ARC Commodity Factor Risk Model
Monthly Report December 2022

The Asset Risk Company (ARC) Commodity Model is a cross-sectional commodity factor model. The model contains 50 of the most widely traded commodity products with approximately 1,200 futures in total over all maturities. All futures in the model have exposures to sectors, sub-sectors, and style factors such as basis, momentum, and open interest. The model is estimated daily with 21 years of history. It provides a framework for managing risk and investment decision making.

In this report, you will find:

- Performance of Sectors, Sub-Sectors and Style Factors
- Inflation prediction
- Examples of Style Tilted Portfolios (Low Vol, Value, Momentum, Backwardation)
- Risk Factor Decompositions of Popular Commodity Indexes (BCOM, GSCI)

The ARC Commodity Model is a powerful tool to help many constituencies in the financial industry, trading, and real economy. Some of the applications of the model are very straightforward, but some uses of the model are more nuanced. We recommend this short piece that provides details on both common and novel use cases for a commodity factor model: https://www.assetriskcompany.com/whyfactor.html. You can access our latest research at https://www.assetriskcompany.com/library.html.

Sectors and Factors Performance Report:

Table 1. Sectors and Subsectors Performance* Annualized 5 years

Sectors/Subsectors	Dec 22	2022	5-year Return	5-year Volatility*
Agriculture	**-0.7%**	**18.7%**	**15.0%**	**11.9%**
Grain And Oilseed	-0.2%	15.6%	16.7%	14.1%
Lumber And Pulp	-15.6%	-52.1%	9.8%	51.4%
Proteins	-1.6%	34.6%	12.7%	10.5%
Energy	**-3.2%**	**13.7%**	**2.3%**	**16.0%**
Biofuels	-5.7%	18.6%	14.7%	22.0%
Coal	-9.0%	113.5%	25.1%	22.9%
Crude Oil	-4.9%	1.3%	-1.2%	18.8%
Natural Gas	0.3%	27.9%	2.9%	15.6%
Petrochemicals	-3.8%	-5.9%	-2.4%	20.3%
Refined Products	1.2%	29.6%	4.0%	21.0%
Metals	**1.7%**	**9.9%**	**11.4%**	**15.2%**
Base	-0.4%	-5.5%	11.8%	18.7%
Precious	6.7%	37.1%	12.7%	17.6%

With the exception of Precious Metals, December was a tough month for commodities. However all sectors were up for 2022, with double digit returns for Agriculture and Energy. Commodities were clearly the bright star of the market in what was a terrible year for traditional asset classes. Crude Oil and Natural Gas were very volatile in 2022, mostly due to the events in Ukraine. Crude Oil is almost flat for the year (1.3%) while NG was up 27.9%. As a reminder, ARC sectors and sub-sectors returns are not estimated using a static configuration of commodity weightings. The returns come naturally from a cross-sectional regression of the 1,200 assets in the model and

therefore cover the entire term structure. For instance, Natural Gas has more than 120 maturities in the model. In December we saw a large drop for the front months. However over the entire curve the average weighted return was -2.6%. The model uses all of that information to derive sector and subsector returns and one can think of our sectors as risk weighted on the entire curve.

Table 2. Styles Performance *Annualized 5 years

Factor	Dec 22	2022	5-year Return	5-year Volatility
Basis	-0.8%	-14.5%	-6.6%	5.5%
Open Interest	-1.3%	13.2%	1.7%	4.2%
Momentum	0.8%	5.5%	1.4%	5.6%
ST Momentum	-2.1%	-9.9%	-6.4%	5.9%
Trading Activity	-0.2%	-5.7%	-0.4%	2.4%
Volatility	-0.6%	-2.0%	3.6%	8.3%
ST Volatility	2.5%	8.5%	0.8%	8.3%

Open Interest and ST Volatility had an extraordinary year with performance way above their 5 year historical performance, while Basis and ST Momentum also delivered strong returns (by shorting the factor). Both Basis and ST Momentum (shorted) have Sharpe ratios above 1 over the last 5 years! Remember that the factor returns are estimated through cross-sectional regression. The factor returns here come from large portfolios of what are known as "factor replicating" portfolios. The factor replicating portfolios are not a practical way to trade and consist of positions (both long and short) in most of the instruments in the model's universe. We provide a much more parsimonious factor tilted (long only) portfolios later in this analysis.

Inflation:

Another application of a commodity factor model is inflation, forecasting, or attribution. We find that the ARC Commodity Model is a good predictor for breakout moves in the headline number, both in bouts of inflation and deflation. For the upcoming December inflation number we forecast a flat CPI and year on year inflation decreasing to 6.5%.

Style Tilted Portfolios Performance Report:

For December, BCOM and GSCI are down 2.4% and 1.4% and finish the year up respectively 16.1% and 26%. Momentum was down this month but was the big winner for 2022 with +33.7%. Value, which we defined as futures with low momentum scores, had a tough year but still does quite well over the last 5 years. Low Vol had a good year +12.5% which was similar to BCOM but with half of the realized volatility. Note that over the past 5 years all tilted portfolios have better Sharpe ratios than BCOM, with Low Vol and Value leading the way.

