WHITEPAPER

SQUEEZING A LITTLE MORE OUT OF COMMODITIES – EARNING ALPHA FROM THE THOMSON REUTERS/JEFFERIES CRB INDEX

ANDREW CLARK
CHIEF INDEX STRATEGIST
THOMSON REUTERS INDICES
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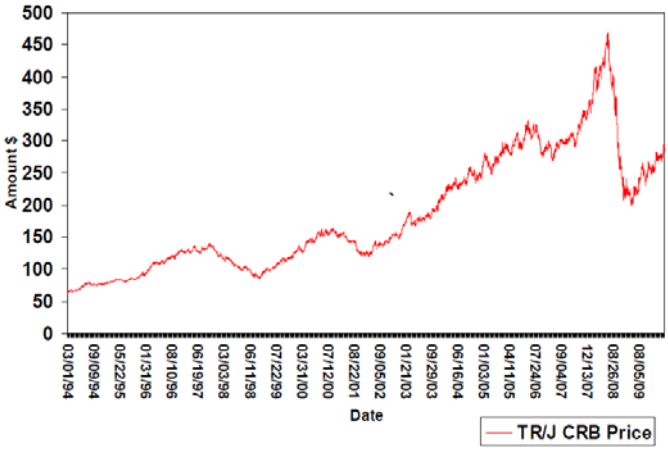
INTRODUCTION

Commodities in the U.S. have been on a long and impressive run since January 1994. The price of the Thomson Reuters/Jefferies CRB index rose 105% from January 1994 through September 2001 and then "stepped on the gas" during the 4th quarter of 2001. From then until the end of June 2008, the CRB price rose 254%. After that point the commodity markets, like most other markets at the time, went into a free fall with the CRB falling approximately 50% in price from its July 2008 high. The CRB's price stabilized in February 2009 and has risen approximately 50% since then. Over this bumpy but clearly upwardly sloping ride, the CRB's price has risen almost 400% since January 1994. Graph 1 shows the daily price of the TR/J CRB from January 1994 through November 2010.

Graph 1: Daily TR/J CRB Prices (January 1994 – November 2010)



When comparing the TR/J CRB to its siblings – the DJ-UBS and S&P GSCI indices – the TR/J CRB has performed better over the last several years, be it on a risk-adjusted on non risk-adjusted basis.

Table 1: Benchmark Index Performance Comparison

Historic performance

	Thomson Reuters/ Jefferies CRB Index	Dow Jones/UBS Commodity Index	S&P GSCI	S&P GSCI – Light Energy
10 Year				
Annualized Return	9.02%	7.15%	5.05%	3.60%
Annualized Volatility	18.89%	18.20%	26.24%	18.64%
Sharpe Ratio	0.48x	0.39x	0.19x	0.19x
5 Year				
Annualized Return	3.23%	1.96%	(3.01%)	0.58%
Annualized Volatility	21.70%	21.24%	28.99%	22.42%
Sharpe Ratio	0.15x	0.09x	NM	0.03x
1 Year				
Annualized Return	23.65%	18.91%	13.49%	15.35%
Annualized Volatility	21.73%	21.27%	29.00%	22.45%
Sharpe Ratio	1.09x	0.89x	0.47x	0.68x

Our goal in this paper is to try and improve on what is already an impressive index performance in a securities market that has seen spectacular growth in the past 17 years.

The next section of this paper will review the current methodology of the TR/J CRB. The third section will take the TR/J CRB methdology and turn it into constraints our alpha index will work with. Also in this section we will look at the alpha index returns versus those of the existing TR/J CRB. The final section will have our conclusions.

