19.46%. It is interesting to note that volatility tends to peak during a slump in the market, as is the case with the CAC40.

Building a portfolio

Now, let's build two separate portfolios. The first will have a notional allocation in CAC40 futures contracts and Bund contracts (50% of assets in each product with monthly reallocation). The second will be allocated in terms of volatility risk, spread equally between the CAC40 and the Bund. Both markets will make equal contributions in terms of volatility, which implies, therefore, different notional exposures. For each portfolio, we will be buying only and there will be no alerts, as the aim is to study the leverage and the risk between the portfolio we will call the "Notional Portfolio" and the portfolio we will call the "Volatility Portfolio".

Below: daily simulation of the "Notional Portfolio" from 1 January 1990 to 31 October 2014:
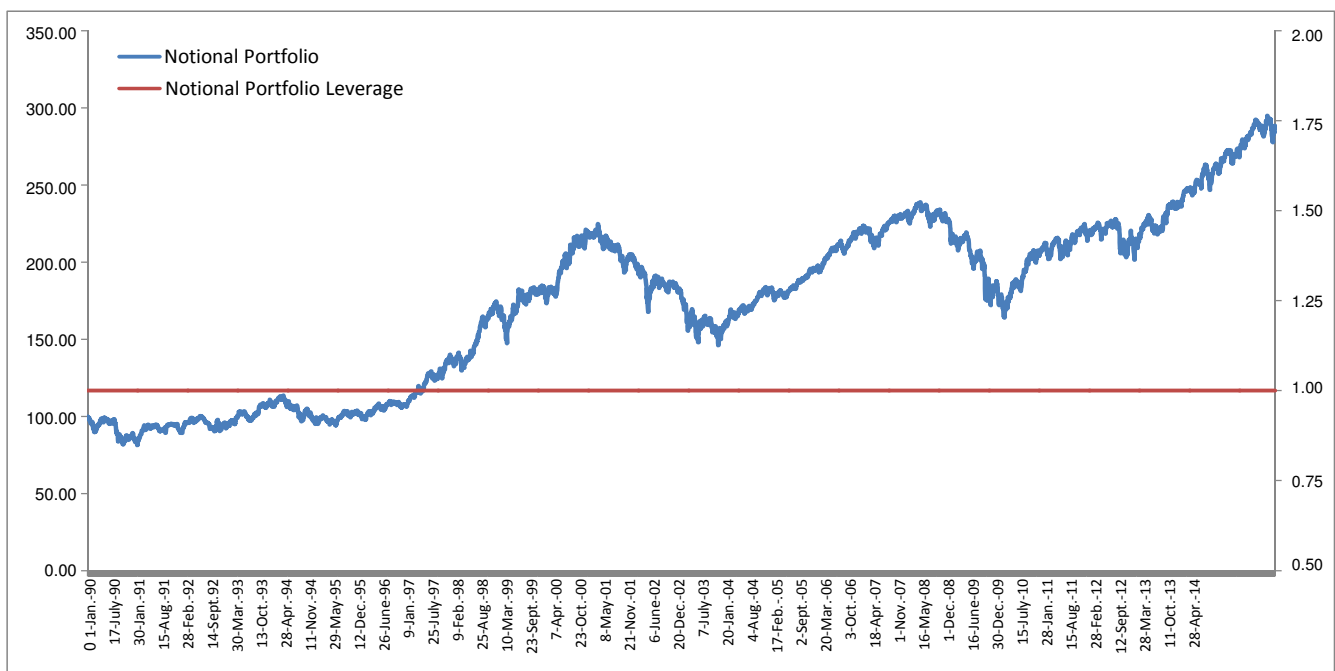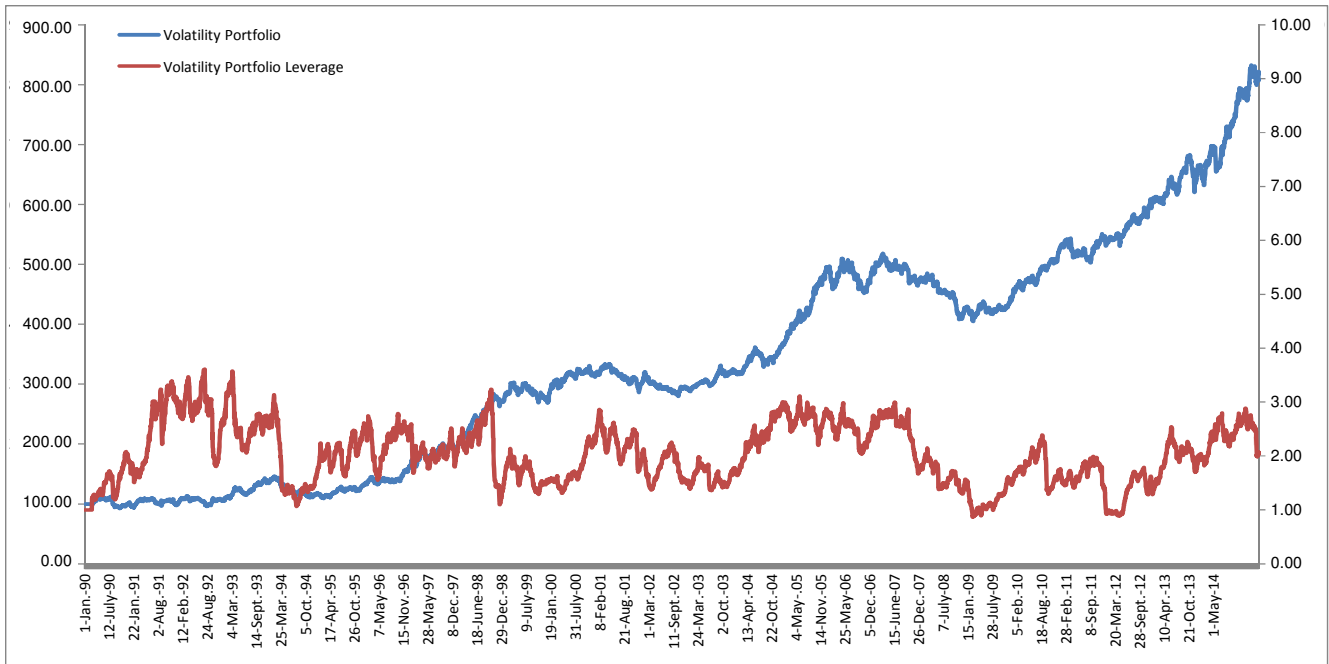

