Commodity Portfolio Monthly

Spilling the beans on volatility

Bank of America Merrill Lynch

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Volatility across various markets can be correlated

Systematic sellers of options across various markets tend to capture a positive return from this activity, just like insurers have to be compensated for underwriting flood or fire risks. However, vol across various underlyings can be at times highly correlated, as we observed in 2008. So does it make sense to diversify a short-vol portfolio across different asset classes like FX, rates, commodities or equities? In broad terms, selling vol across different asset classes to diversify a portfolio will tend to improve risk-adjusted returns for investors, but not always. We show how spillover measures can help establish interdependence across markets and improve risk management of short vol exposures.

Spillover measures can quantify vol interdependence

In this note, we first estimate long-run return and volatility spillover measures between the US equity and global commodity markets and conclude these are relatively low. We then explore spillover effects within a group of commodity subsectors and also observe a low level of interdependence, suggesting diversification can be beneficial. We then go on to create a rolling spillover measure to study the time-varying nature of return and volatility interdependence across equities and commodities, as well as within various commodity subsectors. Lastly, we turn the spillover measure into a dynamic signal to determine if it can help improve the info ratio of systematic cross asset and intra commodity short vol portfolios.

A spillover signal may improve static short vol returns

The results are encouraging. Looking at BCOM and the SPX, we find that the spillover measures for our full 1991–2017 data sample are 4.1% for returns and 10.1% for volatilities, suggesting that adding systematic short commodity vol exposure to a short equity vol strategy, or *vice versa*, can enhance risk-adjusted returns. As we then turn a rolling spillover measure into a signal, our results also support the idea that it is a useful tool when it comes to controlling for cross-asset volatility risk. In both a benchmark equity/commodity EW systematic short-vol portfolio as well as an intra commodity short-vol portfolio, our backtesting suggests that a spillover signal would have improved the information ratio of a diversified static short vol strategy.

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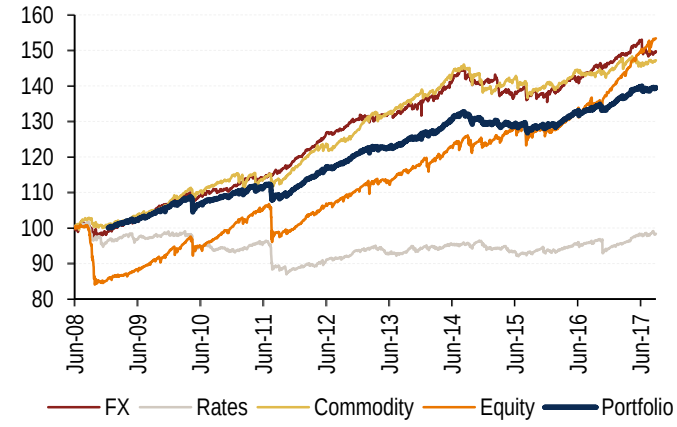
Spilling the beans on volatility

Volatility across various markets tends to be correlated

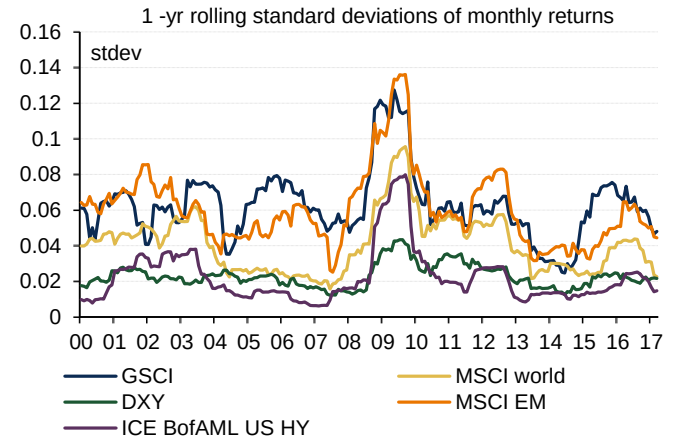
Naturally, markets tend to overestimate future realized volatility in the long run as "hedging" demand tends to systematically exceed "insurance" supply in most asset classes, creating a positive volatility risk premium (VRP). As a result, systematic sellers of options across various markets tend to capture a positive return from this activity (Chart 1), just like insurers have to be compensated for underwriting flood or fire risks. However, insurers often face a collection of random and unrelated risks in different geographic locations. In contrast, volatility across various asset classes can be at times highly correlated (Chart 2), as we observed in 2008. So does it make sense to diversify a short-vol portfolio?

Chart 1: Hypothetical back-tested short 1m variance swap (ratio-sized) strategies across asset classes & enhanced-ERC based short vol portfolio



Source: BofA Merrill Lynch Global Research. Data from 20-Jun-08 to 15-Sep-17. We use FXE (EURUSD), TLT (US rates), USO (Oil) & S&P as proxies for FX, Rates, Commodity and Equity. Back-tested performance is hypothetical in nature; it is not intended to be an indicative of actual or future performance. The actual performance of strategies may vary significantly from back-tested performance

Chart 2: Volatility across various asset classes tends to be correlated over time



Source: Bloomberg, BofA Merrill Lynch Global Research

So does it make sense to diversify a short-vol portfolio?

In principle, diversifying risk through a portfolio of short volatility strategies in rates, FX, equities, or commodities makes sense. After all, option prices, like insurance premia, need to compensate sellers for the risk of rare but large payouts and selling vol across different assets can be diversifying (Table 1). For example, in our back-test, a cross-asset short 1m var portfolio exhibited a ~50% superior risk-adjusted return compared to its components (see The harvester's guide to the (volatility) galaxy). However, the risk of a correlated macro shock is significant and investors need to be compensated to systematically sell vol across various instruments as a volatility shock in an asset class such as commodities can often spill over into other asset classes like rates or equities.

Correlation describes linear interconnection between markets…

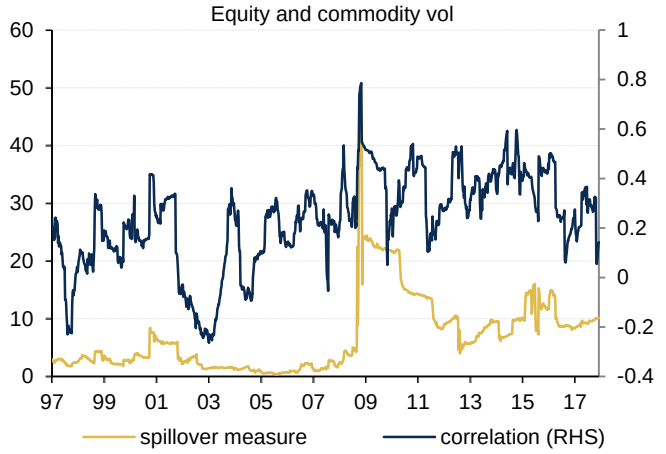
Surely, the simplest way of describing the interconnection between markets is by performing a correlation analysis. However, correlation only captures the evolution of the linear dependence between two particular markets. In this note, we analyze the interconnections between markets from a different angle using a spillover measure. The measure is based on the shares of the forecast error variance ascribed to spillovers between particular markets and is not necessarily linked to correlation (Chart 3). This tool, however, enables us to describe a reaction of a market to change in another particular market and to obtain a more comprehensive, non-linear picture of data interdependence.