CURRENT TR/J CRB METHODOLOGY

Founded in 1957, the CRB Index has a long history as the most widely followed index of commodities futures. As markets have evolved, the CRB has undergone periodic updates – the latest occurring in 20051. Updates included:

- Component Changes: Over the years, commodities including eggs, oats, lard, rubber, potatoes and wool have been dropped and replaced by more liquid and significant

[1] A complete description of the current TR/J CRB methodology can be found at http://www.jefferies.com/cositemgr.pl/html/ProductsServices/SalesTrading/Commodities/ReutersJefferiesCRB/Details/index.shtml

contracts. In the latest revision there are 19 securities

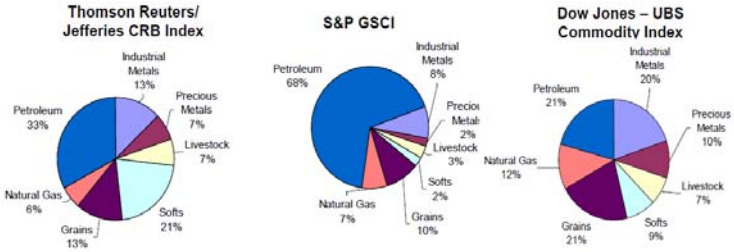
- Weighting: The 10th revision (2005) included a weighting change from equal weighted components to a 4-tiered grouping system designed to reflect the significance of each commodity
    - Energy: 39%
    - Agriculture: 41%
    - Precious Metals: 7%
    - Base/Industrial Metals: 13%
- Rebalance: The 10th revision also instituted monthly rebalancing and rollover schedules. The rollover rules include
    - Roll into the nearest contract:
    - Four-day rollover schedule for each commodity beginning on the first business day of the month and ending on the fourth business day

The next two tables show the weights for each of the commodities in the current TR/J CRB (Table 2) and how those weights compare to the DJ-UBS and the S&P GSCI indices (Table 3)

Table 2: The Thomson Reuters/ Jefferies CRB Index

	Commodity	Index Weight	Contract Months	Exchange
Group I	WTI Crude Oil	23%	Jan - Dec	NYMEX
	Heating Oil	5%	Jan - Dec	NYMEX
	RBOB Gasoline	5%	Jan - Dec	NYMEX
	Total	**33%**		
Group II	Natural Gas	6%	Jan - Dec	NYMEX
	Corn	6%	Mar, May, Jul, Sep, Dec	CBOT
	Soybeans	6%	Jan, Mar, May, Jul, Nov	CBOT
	Live Cattle	6%	Feb, Apr, Jun, Aug, Oct, Dec	CME
	Gold	6%	Feb, Apr, Jun, Aug, Dec	COMEX
	Aluminum	6%	Mar, Jun, Sep, Dec	LME
	Copper	6%	Mar, May, Jul, Sep, Dec	COMEX
	Total	**42%**		
Group III	Sugar	5%	Mar, May, Jul, Oct	NYBOT
	Cotton	5%	Mar, May, Jul, Dec	NYBOT
	Coffee	5%	Mar, May, Jul, Sep, Dec	NYBOT
	Cocoa	5%	Mar, May, Jul, Sep, Dec	NYBOT
	Total	**20%**		
Group IV	Nickel	1%	Mar, Jun, Sep, Dec	LME
	Wheat	1%	Mar, May, Jul, Sep, Dec	CBOT
	Lean Hogs	1%	Feb, Apr, Jun, Jul, Aug, Oct, Dec	CME
	Orange Juice	1%	Jan, Mar, May, Jul, Sep, Nov	NYBOT
	Silver	1%	Mar, May, Jul, Sep, Dec	COMEX
	Total	**5%**		

Table 3: Comparison of benchmark commodity indices



Diversification	Broad	Energy-focused	Broad
Roll (business) days	1st - 4th	5th - 9th	5th - 9th
Rebalancing frequency	Monthly	N/A	Annual
Reweighting frequency	10 revisions since 1957	Annual	Annual

Sector weightings upon 2009 rebalancing/reweighting

ALPHA INDEX METHODOLOGY AND RESULTS

Given the current revision to the TR/J CRB index, we need to have the following constraints in place in order to fairly replicate (and hopefully outperform) the current TR/J CRB index.

Those constraints are:

Cardinality – all 19 securities must be in the index at all times

The minimum position for a commodity is 1% while the maximum is 23% (see Table 2)

Rollover rules must be the same as those specified in the TR/J CRB methodology.

Rebalancing must occur monthly

Turnover cannot exceed the average turnover for the TR/J CRB

With these constraints in place, the only modification the alpha methodology will make to the existing TR/J CRB methodology is to let the individual commodity allocation float from month versus being fixed. The float however is constrained by the upper and lower position limits as specified in the current TR/J CRB methodology.

