Systematic Flows Monitor

Equity price trend has a high bar, further declines could see CTAs start unwinding

10 March 2024

Equity Derivatives
Global

BofA Data Analytics

Decline in equity price trend could see CTAs trim longs

Since October month-end last year, the S&P 500, NASDAQ-100, EURO STOXX 50, and Nikkei 225 are each up more than 20%. However, for the S&P 500 and NASDAQ-100, the pace of increases has slowed in recent weeks which correspondingly could lead to a decrease in short-term price trend signals for trend followers. As a result, CTAs could start trimming their longs and according to our model, in bearish price paths next week selling could pick up in momentum. Should declines reach 3% to 5%, depending on the index, then CTAs could see their stop loss triggers hit which could amplify downside. While we think this risk is worth monitoring, it is matched against the potential for dip buying on the back of Friday's decline. Also of note, next week we see larger CTA buying in EURO STOXX Banks (SX7E) in median to bullish price paths.

Rally in USTs could lead to CTA short covering next week

Our model indicates that trend followers continued adding to short US Treasury futures positions across the curve last week but that these shorts could see covering next week as price trend becomes less negative. Risks are skewed towards buying in median to bullish bond price paths while on the downside we do not see extra shorts building. Outside of the US, our model has CTAs neutral on Bund futures and long KTBs. Both Bund and KTB positioning are expected to follow futures prices next week.

Trend followers likely selling USD and buying Gold

In FX, our model anticipates that trend followers could be selling USD versus most currencies that we track. If so, then systematic investors would be aligned with our FX strategists' recent bearish view on USD. Next week our model anticipates short covering in EUR, AUD, and JPY, and continued GBP and MXN buying. In commodities, our model shows CTAs buying Gold in any price path as its trend strength rapidly increasing.

SPX gamma profile appears long but dynamic in size

In weeks prior we debuted our estimates of SPX option gamma positioning (see Systematic Flows Monitor 23-Feb-24). In this report and each week going forward we will provide an update to those figures. Our estimates show that in recent history delta-hedgers have typically been long gamma from SPX options and thus were likely trading against market moves. Additionally, we find that over the past month delta-hedgers may have reduced S&P e-mini 1-month realized volatility by ~0.9pts (7%). As of Thursday's close, delta-hedgers had a gamma position of +$2bn and may be long $500mn - $4bn into early next week for a wide range of spot levels. Consequently, in the near-term delta-hedging activities may act as a modest drag on equity moves in either direction.

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CTA – commodity trading advisor

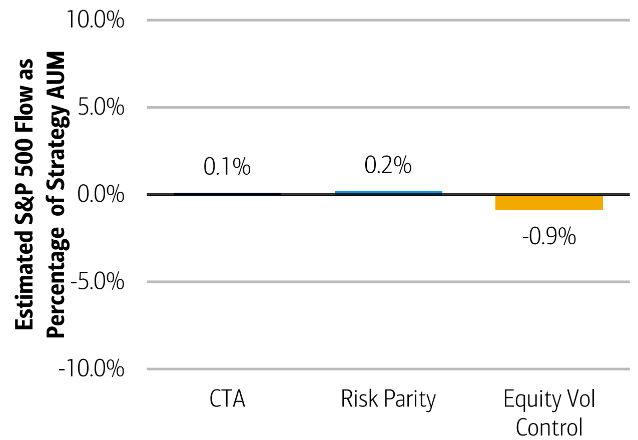
Current S&P 500 1-Day Systematic Flows

On Monday 11-Mar-2024 our models show little net change in allocations from systematic quant strategies, namely CTAs, risk parity, and equity vol control. The exception is in the case CTAs hit their stop-loss triggers on stretched S&P 500 longs, which according to our model would come at 4978 (2.8% one-day decline).

Our estimates show that in recent history delta-hedgers have typically been long gamma from SPX options and thus were likely trading against market moves. As of Thursday's close, delta-hedgers had a gamma position of +$2bn and may be long $500mn - $4bn into early next week for a wide range of spot levels. Consequently, in the near-term delta-hedging activities may act as a modest drag on equity moves in either direction.

Exhibit 1: Estimated 1-day S&P 500 Flow from CTAs, Risk Parity, and Equity Vol Control

Estimates are for Monday, 11-Mar-2024. CTA estimate does not include the flows from CTA's should the S&P 500 hit our model's stop loss/full unwind trigger of 4978 (2.8% one-day decline)



Source: BofA Global Research. Data as of 8-Mar-2024.

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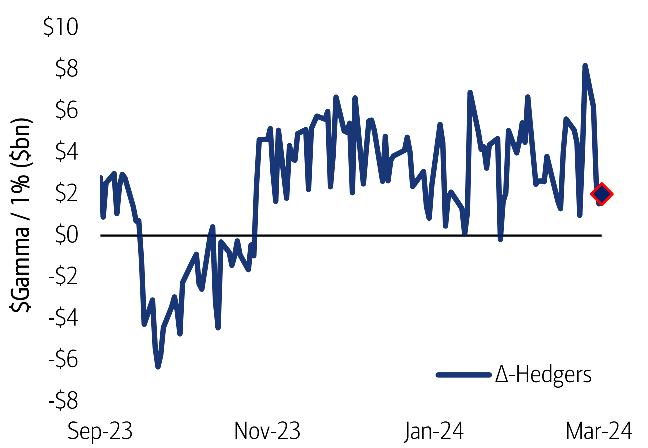
Exhibit 2: End-of-day SPX option gamma for delta-hedgers

EOD SPX gamma for Δ-Hedgers



Source: BofA Global Research, CBOE. Data through 07-Mar-24.

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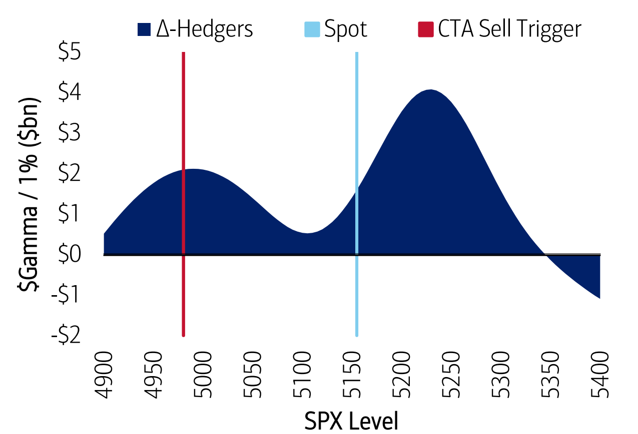
Exhibit 3: Current SPX gamma for delta-hedgers across spot levels

Current EOD SPX gamma for Δ-Hedgers after a hypothetical move in spot



Source: BofA Global Research, CBOE. Data for 07-Mar-24. Gamma is recomputed after each hypothetical move in spot holding fixed strike vols and option positions constant.

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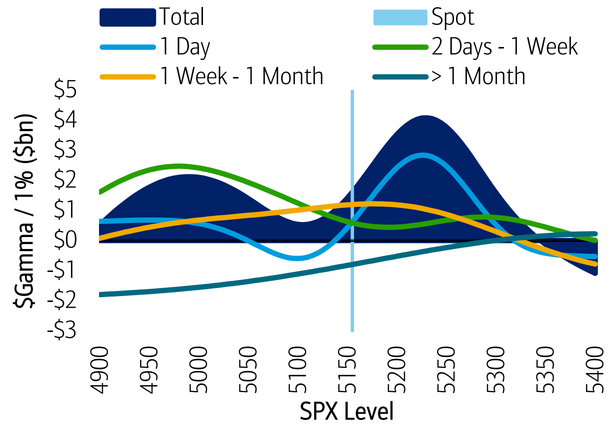
SPX Option Gamma Positioning

Using our SPX gamma levels (as shown in Exhibit 2), we then infer the likely impact of delta-hedging on the underlying equity market. Specifically, Exhibit 5 highlights our estimate for the impact of gamma (via delta-hedging with futures) on S&P 500 e-mini 1-month realized volatility if delta-hedging occurred only in the last hour, last 30-minutes, or last 15-minutes of the trading session. See the appendix for additional details on how the market impact analysis was conducted.

As an example, Exhibit 5 indicates that if delta-hedging was confined to the last 15-minutes of the trading day (15:45 to 16:00), then SPX gamma may have been responsible for a 0.9pt (7%) reduction in S&P 500 e-mini realized vol over the past 1-month. Further, over the past 6-months the largest expansion in 1-month realized vol due to gamma occurred in Oct-23 (causing a 1.7pt or 15% increase in vol) while the largest reduction in vol was during Dec-23 (leading to a 1.6pt or 14% decrease in vol).

Exhibit 4: SPX gamma for delta-hedgers across spot levels & tenors

SPX gamma contribution of various tenors at different underlying levels



Source: BofA Global Research, CBOE. Data as of 07-Mar-24. Tenors are given in business days.

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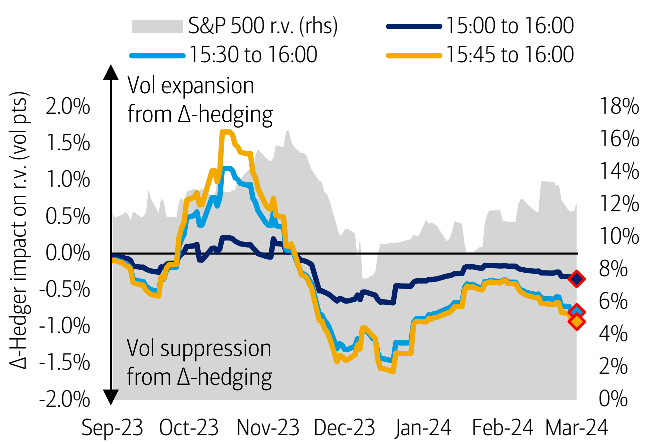
The gamma figures highlighted thus far (for instance in Exhibit 2) have been at market close, consequently expiring options were necessarily excluded. By contrast, Exhibit 6 provides our estimate for the net SPX gamma of delta-hedgers measured on an intraday basis and shows the contribution from (i) non-expiring options, (ii) expiring open interest (options which are expiring but were traded prior to their expiration date), and (iii) expiring volume/0DTEs (options traded exactly on their expiration date). For more details on the 0DTE complex refer to our comprehensive reports Separating fact from fiction on 0DTEs and What's changed & what hasn't in the 0DTE ecosystem?.

