

# CTA Common Denominator Index

An investible benchmark index for the CTA and managed futures

industry

Tillmann Sachs, Robert L.K. Tiong<sup>1</sup>

This draft: 4 September 2014

Tillmann Sachs  
J8 Capital Management LLP  
3 Charlotte Close  
Ashted KT21 2RH  
United Kingdom  
tillmann.sachs@j8capital.com  
+44 13 7227 0975

---

<sup>1</sup> Robert L.K. Tiong: Nanyang Technological University, Singapore. Tillmann Sachs: J8 Capital Management LLP, London. We thank Vitali Sakovic, Matthew Jones, Tan Chong It and Hui Yu Chen for their contribution.

## **Abstract**

The objective of this paper is to develop an investible index which is a fair representation of the CTA and managed futures industry. For this purpose, we have conducted an international survey among practitioners to establish common denominators in the CTA and managed futures industry. We use the survey findings as input parameters in the index construction to provide a "democratic representation" of the industry.

The paper first discusses the nature of investible indices. Secondly, the new index is constructed by using standard methodologies for calculating investible indices and drawing on the survey results for parameter selection. Thirdly, all index parameters are tested for their sensitivity. Finally, the resulting new index is compared against existing CTA and managed futures benchmark indices. We use three indices for in-depth comparison but show statistics for a total of 19 indices.

The CTACDI mimics popular CTA and managed futures benchmark indices with statistical significance shows higher risk adjusted returns and shorter and lower drawdown periods than its peers.

## **Investible and non-investible benchmark indices**

Investible indices are commonly referred to being replicable by trading their underlying constituents in the markets. For example, a trader can replicate the S&P 500 index by buying and selling the stocks of those companies which are included in the S&P 500. Investible indices allows for sufficient time for trade execution between determining the underlying constituents and weights and their effective inclusion in the index. The rules or methodology to calculate investible indices are often

published and any trader can start trading according to these rules and replicate the index to get exposure to the index. The S&P 500 is an investible index and because of its popularity it is used as a benchmark index for US equities. Another example is the S&P Goldman Sachs Commodity Index which follows a predefined index methodology, is often referred to as benchmark for the commodity markets, and can be replicated by traders.

Non-investible indices are commonly referred to as indices which cannot be replicated by trading their underlying constituents. Often, such indices either cover a very wide universe which is not practical to trade, or in their construction methodology, they do not allow for enough time between calculation and trade execution. For example, the Case-Shiller property indices measure the change in property prices across US cities. To replicate the index in trading and to offer the index as investor product, one would need to physically buy and sell all the underlying properties included in the index calculation, which is impossible for the illiquid nature of properties, and also for the sheer number to be included.

Most CTA and managed futures benchmark indices are non-investible. Their calculation methodologies do not allow for sufficient time to transact in the underlying funds and their effective inclusion in the index calculation. Another practical obstacle arises from minimum investment amounts per manager as well as the number of funds included which may lead to a very large cash amount needed to trade the underlying constituents with sufficient granularity to replicate the benchmark indices.

The CTA Common Denominator Index (CTACDI) is investible. First, the index trades few core futures only which require less capital than subscribing to funds. Second, the index methodology allows for enough time between trading signal calculation and execution of the trades in the markets. Finally, the methodology draws on the most

commonly used and applied techniques within the CTA and managed futures industry.

## **Application of summary survey results in index construction - common denominators in the CTA and managed futures industry**

Together with the researchers from Nanyang Technological University (NTU) in Singapore, we designed a survey to determine the common denominators in the CTA and managed futures industry. The survey was conducted from 17th June 2014 until 11th July 2014 by NTU. The online questionnaire was sent to over 3,500 practitioners globally and we collected 51 responses. The full survey results are published in the Journal of Index Investing, forthcoming (Chen et al. 2014).

In summary, the survey found that the CTA and managed futures industry may be generalized in trading a risk weighted momentum portfolio of global core futures markets managed to a target volatility and applying a 2/20 fee structure.

1) The most common markets traded by CTAs and managed futures managers are: S&P 500, EURO FX, Gold, Copper, WTI Crude Oil, Eurodollar, and 10yr US Treasury. We use these top seven markets in our index, because they represent the five key global markets of equity indices, currencies, commodities, interest rates, and government bonds. Within the commodities, WTI Crude Oil, Gold, and Copper also represent the top three most popular sectors of energy, precious metals, and industrial metals.

2) The most common return engine is "Momentum or Trend Following" before carry trades, relative value trades, term structure arbitrage, or fundamental or value trades. In annex 2, we demonstrate, why the widely referred to 12 months

momentum is in fact a good choice of parameter, and we use a 12 month momentum signal for the index.

3) The most common risk or asset allocation technique is risk parity followed by equal notional weights, minimum variance, Sharpe ratio weighted, or full distribution/Omega portfolios. For the risk parity calculation in the index, we will use 90 week days as look back period with monthly portfolio rebalancing only.

4) The most common money management technique is target volatility, followed by drawdown limits, value-at-risk, or unconstrained techniques. For the target volatility mechanism, the index will use 90 week days as look-back period for the volatility measure and a target volatility of 5% per annum with monthly leverage adjustments.

5) The most common fee structure was a management fee of between 1.5 to 2% per annum and a high watermark performance fee of 15 to 20%. We chose a 2/20 fee structure with daily accruals for our index calculation.

We ignore hurdle rates in the fee structure but we assume brokerage costs and slippage per underlying market. We also apply US T-Bill returns on cash.

Annex 2 shows sensitivity analysis performed on the parameters chosen for the index construction.

## **The CTA Common Denominator Index - a new CTA benchmark**

The CTA Common Denominator Index (CTACDI) is created to serve investors as an investible and fair representation of the CTA and managed futures industry and to gain exposure to CTA-like returns. We show that the CTACDI mimics popular CTA and managed futures benchmark indices. The CTACDI is a "democratic", investable, liquid, and scalable benchmark index, derived from survey results on the common

denominators in the CTA and managed futures industry. The objective is not to outperform the industry or to introduce other enhancements or optimizations but to deliver a fair representation.

## **EXISTING CTA AND MANAGED FUTURES BENCHMARK INDICES**

There are a number of CTA indices provided by financial service providers. Most benchmark indices are not investible. They track performance of managers and some select managers in hindsight. Many benchmark indices include and exclude managers based on size and/or performance which may lead to a size or performance bias.

We initially compare our CTACDI against three popular CTA and managed futures indices to see if the survey results are broadly in line with the industry. We select three indices which include a wide number of CTA or managed futures programmes, and which are net of costs and fees:

- Barclay CTA Index
- Newedge CTA Index
- Credit Suisse Managed Futures Hedge Fund Index

The Barclay CTA Index was launched in 1987. It currently includes 551 programmes which are selected on an annual basis. To be included in the index an advisor must have a 4 year track record, and any new programs run by an already included advisor are not taken into account until their second year. The Barclay CTA Index rebalances and selects constituents annually.

The Newedge CTA Index has been tracking the industry since 2000. In 2007 the selection criteria for the index changed to include the 20 largest CTAs by AUM only. The index is equal weighted and the index constituents are confirmed and

rebalanced annually. All included funds must be open to new investments and report returns daily.