Table 1: Option prices need to compensate sellers for the risk of rare but large payouts and selling vol across different assets can be diversifying

Strategy	Return	Volatility	Sharpe	MaxDD*	Calmar	Correl**
FX	4.8%	3.8%	1.28	-6.5%	0.74	9%
Rates	0.3%	3.7%	0.08	-12.3%	0.02	-7%
Commodity	4.4%	3.8%	1.16	-6.5%	0.68	23%
Equity	6.8%	5.3%	1.28	-10.0%	0.68	57%
X-asset avg.	3.9%	4.0%	0.98	-8.4%	0.46	
Vol Cluster	3.9%	2.8%	1.41	-4.6%	0.85	

Source: BofA Merrill Lynch Global Research. Data from 20-Jun-08 to 15-Sep-17. We use FXE (EURUSD), TLT (US rates), USO (Oil) & S&P as proxies for FX, Rates, Commodity and Equity *MaxDD = Max Drawdown. ** Correlation vs their underlying assets. Back-tested performance is hypothetical in nature; it is not intended to be an indicative of actual or future performance. The actual performance of strategies may vary significantly from back-tested performance

Chart 3: The spillover measured by the shares of the forecast error variance ascribed to spillovers is not necessarily linked to correlation



Source: BofA Merrill Lynch Global Research estimates

...but a spillover measure shows non-linear interdependence

Academic literature (see Diebold and Yilmaz (2009, 2014))[1] has tried to study market interdependence by creating measures of spillover effects. These spillover measures are based on the forecast error's covariance matrix. Once the error matrix is estimated, the variance decompositions allow us to split the forecast error variances of each variable into parts attributable to the various system shocks. In this note, we first use these tools to investigate the return and volatility spillovers between the US equity and global commodity markets. We then explore spillover effects within a group of commodity subsectors. Lastly, we apply a rolling spillover measure to various sample portfolios to determine if the signal can help improve portfolio info ratios.

Intra equity market vol is generally highly interconnected...

The first step in our work is to characterize return and volatility spillovers over an entire sample. For each asset *i*, we simply add the shares of its forecast error variance coming from shocks to asset *j* then we add across all *i*. In essence, we do an input-output decomposition of the spillover measure. The *ij*-th entry in the table is the estimated contribution to the forecast error variance of market *i* coming from innovations to market *j*. The off-diagonal column sums (labelled Contributions to others) or row sums (labelled Contributions from others), when aggregated across markets, give the numerator of the spillover measure (Exhibit 1). Similarly, the column sums or row sums (including diagonals), when aggregated across countries, give the denominator of the spillover measure. Previous academic studies have found intra equity market vol spillover measures to be higher than 35% (Chart 4), suggesting cross-equity market vol selling may not be very diversifying in a portfolio.

[1] Diebold, Francis X., and Kamil Yilmaz. "Measuring financial asset return and volatility spillovers, with application to global equity markets." The Economic Journal 119.534 (2009): 158-171.
Diebold, Francis X., and Kamil Yılmaz. "On the network topology of variance decompositions: Measuring the connectedness of financial firms." Journal of Econometrics 182.1 (2014): 119-134.

Exhibit 1: Spillover table

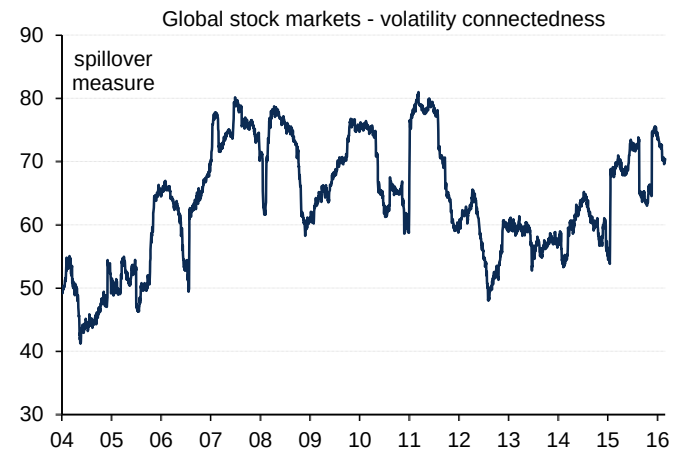
Spillover Table, Global Stock Market Volatility, 10/1/1992-23/11/2007

	From																		
To	US	UK	FRA	GER	HKG	JPN	AUS	IDN	KOR	MYS	PHL	SGP	TAI	THA	ARG	BRA	CHL	MEX	TUR	Contribution From Others
US	63.9	14.9	3.9	1.9	4.9	0.2	1.8	0.3	1.6	0.9	0.4	2.6	0.3	0.1	0.1	0.0	0.1	0.2	2.0	36
UK	22.9	34.5	5.0	1.3	7.4	0.5	2.1	0.3	1.0	0.8	0.1	2.4	0.2	0.2	0.4	0.2	0.1	0.1	0.7	66
FRA	24.0	32.8	27.3	0.2	5.4	0.2	2.8	0.4	0.3	1.2	0.4	2.4	0.2	0.3	0.6	0.3	0.1	0.1	0.9	73
GER	26.9	29.5	13.6	13.7	4.8	0.2	3.9	0.2	0.2	1.3	0.8	2.0	0.2	0.4	0.6	0.3	0.1	0.2	1.0	86
HKG	2.0	0.5	0.7	0.9	87.7	0.1	0.1	0.1	1.1	0.5	1.5	3.1	0.6	0.1	0.0	0.1	0.0	0.1	0.3	12
JPN	2.7	3.3	0.4	0.7	1.6	82.9	0.1	0.1	0.9	1.1	0.1	1.6	0.5	0.0	0.6	0.3	0.3	0.2	2.8	17
AUS	3.9	2.2	0.3	0.6	13.9	0.2	31.7	1.2	1.7	1.3	0.1	2.3	0.1	1.0	0.1	0.2	0.2	0.3	0.1	65
IDN	2.8	0.9	0.3	1.0	6.1	0.3	0.6	71.4	6.9	2.3	2.3	2.8	0.7	0.0	0.0	0.3	0.2	0.2	0.9	29
KOR	2.5	0.6	0.4	0.4	9.1	1.0	1.0	10.3	67.5	1.3	0.9	2.5	0.8	0.5	0.1	0.1	0.2	0.3	0.8	32
MYS	1.3	0.6	0.3	0.6	7.2	1.0	0.9	0.6	1.7	76.7	3.1	6.1	0.3	0.3	0.9	0.6	0.1	1.3	1.9	29
PHL	2.1	0.3	0.3	0.4	8.9	0.3	0.4	8.8	3.0	6.1	66.7	1.5	0.2	0.2	0.2	0.2	0.1	0.2	0.3	33
SGP	12.5	4.1	0.6	0.1	12.2	0.8	0.8	7.6	7.2	2.8	1.3	45.8	0.3	0.1	0.7	0.7	0.0	0.7	1.2	54
TAI	8.5	0.1	0.1	0.2	2.8	0.7	1.3	0.5	9.5	0.7	1.7	0.6	69.0	0.2	0.1	0.8	0.2	0.7	1.3	31
THA	0.5	0.7	0.1	0.3	9.0	0.2	0.3	3.6	2.9	0.1	0.8	3.3	0.2	73.9	0.1	0.3	0.1	0.7	0.2	26
ARG	3.5	1.3	1.6	0.4	2.7	0.3	1.2	0.3	0.1	2.1	0.2	0.8	0.1	0.2	81.0	3.9	0.8	0.6	1.0	19
BRA	1.5	2.3	1.1	0.3	12.6	0.1	3.3	1.0	0.3	10.0	0.7	3.1	0.3	0.2	11.7	45.2	0.3	0.9	0.8	55
CHL	3.5	0.7	0.7	0.3	2.7	0.1	3.6	1.1	0.2	1.8	0.3	1.8	0.3	0.4	3.6	3.0	78.7	0.2	0.1	26
MEX	6.5	1.3	0.7	0.3	25.0	0.2	1.8	0.3	0.5	2.1	0.3	2.1	0.2	0.5	6.3	3.9	0.3	44.1	1.1	56
TUR	2.8	1.7	0.8	0.7	3.9	0.3	1.2	0.3	1.1	2.7	0.5	0.9	4.0	0.1	0.7	0.3	0.2	1.1	76.8	23
Contribution to others	138	98	52	10	170	7	30	38	41	40	16	45	10	5	27	14	3	8	17	709.6
Contribution including own	202	133	80	25	258	90	65	109	108	111	83	91	79	79	108	60	77	52	91	Spillover Index = 59.1%

