ARC Commodity Factor Risk Model
Monthly Report December 2021

The Asset Risk Company (ARC) Commodity model is a cross-sectional commodity factor model. The model contains 50 of the most 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, open interest. The model is estimated daily with 20 years of history. It provides a framework for managing risk and investment decisions.

In this report, you will find:

- Performance of Sectors, Sub-Sectors and Style Factors
- Inflation prediction
- Examples of Styles Tilted Portfolios (Low Vol, Value, Momentum, Backwardation)
- Risk Factor Decomposition 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, 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

Sectors	Dec 2021	YTD Perf	Historical Returns*	Volatility*
Agriculture	**9.0%**	**36.9%**	**11.4%**	**10.3%**
Grain And Oilseed	6.2%	42.3%	14.0%	12.1%
Lumber And Pulp	34.1%	71.0%	33.6%	48.0%
Proteins	5.8%	19.7%	7.1%	9.7%
Softs	7.3%	22.8%	5.0%	11.5%
Energy	**3.3%**	**40.1%**	**0.0%**	**13.6%**
Biofuels	7.0%	77.8%	11.0%	21.4%
Coal	-5.5%	41.8%	10.9%	17.3%
Crude Oil	5.1%	37.6%	-1.0%	16.2%
Natural Gas	-0.9%	27.5%	-3.3%	10.7%
Petrochemicals	2.9%	40.5%	-0.6%	18.7%
Refined Products	9.2%	39.9%	-0.2%	19.3%
Metals	**6.0%**	**16.9%**	**14.5%**	**15.0%**
Base	10.8%	50.7%	18.8%	18.1%
Precious	-0.4%	-17.7%	9.3%	17.0%

* Annualized 2017-2021

As a reminder, ARC sectors and sub-sectors returns are not estimated using a static configuration of commodity weightings. The returns come naturally from the cross-sectional regression of the 1,200 assets in the model and therefore cover the

entire term structure. For instance NG and CL have more than 120 maturities each in the model.

All 3 sectors posted a positive month. On the Energy front, Oil related sectors were all positive with Crude Oil up 5.1% in December and Refined Products up 9.2%. Noticeably natural gas was down this month. All subsectors in Agriculture were up this past month with Lumber and Pulp posting an astonishing +34.1% this month, after +28.8% in November. One could argue that this sector is the poster child of the incertitude of the supply chain woes. Readers will note that the Sharpe Ratio of our Agriculture sector is above 1 over the last 5 years. Base Metals are up this month (+10.8%) while Precious Metals are down (-0.4%).

With the Energy and Agriculture sectors up in December, one would expect inflation to increase again in December. We will show in the section below that it is in fact a bit more complicated as our research indicated that CPI and Inflation are driven by both the current but also previous month's sector returns.

Table 2. Styles Performance

Factor	Dec-21	YTD	Historical Returns*	Volatility*
Basis	**0.7%**	**-6.4%**	**-5.4%**	**5.3%**
Open Interest	**-1.6%**	**-0.1%**	**-1.0%**	**3.6%**
Momentum	**-1.2%**	**0.6%**	**0.4%**	**4.9%**
ST Momentum	**-2.7%**	**-9.7%**	**-6.4%**	**5.3%**
Trading Activity	**0.5%**	**4.0%**	**0.7%**	**2.1%**
Volatility	**0.0%**	**9.7%**	**4.8%**	**6.3%**
ST Volatility	**4.3%**	**-2.2%**	**-2.0%**	**6.5%**

* Annualized 2017-2021

Momentum factors are both down this month significantly. Noticeably Short Term Volatility (30 days) is up +4.8%. We will, again, highlight that the Sharpe Ratio of ST Momentum is 1.2 over the last 5 years (taken from the short side).

Inflation:

Another application of a commodity factor model is inflation forecasting or attribution. With inflation at 6.8% in December, the highest in 30 years, expectations are high for next month's print. Commodities contribute a large part to the CPI. We find that the ARC Model is a good predictor for breakout moves in the headline number, both in bouts of inflation and deflation. Out of sample R-Square over 20 years is above 80% for our estimated inflation vs realized. In November and October we expected contributions to CPI to be +0.5% for both months vs realized of +0.5% and +0.8%. For December our estimate is a flattish CPI (+0.1%) which would keep inflation constant at 6.8%. To wit, inflation is the percentage change of the CPI index over 12 months. Therefore it is dependent on the latest CPI change but also the one that left the 12 month interval. Last year December CPI change was +0.1%, therefore it will take a small increase of CPI (+0.2%) to increase inflation.

Styles Tilted Portfolios Performance Report:

Historical data going back 20 years confirms that style tilted factors significantly outperform the most widely followed commodity indices. We track these style tilted portfolios on a monthly basis. The Low Vol portfolio, for example, is composed of commodities whose exposures favor low volatility. The Low Vol portfolio also exhibits the lowest realized volatility over the time period. All commodity futures included in the portfolios are specifically selected so that they have large open interest. The other three portfolios are similarly constructed each favoring its respective factor. The portfolios are long only.