The Credit Suisse Managed Futures Hedge Fund Index is an AUM weighted index and currently consists of 31 managers, each with a minimum of USD 50 million AUM, and at least a 1 year trading record. The Credit Suisse Managed Futures Hedge Fund Index aims to represents more than 85% of total AUM in the managed futures space. The index rebalances monthly, and constituents are confirmed quarterly.

Exhibit 1 summarizes these three popular but non-investible CTA and managed futures benchmark indices.

Index	Re-balancing frequency	Number of programs	Required Record	minimum Track	Weighting
Barclay CTA	annually	551	4 years		equal
Newedge CTA	annually	20	N/A, 20 Largest AUM		equal
Credit Suisse Managed Futures	monthly/quarterly	31	1 year, AUM. \$50m		AUM

*Exhibit 1: Comparison of popular CTA and managed futures industry benchmarks.*

Annex 3 shows the correlations between these indices being very high at around 0.9. This is, because the indices track the same managers and funds to a certain extend. The correlations to the CTACDI are a bit lower, yet high with around 0.6, allowing us to conclude that a good portion o the industry returns may be explained with a simple trading methodology as outlined in the following section.

## **THE CTA COMMON DENOMINATOR INDEX**

To construct an investible benchmark index, we borrowed from established index methodologies such as the S&P Goldman Sachs Commodity Index [2014] and S&P Index Mathematics [2014]. We define our own underlying rolling long or short future indices (see also annex 1) and used sensitivity analysis to determine robust

parameterization (see annex 2) for: momentum look-back period, the signal observation frequency, portfolio rebalancing frequency, the look-back period of volatilities used in risk parity and target volatility calculations, and portfolio weighting mechanism. We did not perform sensitivity analysis on the target volatility level and fee structure as they affect risks and return linearly only.

## Markets

The survey participants were asked to select the most relevant markets for CTAs and managed futures managers to trade in. The top 7 ranking markets each represent one of the core asset classes of equity indices, commodities, currencies, government bonds, and interest rates and within commodities the 3 most relevant commodity sectors of energy, precious, and industrial metals (Exhibit 2). We accept these top 7 markets as representative constituents of the wider global market spectrum and include these seven markets in the CTACDI.

Number of ticks	Market	Asset class
49	S&P 500	Equity index future
48	Euro FX	Currency future
46	Gold	Commodity future - precious metal
45	Copper	Commodity future - industrial metal
44	Eurodollar	Interest rate future
43	WTI Crude Oil	Commodity future - energy
41	10yr US Treasury Note	Government bond future

*Exhibit 2: Top 7 most relevant markets included in the CTA Common Denominator Index.*

For each market, we now calculate rolling excess return indices as described in Annex 1.

## Trade signal calculation and implementation

The survey participants chose "momentum or trend following" as the most relevant return engine. In creating the momentum return engine for the CTACDI, we chose a 12 month look-back period for a simple price return calculation to derive the trading signals. In Annex 2, we show 12 months being a reasonably "good", or "robust",



parameter, using literature review and a new method derived from discussions on robust system designs by Faith [2007] and Narang [2012].

The trading signal  $S(t)$  is calculated daily on the close of the markets. The signal is then implemented on that close and becomes effective for the next day's return.

The signal takes the form

$$S(t) = \begin{cases} +1, & M(t) \geq 0 \\ -1, & M(t) < 0 \end{cases} \quad \text{Equation 1}$$

where  $M$  is the 12 month momentum, calculated as

$$M(t) = \frac{P(t)}{P(t-12M)} - 1 \quad \text{Equation 2}$$

The daily returns  $r_i(t)$  are calculated as

$$r_i(t) = \frac{P(t)}{P(t-1)} - 1 \quad \text{Equation 3}$$

where  $P$  is the underlying long-only index closing price of the long-only underlying index on that day.

The long/short returns,  $r_i(t)_{LS}$ , is calculated by

$$r_i(t)_{LS} = r(t) \times S(t - 1). \quad \text{Equation 4}$$

The index is always invested in the markets and zero or neutral positions are not possible.

### Portfolio construction

The survey confirmed risk parity as the most common "risk or asset allocation" method among CTAs and managed futures programmes.

The concept of risk parity stems from Bridgewater's All Weather allocation principles first established in 1996. It allocates more capital to less volatile and less capital to more volatile markets. It is inverse volatility weighted.

In risk parity, we first calculate the inverse volatilities of the underlying markets by

$$InV_i(t) = \frac{1}{\sigma_i(t)} \quad \text{Equation 5}$$

where  $\sigma_i$  is the 90-week-day volatility, calculated as the annualized standard deviation of the returns of the previous 90 week days.

$$\sigma_i = \sqrt{\frac{1}{90} \sum_{i=-91}^{-1} (r_i - \mu)^2} \quad \text{Equation 6}$$

where  $\mu$  is the mean of the previous 90 day returns.

The weights are calculated as follows:

$$W_i(t) = \frac{InV_i(t)}{\sum_{i=1}^n InV_i(t)} \quad \text{Equation 7}$$

where  $n$  is the number of underlying markets in the portfolio.

The portfolio return,  $r_T$ , is calculated the by sum of the weights multiplied by the underlying's returns.

$$r_T = K \times \sum_{i=1}^n (W_i(t) \times r_i(t)) \quad \text{Equation 8}$$

$K$  is the leverage factor and described below. The portfolio rebalances monthly.

### Money management

The survey found that using a target volatility mechanism is the most common way to manage money in the CTA and managed futures industry. Leverage in the portfolio is decreased in volatile markets and increased in less volatile markets as measured by realized volatility versus target volatility.

The CTACDI employs a target volatility mechanism as described in S&P Index Mathematics [2014]. The leverage factor,  $K$ , is calculated by

$$K = \min \left\{ K_{max}, \frac{[Target Volatility]}{[Realized Volatility]} \right\} \quad \text{Equation 9}$$

where  $K_{max}$  is the maximum leverage permitted. For the CTACDI,  $K$  is unconstrained.

The realized volatility for the portfolio is calculated as above on the unleveraged index returns, and the target volatility for the CTACDI is set at 5% for a good mimic of CTA benchmark indices.

Embedded interest, costs and fees

The survey set the band for the most common management fee between 1.5 and 2% per annum and for the high water mark performance fee between 15 and 20%. For the CTACDI, we calculate the embedded fees daily accruing with management of fee 2% per annum and a high water mark performance fee of 20%.

The index calculation includes interest earned on cash. It is calculated as the daily returns on 90 day US Treasury Bills and the AUM. We use the same formula and methodology as provided by S&P GSCI<sup>R</sup> [2014] for the Total Return Index calculation:

$$TBR_d = \left[ \frac{1}{1 - \frac{91}{360} \times TBAR_{d-1}} \right]^{\frac{1}{91}} - 1 \tag{Equation 10}$$

with  $d$  being CTACDI business days, as specified by the NYSE Euronext calendar.

The T-Bill returns are added to the excess returns. Then we subtracted trading costs, management fees and performance fees from the total returns.