Note: The underlying variance decomposition is based upon a weekly VAR of order 2, identified using a Cholesky factorisation with the ordering as shown in the column heading. The (i, j)-th value is the estimated contribution to the variance of the H-step-ahead stock return volatility forecast error of country i coming from innovations to the stock return volatility of country j. We calculate Chile's volatility using the Santiago Stock Exchange IGPA Index for January 1992-May 2004, and using the Santiago Stock Exchange IPSA index for June 2004 onward. The mnemonics are defined as in Table 1.

Source: Diebold, Francis X., and Kamil Yilmaz (2009)

Chart 4: Intra equity market vol spillover is high, suggesting cross-equity market vol selling may not be very diversifying in a portfolio



Source: http://financialconnectedness.org

...but our spillover measure scores low intra commodity

In stark contrast, when we run the same exercise across commodity sectors, we find instead that the forecast error variance delivers instead a spillover measure of 9% for returns and 13% for volatilities. This result is intuitive, as commodity sectors tend to be driven by different micro factors (See Everything you wanted to know about commodity volatility). When it comes to returns, metals and softs are the sectors mostly affected by the innovations to other sectors (Table 2). On the other hand, energy and grain are the most influential sectors carrying their shocks to other sectors. In terms of volatilities, softs and metals are the sectors mostly affected by the innovations to other sectors (Table 3). Precious metals, energy, and grain are the most influential sectors carrying their shocks to other sectors. So commodities seem to present a different opportunity set to equities from a volatility standpoint.

Table 2: Full-sample spillover table (returns of commodity sectors)

Return spillover	Energy	Grain	Industrial metal	Precious metal	Softs	Livestock	Contribution from others
Energy	98.6	0.0	0.1	1.0	0.2	0.0	1.4
Grain	4.6	94.3	0.2	0.7	0.2	0.0	5.7
Industrial metal	8.5	4.4	86.8	0.2	0.0	0.0	13.2
Precious metal	3.9	3.1	6.9	85.9	0.3	0.0	14.1
Softs	4.2	8.3	3.0	0.8	83.6	0.1	16.4
Livestock	0.8	0.3	0.3	0.6	0.3	97.7	2.3
Contribution to others	21.9	16.2	10.4	3.3	1.0	0.2	spillover = 8.8%

Source: BofA Merrill Lynch Global Research estimates

Note: Data spans from Apr. 1991 to Dec. 2017. The variance decomposition is based upon a weekly VAR order of 2, identified using a Cholesky factorisation with the ordering as shown in the column heading. The ij-th entry is the estimated contribution to the variance of the 10-week-ahead return forecast error of sector i coming from innovations to returns of sector j.

Table 3: Full-sample spillover table (volatilities of commodity sectors)

Vol spillover	Energy	Grain	Industrial metal	Precious metal	Softs	Livestock	Contribution from others
Energy	95.1	2.1	0.4	0.8	0.6	0.9	4.9
Grain	3.1	89.6	1.9	2.6	2.2	0.6	10.4
Industrial metal	4.5	3.6	80.9	8.9	1.4	0.8	19.1
Precious metal	2.7	3.1	2.2	88.2	3.5	0.3	11.8
Softs	4.0	6.2	0.5	5.8	79.7	3.8	20.3
Livestock	3.9	1.5	0.1	1.8	2.3	90.3	9.7
Contribution to others	18.1	16.5	5.3	19.9	10.0	6.4	spillover = 12.7%

Source: BofA Merrill Lynch Global Research estimates

Note: Data spans from Apr. 1991 to Dec. 2017. The variance decomposition is based upon a weekly VAR order of 2, identified using a Cholesky factorisation with the ordering as shown in the column heading. The ij-th entry is the estimated contribution to the variance of the 10-week-ahead volatility forecast error of sector i coming from innovations to volatility of sector j. Garman and Klass (1980)'s approach for intraday range-based volatility is used: Volatility = 0.511(h-l)2 – 0.019[(c-o)(h+l-2o)-2(h-o)(l-o)]-0.383(c-o)2 where h, l, o and c stand for the log of daily high price, low price, opening price and close price respectively.

Cross-asset, commodities and equities also score low

Most importantly, investors often wonder if selling volatility across different asset classes is adding or subtracting risk to a diversified portfolio. When we run the same exercise looking at BCOM and the SPX, we find that the spillover measures for our full 1991–2017 data sample are both 4.1% (returns) and 10.1% (volatilities). True, the volatility spillovers are more than twice as large as the return spillovers, but they are both quite low compared to the spillovers among the global stock markets (35% ~ 40%) and even compare well to the intra-commodity spillover measure (12.7%). This result suggests that adding systematic short commodity vol exposure to a short equity vol strategy, or vice versa, can enhance risk-adjusted returns.

Table 4: Full-sample spillover table (returns)

Return spillover	SPX	BCOM	Contribution from others
SPX	99.2	0.8	0.8
BCOM	7.3	92.7	7.3
Contribution to others	7.3	0.8	spillover = 4.1%

Source: BofA Merrill Lynch Global Research estimates

Note: The results are based on weekly vector autoregressions of order 2 (selected using the Schwarz criterion), identified using a Cholesky factorisation with the ordering as shown in the column heading, and 10-weekahead forecasts.

Table 5: Full-sample spillover table (volatility)

Vol spillover	SPX	BCOM	Contribution from others
SPX	90.3	9.7	9.7
BCOM	10.5	89.5	10.5
Contribution to others	10.5	9.7	spillover = 10.1%

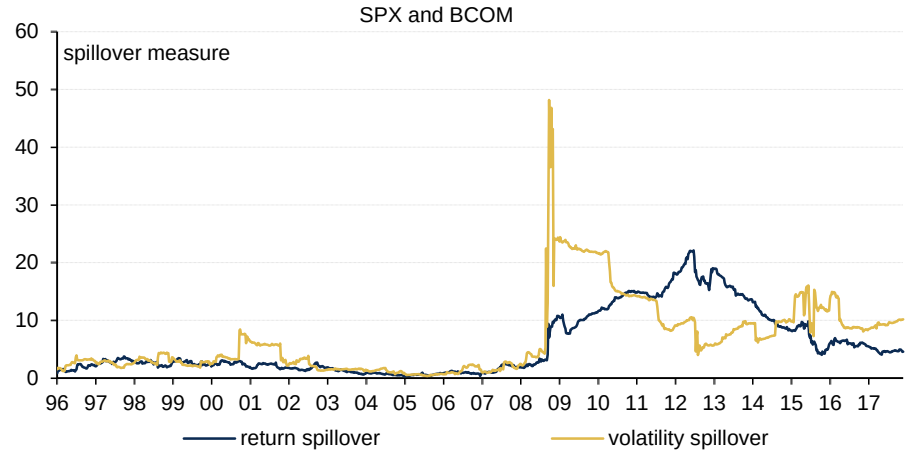
Source: BofA Merrill Lynch Global Research estimates

Note: The results are based on weekly vector autoregressions of order 2 (selected using the Schwarz criterion), identified using a Cholesky factorisation with the ordering as shown in the column heading, and 10-weekahead forecasts.