Table 3. Factor Tilted Portfolios and BCOM Performance

Returns	Value	Momentum	Low Vol	Backwardation	BCOM
YTD	33.4%	24.8%	27.9%	32.4%	27.1%
Dec. 2021	4.1%	4.1%	4.0%	5.1%	3.5%
Annualized*	13.6%	5.0%	6.8%	7.9%	3.6%
Volatility*	15.0%	14.5%	9.2%	15.6%	13.3%

*2017/2021

All the tilted portfolios outperformed the index this month. Overall, as our research shows over 20 years, Low Vol, Value and Backwardation provide better returns than BCOM. Low Vol obviously, does so, with a much lower volatility. Over the last 5 years BCOM Sharpe is 0.3 vs 0.9 for Value, 0.7 for Low Vol, 0.5 for Backwardation and 0.4 for Momentum.

Factor Correlations:

Table 4. Factor Correlations

Correlations	Agriculture	Energy	Metals	Basis	Open Interest	Momentum	ST Momentum	Trading Activity	Volatility	ST Volatility
Agriculture	1.00	0.34	0.42	(0.32)	0.18	0.29	0.15	(0.02)	(0.04)	0.24
Energy	0.50	1.00	0.28	0.06	0.48	0.21	(0.08)	(0.25)	(0.26)	0.33
Metals	0.50	0.07	1.00	(0.06)	0.21	0.28	0.10	(0.10)	(0.01)	(0.01)
Basis	(0.21)	0.41	(0.12)	1.00	0.05	(0.04)	(0.13)	(0.07)	(0.26)	0.01
Open Interest	0.23	0.65	0.10	0.52	1.00	0.38	0.04	(0.58)	(0.38)	(0.13)
Momentum	0.42	(0.05)	0.32	(0.07)	0.16	1.00	0.20	(0.14)	(0.28)	(0.16)
ST Momentum	(0.02)	(0.40)	0.14	(0.13)	(0.16)	0.45	1.00	(0.11)	(0.02)	(0.03)
Trading Activity	(0.25)	(0.40)	(0.39)	(0.28)	(0.74)	(0.03)	(0.01)	1.00	0.19	0.04
Volatility	(0.31)	(0.52)	0.15	(0.21)	(0.31)	(0.14)	0.49	(0.01)	1.00	(0.33)
ST Volatility	0.80	0.60	0.27	(0.13)	0.20	0.29	(0.14)	(0.15)	(0.57)	1.00

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

There is much to note in the factor correlations matrix. First, along the top level sectors note that correlations stay roughly consistent between Agriculture, Energy and Metals. 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.

Commodity Indices Risk Decomposition

In terms of sector exposures, BCOM is approximately equal weighted, though the Energy allocation is increasing. As expected, GSCI is overweight in Energy. 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, which in most cases is the most traded contract. Noticeably both indices have negative exposures to Short Term Momentum this month, while GSCI has more exposures to Momentum than BCOM. We also note the large negative exposure to Trading activity for GSCI. It indicates that futures in the index saw a drop in volume during the December period, possibly an allocation away from the energy sector.

Table 5. Factor Exposures

Factors	BCOM	GSCI
Agriculture	0.35	0.26
Energy	0.35	0.57
Metals	0.30	0.17
Basis	0.78	0.80
Open Interest	2.49	2.46
Momentum	0.10	0.45
ST Momentum	-0.48	-0.37
Trading Activity	0.08	-1.17
Volatility	0.25	0.31
ST Volatility	0.35	0.63

Exposures, z-scores for BCOM and GSCI as of 12/31/2021

The model allows users to track exposures to Styles factors at the contract level. Key contributors to Momentum are driven by energy futures in both BCOM and GSCI.
We see an uptick in Ex-Ante Volatility for GSCI, reflecting the higher volatility seen in energy futures in the last few months (Crude Oil and Natural Gas). Open Interest is the largest contributing factor for both indices followed by Energy. Note that styles' risk contribution to the total risk is larger than sectors' contributions, for both BCOM and GSCI. It really highlights the fact that looking at sectors or sub-sectors allocation for a commodity portfolio is not enough. 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.

Table 6. Risk Attribution of BCOM and GSCI

Total Risk	**19.5%**	**22.8%**
Agriculture	1.9%	1.3%
Energy	**4.0%**	**7.0%**
Metals	2.8%	1.3%
Basis	1.1%	1.2%
Open Interest	**8.4%**	**8.3%**
Momentum	0.1%	0.6%
ST Momentum	0.3%	0.2%
Trading Activity	-0.1%	1.4%
Volatility	-0.7%	-1.0%
ST Volatility	0.9%	2.2%
Specific Risk	**4.8%**	**4.2%**

Ex-Ante Annual Volatility Decomposition for BCOM and GSCI as of12/30/2021

Conclusion:

In this report, we have shown the factor performance driving the commodity markets. Using the ARC model, Styles 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.