In Exhibit 3, we assumed following trading costs and slippage per annum and markets before leverage:

Asset Class	Commodities	Equities	Rates	Currencies	Gov't Bonds
Cost (basis points)	25	25	10	10	10

*Exhibit 3: Cost and trading slippage assumptions per asset class*

## Performance comparison to other benchmark indices

In determining if the resultant index is a "good and fair" representation of the CTA and futures industry, we primarily compare the time series against three popular benchmark indices as described above.

First we find that, with 95% confidence, the CTACDI correlates with popular CTA and managed futures indices between a lower bound of 0.47 and upper bound 0.69 (Exhibit 4).

	correlation	95% confidence interval	
		lower bound	upper bound
Barclay CTA	0.58	0.47	0.67
Credit Suisse Managed Futures	0.61	0.51	0.69
NewEdge CTA	0.59	0.48	0.68

Exhibit 4: Correlation between CTACDI and 3 other popular benchmark indices.

For correlations with other benchmark indices, please see annex 3.

Second, Exhibit 5 shows the CTACDI time series to mimic popular CTA and managed futures indices.

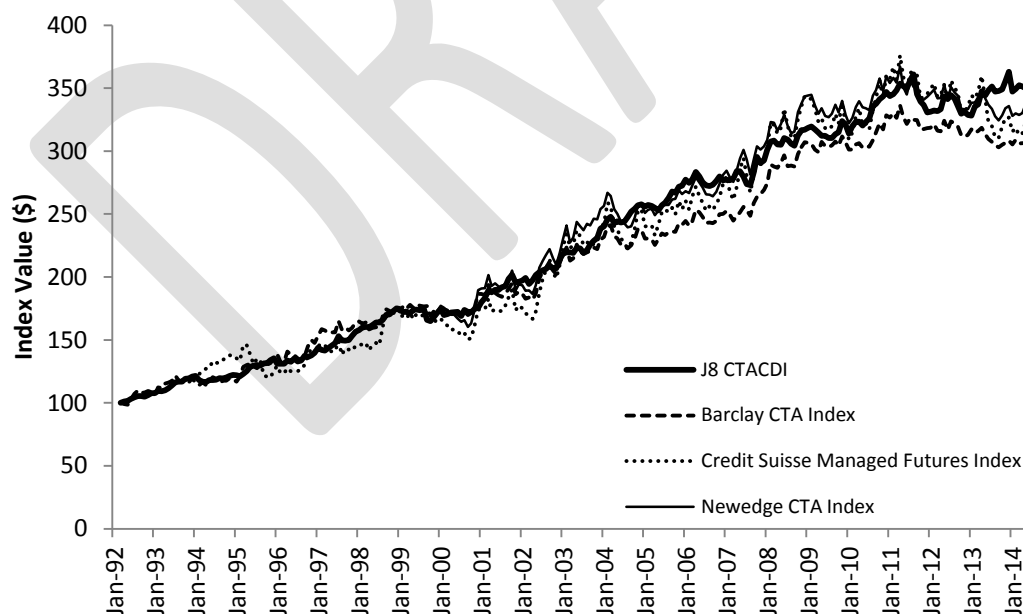


Exhibit 5: Simulated historical performance of the CTACDI with popular CTA benchmark indices, starting March 1992 until June 2014 with Barclay CTA Index starting March 1992, Credit Suisse Managed Futures Index starting end December 1993 and rebased to the CTACDI value on that day, and NewEdge CTA Index starting end December 1999 and rebased to the CTACDI value on that day. Source: Capital Management LLP and Bloomberg LP. Note: Past performance is not indicative for future performance.

Exhibit 6 compares the historical performance statistics of the CTACDI with popular benchmark indices. For comparison to more benchmark indices, see annex 4.

	CTACDI	NewEdge CTA	Barclay Trader CTA	Credit Suisse Managed Futures Index
Annualized Returns	5.42%	4.61%	4.69%	4.94%
Annualized Volatility	4.78%	8.63%	7.74	11.52
Negative Month Volatility	2.94%	4.58%	3.88%	6.58%
Sharpe Ratio (0)	1.13	0.53	0.60	0.42
Sortino Ratio (0)	1.8429	1.0055	1.2084	0.7509
Max Drawdown	-9.27%	-11.63%	-10.10%	-17.74
Max Drawdown Length [months]	33	37	37	37
Average length of 5 Largest DD [months]	16	18	21	25
Skew	-0.17	0.20	0.54	0.02
Kurtosis	0.54	0.64	1.08	-0.01
Profitable Months	64%	56%	53%	55%

*Exhibit 6: Historical performance statistics of the CTACDI (starting April 1992), Barclay CTA Index (starting APR 1992), Newedge CTA Index (starting January 2000), and Credit Suisse Manages Futures Index (starting January 1994).*

The CTACDI index has significantly higher risk adjusted returns than its non-investible peers, and shows lower and shorter drawdown periods.

In Annex 5, we compare the drawdown risk characteristics of the CTACDI with popular benchmark indices in drawdown graphs. The CTACDI experiences drawdowns of similar characteristic and time as the other benchmark indices.

## Conclusions

We set out with a survey to establish the common denominators in the CTA and managed futures industry and we discovered a simple investible method to mimic the industry. The CTA Common Denominator Index is derived from the core principles practitioners use in the industry. This minimalistic, and democratic index trades seven core futures markets of the S&P 500, Euro, Gold, Copper, WTI Crude Oil, Eurodollar, and 10yr US Treasury Note only. It applies risk parity for portfolio construction and target volatility for money management. Cash is compounded at the

risk-free rate of 90 day US T-Bills and it embeds trading costs and slippage and a common 2/20 fee structure.

The findings lead us to conclude that the CTA and managed futures industry by far and large may be described as a low-to-medium frequency momentum or trend following industry, trading global liquid markets only in a risk weighted portfolio, managed to a target volatility.

Coincidentally, we found that the CTACDI also seems to mimic the movements of those popular but non-investible CTA and managed futures benchmark indices. Therefore, the CTACDI may not only serve as a new benchmark index for the industry but also be used in investment products to gain exposure to CTA like returns.

## References

Baltas, A.-N., Kosowski, R. "Momentum Strategies in Futures Markets and Trend-following Funds." Imperial College Business School, 2012

Bridgewater. "The All Weather Story"  
<http://www.bwater.com/Uploads/FileManager/research/All-Weather/All-Weather-Story.pdf>

Chen, Hui Yi. Sachs, Tillmann. Tiong, L.K. Robert. "Common denominators in the CTA and managed futures industry - a survey report." Journal of Index Investing, Institutional Investor Journals, 2014 forthcoming.

Faith, Curtis M. The Way of the Turtle. McGrawn-Hill, 2007.

Gorton, Gary B. Hayashi, Fumio. Rouwenhorst, K. Geert. "The Fundamentals of Commodity Futures Returns." 2012.

Gorton, Gary B. Rouwenhorst, K. Geert. "Facts and Fantasies about Commodity Futures." Yale ICF Working Paper No. 04-20, 2005.

Moskowitz, Tobias. Ooi, Yao Hua., Lasse H. Pedersen. "Time Series Momentum."  
[2010]

Narang, Rishi K. Inside the black box. John Wiley & Sons, Inc., 2013.

