

Global Rates and FX Primer

FX Quant Insight primer - 2025

The FX Quant Insight framework

In the long-run, exchange rates should converge toward the equilibrium rate. In the medium-term, relative monetary and fiscal policies play a major role in driving exchange rate fluctuations. For the short-term, we see trends and flows as key drivers and synthesize four quantitative components every Monday to form “FX View of the Week”:

1. **Option Flow Signals:** we use weekly shifts of the FX vol curves and SDR (Swap Data Repository) data to get signals for the coming week from options.
2. **Technical Matrix:** we use BofA FX positioning analysis, ADX, Bollinger bands, support, resistance, trend unwind trigger and take-profit levels to derive a signal by quantifying FX trends.
3. **CARS Signals:** the BofA CARS (Cross-asset regime-switching) model uses cross-asset factors to make weekly predictions for G10 FX in a systematic fashion.
4. **Interactive Time Zone:** investors can examine historical cumulative returns at different hours of the day and variable lookback periods for major FX pairs.

Exhibit 1: Sample quant signals from March 24 2025

Top signals from quant models

Section	Insight	Rationale
Option Flow	Bullish USD	Short-date option flow broadly turned bullish USD last week.
Technical Matrix	USD downtrend	USD downtrend persists vs GBP, CHF, and NOK.
CARS	Macro Shock	CARS remain in shock regime as US equity has yet to rebound.
Time Zone	USD retracement	USD retraced some loss in Europe and Asia hours last week.
EM FX	Bullish USD/KRW	Option flow and spot trend continuation are both bearish for KRW.

Source: BofA Global Research. This is a sample view of the front-page table for the FX Quant Insight publication from March 24 2025 and does not indicate any current Research views.

BofA GLOBAL RESEARCH

These four components cover different aspects of the FX market, and the weekly FX Quant Insight publication would summarize key takeaways from each component as shown by the Exhibit 1 example for us to form a short-term FX view for the coming week.

Recent additions to the weekly FX Quant Insight

Over the past few months, we implemented two new features. First, we introduced the trigger and take-profit levels to the Technical Matrix table. The concept was first published in our report: [Liquid Insight: Tariff chasers 05 February 2025](#). These are hypothetical spot levels that would neutralize an existing FX spot uptrend or downtrend. Second, we expanded the list of available currencies in the Time Zone interactive dashboard to include EUR/G10 pair and major G10 and EM crosses.

Trading ideas and investment strategies discussed herein may give rise to significant risk and are not suitable for all investors. Investors should have experience in relevant markets and the financial resources to absorb any losses arising from applying these ideas or strategies.

BofA Securities does and seeks to do business with issuers covered in its research reports. As a result, investors should be aware that the firm may have a conflict of interest that could affect the objectivity of this report. Investors should consider this report as only a single factor in making their investment decision.

Refer to important disclosures on page 16 to 18.

12812039

Timestamp: 01 April 2025 07:48AM EDT

01 April 2025

G10 FX Strategy
Global

Howard Du, CFA
G10 FX Strategist
BofAS
+1 646 743 7017
yuhao.du@bofa.com

CARS (model): Cross-Asset Regime Switching

SDR: Swap Data Repository

MAA: Moving Average Aggregator

UD: Up/Down volatility

RS: Residual Skew

ADX: Average Directional Movement Index

DMI: Directional Movement Index

Option Flow Signals

Our options flow signals combine SDR (Swap Data Repository) flows data (see our report: [FX Viewpoint: SDR: What do FX options flows tell us? 01 February 2021](#)) with Event analysis framework (see our report: [FX Viewpoint: Vol-guided decisions 18 March 2021](#)) to gauge bullish and bearish sentiments.

SDR (swap data repository) option flow

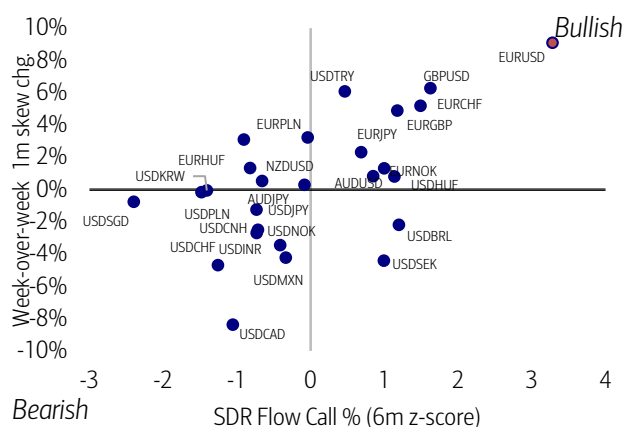
Option flow offers preview of future spot moves