	Notional Portfolio
Return over the period	187.06%
Annualised Return	4.33%
Volatility	11.09%
Sharpe ratio	0.425
Maximum drawdown	35.14%

Source: Seven Capital   *Figure 1*

Over this period of nearly 24 years, the "Notional Portfolio" achieved an overall performance of 187.06%, giving an annualised return of 4.33%. As a result, volatility is 11.09% with a maximum drawdown of 35.14%. This gives us a Sharpe ratio[4] of 0.42. Leverage remains constant at 1, given that the Notional Portfolio always invests 100% of its assets.

Below: daily simulation of the "Volatility Portfolio" from 1 January 1990 to 31 October 2014:

Source: Seven Capital

Graph 4

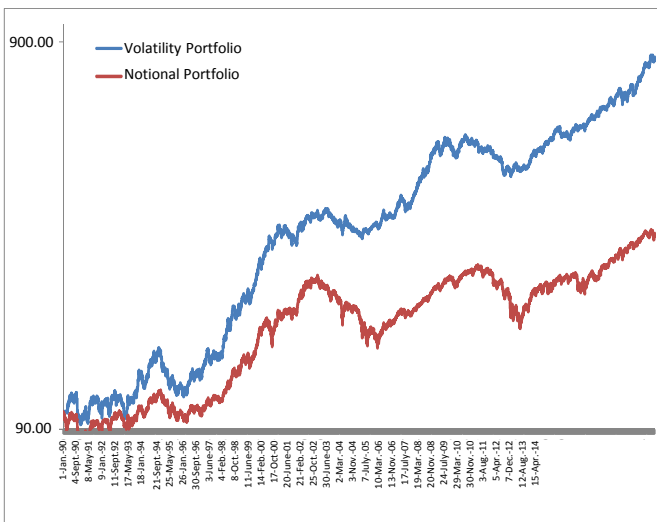|	Volatility Portfolio
Return over the period	718.11%
Annualised Return	8.82%
Volatility	11.02%
Sharpe ratio	0.797
Maximum drawdown	25.20%