A rolling spillover measure can be a helpful market signal

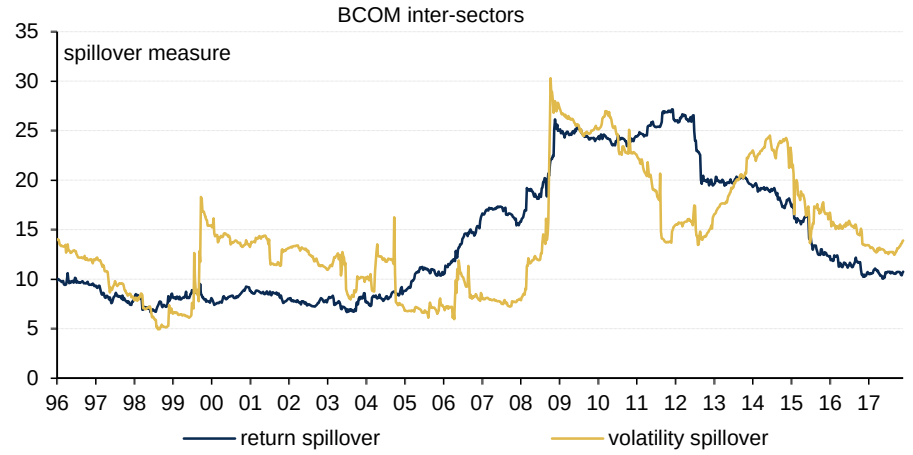
Still, return and volatility spillovers are not static and can vary over time. To study the spillover dynamics, we run a rolling-sample analysis using 200-week average and assess the spillover variation over time via the corresponding time series of spillover measures. The results for the equity and commodity markets suggest that return and volatility spillovers stayed muted until 2008. Then the volatility spillover measure had another jump around 2015 and has stayed at a relatively higher level than the return spillover measure. For commodities, the vol spillovers are usually higher than the return spillovers and tend to be more 'volatile'. While commodity spillover measures also jumped after 2008, we also find a recent downward movement of spillovers in both returns and volatilities in recent years.

Chart 5: Rolling-sample analysis (spillover between equity and commodity market)



Source: BofA Merrill Lynch Global Research estimates
Note: We plot moving return and volatility spillover measure, defined as the sum of all variance decomposition 'contributions to others' from spillover tables, respectively, estimated using 200-week rolling windows.

Chart 6: Rolling-sample analysis (spillover among commodity sectors)



Source: BofA Merrill Lynch Global Research estimates
Note: We plot moving return and volatility spillover measure, defined as the sum of all variance decomposition 'contributions to others' from spillover tables, respectively, estimated using 200-week rolling windows.

Starting with simple equity/commodity short vol portfolios…

The next step in our work is to establish whether our spillover measure can be a helpful tool to signal increases in cross-asset or intra-asset risk. As we discussed previously, a systematic commodity vol selling strategy, such as selling of delta hedged straddles on a basket of commodities, has stand-alone returns comparable to other commodity risk premia strategies. Moreover such a strategy would have enhanced the risk-adjusted performance of a cross-asset short vol risk premia portfolio. In our backtesting, the equal-weight basket of equity and commodity short volatility strategies would have improved the info ratio. However, when spillover levels are high (easier shock propagation), the escalated market connectedness can easily transfer a shock from one market to the other, which would generally hurt an equally weighted short vol basket.

Table 6: The equal-weight basket of equity and commodity short volatility strategies would have improved the info ratio

	Short volatility strategies		
	Equity	Commodity	EW-basket
Annualized return	12.1%	6.3%	9.2%
Annualized vol	9.7%	6.1%	6.6%
Info ratio	1.25	1.03	1.39

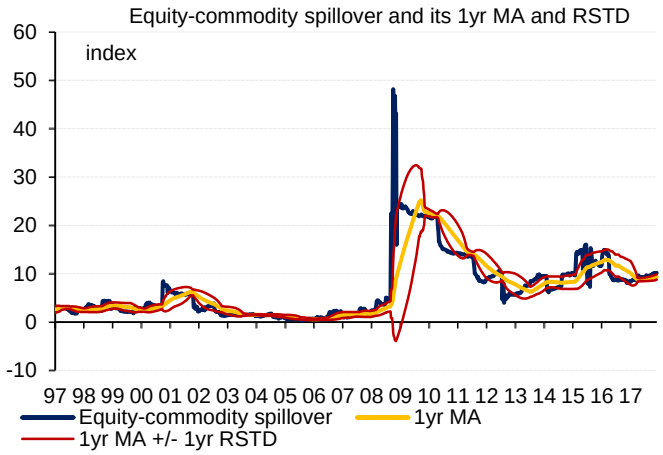
Source: BofA Merrill Lynch Global Research estimates

Note: Based on monthly returns from Jan. 2008 to Dec. 2017. The actual performance of the strategy may vary significantly from the back-tested performance. The back-tested performance results are based on criteria applied retroactively with the benefit of hindsight and knowledge of factors that may have positively affected its performance, and cannot account for all financial risks that may affect the performance of the strategy going forward.

...we create signals that leverage our spillover measure

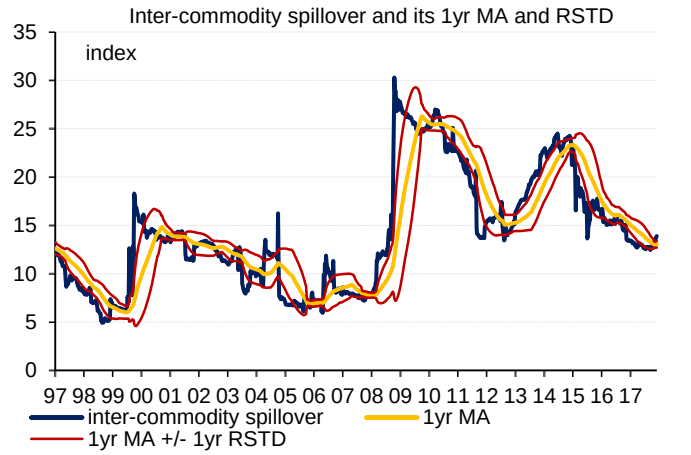
The spillover measure can be used to set exposure allocations in an equity/commodity portfolio. In our backtesting, we take a 1 year moving average (MA) of the spillover measure as a reference point so the current level can be compared to determine if it is high or low (Chart 7). To remove noise and deal with distortions caused by rapid changes in spillovers, we measure baseline noise as the 1 year-rolling standard deviation (RSTD). In this example, we increase exposure by 50% when the current spillover measure is smaller than the 1 year MA minus the 1 year RSTD. We decrease the exposure by 50% when the current level of spillover measure is greater than 1yr MA plus 1yr RSTD. Otherwise we keep the exposure flat. We apply the same methodology to the intra commodity space (Chart 8).