Averaged on an intraday basis and over the last 5-days, delta-hedgers were net long $7.0bn of SPX gamma with $2.5bn from non-expiring options, $1.8bn from 0DTEs, and $2.6bn from expiring open interest (Exhibit 6).

Exhibit 5: Estimated impact of Δ-hedging on S&P 500 realized vol

Estimated impact of EOD SPX gamma on S&P 500 e-mini 1-month realized volatility via delta-hedging, with hedging confined to different time windows near the close (=market observed realized vol – estimated vol w/o Δ-hedgers)



Source: BofA Global Research, CBOE. Data as of 07-Mar-24.

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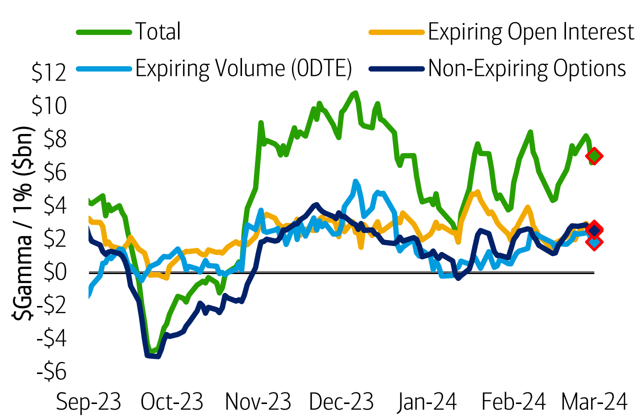
Exhibit 6: Intraday gamma split between expiring/non-expiring options

Intraday SPX Δ-Hedger gamma for expiring volume (0DTEs), expiring open interest, and non-expiring options, averaged intraday over the entire trading session and also with a 5-day moving average



Source: BofA Global Research, CBOE. Data as of 07-Mar-24.

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Trend Following (CTA) Model

For each component we apply our CTA model over the next five trading sessions under bullish, neutral, and bearish price paths. Exhibit 7 summarizes our model applied to 13 common CTA underlyings within equities, fixed income, commodities and FX.

To illustrate how to interpret Exhibit 7, using the first row as an example, the takeaways are: (1) Our CTA model's S&P 500 position is long, (2) The current trend signal is 84% where -100% is max short and +100% is max long, (3) Over the next 5 trading sessions and based on price paths using historical data, the trend signal is projected to fall in bearish to median and hold firm on a bullish price path, and (4) a full unwind (sell trigger) of the long position could come with a 2.8% decline (4978 index level).

Exhibit 7: Summary of BofA Trend Following (CTA) Model Positions, Projections, and Key Levels

An important consideration with buy & sell triggers is they are hard to model as they can vary based on trend-following model construction. Our analysis supports the idea that the further we get from our model's trigger, it's increasingly likely more (and eventually most) CTAs will have executed their position. *Please see the appendix for details on how we determine trend strength, bearish/median/bullish price projections, and buy & sell triggers.*

				5-day Trend Projection							
Asset Class	**Underlying**	**Model CTA Position**	**Trend Strength**	**Bearish**	**Median**	**Bullish**	**Current Spot**	**Sell Trigger**	**%-age**	**Buy Trigger**	**%-age**
Equities	S&P 500	Long	84%	74%	82%	84%	5124	4978	-2.8%	--	--
	NASDAQ-100	Long	73%	63%	68%	72%	18018	17310	-3.9%	--	--
	Russell 2000	Long	66%	57%	68%	69%	2083	--	--	--	--
	SX5E	Long	100%	84%	100%	99%	4961	4844	-2.4%	--	--
	SX7E	Long	68%	57%	84%	86%	127	121	-4.8%	--	--
	NIKKEI 225	Long	98%	90%	100%	100%	39689	38437	-3.2%	--	--
Bonds	10yr Tsy Futures (TY)	Short	-42%	-39%	-29%	-21%	111.81	--	--	114.63	2.5%
	Bund Futures (RX)	Neutral	-13%	-15%	0%	6%	133.77	--	--	--	--
	Korea Treasury Bond (KAA)	Long	37%	26%	42%	49%	113.84	109.24	-4.0%	--	--
Commodities	Gold	Long	35%	54%	75%	78%	2184.8	--	--	--	--
	Oil	Long	29%	4%	27%	39%	77.9	--	--	--	--
	Aluminum	Short	-42%	-49%	-39%	-20%	2214.7	--	--	--	--
	Copper (BCOM, HG)	Short	-3%	-1%	21%	35%	389.2	--	--	--	--
	Copper (GSCI, LP)	Long	17%	11%	32%	37%	8561.2	--	--	--	--
	Soybeans	Short	-85%	-83%	-81%	-76%	1184.8	--	--	1193	0.7%
	Soybean Oil	Short	-68%	-73%	-70%	-64%	46.2	--	--	48	4.4%
	Soybean Meal	Short	-82%	-81%	-78%	-74%	342.0	--	--	347	1.5%
FX	EUR/USD	Short	-9%	13%	22%	36%	1.0938	--	--	--	--
	GBP/USD	Long	29%	42%	55%	62%	1.2855	1.2402	-3.5%	--	--
	AUD/USD	Short	-19%	-12%	4%	13%	0.6623	--	--	--	--
	USD/JPY	Long	72%	26%	52%	59%	147.1	146.8	-0.2%	--	--
	USD/MXN	Short	-46%	-66%	-57%	-41%	16.8080	--	--	17.3968	3.5%
	USD/CAD	Long	20%	9%	17%	33%	1.3487	--	--	--	--

Source: BofA Global Research. Data as of 8-Mar-2024.

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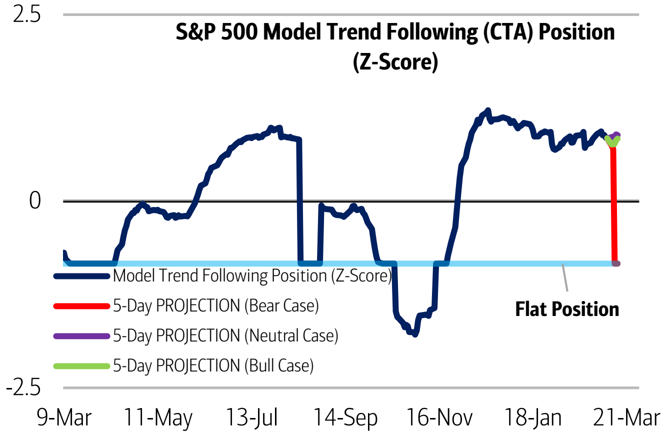
Equities

Exhibit 8: BofA Model Trend Following (CTA) S&P 500 Position
Z-score of position shown below along with projection of how the position could evolve over the next 5 trading sessions based on bullish, neutral, and bearish scenarios



Source: BofA Global Research. Data as of 8-Mar-2024.

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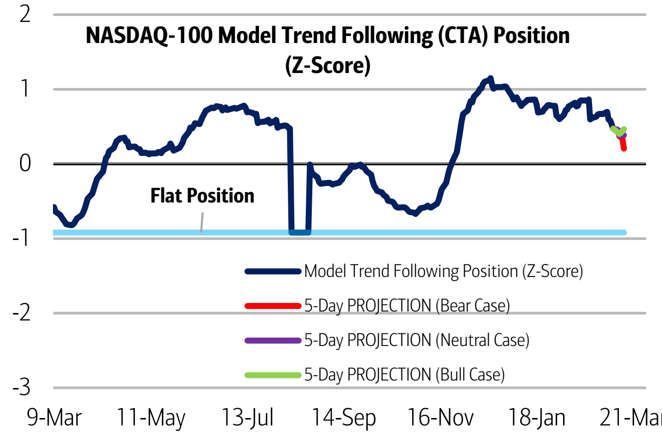
Exhibit 9: BofA Model Trend Following (CTA) NASDAQ-100 Position
Z-score of position shown below along with projection of how the position could evolve over the next 5 trading sessions based on bullish, neutral, and bearish scenarios



Source: BofA Global Research. Data as of 8-Mar-2024.

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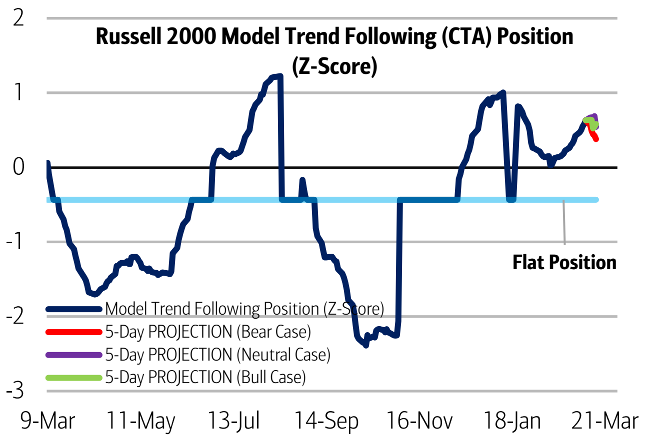
Exhibit 10: BofA Model Trend Following (CTA) Russell 2000 Position
Z-score of position shown below along with projection of how the position could evolve over the next 5 trading sessions based on bullish, neutral, and bearish scenarios



Source: BofA Global Research. Data as of 8-Mar-2024.