Du Plessis, Johan. Demystifying Momentum: Time-series and cross-sectional momentum, volatility and dispersion. Master's thesis. University of Amsterdam, Amsterdam, 2013

S&P Dow Jones Indices. S&P GSCI<sup>R</sup> Methodology. McGraw Hill Financial. May 2014.

S&P Dow Jones Indices. Index Mathematics, Methodology. McGraw Hill Financial. March 2014

## Annex 1 - Long only rolling futures indices

The long only rolling futures indices are calculated in the same way single underlying sub-indices of the S&P Goldman Sachs Commodity Index [2014] are calculated. We roll the futures on the close of the first trading day of a month and used following lead contract tables:

	Nat Gas	Crude WTI	Brent	Heating Oil	Unlead Gas	Gasoil	Wheat	Corn	Soybeans	Soubean Oil	Soybean Meal	Sugar	Cotton	Cocoa	Coffee	Lean Hogs	Live Cattle	Feeder Cattle
Jan	G	G	H	G	G	G	H	H	H	H	H	H	H	H	H	G	G	H
Feb	H	H	J	H	H	H	H	H	H	H	H	H	H	H	H	J	J	H
Mar	J	J	K	J	J	J	K	K	K	K	K	K	K	K	K	J	J	J
Apr	K	K	M	K	K	K	K	K	K	K	K	K	K	K	K	M	M	K
May	M	M	N	M	M	M	N	N	N	N	N	N	N	N	N	M	M	Q
Jun	N	N	Q	N	N	N	N	N	N	N	N	N	N	N	N	N	Q	Q
Jul	Q	Q	U	Q	Q	Q	U	U	X	Z	Z	V	Z	U	U	Q	Q	Q
Aug	U	U	V	U	U	U	U	U	X	Z	Z	V	Z	U	U	V	V	U
Sep	V	V	X	V	V	V	Z	Z	X	Z	Z	V	Z	Z	Z	V	V	V
Oct	X	X	Z	X	X	X	Z	Z	X	Z	Z	H	Z	Z	Z	Z	Z	X
Nov	Z	Z	F	Z	Z	Z	Z	Z	F	F	F	H	Z	Z	Z	Z	Z	F
Dec	F	F	G	F	F	F	H	H	F	F	F	H	H	H	H	G	G	F

Exhibit 7: Contract table of lead month contracts per market

	Aluminum	Copper	Zinc	Nickel	Lead	Tin	Gold	Silver	Gov't bonds	Interest rates	Currencies	Equities
Jan	G	H	G	G	G	G	G	H	H	H	H	H
Feb	H	H	H	H	H	H	J	H	H	H	H	H
Mar	J	K	J	J	J	J	J	K	M	M	H	H
Apr	K	K	K	K	K	K	M	K	M	M	M	M
May	M	N	M	M	M	M	M	N	M	M	M	M
Jun	N	N	N	N	N	N	Q	N	U	U	M	M
Jul	Q	U	Q	Q	Q	Q	Q	U	U	U	U	U
Aug	U	U	U	U	U	U	Z	U	U	U	U	U
Sep	V	Z	V	V	V	V	Z	Z	Z	Z	U	U
Oct	X	Z	X	X	X	X	Z	Z	Z	Z	Z	Z
Nov	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z
Dec	F	H	F	F	F	F	G	H	H	H	Z	Z

Exhibit 8: Contract table of lead month contracts per market



## **Annex 2: Sensitivity analysis of index parameters**

Five parameters in the index had to be established and set to fixed values. To determine a "robust" parameterization, we conducted for each parameter a sensitivity analysis to changes in the parameter's value on statistical performance measures. We evaluated the results based on robustness considerations propagated by Faith [2007] and Narang [2012].

We discuss "robust" parameterization in the first sensitivity analysis on the momentum look-back period and apply same principles for the remaining four parameters.

### **TWELVE MONTHS MOMENTUM**

A 12 months look-back period is popular in academic literature on commodity futures returns and time series analysis (see Moskowitz, et al. [2010]; Baltas, et al. [2013]; Plessis [2013], Gorton et al. [2012]). We confirm and show in this section that choosing 12 month momentum one robust parameter by taking a different approach based on robustness considerations propagated by Faith [2007] and Narang [2012].

#### What is "robust"?

It is sometimes conducive to choose a trading parameter which may produce exciting results in time series back-test. However, in live trading, it may produce disappointing results.

We try to avoid such optimistic parameterization and demonstrate our approach to robust parameterization with the following methodology. Here, it is to determine or confirm a "robust" momentum look-back period in 57 global markets. The 57 markets included 20 commodity markets, 10 government bond markets, 9 currency markets, 6 interest rate markets, and 12 equity indices.

First: We calculate long-only rolling indices for each of the 57 futures markets, see Annex 1.

Second: For each market  $i$  on each day we calculate the momentum  $M^i$ , using look-back periods  $m$ , ranging from 1 to 18 months.

$$M^i(t) = \frac{P^i(t)}{P^i(t-m)} - 1, \quad \text{Equation 11}$$

where  $P(t)$  is the price of the long-only rolling index at  $t$ .

Third: The trading signal takes the form

$$S(t) = \begin{cases} +1, & M(t) \geq 0 \\ -1, & M(t) < 0 \end{cases} \quad \text{Equation 12}$$

If the momentum is positive, we enter into a long position for the next day's return, and short otherwise. This produces a long/short momentum time series for each of the 57 underlying markets and each of the 18 look-back periods.

Fourth: We then calculate for each market and each look-back period the "Robust Risk/Reward Ratio" (RRRR), first introduced by Faith [2007]:

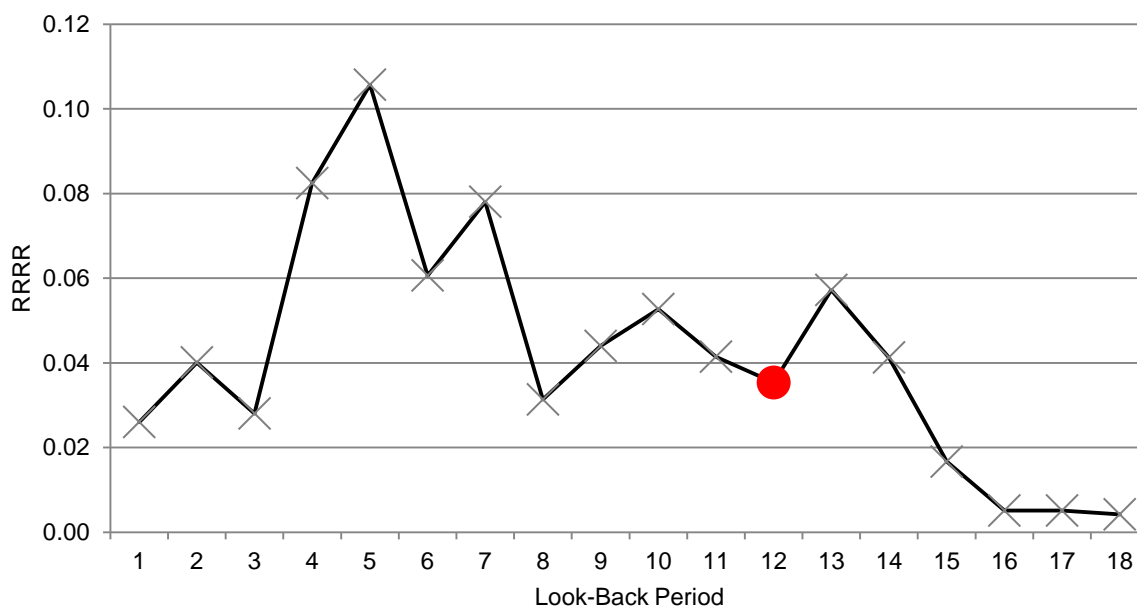
$$RRRR_m^i = \frac{\text{Regressed Annual Return}_m^i}{\text{Length Adjusted Average Maximum Drawdown}_m^i}. \quad \text{Equation 13}$$