Typically, a mean-variance optimization (MVO) would be used to construct our alpha index. The reason we cannot use the standard MVO is because the first two constraints listed above are non-convex constraints. This means a modified nonlinear version or mixed integer version of MVO needs to be used. We will follow the modified nonlinear route as available in the fPortfolio package in R[2].

We will use two forms of optimization to construct our alpha portfolio. One we will call RMVO which is a robust version of MVO (meaning it can work with outliers), and one we will call MKO (mean-kurtosis optimization) which trades off tail-risk (kurtosis) and the mean. RMVO uses the MASS and mvoutlier packages in R (as well as fPortfolio). MKO is a Thomson Reuters construction that uses a multi-objective evolutionary algorithm (MOEA) to calculate the monthly portfolios.

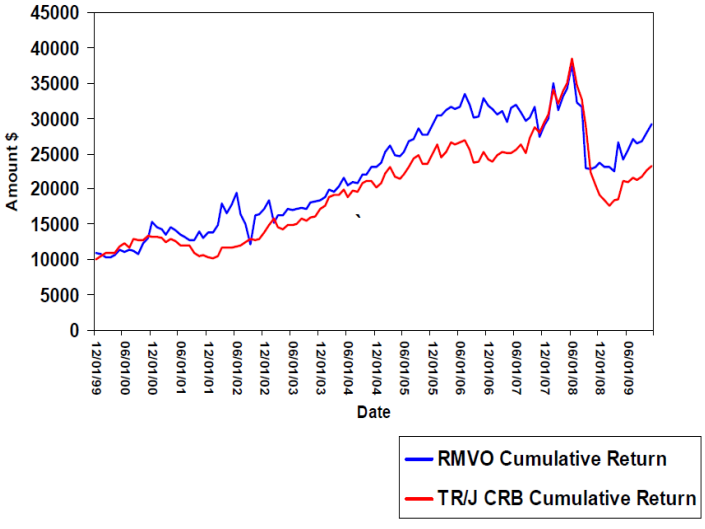
The starting point for each optimization routine is the series of commodity prices from which returns are calculated. Prices are known to be noisy and the same can be said of returns. In order to clean or reduce the noise of the return series', we use Random Matrix Theory (RMT). RMT scrubs the return series by constructing a matrix of the daily returns of each commodity over the prior six months. From this matrix, eigenvectors are computed. The first eigenvector is subtracted from the remaining eigenvectors leaving the resulting matrix cleaned or scrubbed of noise. The package tawny in R will perform this operation for you (and also give the mathematical details on why this process works). Thomson Reuters has been using RMT for the past four years in its quarterly construction of Optimal Indices (OIs). The OIs have consistently outperformed their benchmarks on a risk-adjusted basis because of the cleaning RMT provides.

After cleaning the matrix of returns, the next step in the RMVO process is to down weight outliers that may exist in the returns matrices. This is done via the pcout routine in the mvoutlier package in R. pcout is a way of identifying multivariate outliers in high-dimensional or large datasets. We clearly have a high-dimensional dataset because each monthly matrix will have 19 securities with returns for the prior six months (126 business days). pcout constructs a weight for each multidimensional observation and gives to outliers a weight less than 1 (the values decrease from 1 based upon the distance the outlier is from the center or major mass of data points). This set of weights – 1 for the major mass of points and a varying set of smaller values for the outliers - is used to construct a cleaned, robust covariance matrix for the MVO.

An MVO is computed at each month-end within the constrained, cleaned and outlier adjusted return series'. The resultant Sharpe portfolio for each month end becomes the portfolio for the next month and the process is repeated month-by-month for 10 years.

The graph below shows the cumulative returns of the RMVO and the TR/J CRB benchmark from 12/31/1999 through 11/30/2009.

Graph 2: RMVO Cumulative Returns vs. CRB (investment of $10,000)



As is clear from the graph, in most months the alpha (RMVO) portfolio performed the same or better than the TR/J CRB.

What the Graph 2 does not show is that on a risk-adjusted basis (as measured by Sharpe ratios), RMVO

[2] fPortfolio is part of the Rmetrics family of packages available in R. The main Rmetrics website is: https://www.rmetrics.org/

is approximately the same as the TR/J CRB. As shown in Table 4, RMVO has the higher annualized returns so given the similarity in risk-adjusted returns the RMVO is the better choice between the TR/J CRB and itself.