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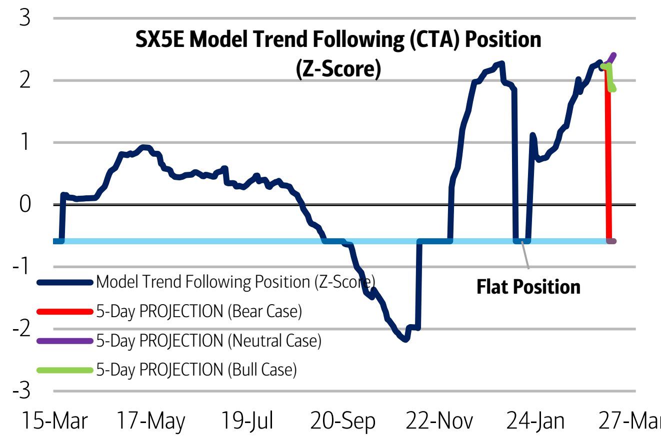
Exhibit 11: BofA Model Trend Following (CTA) ESTX50 Position
Z-score of position shown below along with projection of how the position could evolve over the next 5 trading sessions based on bullish, neutral, and bearish scenarios



Source: BofA Global Research. Data as of 8-Mar-2024.

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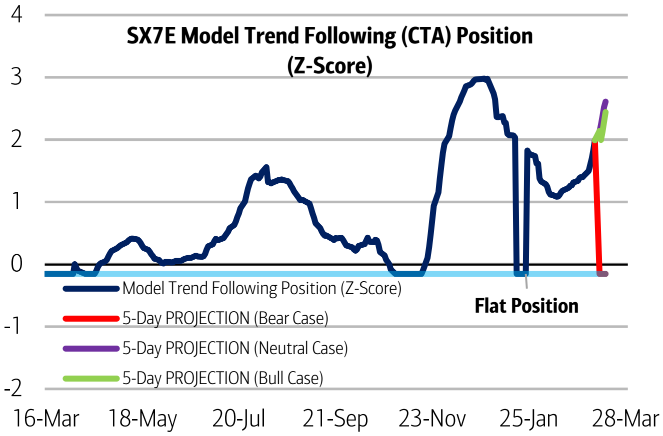
Equities (continued)

Exhibit 12: BofA Model CTA EURO STOXX Banks Position
Z-score of position shown below along with projection of how the position could evolve over the next 5 trading sessions based on bullish, neutral, and bearish scenarios



Source: BofA Global Research. Data as of 8-Mar-2024.

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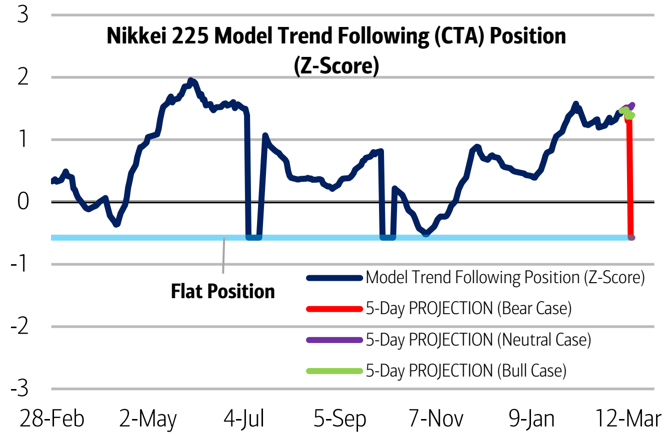
Exhibit 13: BofA Model Trend Following (CTA) NIKKEI 225 Position
Z-score of position shown below along with projection of how the position could evolve over the next 5 trading sessions based on bullish, neutral, and bearish scenarios



Source: BofA Global Research. Data as of 8-Mar-2024.

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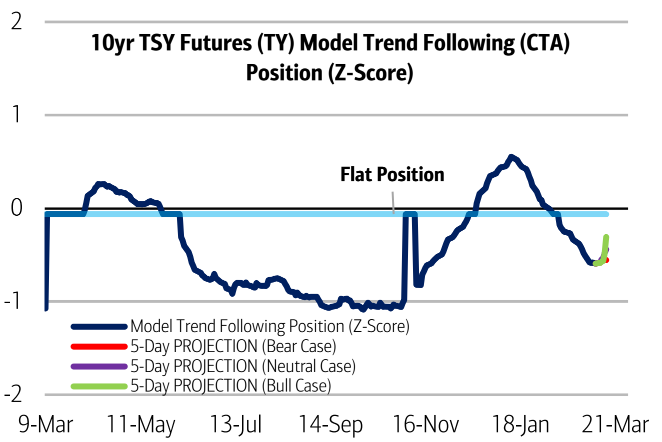
Fixed Income

Exhibit 14: BofA Model Trend Following (CTA) TY Futures Position
Z-score of position shown below along with projection of how the position could evolve over the next 5 trading sessions based on bullish, neutral, and bearish scenarios



Source: BofA Global Research. Data as of 8-Mar-2024.

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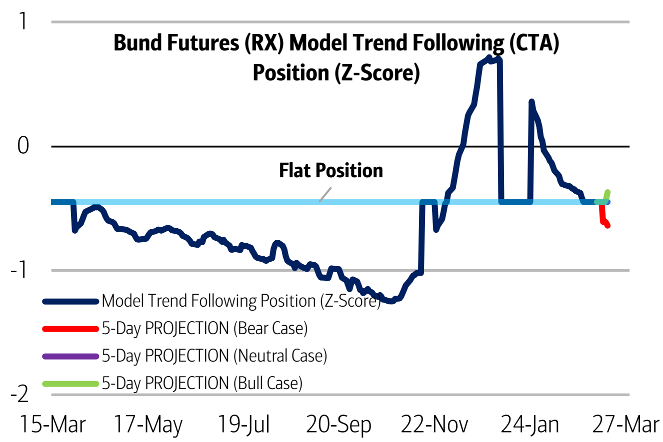
Exhibit 15: BofA Model Trend Following (CTA) Bund Position
Z-score of position shown below along with projection of how the position could evolve over the next 5 trading sessions based on bullish, neutral, and bearish scenarios



Source: BofA Global Research. Data as of 8-Mar-2024.

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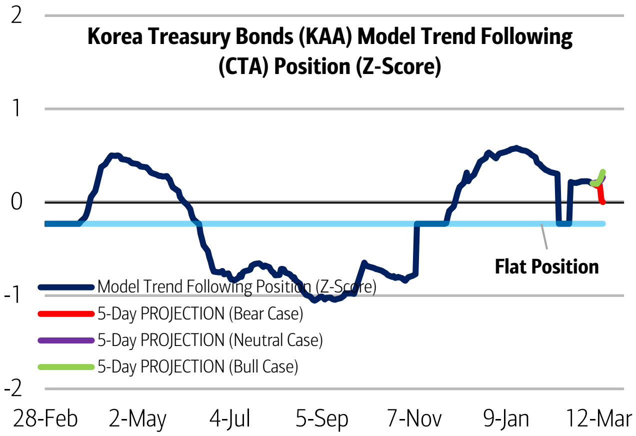
Fixed Income (continued)

Exhibit 16: BofA Model Trend Following (CTA) KTB Futures Position
Z-score of position shown below along with projection of how the position could evolve over the next 5 trading sessions based on bullish, neutral, and bearish scenarios

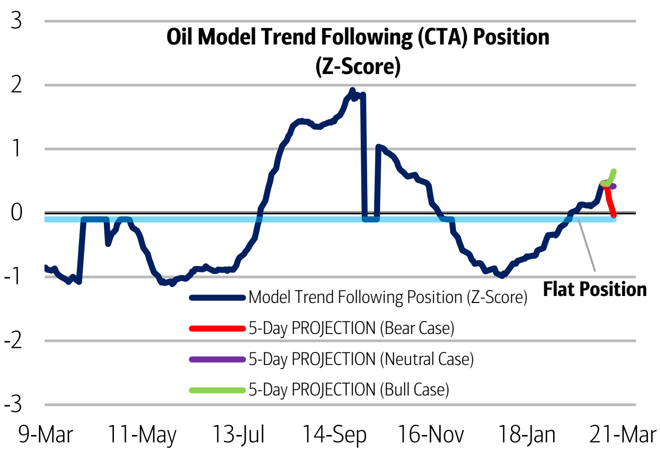


Source: BofA Global Research. Data as of 8-Mar-2024.

BofA GLOBAL RESEARCH

Commodities

Exhibit 17: BofA Model Trend Following (CTA) Oil Position
Z-score of position shown below along with projection of how the position could evolve over the next 5 trading sessions based on bullish, neutral, and bearish scenarios



Source: BofA Global Research. Data as of 8-Mar-2024.

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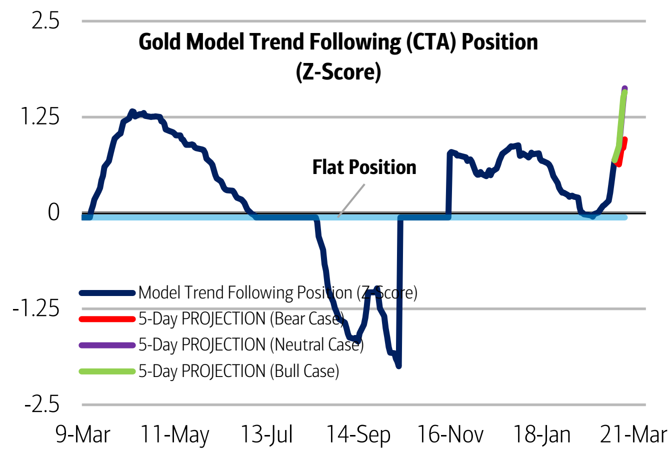
Exhibit 18: BofA Model Trend Following (CTA) Gold Position
Z-score of position shown below along with projection of how the position could evolve over the next 5 trading sessions based on bullish, neutral, and bearish scenarios



Source: BofA Global Research. Data as of 8-Mar-2024.