Chart 7: We take a 1 year moving average (MA) of the spillover measure as a reference point...



Source: BofA Merrill Lynch Global Research estimates

Chart 8: ... so the current level can be compared to determine if it is high or low

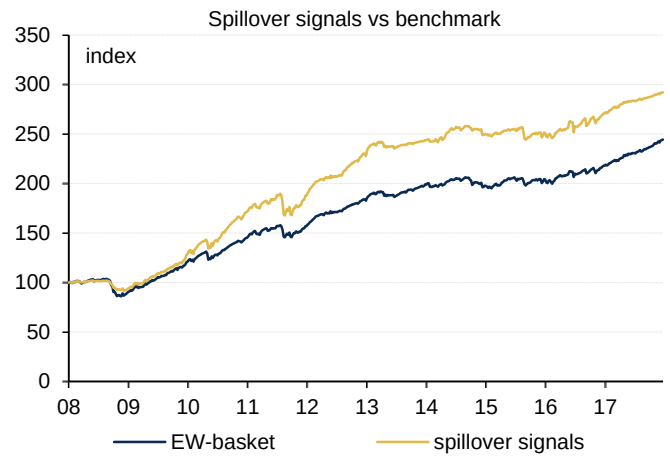


Source: BofA Merrill Lynch Global Research estimates

Short vol cross-asset and intra commodity info ratios...

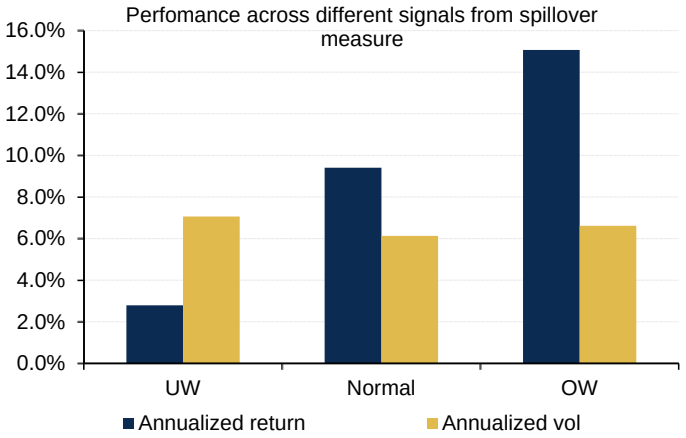
The results support the idea that the spillover measure is a useful tool when it comes to controlling for cross-asset volatility risk. When looking at our benchmark equity/commodity EW systematic short-vol portfolio, our backtesting suggests that the signal would have improved the information ratio of the portfolio strategy from 1.39 to 1.56 (Chart 9). Moreover, when looking at the reliability of the signals in different periods, we find that the signals have been precise in the sense that the baseline strategy would have outperformed (underperformed) its average performance when it was recommended to be overweight (underweight) (Chart 10).

Chart 9: Our backtesting suggests that the signal would have improved the information ratio of the portfolio strategy from 1.39 to 1.56…



Source: BofA Merrill Lynch Global Research estimates
Note: Based on monthly returns from Jan. 2008 to Dec. 2017. The actual performance of the strategy may vary significantly from the back-tested performance. The back-tested performance results are based on criteria applied retroactively with the benefit of hindsight and knowledge of factors that may have positively affected its performance, and cannot account for all financial risks that may affect the performance of the strategy going forward.

Chart 10: …and the signals have been precise

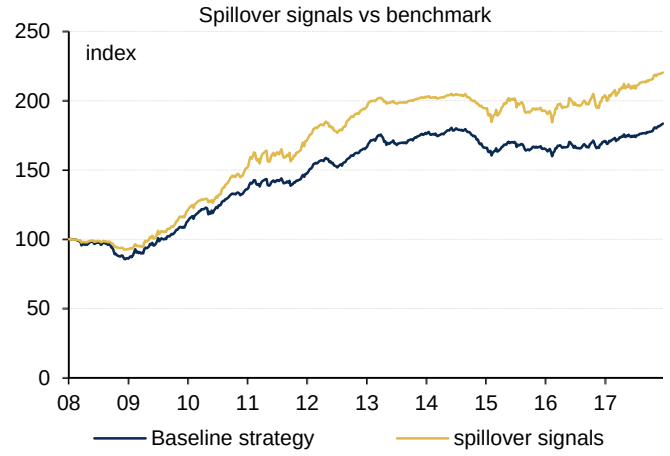


Source: BofA Merrill Lynch Global Research estimates
Note: Based on monthly returns from Jan. 2008 to Dec. 2017. The actual performance of the strategy may vary significantly from the back-tested performance. The back-tested performance results are based on criteria applied retroactively with the benefit of hindsight and knowledge of factors that may have positively affected its performance, and cannot account for all financial risks that may affect the performance of the strategy going forward.

…could improve on signals that use spillover measures

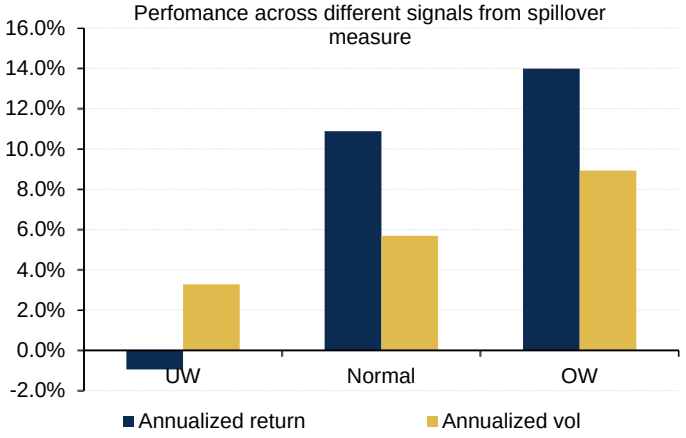
Having established that our spillover measure can help improve risk-adjusted returns in a sample cross-asset equity/commodity short vol portfolio, we go on to apply the same methodology to the intra commodity space. The baseline strategy is a set of systematic selling of delta hedged-straddles on a basket of commodities (see section 4 in Everything you wanted to know about commodity volatility), equally weighted. Just as in the case of the commodity/equity portfolio, we extract signals from the inter-commodity spillover measure and show that the info ratio would have increased from 1.03 to 1.26, according to our backtesting. In contrast to the cross-asset strategy, the improvement in the intra-commodity strategy is mainly contributed by the underweight signals.

Chart 11: The info ratio would have increased from 1.03 to 1.26, according to our backtesting



Source: BofA Merrill Lynch Global Research estimates
Note: Based on monthly returns from Jan. 2008 to Dec. 2017. The actual performance of the strategy may vary significantly from the back-tested performance. The back-tested performance results are based on criteria applied retroactively with the benefit of hindsight and knowledge of factors that may have positively affected its performance, and cannot account for all financial risks that may affect the performance of the strategy going forward.