Table 4: Return, Volatility and Sharpe Ratio Comparisons

10 Years	RMVO	TR/J CRB
Annualized Return	11.31%	9.02%
Annual Volatility	18.84%	18.89%
Sharpe Ratio	0.60	0.48

5 Years	RMVO	TR/J CRB
Annualized Return	5.93%	3.23%
Annual Volatility	21.18%	21.7%
Sharpe Ratio	0.28	0.15

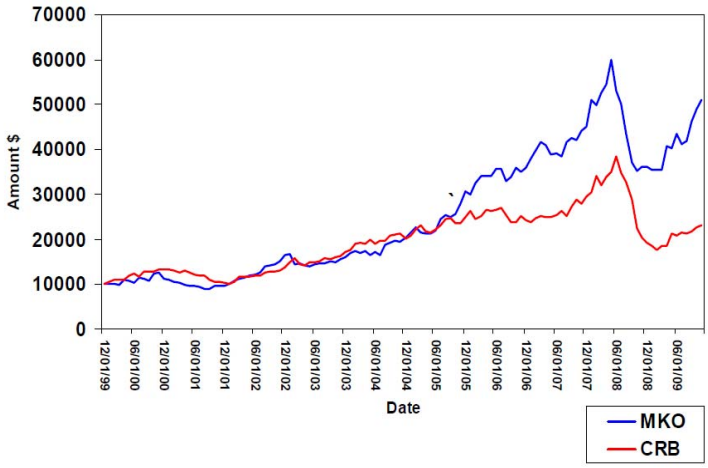
1 Year	RMVO	TR/J CRB
Annualized Return	26.06%	23.65%
Annual Volatility	23.16%	21.73%
Sharpe Ratio	1.13	1.09

Is it possible to better the RMVO returns by using MKO portfolios? The answer is yes.

The MKO portfolios, as mentioned above, are formed using an MOEA which trades off return, kurtosis and the constraints all at once. It uses the cleaned return matrices but is not adjusted for outliers. The MOEA each month generates a family (literally a phenotype) of "efficient" portfolios. The portfolio with the best (highest) tangency (pseudo-Sharpe) result becomes the portfolio for the next month.

In Graph 3 the cumulative return of the MKO portfolios are plotted against the TR/J CRB returns:

Graph 3: MKO Cumulative Returns vs. CRB (investment of $10,000)



The MKO methodology returns more than twice the money of the TR/J CRB ($51K vs. $23K) and, as would be expected, has a higher annualized return than the TR/J CRB for the 10 year period (14.75% vs. 9.02%). The volatility over the 10 years is higher (19.04% vs. 18.89%). But it is not high enough to equate the two risk-adjusted returns – 0.76 for MKO and 0.48 for the CRB.

What does need highlighting at this point is the very similar performance of the MKO & the CRB over the first six years of the test period (2000 – 2005). Remember that the last revision of the TR/J CRB was made in 2005. Prior to that, the prior CRB methodology was one of equal weights, 17 securities vs. 19 today, a forward averaging window versus today's rolling into the nearby contract and a geometric averaging technique not monthly arithmetic rebalancing. This difference in constraints would contribute to the variance in the performance of the RMVO and MKO to the prior version of the CRB. It would be prudent therefore not to draw firm conclusions for the whole test period but one can be fairly confident in comparisons made over the past five years.

CONCLUSIONS

This paper has shown there are least two ways of producing alpha using the current TR/J CRB as the benchmark.

We did so by using constraints that mimicked those in the current TR/J CRB methodology with one exception: we let the percentage held for each commodity vary from month to month. By doing so we produced two alternative indices that outperform the current TR/J CRB configuration over the past five years.

One question left outstanding is the appearance of outperformance of the RMVO over the 9th revision of the TR/J CRB. The 9th revision of the TR/J CRB had different constraints than the RMVO. This being the case, outperformance the RMVO shows over the first five years of the test needs to be interpreted with care.

FOR MORE INFORMATION

Thomson Reuters Indices
Andrew Clark
Chief Index Strategist
Tel: +1 303.357.0557
andrew.clark@thomsonreuters.com