"The average maximum drawdown is computed by taking the five largest drawdowns and dividing by five. The length adjustment is made by taking the average maximum drawdown length in days and dividing it by 365 and then multiplying that number by the average maximum drawdown".

A higher ratio indicates higher regressed returns per length-adjusted average maximum drawdown. We chose this ratio because it provides a good indication on the risk of losing and recovering money in a time series; we measure regressed returns instead of single point to single point returns, and also we take into

consideration multiple draw-downs and draw-down lengths instead of, for example, only the single largest maximum draw-down.

Fifth: Per underlying, we calculate 18 RRRRs, one for each look-back period from 1 to 18 months. *Exhibit 9* provides an example for CL.



*Exhibit 9: Example of RRRR for 1 to 18 months look-back period for WTI Crude Oil (CL), showing that 12 months is one robust parameter as discussed below.*

Sixth: In choosing a "robust" look-back period, we again refer to Faith [2007] and Narang [2012]. The conceptual drawing in Exhibit 10 exemplifies the choice for a robust parameter. We avoid maxima (B) as, although showing great results on the back-test, live results are likely to be worse as the live trading environment may cause the graph to shift slightly either to the left or right. However, when you choose a point along the slope (A), it is likely that in real live trading your results will either be better or worse, but within expectation.

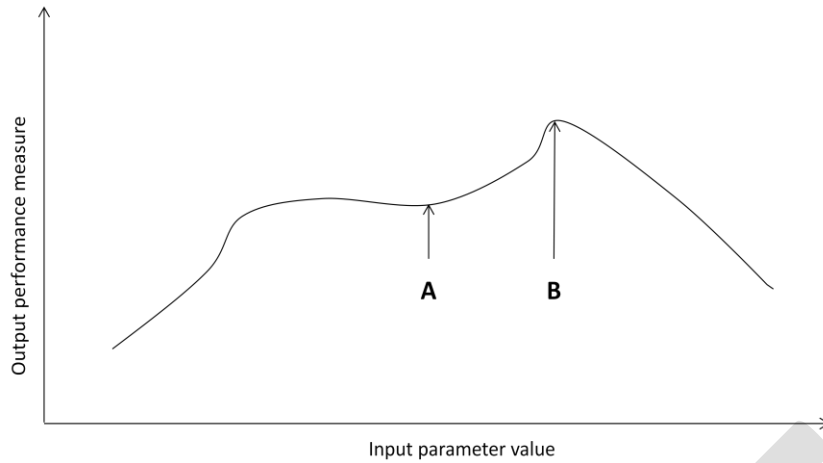


Exhibit 10: Parameters A and B, where A is likely to be a more "robust" point than B. Also see Faith [2007], Figure 11-5, and Narang [2012], Exhibit 9.5 for more examples.

We use a new method to analyse robustness and call it "Robustness Test Ratio" (RTR). This ratio ranks each look-back period (input parameter) in terms of "robustness" of output. "Robust" is a parameter that is not a maximum and also not neighbored by extreme values or erroneous parameters. We manually assign a negative value to erroneous output values. Erroneous points can occur if the arguments in calculating the denominator of RRRR are not satisfied.

$$RR^i(m) = \begin{cases} 0, & \text{if } RRRR_{m-1}^i < RRRR_m^i < RRRR_{m+1}^i \\ 0, & \text{if } RRRR_{m-1}^i < 0 \\ 0, & \text{if } RRRR_{m+1}^i < 0 \\ \frac{\frac{1}{3}(RRRR_{m-1}^i + RRRR_m^i + RRRR_{m+1}^i)}{\text{range}(RRRR_{m-1}^i, RRRR_m^i, RRRR_{m+1}^i)}, & \text{otherwise} \end{cases} \quad \text{Equation 14}$$

Following Exhibit 11 shows the Robustness Test Ratios for WTI Crude Oil (CL) from Exhibit 9.

Month	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
RTR(m)	0.00	0.92	0.93	0.00	1.81	0.00	1.09	2.00	0.00	2.49	2.04	0.00	0.95	0.58	0.78	5.34

Exhibit 11: Robustness Test Ratios for WTI Crude Oil (CL)

Here, 11 months is the champion, however, 12 months satisfies the conditions of being a robust parameter point, too.

Seventh: In our next step of the 12 months robustness test analysis, we determine for each market the champion look-back period with the highest RTR. Exhibit 12 plots the histogram for how often a month was chosen as "robust" in all the 57 underlying markets. The 95% confidence interval is 10.26 to 12.12 months, suggesting 12 months likely being a robust look-back period.

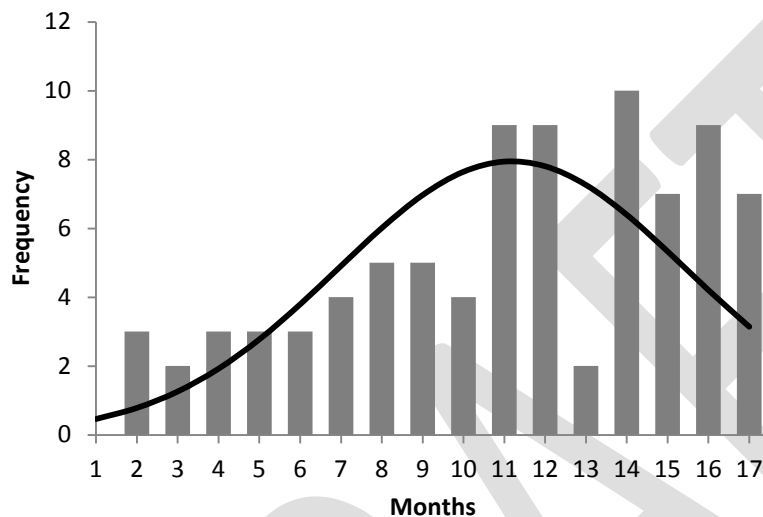


Exhibit 12: Histogram of most robust month of all underlying markets

### **SIGNAL OBSERVATION FREQUENCY**

We test the sensitivity of the portfolio performance to changes in the observation frequency of the 12 months momentum. The portfolio contains the 7 core markets and is risk parity weighted. In this test, we exclude US T-Bill returns, costs, and fees. We measure again the portfolio RRRR but also the portfolio Sharpe ratio, as now, changes may have impact on the overall portfolio parameters. Also we assume, that each underlying will have the same observation frequency.