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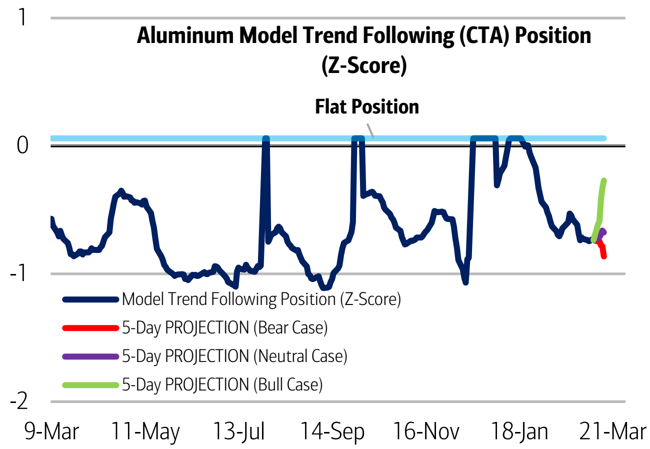
Commodities (continued)

Exhibit 19: BofA Model Trend Following (CTA) Aluminum Position

Z-score of position shown below along with projection of how the position could evolve over the next 5 trading sessions based on bullish, neutral, and bearish scenarios



Source: BofA Global Research. Data as of 8-Mar-2024.

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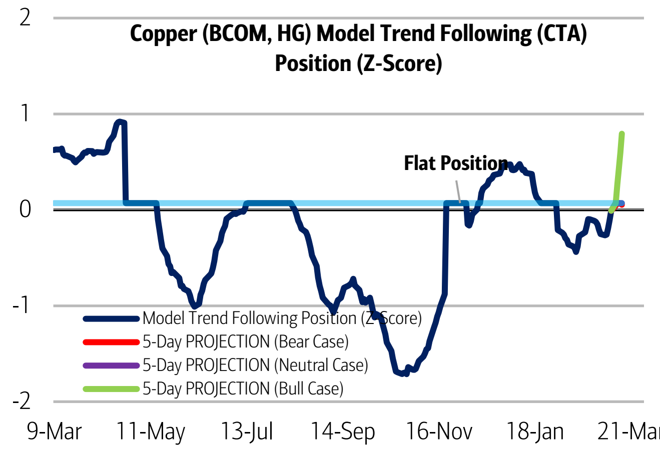
Exhibit 20: BofA Model Trend Following (CTA) Copper (HG) Position

Z-score of position shown below along with projection of how the position could evolve over the next 5 trading sessions based on bullish, neutral, and bearish scenarios



Source: BofA Global Research. Data as of 8-Mar-2024.

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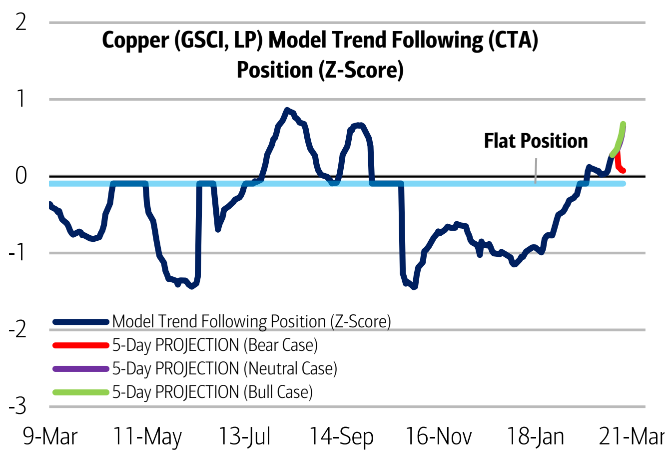
Exhibit 21: BofA Model Trend Following (CTA) Copper (LP) Position

Z-score of position shown below along with projection of how the position could evolve over the next 5 trading sessions based on bullish, neutral, and bearish scenarios



Source: BofA Global Research. Data as of 8-Mar-2024.

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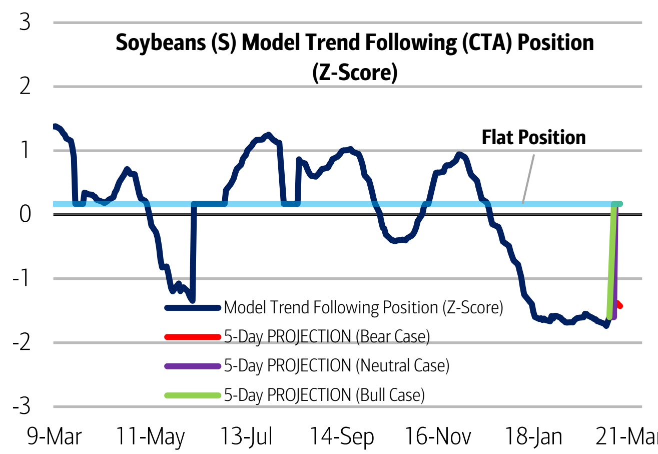
Exhibit 22: BofA Model Trend Following (CTA) Soybean (S) Position

Z-score of position shown below along with projection of how the position could evolve over the next 5 trading sessions based on bullish, neutral, and bearish scenarios

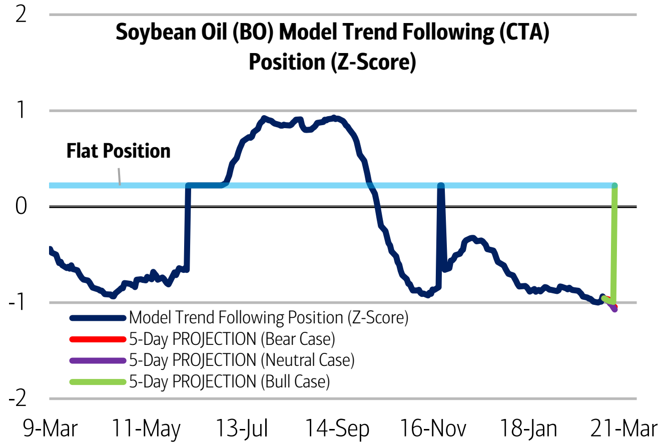


Source: BofA Global Research. Data as of 8-Mar-2024.

BofA GLOBAL RESEARCH

Commodities (continued)

Exhibit 23: BofA Model Trend Following (CTA) Soybean Oil Position
Z-score of position shown below along with projection of how the position could evolve over the next 5 trading sessions based on bullish, neutral, and bearish scenarios



Source: BofA Global Research. Data as of 8-Mar-2024.

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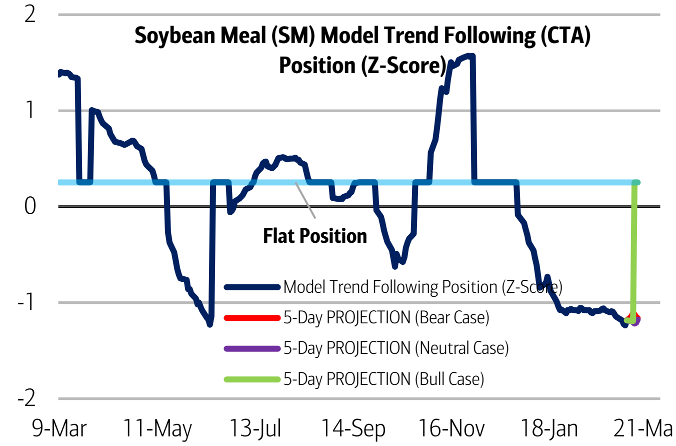
Exhibit 24: BofA Model Trend Following (CTA) Soybean Meal Position
Z-score of position shown below along with projection of how the position could evolve over the next 5 trading sessions based on bullish, neutral, and bearish scenarios



Source: BofA Global Research. Data as of 8-Mar-2024.

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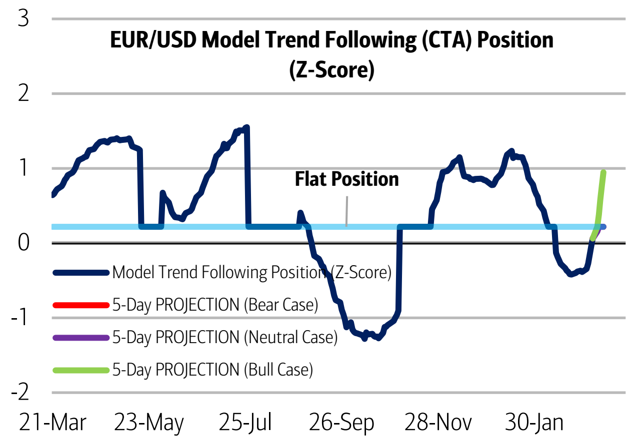
Foreign Exchange (FX)

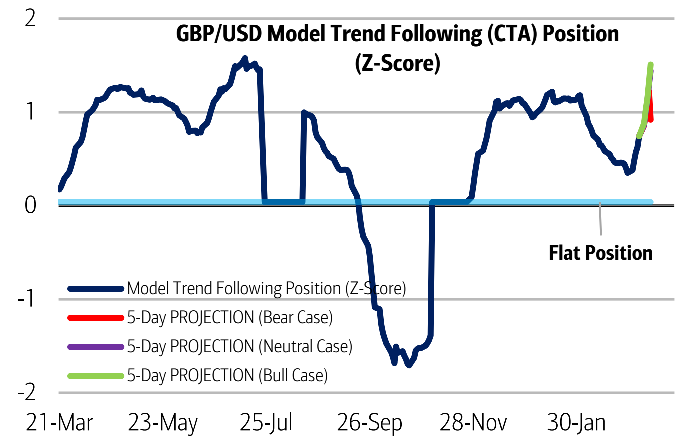
Exhibit 25: BofA Model Trend Following (CTA) EUR/USD Position
Z-score of position shown below along with projection of how the position could evolve over the next 5 trading sessions based on bullish, neutral, and bearish scenarios



Source: BofA Global Research. Data as of 8-Mar-2024.

BofA GLOBAL RESEARCH

Exhibit 26: BofA Model Trend Following (CTA) GBP/USD Position
Z-score of position shown below along with projection of how the position could evolve over the next 5 trading sessions based on bullish, neutral, and bearish scenarios



Source: BofA Global Research. Data as of 8-Mar -2024.