Table 3. Factor Tilted Portfolios and BCOM Performance

Perf	Value	Momentum	Low Vol	Backwardation	BCOM
December	2.7%	-1.5%	1.3%	-0.2%	-2.4%
2022	3.3%	33.7%	12.5%	23.8%	16.1%
Annualized	12.5%	9.2%	9.8%	11.6%	6.4%
Volatility	15.5%	17.5%	9.7%	16.6%	15.8%

Factor Correlations:

Long term correlations between sectors and style factors are also relatively low. The model is able to separate sector allocation risk from style risk providing key insights in the real key drivers of risk and performance of a portfolio.

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Table 4. Factor Correlations

Correlations	Agriculture	Energy	Metals	Basis	Open Interest	Momentum	ST Momentum	Trading Activity	Volatility	ST Volatility
Agriculture	1.00	0.46	0.43	(0.13)	0.05	0.04	0.03	0.01	0.08	0.19
Energy	0.35	1.00	0.45	(0.01)	0.43	(0.21)	0.11	(0.09)	(0.14)	0.45
Metals	0.20	0.24	1.00	(0.29)	0.23	0.10	0.23	(0.02)	(0.09)	0.31
Basis	0.43	0.38	0.01	1.00	(0.27)	(0.14)	(0.22)	0.21	0.03	0.02
Open Interest	(0.20)	0.20	0.02	(0.46)	1.00	(0.29)	(0.09)	(0.69)	(0.34)	0.13
Momentum	0.34	(0.23)	0.32	0.01	(0.46)	1.00	0.24	0.16	0.30	(0.15)
ST Momentum	0.25	(0.23)	(0.23)	(0.05)	(0.32)	0.29	1.00	0.15	0.04	0.20
Trading Activity	0.11	0.02	0.02	0.49	(0.74)	0.41	0.20	1.00	0.20	0.04
Volatility	0.66	0.55	(0.04)	0.54	(0.09)	(0.08)	0.22	0.20	1.00	(0.64)
ST Volatility	0.37	(0.12)	0.27	(0.13)	(0.22)	0.66	0.36	0.16	(0.04)	1.00

1 yr correlations on the right (above the diagonal), 30 days on left (below the diagonal).

Commodity Indices Risk Decomposition

GSCI is overweight in Energy and BCOM is roughly equally weighted between sectors. Both indices have high z-scores with respect to Open Interest reflecting the fact that the indices' constituents are weighted more heavily on the front month contract. GSCI is more sensitive to Short Term Momentum than BCOM.

Table 6. Factor Exposures

Factors Exposures	BCOM	GSCI
Agriculture	0.33	0.25
Energy	0.36	0.61
Metals	0.31	0.14
Basis	0.80	0.75
Open Interest	2.51	2.29
Momentum	0.24	0.38
ST Momentum	-0.02	-0.88
Trading Activity	-0.30	0.57
Volatility	0.47	0.62
ST Volatility	0.37	0.37

Exposures, z-scores for BCOM and GSCI as of 12/30/202

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Table 7. Risk Attribution of BCOM and GSCI

Index	BCOM	GSCI
Total Risk	**23.4%**	**24.2%**
Agriculture	2.4%	1.7%
Energy	4.4%	9.4%
Metals	3.7%	1.3%
Basis	-0.3%	-0.1%
Open Interest	11.4%	8.7%
Momentum	-0.2%	-0.3%
ST Momentum	0.0%	0.4%
Trading Activity	0.7%	1.0%
Volatility	-0.6%	-0.3%
ST Volatility	1.2%	1.7%
Specific Risk	5.4%	5.8%

Ex-Ante Annual Volatility Decomposition for BCOM and GSCI as of 12/30/2022

We use a 6 month half life for this risk decomposition so the model is fairly reactive to market conditions. Despite different sector allocations, both indices have similar risk and exposures to styles. If your portfolio is long/short you want to see if you have systematic exposures and your potential alpha (specific). For long only managers, you want to find your exposures versus your benchmark. As shown above in the correlation tables, sector correlations with style factors are relatively small. The model is able to separate risk due to sector allocation and styles risk. All risk is not equal. Systematic risk can display non normal behavior when compared to specific or idiosyncratic risk. Both types of risks are driven by fluctuation, but systematic risk is driven by the "crowd" expressing some thematic bet. The systematic risk is related to market risk.

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Conclusion:

In this report, we have shown the factor performance driving the commodity markets. Using the ARC Commodity model, style tilted portfolios have shown great performance and seem to be suitable benchmarks for active managers to track. We then conducted an analysis into the risk dynamics of two major commodity indices. The view of commodities as diversifiers is quite accurate. All of this was possible with the ARC model. The model enables the user to look at their book or portfolio and how it fits into their thesis as well as how it fits in the broader economic landscape.