Exhibit 13 shows the results. Though weekly observations may yield slightly higher Sharpe and RRR ratios, daily observations seem reasonable, too. Certainly one would not want to exceed monthly observation frequencies. A daily observation

frequency is also supported by the survey findings, and the CTACDI uses daily observations.

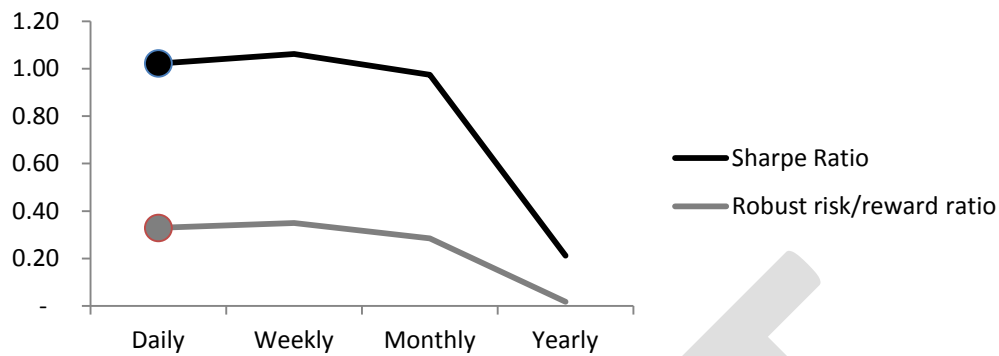


Exhibit 13: Signal observation frequency robustness

### RISK PARITY LOOK-BACK PERIOD

A 90 day look-back period for realized volatility calculation is widely established in the industry. We found that shorter look-back periods may yield higher performance statistics, but are also less stable. Exhibit 14 supports a 90 day look-back period as a robust point. The CTACDI uses 90 week days.

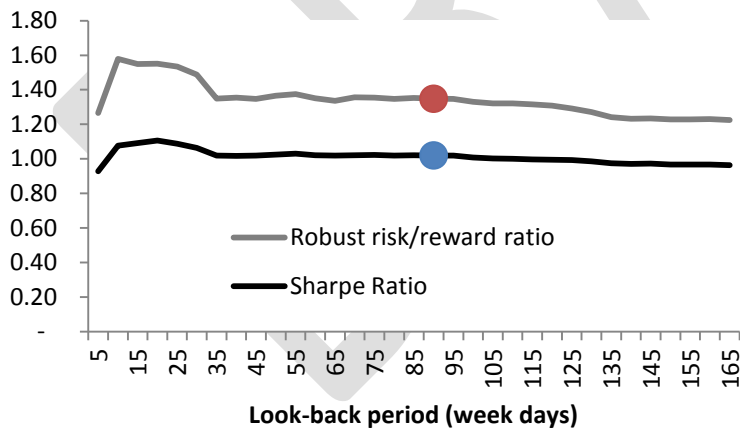


Exhibit 14: Risk parity look-back period analysis

### TARGET VOLATILITY LOOK-BACK PERIOD

To be able to perform sensitivity analysis on the volatility look-back period for calculating the target volatility mechanism, we chose a 5% volatility target and

unconstrained leverage. All other parameters remained unchanged as discussed above. Exhibit 15 demonstrates that shorter look-back periods may produce higher performance statistics but are also less stable. Again, "90 days" is widely used in the industry and this analysis suggests that 90 days is indeed a robust point. The CTACDA uses 90 week days.

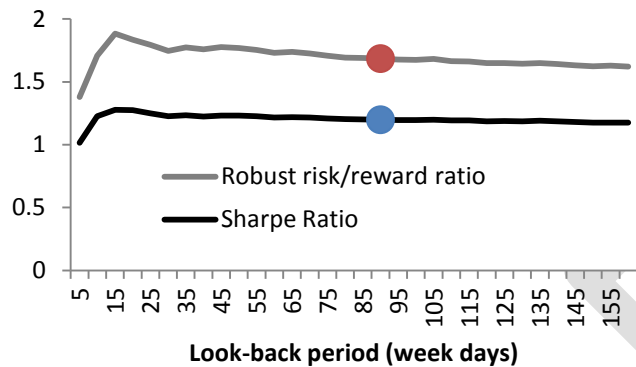


Exhibit 15: Target volatility look-back period analysis

## REBALANCING FREQUENCY

We chose a weekly portfolio rebalancing frequency and Exhibit 16 supports its choice being robust. Despite daily rebalancing giving slightly better performance statistics, it is more economical executable to rebalance the portfolio weekly or even monthly.

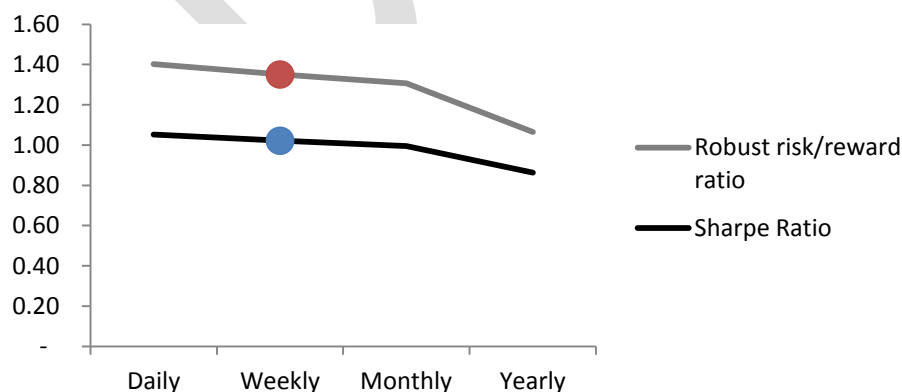


Exhibit 16: Rebalancing frequency analysis

## WEIGHTING

To examine the effect of risk parity on the portfolio statistics, it was compared against the same portfolio with equal notional weight. Exhibit 17 demonstrates how risk parity improves the overall portfolio performance.

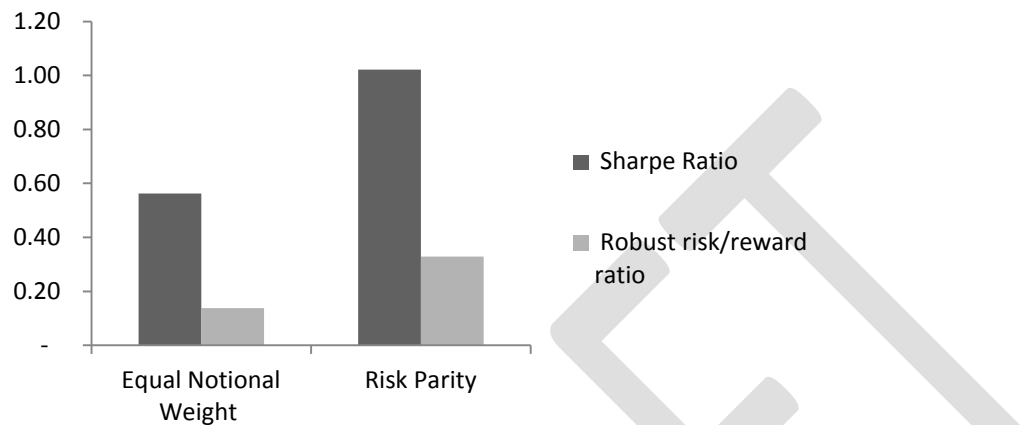


Exhibit 17: Comparison between equal notional weight and risk parity.