Source: Seven Capital   *Figure 2*

Over this period of nearly 24 years, the "Volatility Portfolio" achieved an overall performance of 718.11%, giving an annualised return of 8.82%. As a result, volatility is 11.02% with a maximum drawdown of 25.20%. This gives us a Sharpe ratio of 0.79. Leverage fluctuates between 0.86 and 3.61, with an average of 2.03.

Portfolio comparison

Having analysed the statistics for the "Notional Portfolio" and the "Volatility Portfolio", we can now compare them and confirm whether increased leverage always means increased risk.

Below left is a graph that uses a logarithmic scale to compare the cumulative and back-tested VLs of the two portfolios, with the leverage on the right-hand graph:

Source: Seven Capital   *Graph 5*
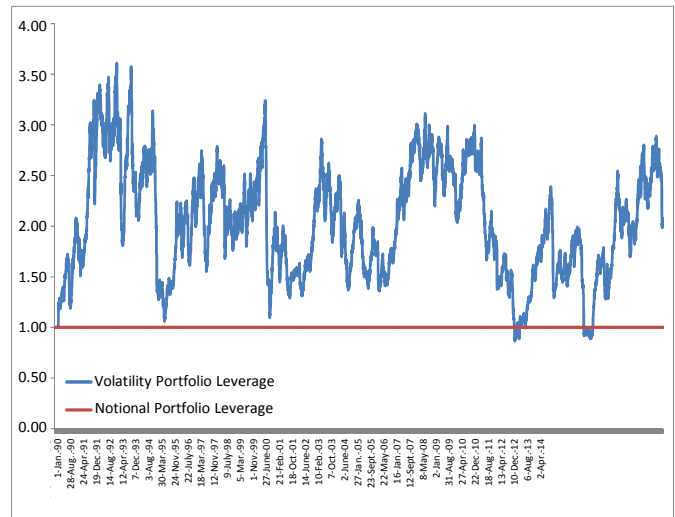
Source: Seven Capital   *Graph 6*

	Notional Portfolio	Volatility Portfolio
Return over the period	187.06%	718.11%
Annualised Return	4.33%	8.82%
Volatility	11.09%	11.02%
Sharpe ratio	0.425	0.797
Maximum drawdown	35.14%	25.20%

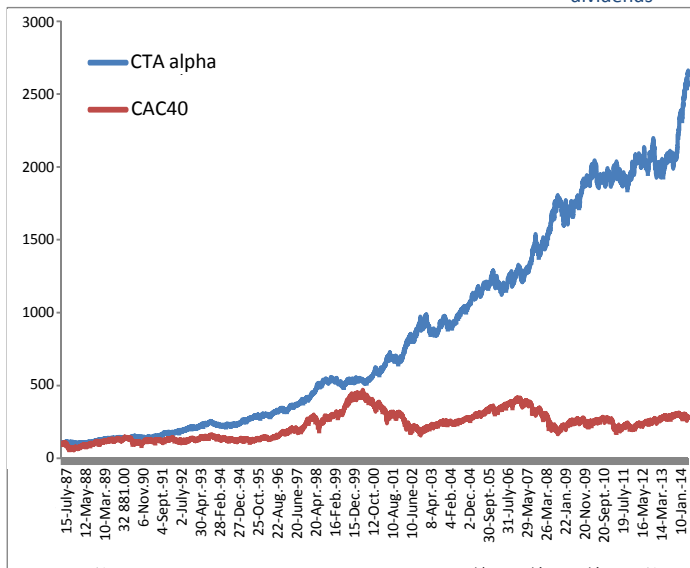*Source: Seven Capital*   *Figure 3*

The "Volatility Portfolio" far outperforms the "Notional Portfolio", with double the annualised return: 8.82% versus 4.33%. The volatility of the two portfolios is similar, close to 11%. As a result, therefore, the "Volatility Portfolio" has a Sharpe ratio of 0.80, compared to 0.42 for the "Notional Portfolio". In terms of equivalent volatility risk, therefore, the "Volatility Portfolio" is twice as profitable. Moreover, the risk of the "Volatility Portfolio" has significantly decreased, as the drawdown has reduced from 35.14% to 25.20%. This means that the leverage of the "Volatility Portfolio", as well as delivering additional returns, has decreased the risk. There are, therefore, two types of leverage: positive leverage which reduces risk as our example shows, and negative leverage, which increases risk.