As FX options expire in the future, we can effectively use option flows in the recent past as a proxy for investors' expectation of future spot movements and gauge directional risks. Exhibit 2 plots the 6m z-score of call percentage (% of aggregated call option notional vs total notional) for the FX options transactions in the previous week with 3m or less tenors as reported by the SDR along the x-axis. Along the y-axis, it plots the week-over-week 1m skew (25-delta risk reversal divided by atm vol) change. Option flows show bullish spot signals for FX pairs that fall in the top-right quadrant, as demand has been in favor of out-of-the-money (OTM) calls for these pairs. By contrast, option flows have been bearish for pairs that fall in the bottom-left quadrant.

In this example (for the week of Feb 28 to Mar 7 2025), we find option flow and skew moving sharply for EUR calls by more than +3 z-scores (Exhibit 2) due to unexpectedly large fiscal reform for Europe after the German election.

Exhibit 2: Demand for EURUSD call was +3.3 z-scores for first week of March 2025

1m skew change vs call percentage z-score

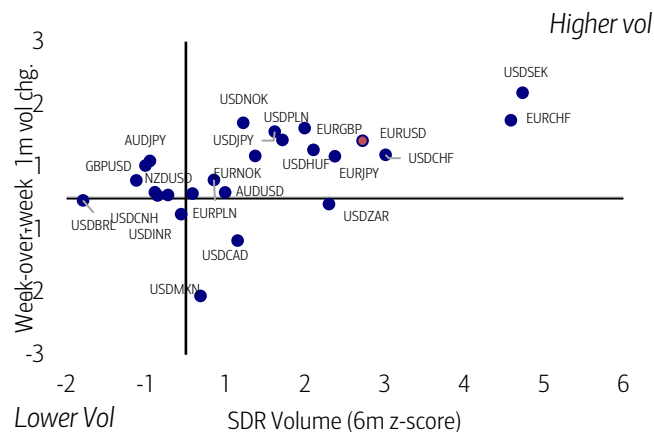


Source: BofA Global Research, DTCC. Note: CNH flows are proxied by "CNY" flows in SDR. For the week of Feb 28 to Mar 7 2025.

BofA GLOBAL RESEARCH

Exhibit 3: High volume and rising vol confirm demand for EURUSD calls

1m implied vol change vs volume z-score



Source: BofA Global Research, DTCC. Note: CNH flows are proxied by "CNY" flows in SDR. For the week of Feb 28 to Mar 7 2025.

BofA GLOBAL RESEARCH

Option flow also pinpoints focal point of the market

Similarly, we can plot the previous week's SDR volume z-score vs week-over-week 1m vol change to gauge which pairs have caught the market's attention. We measure rising options demand by rising SDR flow volumes coinciding with a pick-up in implied vol. Exhibit 3 shows increased options trading volume and rising implied vol levels for EURUSD in the same week. The high volume amid rising implied vol further confirmed the market's outsized demand for EUR calls.

How well does option flow work?

To evaluate options flow signals, we first considered the weekly SDR call percentage signal by itself (naively bullish an FX pair in spot if options call percentage is above 50%). We then find that signals have more predictive power by considering z-score thresholds of weekly call percentages.



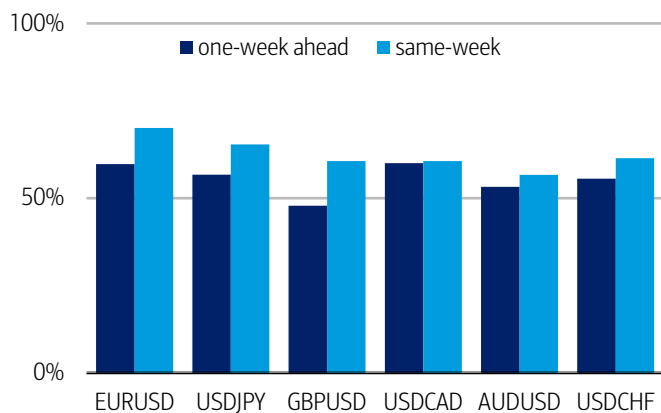
Typically spot move and option flow would be in tandem; in aggregate, Exhibit 4 shows for 6 major and liquid USD/G10 pairs, since October 2022 weekly option flows have broadly had a hit ratio of above 50% when compared to spot move in the same week.