### Annex 3: Correlation analysis of CTACDI with traditional and alternative benchmark indices

	CTA and Managed Futures										Systematic				Hedge Funds				Long Only		
	CTACDI	NewEdge CTA	NewEdge Trend	Barclay Trader CTA	Credit Suisse Managed Futures	HRFX Macro CTA	Altegris 40	CISDM	iStoxx ECM	Barclay Trader Sys	HFRI Sys Div	HRFX Macro Sys Div	Barclay BTOP50	HRFX Gbl HFI	HFRI W. Comp	HFRI Macro Tot	Barclay Trader Div	S&P 500	S&P GSCI TR	Barc US Agg Tot Ret	
CTACDI	1.00																				
NewEdge CTA	0.60	1.00																			
Newedge Trend	0.61	0.97	1.00																		
Barclay Trader CTA	0.51	0.93	0.92	1.00																	
Credit Suisse Managed Futures	0.50	0.95	0.95	0.84	1.00																
HRFX Macro CTA	0.41	0.64	0.62	0.52	0.52	1.00															
Altegris 40	0.53	0.96	0.96	0.93	0.92	0.54	1.00														
CISDM	0.54	0.92	0.91	0.97	0.87	0.54	0.93	1.00													
iStoxx ECM	0.57	0.96	0.92	0.91	0.92	0.68	0.94	0.91	1.00												
Barclay Trader Sys	0.52	0.93	0.93	0.98	0.84	0.52	0.94	0.96	0.92	1.00											
HFRI Sys Div	0.35	0.49	0.44	0.30	0.40	0.63	0.34	0.42	0.90	0.29	1.00										
HRFX Macro Sys Div	0.16	0.00	0.01	-0.06	0.00	0.05	0.01	-0.07	-0.02	-0.02	0.02	1.00									
Barclay BTOP50	0.50	0.97	0.97	0.92	0.88	0.53	0.96	0.92	0.94	0.93	0.28	0.02	1.00								
HRFX Gbl HFI	0.17	0.28	0.28	0.21	0.22	0.66	0.22	0.21	0.13	0.18	0.46	-0.18	0.20	1.00							
HFRI W. Comp	0.10	0.08	0.07	0.07	0.05	0.41	0.04	0.09	0.12	0.04	0.56	-0.16	0.01	0.82	1.00						
HFRI Macro Tot	0.40	0.73	0.69	0.50	0.48	0.71	0.49	0.59	0.83	0.49	0.60	-0.09	0.47	0.62	0.64	1.00					
Barclay Trader Div	0.54	0.90	0.90	0.98	0.83	0.52	0.91	0.96	0.88	0.97	0.33	-0.02	0.90	0.16	0.04	0.50	1.00				
S&P 500	0.04	-0.15	-0.15	-0.05	-0.08	0.10	-0.11	-0.07	-0.12	-0.06	0.40	-0.03	-0.12	0.55	0.73	0.30	-0.10	1.00			
S&P GSCI TR	0.09	0.16	0.19	0.15	0.18	0.24	0.15	0.21	0.06	0.12	0.14	-0.12	0.13	0.43	0.37	0.22	0.16	0.24	1.00		
Barc US Agg Tot Ret	0.32	0.19	0.20	0.24	0.20	0.14	0.28	0.22	0.11	0.27	0.08	-0.06	0.24	0.08	0.05	0.27	0.22	0.07	0.01	1.00	

Exhibit 18: Correlation analysis of CTACDI and long-only and CTA/managed futures benchmark indices. Source: Capital Management LLP, Bloomberg LP, Altegris Clearing Solutions, Barclay Hedge, Center for International Securities and Derivatives Markets (CISDM), Credit Suisse. Note: Past performance is not indicative for future performance.

## Annex 4: Comparison of CTACDI with other Hedge Fund Indices

	CTA and Managed Futures									Systematic				Hedge Funds				Long Only		
	CTACDI	NewEdge CTA	NewEdge Trend Index	Barclay Trader CTA	Credit Suisse Managed Futures Index	HFRX Macro CTA	Altegris 40	CISDM	iSTOXX ECM Futures	Barclay Trader Sys	HFRI Sys Div	HFRX Macro Sys Div	Barclay BTOP50	HFRX Gbl HFI	HFRI weight Comp	HFRI Macro Tot	Barclay Trader Div	S&P 500	S&P GSCI	Barc US Agg Tot Ret
Annualized Returns (%)	5.42%	4.61%	5.60%	4.69%	4.94%	5.25%	6.62%	7.11%	1.96%	5.18%	10.03%	4.06%	6.25%	5.36%	11.04%	11.35%	5.90%	7.82%	3.11%	6.47%
Annualized Volatility	4.78%	8.63%	14.73%	7.74%	11.52%	8.39%	10.67%	8.38%	6.64%	9.77%	7.45%	9.90%	8.53%	6.38%	6.84%	7.41%	10.89%	14.60%	20.55%	3.65%
Sharpe Ratio (0)	1.13	0.53	0.38	0.61	0.43	0.63	0.62	0.85	0.30	0.53	1.35	0.41	0.73	0.84	1.61	1.53	0.54	0.54	0.15	1.77
Max Drawdown	-9.27%	-11.63%	-17.66%	-10.10%	-17.74%	-24.49%	-15.74%	-11.94%	-12.49%	-14.09%	-11.77%	-16.65%	-13.31%	-25.21%	-21.42%	-10.70%	-16.35%	-52.56%	-67.65%	-5.15%
Max Drawdown Length (m)	33	37	37	37	37	71	37	37	37	37	37	64	37	79	35	37	37	80	71	13
Average length of 5 Largest DD (m)	16	18	20	21	25	23	22	18	13	24	17	16	21	21	18	18	24	33	41	11
Same Direction as CTACDI (%)	-	73.84%	73.26%	67.27%	71.02%	68.02%	71.05%	70.61%	70.45%	69.45%	66.18%	50.00%	70.30%	67.01%	60.36%	69.82%	67.27%	57.45%	57.82%	65.45%
Skew	-0.17	0.21	0.20	0.55	0.03	0.41	0.26	0.48	0.08	0.74	0.18	0.68	0.48	-0.68	-0.69	0.64	0.47	-0.66	-0.38	-0.29
Kurtosis	0.55	0.64	0.79	1.08	-0.01	1.56	-0.14	0.13	-0.76	2.23	-0.29	1.10	0.82	5.43	2.74	1.19	0.55	1.34	1.99	0.89
Tracking Error	-	0.07	0.12	0.06	0.10	0.08	0.09	0.07	0.06	0.08	0.07	0.10	0.07	0.07	0.08	0.07	0.09	0.15	0.21	0.05
Alpha*	-	0.01	0.00	0.01	0.00	0.00	-0.01	-0.02	0.03	0.00	-0.05	0.01	-0.01	0.00	-0.06	-0.06	0.00	-0.02	0.02	-0.01
Information Ratio	-	0.12	-0.01	0.11	0.05	0.02	-0.13	-0.24	0.62	0.03	-0.63	0.13	-0.11	0.01	-0.71	-0.88	-0.05	-0.16	0.11	-0.21
Profitable Months (%)	64%	56%	55%	53%	55%	55%	56%	55%	55%	53%	61%	51%	57%	65%	72%	64%	53%	64%	57%	70%
Negative Month Volatility	2.94%	4.58%	8.08%	3.88%	6.58%	4.90%	5.32%	3.85%	3.43%	4.98%	3.48%	4.67%	4.16%	5.31%	5.17%	3.55%	5.55%	10.82%	14.73%	2.33%
Sortino Ratio (0)	1.84	1.01	0.69	1.21	0.75	1.07	1.24	1.85	0.57	1.04	2.88	0.87	1.50	1.01	2.14	3.20	1.06	0.72	0.21	2.77