Comparison of the CTA alpha with the CAC40 (leverage versus no leverage)

Now, let's compare our CTA alpha, described in detail in our "Trend Following" study in November 2014, with the CAC40. The CAC40 has no leverage, as 100% of its face value is invested. We are going to observe, however, that our CTA alpha does have leverage. The aim is to confirm whether, in this case, the leverage increases or decreases the risk in terms of volatility and drawdown.
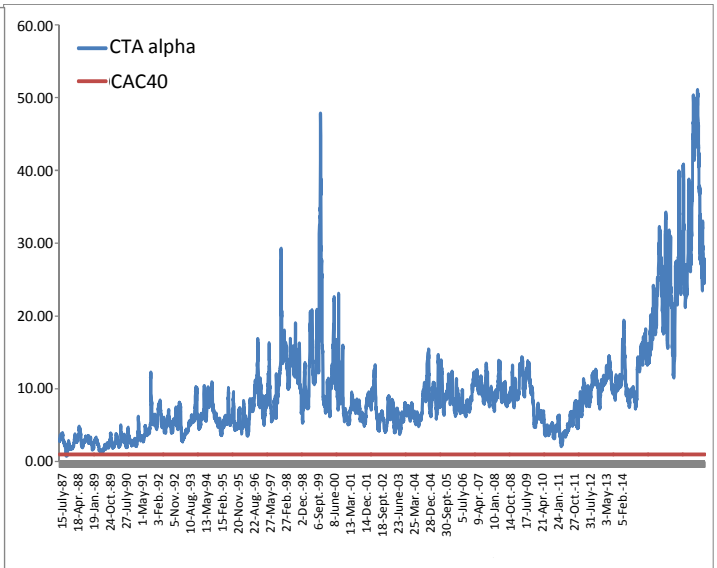
Overall performance of the CTA alpha vs. the CAC40 inclusive of dividends

Leverage of the CTA alpha vs. the CAC40 inclusive of dividends

Source: Seven Capital

Graph 7

Source: Seven Capital

Graph 8

	CTA alpha	CAC40
Return over the period	2555.89%	181.12%
Annualised Return	12.75%	3.85%
Volatility	8.30%	21.92%
Sharpe ratio	1.44	0.28
Maximum drawdown	13.63%	65.29%

Source: Seven Capital

Figure 4

Over the period between 15/07/1987 and 07/11/2014, the CTA alpha yields were 2,556% compared to 181% for the CAC40. This gives an annualised return of 12.75% versus 3.85% for the CAC40. As far as risk is concerned, the CTA alpha is 2.5 times less volatile than the CAC40, 8.30% compared to 21.92%. The maximum drawdown of the CTA alpha is 13.63% compared to 65.29% for the CAC40, thus the CAC40 has a drawdown nearly 5 times higher than that of the CTA alpha.

Therefore, the CTA alpha has higher returns and much lower volatility and drawdown risk than the CAC40. We can see from Graph 8 that the leverage of the CAC40 remains at 1 whereas that of the CTA alpha fluctuates between 0.84 and 51.02, with an average of 9.36. The leverage of the CTA alpha did not, therefore, generate any risk; quite the opposite, it actually reduced the risk.

The increased leverage of the CTA alpha in recent years mainly reflects the sharp decline in volatility of the Euribor Futures (3-month rate over 6 months), which is the benchmark short-term rate for Europe. As a result of the ECB's policy of lowering interest rates, with the main refinancing rate now at 0.05%, and with the prospect of interest rate increases very unlikely in the short-term, the Euribor is fluctuating in a very narrow trading range, resulting in a sharp decline in volatility (see graph 9 below).