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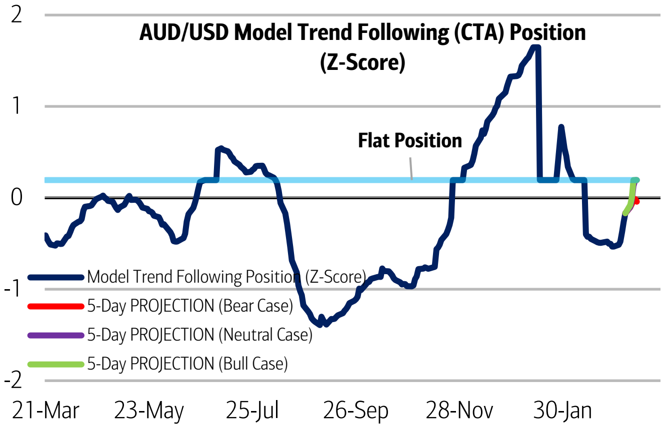
FX (continued)

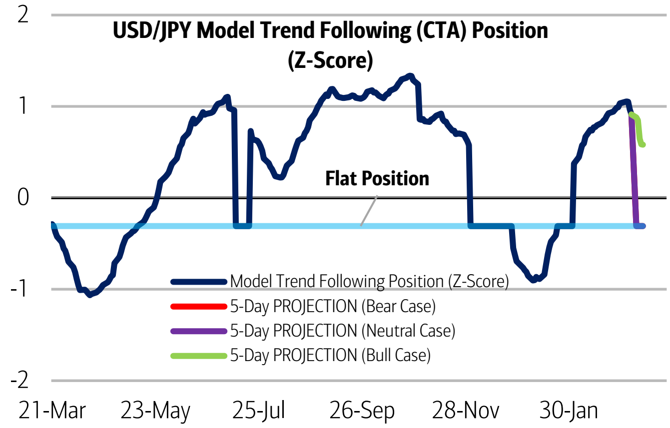
Exhibit 27: BofA Model Trend Following (CTA) AUD/USD Position
Z-score of position shown below along with projection of how the position could evolve over the next 5 trading sessions based on bullish, neutral, and bearish scenarios



Source: BofA Global Research. Data as of 8-Mar-2024.

BofA GLOBAL RESEARCH

Exhibit 28: BofA Model Trend Following (CTA) USD/JPY Position
Z-score of position shown below along with projection of how the position could evolve over the next 5 trading sessions based on bullish, neutral, and bearish scenarios



Source: BofA Global Research. Data as of 8-Mar-2024.

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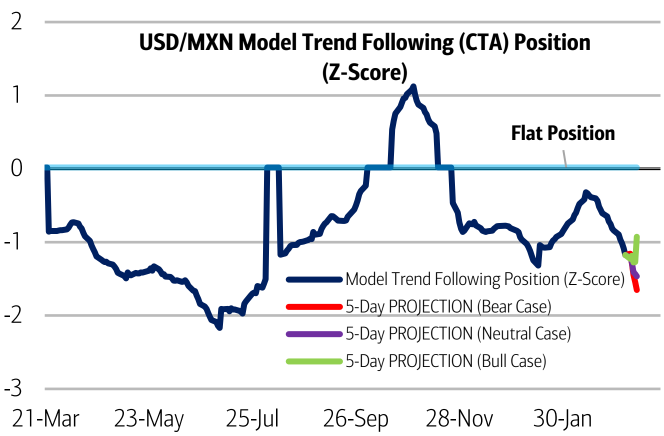
Exhibit 29: BofA Model Trend Following (CTA) MXN/USD Position
Z-score of position shown below along with projection of how the position could evolve over the next 5 trading sessions based on bullish, neutral, and bearish scenarios



Source: BofA Global Research. Data as of 8-Mar-2024.

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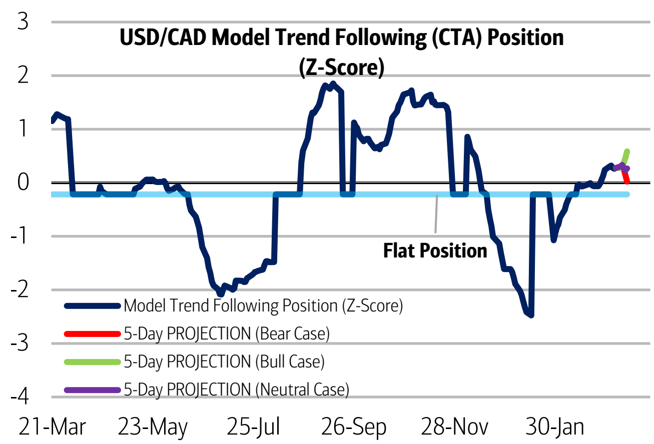
Exhibit 30: BofA Model Trend Following (CTA) CAD/USD Position
Z-score of position shown below along with projection of how the position could evolve over the next 5 trading sessions based on bullish, neutral, and bearish scenarios



Source: BofA Global Research. Data as of 8-Mar-2024.

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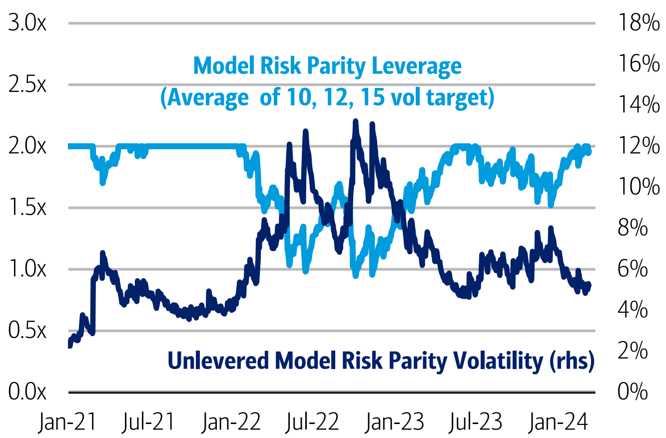
Risk Parity Model

Exhibit 31: BofA Model Risk Parity Realized Volatility & Leverage
Our model risk parity leverage is a function of the prevailing volatility and below we show the average for three popular risk targets



Source: BofA Global Research. Data as of 8-Mar-2024.

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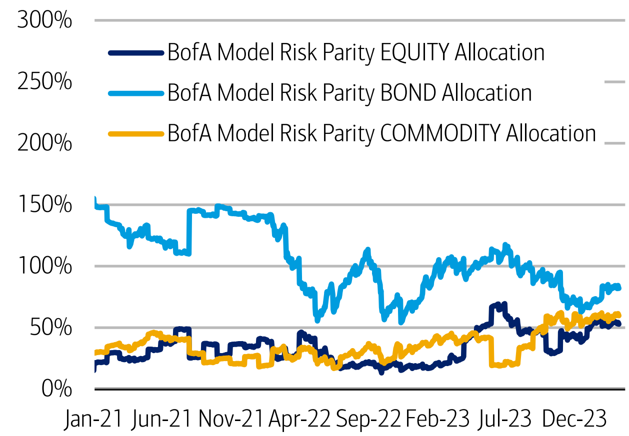
Exhibit 32: BofA Model Risk Parity Asset Class Allocations
Allocations are inversely proportional to an asset's volatility, that is, lower volatility assets have higher allocation



Source: BofA Global Research. Data as of 8-Mar-2024.

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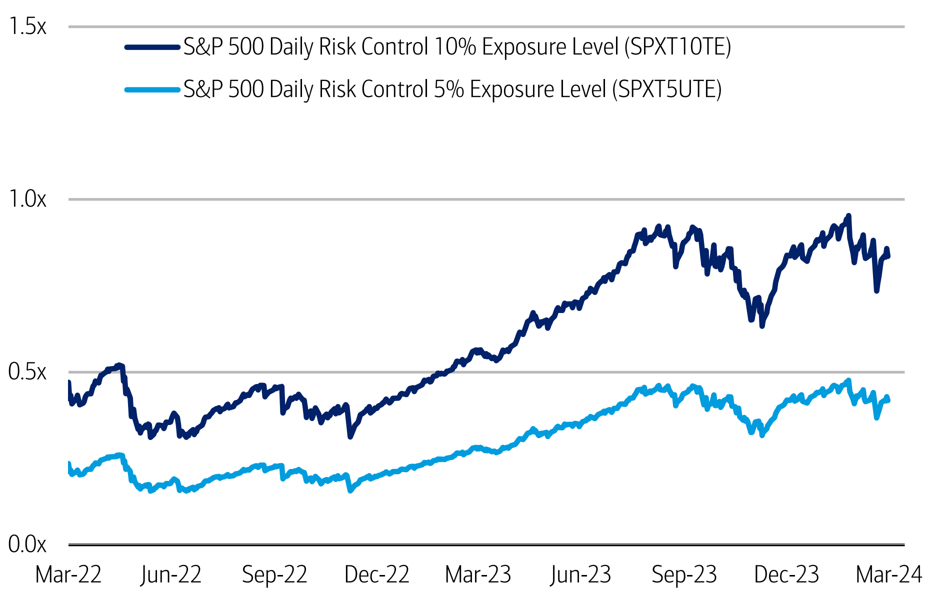
S&P 500 Equity Vol Control

Exhibit 33: S&P 500 Daily Risk Control (10% and 5%) Exposure Level
To model equity vol control, we show the exposure for the S&P Daily Risk Control Index (both 10% and 5%)



Source: BofA Global Research. Data as of 8-Mar-2024.