Exhibit 195: Performance statistics of the CTACDI and other long-only and CTA/managed futures and hedge fund indices. Source: J8 Capital Management LLP, Bloomberg LP, Altegris Clearing Solutions, Barclay Hedge, Center for International Securities and Derivatives Markets (CISDM), Credit Suisse. Note: Past performance is not indicative for future performance.

\*Alpha is calculated as the difference between the annualised returns of the J8 CTACDI and annualised returns of the other index

## Annex 5: Drawdown analysis

Historical drawdowns of the CTACDI and popular benchmark indices.

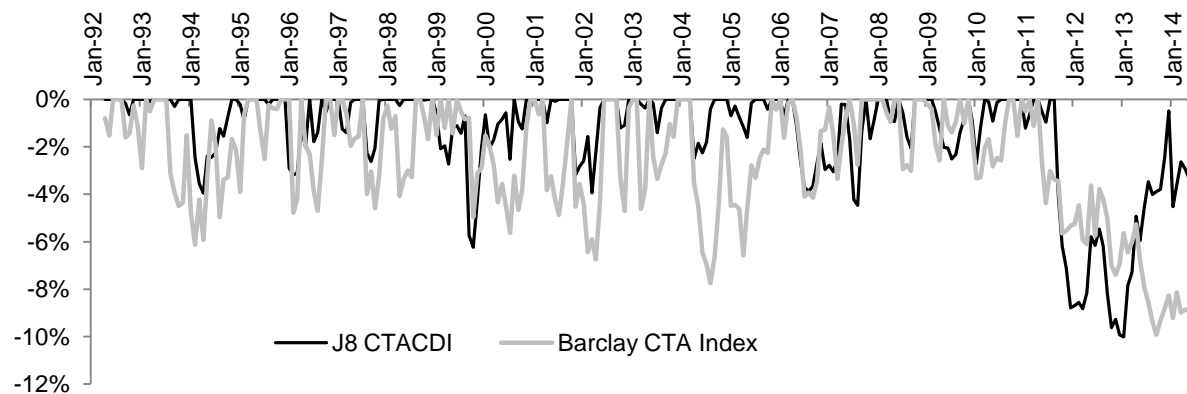


Exhibit 20: Drawdown analysis of CTACDI and Barclay CTA Index, starting January 1992. Source: J8 Capital Management LLP and Bloomberg LP. Note: Past performance is not indicative for future performance.

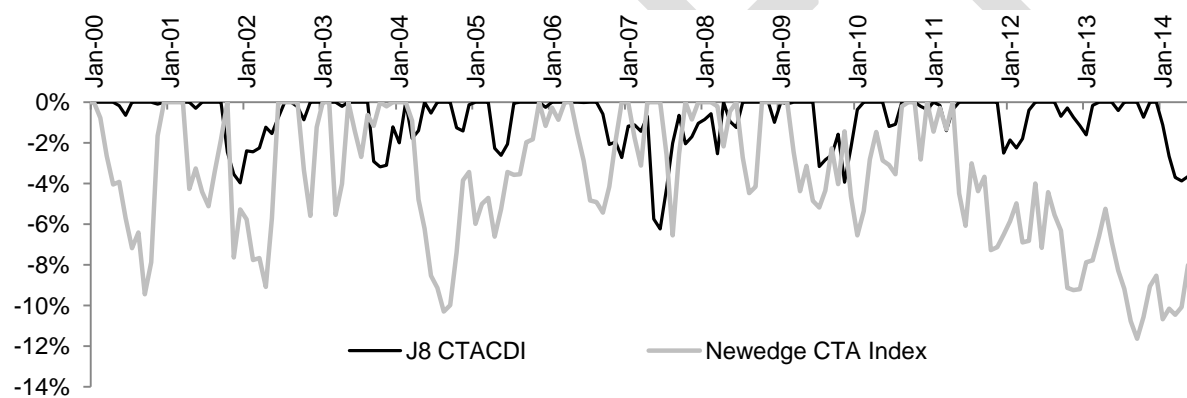


Exhibit 21: Drawdown analysis of CTACDI and Newedge CTA Index, starting January 2000. Source: J8 Capital Management LLP and Bloomberg LP. Note: Past performance is not indicative for future performance.

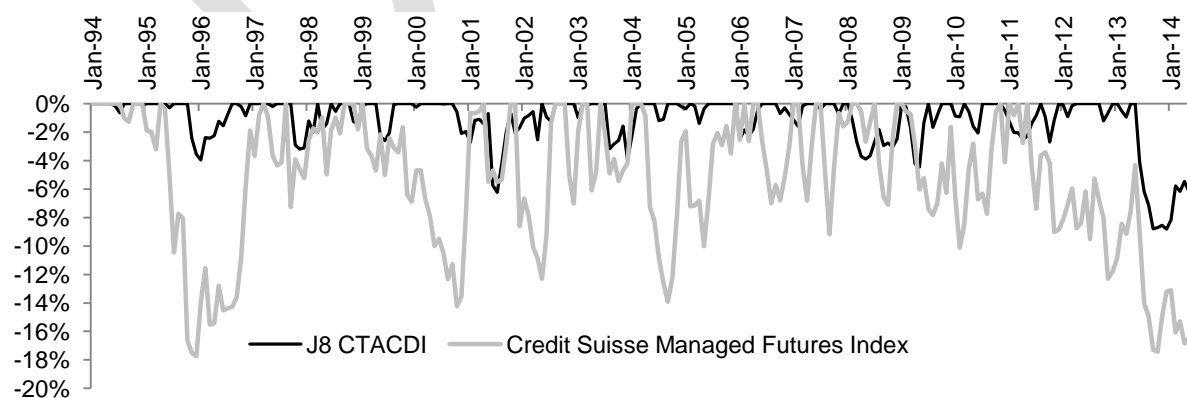


Exhibit 22: Drawdown analysis of CTACDI and Credit Suisse Managed Futures Index, starting January 1994. Source: J8 Capital Management LLP and Bloomberg LP. Note: Past performance is not indicative for future performance.