With the exception of GBPUSD, Exhibit 4 also shows current week's option flow direction having above 50% hit ratio for next week's spot direction. While this hit ratio is not high, it still suggests SDR options data could provide forward-looking insights for spot market.

The hit ratio would improve with the magnitude of option flow. Exhibit 5 shows for EURUSD, the direction of current week's option flow has had hit ratios of respectively 70% and 57% for same-week and one-week ahead spot moves since Oct 2022. But once the option flow is translated to a 6m z-score and thresholds are applied to isolate weeks of outsized option flow, the signal can improve monotonically. At above ± 1.5 z-score cutoff, out-of-sample predictability of EURUSD's option flow for subsequent week's spot move would improve to 70%. Weeks of outsize option flow are typically associated with pivotal moments in the market, like the fiscal reform after the German election in 2025. As a result, the spot trend is more likely to break out and continue in the same direction for the coming week. Following the recent +3.3 z-score seen for EURUSD call flows at the onset of March 2025, EURUSD spot continued to grind higher in the following week from 1.0833 on March 7 to 1.0879 on March 14.

Exhibit 4: Option flow for current week tends to lead to spot move in the same direction for next week

Option flow's same-week and one-week ahead hit ratio on spot move

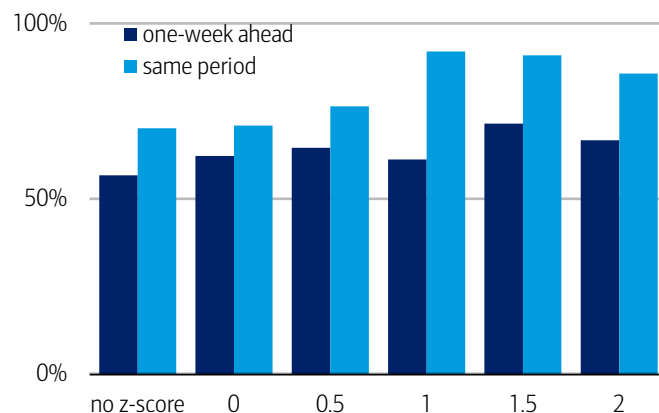


Source: BofA Global Research, Bloomberg, DTCC. The light blue bar shows the percent of times that option flow and spot move were in the same direction within the same week since Oct 2022. The dark blue bar shows the percent of times that option flow and next week's spot move were in the same direction. Date up to Mar 2025.

BofA GLOBAL RESEARCH

Exhibit 5: More extreme option flow can serve as a better predictor of future spot move

EURUSD option flow's hit ratio on spot move at various z-score cutoffs



Source: BofA Global Research, Bloomberg, DTCC. Data from Oct 2022 to Mar 2025.

BofA GLOBAL RESEARCH

Event analysis: vol-guided decisions

Following a significant currency move (a rally or a sell-off), investors often face the dilemma of either chasing the move or fading it. We believe the FX options market can provide valuable information about positioning and sentiment, so we have also developed a framework called the Event analysis that uses the level of volatility, skew and term structure to help with such decisions (see our report: [FX Viewpoint: Vol-guided decisions 18 March 2021](#)).

Given the current spot trend could be rising or falling and the overall option signal could be bullish or bearish as well, we derive four strategies through historical scenario analysis:

- **Bearish Continuation:** sell a currency whose depreciation is accompanied by a parallel shift higher across the vol curve and a rise in put skew.



- Bearish Contrarian: sell a currency whose appreciation is accompanied by an increase in put skew.
- Bullish Continuation: buy a currency whose appreciation is accompanied by a relative inversion of the vol curve and a decline in put skew.
- Bullish Contrarian: buy a currency whose depreciation is accompanied by a fall in 1m vol and a decline in put skew.

Exhibit 6 summarizes spot and vol moves for major currency pairs from the March 10 2025 FX Quant Insight (see our report: [FX Quant Insight, 10 March 2025](#)). Since the Event analysis may not produce a signal every week, we highlight bullish or bearish conditions that have been partially satisfied by green and red shading, respectively. In this example, the table summarizes the FX spot and vol moves from Feb 28 to Mar 7. The model produced several bullish continuation signals for European currencies vs the USD, as the European currencies' spot appreciation from the previous week was accompanied by sharply rising 1m vol and decline of put skew vs the USD. In the following week, EUR and CHF modestly rose vs the USD, while the Scandies continued to march higher.