Chart 12: The improvement in the intra-commodity strategy is mainly contributed by the underweight signals

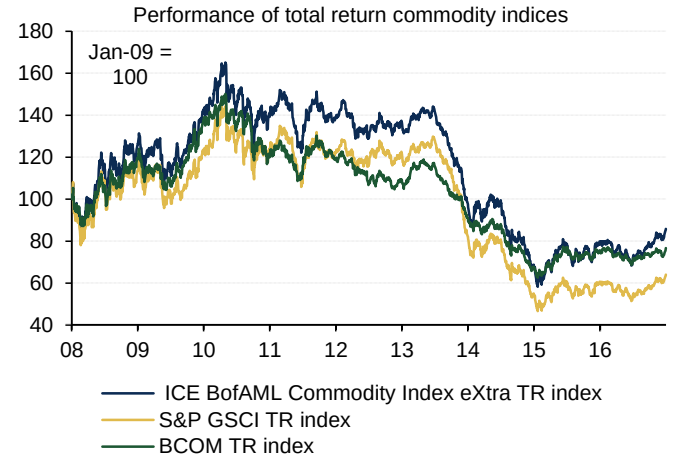


Source: BofA Merrill Lynch Global Research estimates
Note: Based on monthly returns from Jan. 2008 to Dec. 2017. The actual performance of the strategy may vary significantly from the back-tested performance. The back-tested performance results are based on criteria applied retroactively with the benefit of hindsight and knowledge of factors that may have positively affected its performance, and cannot account for all financial risks that may affect the performance of the strategy going forward.

Commodities Portfolio

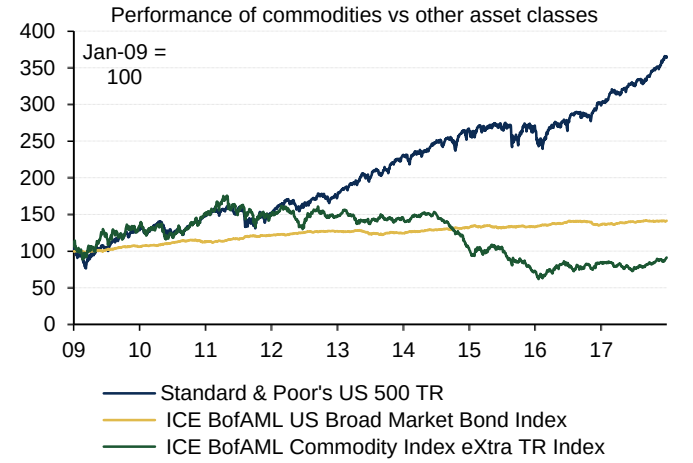
The ICE BofAML Commodity Index eXtra

Chart 13: Performance of total return commodity indices



Source: ICE, Bloomberg, BofA Merrill Lynch Global Research

Chart 14: Performance of commodities vs other asset classes



Source: ICE, Bloomberg, BofA Merrill Lynch Global Research

Table 7: Performance of total return commodity indices

Benchmark	S&P GSCI	BCOM
ICE BofAML Commodity Index eXtra alpha* relative to benchmark	2.88%	2.07%
ICE BofAML Commodity Index eXtra beta* relative to benchmark	0.94	1.11
ICE BofAML Commodity Index eXtra correlation with benchmark	98.65%	92.55%
Average tracking error**	3.34%	8.23%

Source: ICE, Bloomberg, BofA Merrill Lynch Global Research
Based on performance from 31-Dec-2008 to 29-Dec-17
* Alpha and beta coefficients are annualised intercept and slope coefficients of a linear regression of ICE BofAML Commodity Index eXtra TR daily log-returns on the benchmark's daily log-returns.
** Average tracking error is the annualised residual standard deviation of a linear regression of ICE BofAML Commodity Index eXtra TR daily log-returns on the benchmark's daily log-returns.

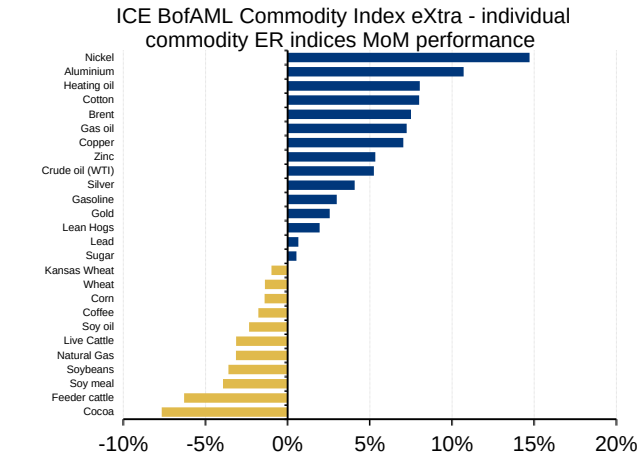
Table 8: Performance of commodities vs other asset classes

From 31-Dec-08 to 29-Dec-17	return	vol	Sharpe
Standard & Poor's US 500 TR	15.25%	16.60%	90%
NASDAQ 100 STOCK INDX	20.31%	18.01%	111%
MSCI Daily TR Gross EM USD	11.25%	17.43%	63%
ICE BofAML US Broad Market Bond Index	3.96%	3.45%	108%
ICE BofAML Commodity Index eXtra TR	-1.69%	20.36%	-9%
S&P GSCI TR	-4.84%	21.47%	-24%
BCOM TR	-2.92%	15.65%	-20%
3-month T-bill returns (risk-free)	0.23%		

Source: ICE, Bloomberg, BofA Merrill Lynch Global Research
Annualised performance based on daily returns from 31-Dec-2008 to 29-Dec-17

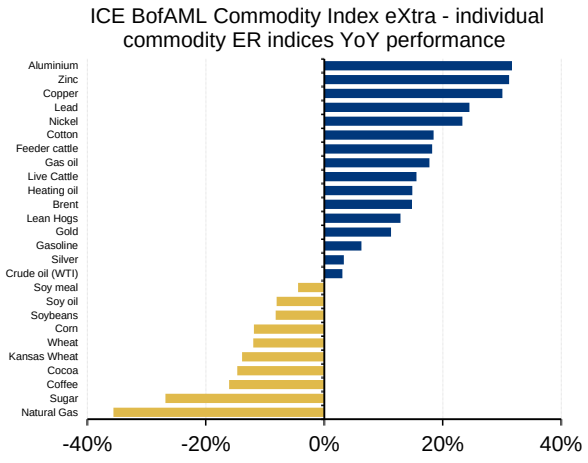
ICE BofAML Commodity Index eXtra sub-indices

Chart 15: Performance month-on-month (MoM)



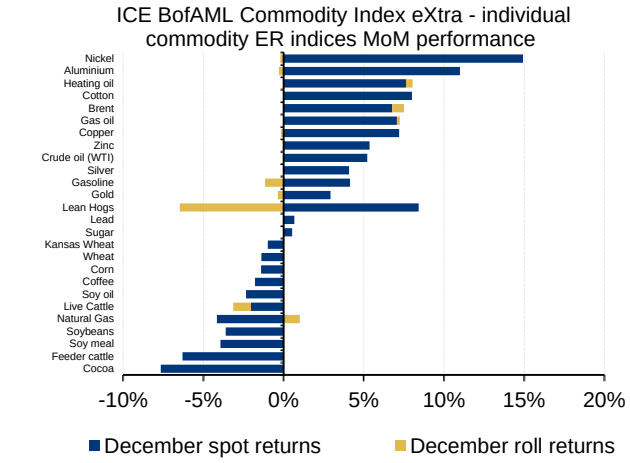
Source: ICE, Bloomberg, BofA Merrill Lynch Global Research