Products	Bloomberg Code	Exchange	Asset class
3 Month Euro Euribor	ER7 Comdty	LIFFE	Short rate

Source: Seven Capital   *Figure 5*

Euribor prices and Euribor volatility
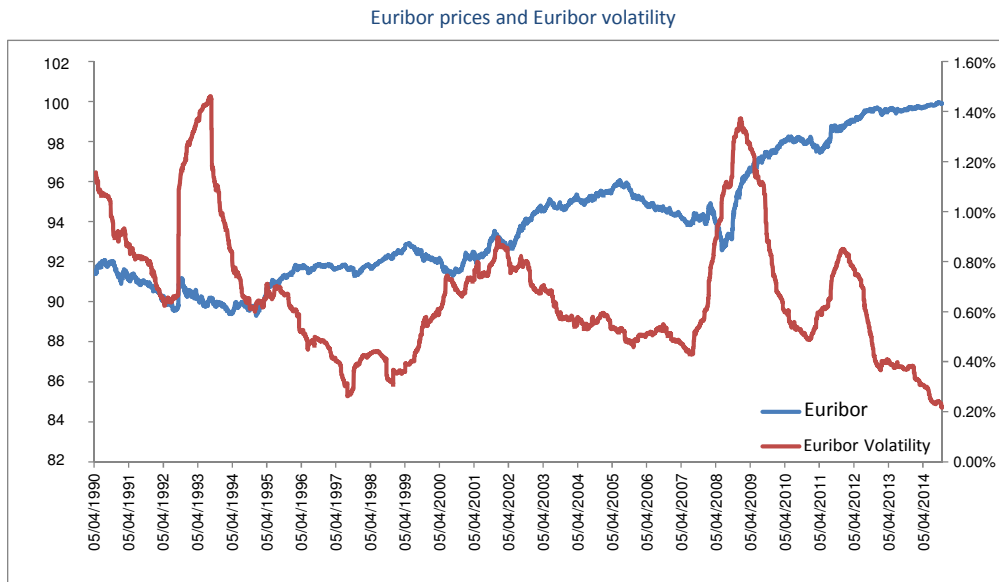
Source: Seven Capital   *Graph 9*

The allocation of the CTA alpha invests in each product with an equal volatility risk budget; the lower the volatility of the product, the greater the investment, which generates strong leverage. Conversely, the higher the volatility of a product, the lower the investment and the lower the leverage.

As regards our Euribor contract, volatility fell to a new low in recent years, which means that our position on this product increased significantly, generating a sharp increase in leverage (see Graph 8). The risk of the CTA alpha did not increase, therefore, but adjusted to the fluctuations in the Euribor and so although the leverage increased significantly, the allocated volatility risk remained unchanged.