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Recent price action around CTA model trigger points

Exhibit 34: Ultra Long Term Tsy Futures (WN) trigger on 18-Jan-2024
WN futures featured in our daily update, please email us to be subscribed

Source: BofA Global Research, Bloomberg

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Exhibit 35: RTY stop loss triggered week of 19-Jan-24
Increased selling at our model's trigger point

Source: BofA Global Research, Bloomberg

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Exhibit 36: KOSPI2 stop loss triggered week of 19-Jan-24
KOSPI2 is featured in our daily update, please email us to be subscribed

Source: BofA Global Research, Bloomberg

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Exhibit 37: CHF/USD stop loss triggered week of 19-Jan-24
CHF is included in our daily update, please email us to be subscribed

Source: BofA Global Research, Bloomberg

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CTA model trigger points (continued)

Exhibit 38: AUD/USD stop loss triggered week of 19-Jan-24
Increased selling at our model's trigger point

Source: BofA Global Research, Bloomberg

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Exhibit 39: EURO STOXX 50 trigger in week ending 10-Nov-2023
Accelerated covering through our model's trigger

Source: BofA Global Research, Bloomberg

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Exhibit 40: Russell 2000 trigger in week ending 3-Nov-2023
Accelerated covering through our model's trigger

Source: BofA Global Research, Bloomberg

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Exhibit 41: EUR/USD stop loss triggered week ending 3-Nov-2023
Accelerated covering through our model's trigger

Source: BofA Global Research, Bloomberg

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CTA model trigger points (continued)

Exhibit 42: 10yr Tsy Futures (TY) trigger in week ending 3-Nov-2023
Accelerated covering through our model's trigger

Source: BofA Global Research, Bloomberg

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Exhibit 43: Ultra Long Term Tsy Futures (WN) trigger on 3-Nov-2023
WN futures featured in our daily update, please email us to be subscribed

Source: BofA Global Research, Bloomberg

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Exhibit 44: Soybean Meal trigger in week ending 27-Oct-2023
Accelerated covering through our model's trigger

Source: BofA Global Research, Bloomberg

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Exhibit 45: Gold stop loss triggered week ending 13-Oct-2023
Accelerated covering through our model's trigger

Source: BofA Global Research, Bloomberg

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CTA model trigger points (continued)

Exhibit 46: Oil stop loss triggered week ending 6-Oct-2023
Increased selling at our model's trigger point

Source: BofA Global Research, Bloomberg

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Exhibit 47: Nikkei stop loss triggered week ending 6-Oct-2023
Increased selling at our model's trigger point

Source: BofA Global Research, Bloomberg

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Exhibit 48: CAD/USD stop loss triggered week ending 22-Sep-2023
Acceleration upward post our model's buy to cover trigger

Source: BofA Global Research, Bloomberg

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Exhibit 49: SPX stop loss triggered week ending 18-Aug-22
Persistent downside following a sell trigger on 15-Aug consistent with CTAs fully exiting a stretched long SPX position

Source: BofA Global Research, Bloomberg

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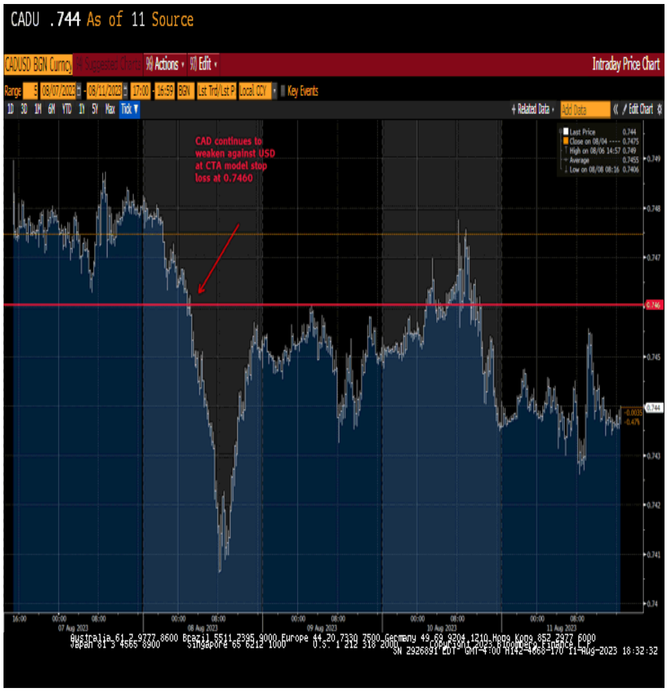
CTA model trigger points (continued)

Exhibit 50: CAD/USD stop loss triggered week ending 11-Aug-23
Increased selling at our model's trigger point



Source: BofA Global Research, Bloomberg

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Exhibit 51: MXN/USD stop loss triggered week ending 4-Aug-23
Increased selling at our model's trigger point

Source: BofA Global Research, Bloomberg

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Exhibit 52: MXN/USD stop loss triggered week of 17-Mar-23
Accelerated selling through our model's trigger

Source: BofA Global Research, Bloomberg

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Exhibit 53: RX stop loss triggered week of 17-Mar-23
Accelerated covering through our model's trigger

Source: BofA Global Research, Bloomberg

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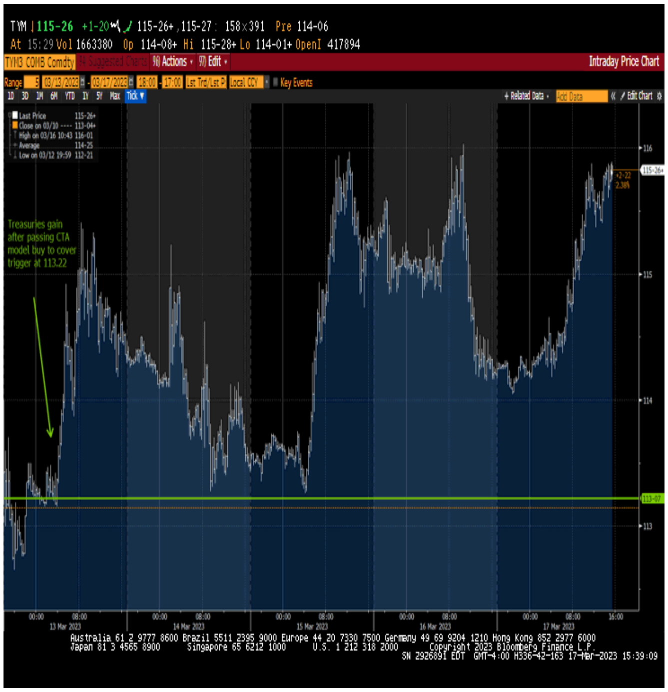
CTA model trigger points (continued)

Exhibit 54: TY stop loss triggered week of 17-Mar-23
Accelerated upside through our model's trigger



Source: BofA Global Research, Bloomberg

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Exhibit 55: SX5E stop loss triggered week of 17-Mar-23
After testing, SX5E accelerated declines through model trigger

Source: BofA Global Research, Bloomberg

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Exhibit 56: Russell 2000 stop loss triggered week of 10-Mar-23
Our model's stop loss coincided with a significant drop in RTY

Source: BofA Global Research, Bloomberg

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Exhibit 57: AUD/USD stop loss triggered week of 24-Feb-23
Ceiling at our model's exit level and as well further downside

Source: BofA Global Research, Bloomberg

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CTA model trigger points (continued)

Exhibit 58: JPY/USD stop loss triggered week of 24-Feb-23
Acceleration in downside post our model's trigger

Source: BofA Global Research, Bloomberg

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Exhibit 59: EUR/USD stop loss triggered week of 24-Feb-23
EUR/USD saw a ceiling post our sell trigger and as well continued downside

Source: BofA Global Research, Bloomberg

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Exhibit 60: TY futures expected to see large shorts week of 24-Feb-23
Persistent downside post a sell trigger early in the week

Source: BofA Global Research, Bloomberg

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Exhibit 61: KTB futures stop loss triggered week of 17-Feb-23
Downside continued through our model's long unwind trigger

Source: BofA Global Research, Bloomberg

BofA GLOBAL RESEARCH

CTA model trigger points (continued)

Exhibit 62: MXN/USD stop loss triggered week of 10-Feb-23
While the move did accelerate around our model stop loss, Mexican central bank actions later in the week propelled the peso higher

Source: BofA Global Research, Bloomberg

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Exhibit 63: RTY outperformance vs SPX week of 3-Feb-23
In the week prior our model forecasted outsized buying pressure in the Russell 2000 relative to the S&P 500

Source: BofA Global Research, Bloomberg

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Exhibit 64: Nikkei-225 stop loss triggered week of 23-Jan-23
After hitting our CTA model's stop loss, the index showed support for the remainder of the week

Source: BofA Global Research, Bloomberg

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Exhibit 65: NASDAQ-100 stop loss triggered on 27-Jan-23
The index saw upward price action which is consistent with CTA short covering

Source: BofA Global Research, Bloomberg

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Appendix

Background on trend following strategies (CTAs)

Trend following strategies have their roots in the commodity asset class as some of the earliest known applications were applied to futures within that asset class. Correspondingly, these trend following strategies were referred to as CTAs which is short for Commodity Trading Advisor. Today, however, global futures markets also comprise stock index, interest rate, currency, and commodity futures. To leverage the benefits of diversification that exists across these asset classes, trend following strategies have broadened their investment universe but are often still referred to as CTAs. Assets in trend following strategies are tracked in a database maintained by BarclayHedge and ***as of 2023-Q4 stood at $336.4bn***.

CTAs can be trend followers but also can be fundamental discretionary

CTA managers often implement rules-based systematic trend following strategies but also can make investment decisions based on fundamental analysis and market views. Those that are systematic could be allocating to futures across multiple asset classes as a function of both trend and volatility. Discretionary CTAs, on the other hand, may also allocate in some part or fully based on fundamentals and economic factors. This class of CTAs may become more concentrated in a given asset class based on outlook and may not be as broadly allocated across markets at any given period.