Chart 16: Performance year-on-year (YoY)



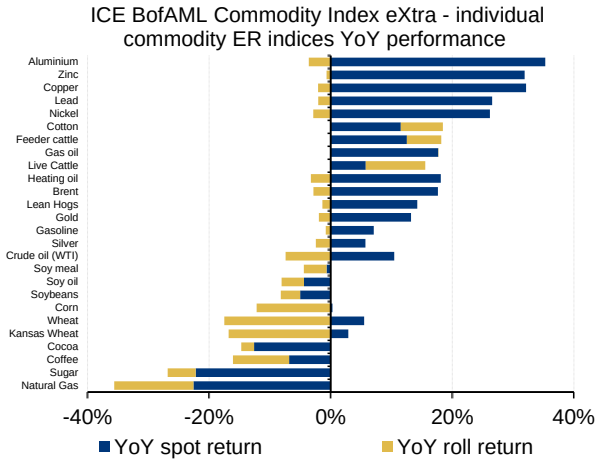
Source: ICE, Bloomberg, BofA Merrill Lynch Global Research

Chart 17: Spot and roll returns month-on-month (MoM)



Source: ICE, Bloomberg, BofA Merrill Lynch Global Research

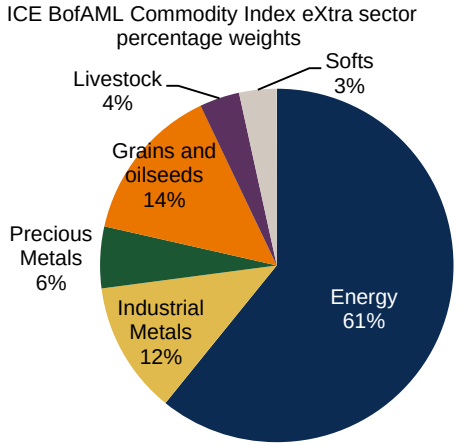
Chart 18: Spot and roll returns year-on-year (YoY)



Source: ICE, Bloomberg, BofA Merrill Lynch Global Research

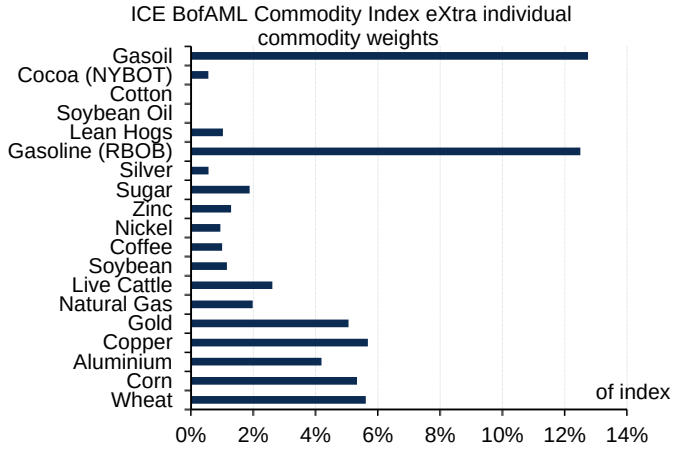
Weights and contracts

Chart 19: Sector weights in the ICE BofAML Commodity Index eXtra



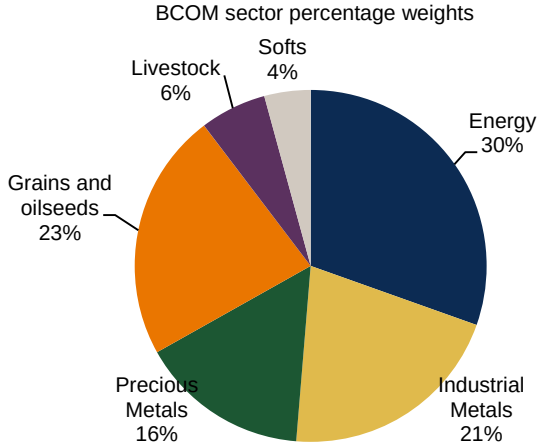
Source: ICE, Bloomberg, BofA Merrill Lynch Global Research

Chart 20: ICE BofAML Commodity Index eXtra individual commodity



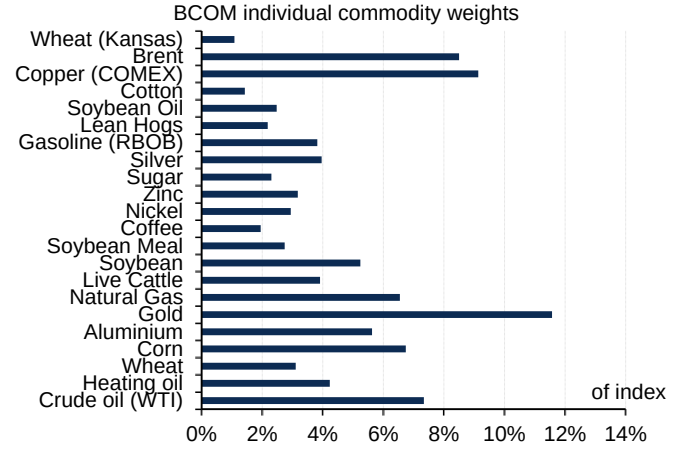
Source: ICE, Bloomberg, BofA Merrill Lynch Global Research

Chart 21: Sector weights in the BCOM



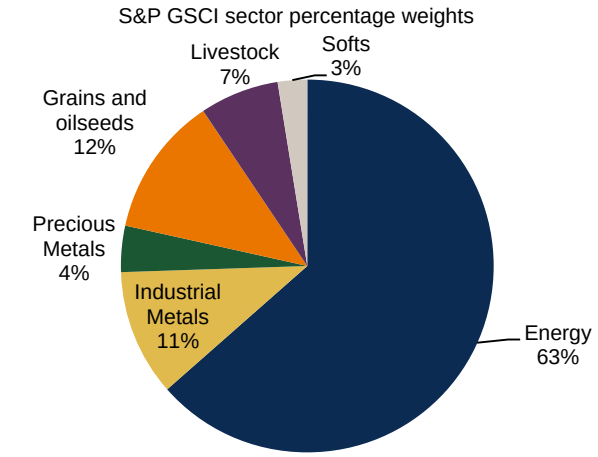
Source: ICE, Bloomberg, BofA Merrill Lynch Global Research

Chart 22: BCOM individual commodity weights



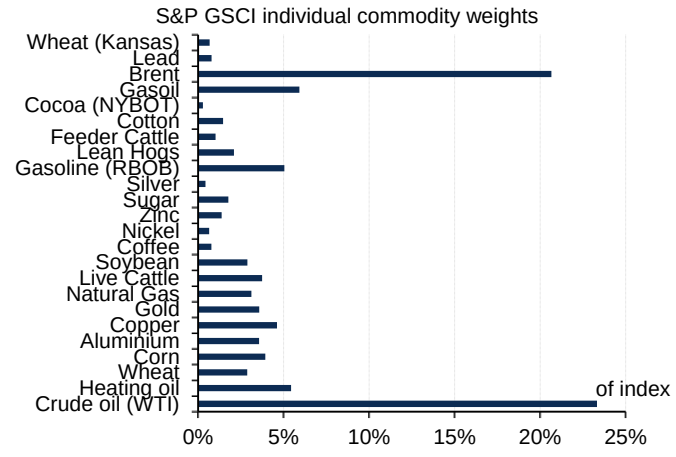
Source: ICE, Bloomberg, BofA Merrill Lynch Global Research