Comparison of the CTA alpha with the CTA alpha without short rates

Now, let's compare our CTA alpha described in detail in our "Trend Following" study in November 2014, with the same CTA alpha without short rates (Euribor and Eurodollars). We will confirm whether highly leverage-hungry short rates present increased or reduced risk for our CTA alpha.
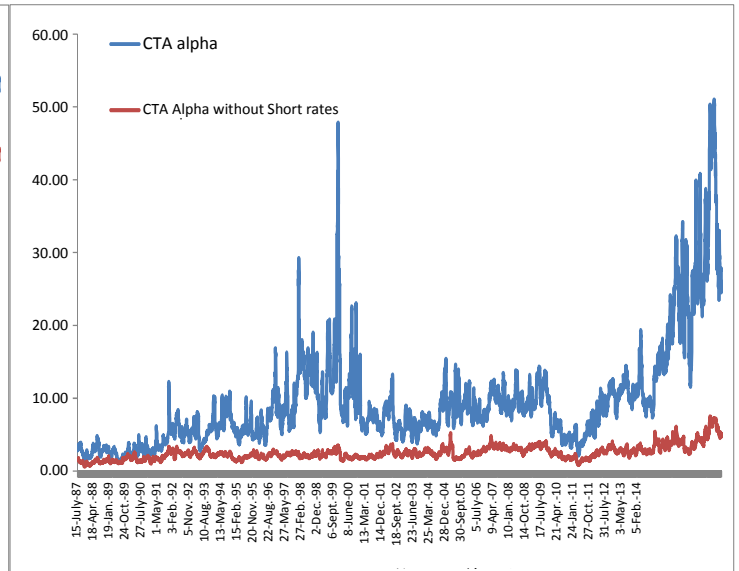
Overall performance of the CTA alpha vs. the CTA alpha without Short rates
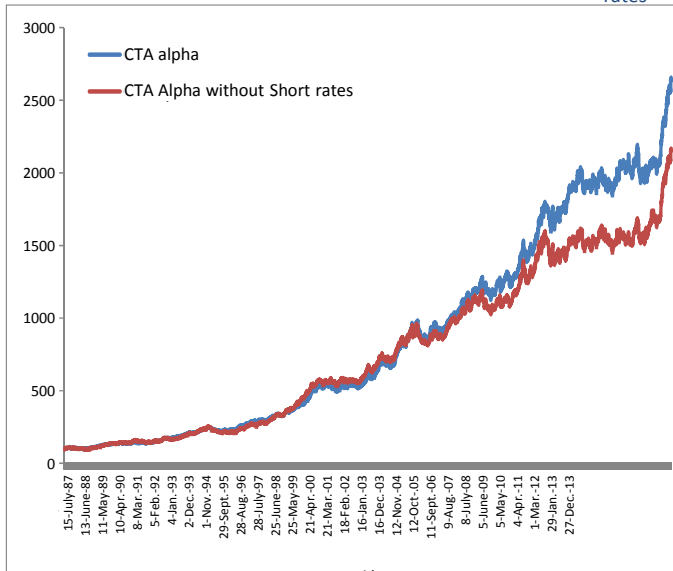
Source: Seven Capital   *Graph 10*

Leverage of the CTA alpha vs. the CTA alpha without Short rates

Source: Seven Capital   *Graph 11*

	CTA alpha	CTA Alpha without Short
Return over the period	2555.89%	2066.44%
Annualised Return	12.75%	11.91%
Volatility	8.30%	9.09%
Sharpe ratio	1.44	1.24
Maximum drawdown	13.63%	18.09%

Source: Seven Cap

Over the period between 15/07/1987 and 07/11/2014, the CTA alpha yields were 2,556% compared to 2,066% for the CTA alpha without short rates. This gives an annualised return of 12.75% compared to 11.91%. In terms of risk, the volatility of the CTA alpha is 8.30% compared to 9.09% for the CTA alpha without short rates. The maximum drawdown of the CTA alpha is 13.63% compared to 18.09% for the CTA alpha without short rates.

Therefore, the CTA alpha has higher returns and lower volatility and drawdown risk than the CTA alpha without short rates. We can see from Graph 11 that the leverage of the CTA Alpha without short rates fluctuates between 0.62 and 7.51, with an average of 2.50, whereas that of the CTA alpha fluctuates between 0.84 and 51.02, with an average of 9.36. Therefore, the additional leverage generated by the short rates provides increased performance whilst reducing risk via lower drawdown and volatility.

Conclusion

Leverage is not always synonymous with increased risk. Therefore, there is bad leverage which increases risk without offering any additional return and good leverage which provides additional return whilst reducing risk. CTAs, such as the example of our CTA alpha, often have high leverage as a result of drastic risk management. In such cases, leverage significantly reduces risk. And so, prior to judging risk by leverage alone, we must look at the underlying investments and confirm the contribution leverage is making, before drawing hasty and incorrect conclusions.

Appendix

1 The leverage effect: Our explanation of leverage on futures contracts. In order to buy or sell a futures contract, you only need a deposit, and not the full value of the futures contract. The deposit required depends on the market in which the futures contract is traded. The deposit may vary between 5% and 20% of the face value of the futures contract.

2. Volatility: Historical volatility is based on the historical changes in the price of a security. It may be calculated over different time frames according to the desired analysis.
In mathematical terms, the standard deviation is reflected by the following formula:

$$\sigma(x) = \sqrt{V(x)} = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n}}$$

3. Drawdown: this term describes a downward movement from the highest point (expressed as a percentage or in currencies) to the lowest point for an investment, a fund or a client account over a given period.

4. Sharpe ratio: annualised return/volatility