Benchmark CTA explained by x-asset, risk controlled, trend following

Despite the inclusion of fundamental, discretionary trading strategies and/or a focus on a subset of asset classes, our analysis suggests CTA performance can largely be explained by:

1. Investments across multiple asset classes (i.e., equity, interest rates, commodities, and currencies

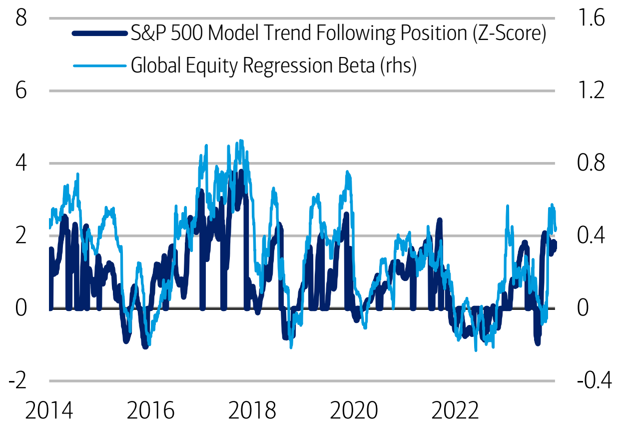
2. The use of trend following signals to determine long or short allocations

3. Risk control mechanisms to determine sizing and increase diversification.

To this effect, we built a top-down multi-factor regression model to explain the performance of a representative benchmark CTA index using a set of cross-asset investments. The CTA benchmark we reference is the SG CTA Index which is comprised of approximately 20 of the largest CTAs by assets, reconstituted yearly with members held in equal weight, and published with daily data. Then, specifically, the multi-factor regression is of global equities, global bonds, commodities, and currency daily returns on the SG CTA index's daily returns. For more details on the top-down multi-factor regression and a discussion on CTA benchmarks, please see our report titled *Quantitative Investment Strategies Panorama*, "Trends aren't going out of fashion", pages 14-19 published in Mar-2017.

In Exhibit 66 and 67 we show the regression beta of both global equities and bonds on the SG CTA Index alongside the z-score of our bottom-up estimate of CTA model sizing (the data displayed in the CTA section earlier) within the S&P 500 and TY futures respectively. Our bottom-up estimate of the position size is estimated by the ratio of component trend to its prevailing volatility. Importantly, our simple bottom-up estimate calculation closely tracks the respective regression betas over time.

Exhibit 66: BofA bottom-up model CTA allocation in the S&P 500 alongside a top-down regression beta of global equities on the SG CTA Index (a popular benchmark CTA index)
Our bottom-up model is in-line with a top-down regression



Source: BofA Global Research. Data as of 8-Mar-2024.

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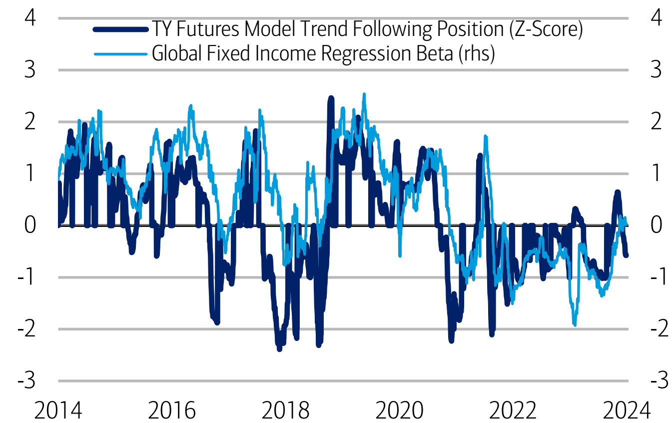
Exhibit 67: BofA bottom-up model CTA allocation in TY futures alongside a top-down regression beta of global bonds on the SG CTA Index (a popular benchmark CTA index)
Our bottom-up model is in-line with a top-down regression



Source: BofA Global Research. Data as of 8-Mar-2024.

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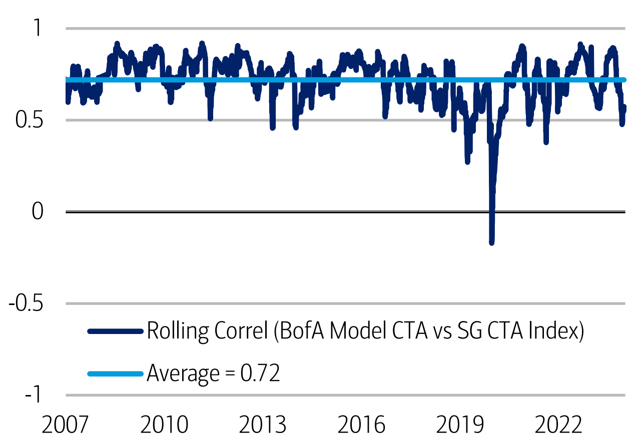
BofA model CTA strategy tracks the benchmark index well

We also constructed a bottom-up CTA strategy using a wide range of futures investments across multiple asset classes. To do so, for each underlying we started with the trend/vol ratio, then assumed equal risk across asset classes and layered on top both rules for stop losses & subsequent re-initiation of positions. In Exhibits 68 and 69 are the rolling correlation and beta of returns for our bottom-up CTA strategy and the SG CTA benchmark index. Correlation of daily returns averages around 0.7 with beta close to 1.

Exhibit 68: Rolling correl. of daily returns of BofA bottom-up model CTA strategy and the SG CTA Index (a popular benchmark CTA index)
Our bottom-up CTA model sized using trend/vol ratios, equal risk across asset classes, and with rules governing stop loss and re-initiation of positions tracks the benchmark CTA index well through time.



Source: BofA Global Research. Data as of 8-Mar-2024.

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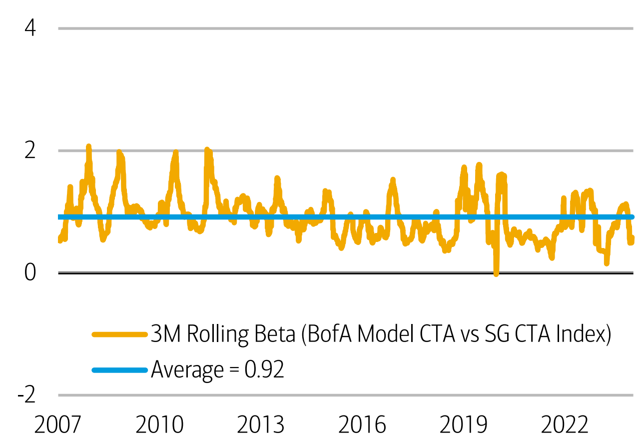
Exhibit 69: Rolling 3M beta of daily returns of BofA bottom-up model CTA strategy and the SG CTA Index (a popular benchmark CTA index)
Our bottom-up CTA model sized using trend/vol ratios, equal risk across asset classes, and with rules governing stop loss and re-initiation of positions tracks the benchmark CTA index well through time.



Source: BofA Global Research. Data as of 8-Mar-2024.

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Background on risk parity strategies

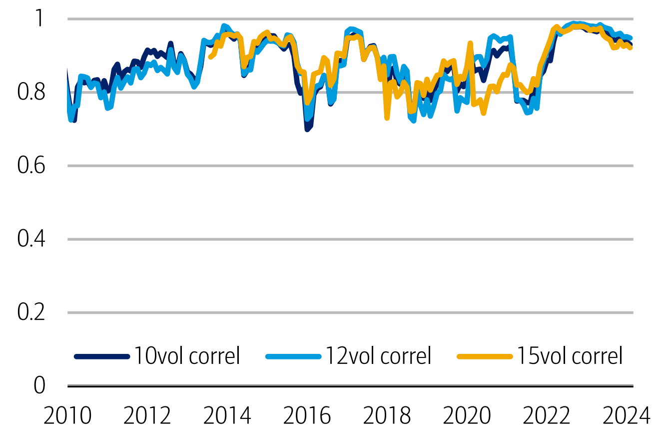
Similar to CTAs, our analysis indicates that risk parity strategies may allocate across the major asset classes and also size their positions as a function of prevailing volatility. However, risk parity strategies are agnostic to price trend and remain fully long each asset class. Risk parity strategies are popular for their ability to target diversification and have a strong track record of positive performance. In 2017, HFR (Hedge Fund Research) launched a suite of benchmark risk parity indices that are comprised of some of the largest risk parity funds. These benchmark indices are published monthly.

The BofA risk parity model is a simple risk parity application applied to equities (S&P 500), bonds (10Y Treasury Futures Total Return), and commodities (S&P GSCI index) rebalanced monthly using the prior three months of data to determine volatility and correlation forecasts. In Exhibits 71 through 73 we show applications of the BofA risk parity model with risk targets of 10, 12, and 15 and in each case compare to the respective HFR risk parity benchmark over monthly periods. Then in Exhibit 70 is the rolling one-year correlation of prior twelve monthly returns for each HFR index and BofA model pair. Correlation tends to be high (> 0.8). As well, the betas are close to 1 with each model strategy closely fitting the respective HFR benchmark.

Unlike for CTAs, there is no database of risk parity funds from which we could gather an estimate of assets tracking the strategy. However, ***commonly used estimates have ranged from $200bn to $750bn.***

Exhibit 70: Rolling 1-year correlation of HFR risk parity and BofA model risk parity monthly returns

HFR risk parity indices with 10, 12, and 15 vol are highly correlated to the respective BofA model risk parity strategies with similar vol targets.



Source: BofA Global Research. Monthly data from Jan-2010. HFR institutional risk parity indices are used.

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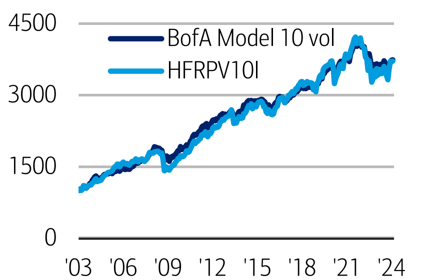
Exhibit 71: BofA Model Risk Parity (10% vol target, 1.5x max leverage)

BofA model risk parity tracks the benchmark HFR risk parity index



Source: BofA Global Research. Data as of 29-Feb-2024.

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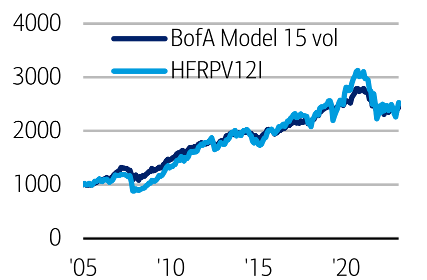
Exhibit 72: BofA Model Risk Parity (12% vol target, 1.5x max leverage)

BofA model risk parity tracks the benchmark HFR risk parity index



Source: BofA Global Research. Data as of 29-Feb-2024.