Chart 23: Sector weights in the S&P GSCI



Source: ICE, Bloomberg, BofA Merrill Lynch Global Research

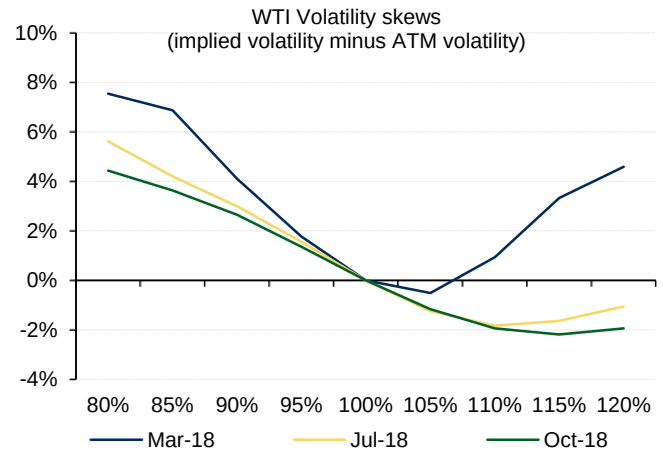
Chart 24: S&P GSCI individual commodity weights



Source: ICE, Bloomberg, BofA Merrill Lynch Global Research

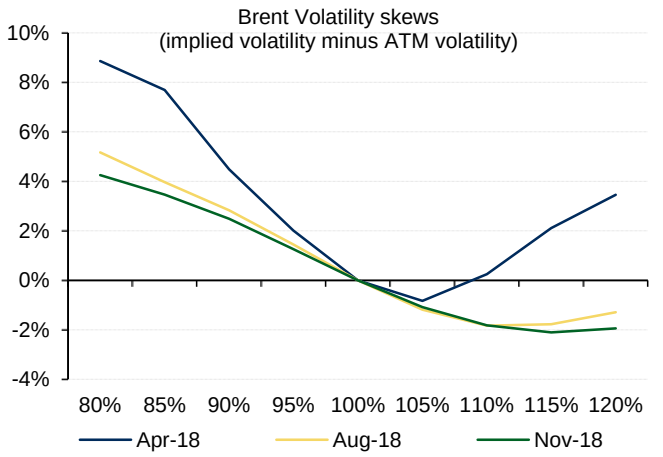
Energy Volatility Skews

Chart 25: WTI Crude Oil



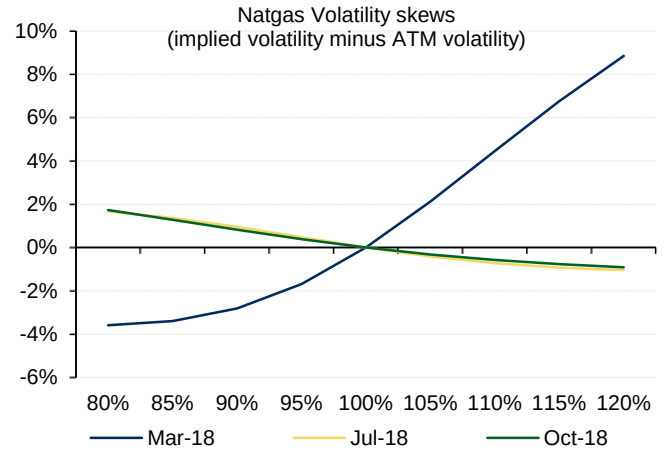
Source: Bloomberg , BofA Merrill Lynch Global Research

Chart 26: ICE – Brent Crude Oil



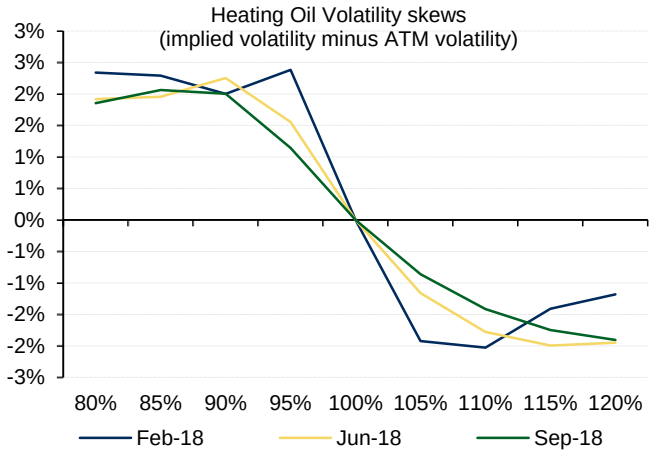
Source: Bloomberg , BofA Merrill Lynch Global Research

Chart 27: Natgas



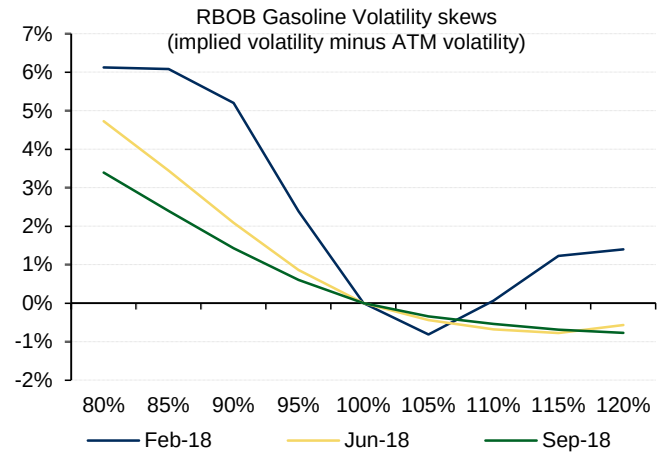
Source: Bloomberg , BofA Merrill Lynch Global Research

Chart 28: Heating Oil



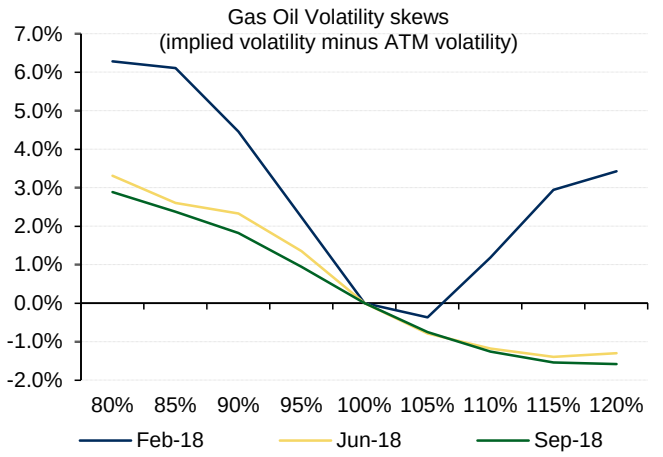
Source: Bloomberg , BofA Merrill Lynch Global Research

Chart 29: RBOB Gasoline



Source: Bloomberg , BofA Merrill Lynch Global Research

Chart 30: ICE – Gas Oil



Source: Bloomberg , BofA Merrill Lynch Global Research

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