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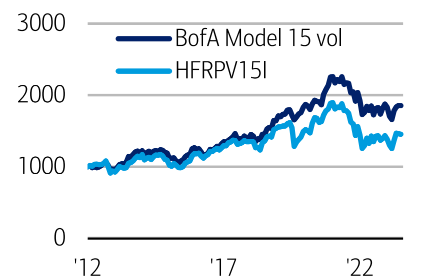
Exhibit 73: BofA Model Risk Parity (15% vol target, 3.0x max leverage)

BofA model risk parity tracks the benchmark HFR risk parity index



Source: BofA Global Research. Data as of 29-Feb-2024.

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Background on equity vol control strategies

Equity vol control is a more simple quantitative strategy relative to CTAs and risk parity. This class of quant dynamically adjusts leverage to target a predefined level of risk based on prevailing equity volatility. For example, if the prevailing level of S&P 500 volatility was 20%, then an S&P 500 10% vol controlled strategy would set leverage to 0.5x, or 50% of total AUM. If on the other hand prevailing volatility was 5%, then leverage would be set to 2x, or 200% of total AUM. Equity vol control strategies are often applied to equity indices with the largest market cap and volumes in order to improve tradability. Risk targets tend to range from 5% to 15%. Versus CTAs and risk parity, assets in equity vol control are the least publicized ***but estimates of $300bn can be reasoned.***

CTA model parameters and outputs explained

Trend strength is calculated using a collection of moving average crosses

Our model trend following strategy requires the measurement of an asset's price trend and we do so using a collection of moving average crosses. The key parts of the calculation are the use of both near and far moving average crosses, weighted equally. A simple example of this would be to measure the 1-month, 3-month, and 10-month moving averages for an asset. Then we compare the 1-month to each the 3-month and 10-month where if it is higher we score it +1 and lower then -1. The two scores are then averaged such that if the 1-month was higher than both the 3- and 10-month the trend strength would be +1 (max long) and if the 1-month was lower than both the 3- and 10-month the trend strength would be -1 (max short). Our actual calculation uses a greater number of crosses and also prorates the crosses based on component volatility in order to make trend strength more continuous over time. Importantly, we do not use the spot price in any cross as our analysis leads us to conclude that actual trend following strategies do not as well.

Bearish/median/bullish price paths are determined using historical data

For each underlying that we apply our trend following model on we also show a projection of how the model position can evolve over the next five trading days. We do this by applying our CTA model on bearish, median, and bullish price paths over the next week. These price paths are determined using historical data for each underlying. Price paths are in part a function of the prevailing volatility of an asset so when determining the various paths we sample only those historical data where volatility is similar to current. Then from this subset of data we can determine low (bear), neutral (median), and high (high) price paths to apply one week ahead.

Rules governing buy and sell triggers in our CTA model

At any given point in time our bottom-up trend following model applied on an underlying asset can be either in a position (long or short) or flat. If in a position, then should a price trend strongly to reverse, our model could potentially hit a stop loss. We assume the stop loss is set such that in an extreme event where every component hits a stop loss simultaneously in the overall model, the loss to the portfolio is approximately 10%. For an underlying asset which our trend following model is currently flat, we assume re-entry occurs under two conditions. If the asset's price hits a local high and its trend strength is positive, a long is initiated. Vice-a-versa, if an asset hits a local low and its trend strength is negative, a short is initiated. The local high/low level can range from lookbacks over the prior five to ten days.

Timescale of leverage changes

CTAs, risk parity, and equity vol control strategies monitor and adjust leverage daily. However, the lag between a model prescribed change in leverage and the actual adjustment varies. Our models and analysis indicate that CTAs are the fastest to respond to model changes, potentially even intraday. Risk parity and equity vol control, however, tend to move slower with adjustments to leverage occurring in the one to two subsequent trading sessions.

Background on option positioning

Key highlights of our approach to option positioning include:

- Deriving gamma estimates based on signed volume data from the exchange rather than using models that risk mis-classifying option buys/sells
- Quantifying the impact of this gamma on S&P realized volatility by estimating the market impact of delta-hedging flows
- Including SPX 0DTE gamma in the picture by accounting for gamma arising from both expiring & non-expiring options

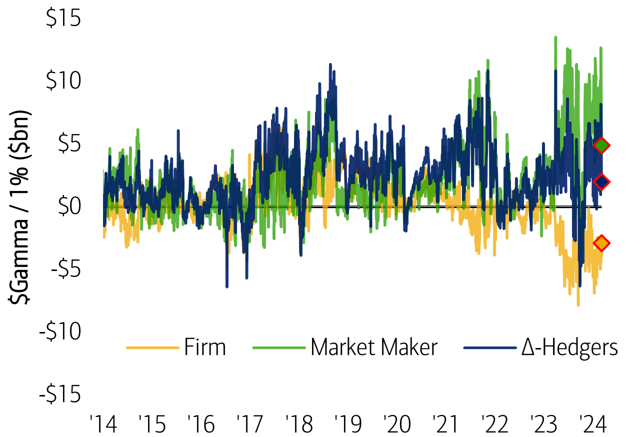
Many market participants have long sought an accurate measure of option positioning to assess the impact that options and their subsequent hedging may have on both the underlying and derivative markets. Our aim here is to provide such estimates for the size and impact of the net gamma of delta-hedgers (often colloquially referred to as "dealer gamma") for SPX options specifically.

At its core any approach to estimating option positioning tends to boil down to one key step: how do you determine if end-users are long or short a particular option? Market participants have addressed this question in a variety of ways historically. To give a few concrete examples (some with more merit than others) you could: (i) naively assume end-users buy all puts and sell all calls, (ii) categorize option trades based on their distance from the bid and ask, or (iii) use a local volatility surface to impute a buy or sell signal from changes in the volatility.

Instead of the aforementioned ideas, our position estimates are grounded in data directly from the exchange which classifies option trades as a buy or sell according to the exchange's own records for 5 types of market participants: customers, pro-customers, broker-dealers, market makers, and firms. By way of example, customers (both regular and professionals) include a mix of retail and sophisticated players like hedge funds, market makers are the usual suspects, while broker-dealers and firms often (though not necessarily exclusively) capture a portion of the trading activities at banks.

Our gamma estimates combine the footprint of market makers and firms (as highlighted in Exhibit 74) under the assumption that only market makers and firms delta-hedge. We find that historically delta-hedgers as we've defined them tend to be skewed net long gamma from SPX options and in the +$0-10bn range. For comparison Exhibit 75 shows the SPX gamma implied by the naïve assumption that end-users buy all puts and sell all calls which is often appreciably larger in magnitude than our estimate of SPX gamma for delta-hedgers.

Exhibit 74: Historical SPX gamma for Firms, MMs and Δ-Hedgers
Our estimates for Δ-Hedger (= firm + mm) gamma assume that firms and market makers (mm) are the only market participants which delta-hedge



Source: BofA Global Research, CBOE. Data as of 07-Mar-24.

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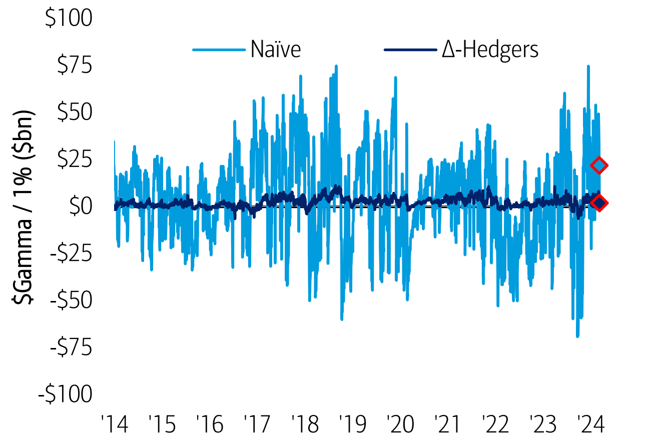
Exhibit 75: Comparison of gamma for Δ-Hedgers with a naïve estimate
A naïve estimate of gamma which assumes end-users buy all puts and sell all calls tends to be larger in magnitude than our gamma level for Δ-Hedgers



Source: BofA Global Research, CBOE. Data as of 07-Mar-24 for the Δ-Hedger gamma level and as of 06-Mar-24 for the naïve gamma estimate.

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Quantifying the impact of gamma on realized volatility

To infer the impact of SPX option gamma on S&P 500 e-mini realized volatility (as presented in Exhibit 5) we perform the following steps: (i) Use the gamma level from the prior day's close and the subsequent realized equity move to estimate the delta that hedgers need to buy or sell. (ii) Quantify the market impact of trading the required delta in the S&P 500 e-mini futures market with trading confined to the last 1-hour, 30-minutes, or 15-minutes of the trading session. (iii) Calculate new hypothetical daily market returns after removing the impact from trading the delta. These new returns are then used to estimate the realized volatility in the absence of delta-hedgers.

A comment on model diversity and market impact

It is important to note that the analysis in this report on trend following and risk parity is based on one implementation of each class of strategy that attempts to track a respective benchmark for each. Actual trend following and risk parity strategies that compose the benchmark indices could vary in their rules-based implementations. This is an important consideration with regards to market impact from this class of strategies. That is, to the extent the models have more diversity, the potentially less impact they can have on the market as trading may not occur at the same levels and/or at the same time. This is a crucial point that is commonly not discussed surrounding this type of analysis.

Options Risk Statement

Potential Risk at Expiry & Options Limited Duration Risk

Unlike owning or shorting a stock, employing any listed options strategy is by definition governed by a finite duration. The most severe risks associated with general options trading are total loss of capital invested and delivery/assignment risk... all of which can occur in a short period.

Investor suitability

The use of standardized options and other related derivatives instruments are considered unsuitable for many investors. Investors considering such strategies are encouraged to become familiar with the "Characteristics and Risks of Standardized Options" (an OCC authored white paper on options risks). U.S. investors should consult with a FINRA Registered Options Principal.

For detailed information regarding risks involved with investing in listed options:

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