Exhibit 6: Following unexpectedly large German fiscal reform, event analysis was broadly bullish for European currencies vs USD

Event analysis signals for March 10 2025

Pair	Old spot	New spot	1m vol	1m vol chg	1y vol	1y vol chg	1y - 1m chg	Currency	Return vs USD	1m skew % chg vs USD	Signals
EURUSD	1.0487	1.0853	8.69	0.92	7.57	0.22	-0.70	EUR	3.43%	10.12	EUR Bullish Continuation
USDJPY	149.50	146.76	12.11	1.06	10.14	0.23	-0.83	JPY	1.85%	-0.02	JPY No Signal
GBPUSD	1.2701	1.2936	8.08	0.52	7.81	0.07	-0.45	GBP	1.83%	6.90	GBP No Signal
USDCHF	0.8968	0.8763	8.02	0.69	7.43	0.15	-0.55	CHF	2.31%	4.19	CHF Bullish Continuation
AUDUSD	0.6225	0.6326	10.09	0.09	9.87	0.09	0.00	AUD	1.61%	1.39	AUD No Signal
USDCAD	1.4482	1.4403	7.11	-0.68	6.12	0.05	0.73	CAD	0.55%	6.17	CAD No Signal
USDSEK	10.5091	10.1055	11.93	1.69	10.96	0.39	-1.30	SEK	3.92%	5.12	SEK Bullish Continuation
USDNOK	11.1874	10.7394	11.22	1.21	11.21	0.27	-0.94	NOK	4.09%	3.29	NOK Bullish Continuation
NZDUSD	0.5617	0.5739	10.29	0.28	9.97	0.10	-0.18	NZD	2.15%	1.56	NZD No Signal
USDSGD	1.3469	1.3303	5.92	0.05	5.56	0.05	0.00	SGD	1.24%	0.81	SGD No Signal
USDKRW	1460.3	1455.6	8.87	0.09	8.94	-0.04	-0.14	KRW	0.32%	0.11	KRW No Signal
USDMXN	20.6855	20.2094	12.32	-1.56	13.49	-0.62	0.94	MXN	2.33%	1.20	MXN No Signal
USDTRY	36.4473	36.5538	9.91	0.96	17.91	0.47	-0.50	TRY	-0.29%	1.88	TRY No Signal
USDZAR	18.6071	18.2451	12.28	-0.10	13.95	-0.02	0.08	ZAR	1.96%	-0.62	ZAR No Signal
USDHUF	381.1	367.8	12.64	0.77	11.98	0.19	-0.58	HUF	3.55%	-0.20	HUF No Signal
USDPLN	3.9653	3.8635	12.05	0.93	11.06	0.12	-0.82	PLN	2.60%	1.14	PLN No Signal

Source: BofA Global Research, Bloomberg.

The table shows the 1-year percentile and 1-week change in 1m and 1y implied vol, the 1y-1m spread, and the 1m 25 delta risk reversal as a percentage of the ATM. For a currency with a put skew, the rules for generating the signal column are the following:

[1] Bearish Continuation: Spot change < -1%, 1m vol change > 0.5%, 1y vol change > 0%, 1m skew chg. < -2; [2] Bearish Contrarian: Spot change > 1%, 1m skew change < -2;

[3] Bullish Continuation: Spot change > 2%, 1y-1m change < -0.1%, 1m skew change > 2; [4] Bullish Contrarian Spot change < -1%, 1m vol change < -0.2%, 1m skew chg. > 1.

Parameters that triggered a bearish condition are colored in red; parameters that triggered a bullish condition are colored in green.

BofA GLOBAL RESEARCH

How well does event analysis work

Exhibit 7 shows the aggregated hit ratio and number of signals for each of the four strategies since 2008 and since 2020 across all the currencies from Exhibit 6. We first looked at the historical performance in our report: [FX Viewpoint: Vol-guided decisions 18 March 2021](#), and now extend the result to March 2025. Over the long run since 2008, all four strategies showed hit ratios that ranged from 52% to 58%. In more recent years, three strategies continued to maintain similar hit ratios, but the Bullish Continuation event analysis strategy for global currencies vs the USD in recent history is largely driven by the persistently resilient USD, in our view. After rallying to a decades-high in 2022, the USD has yet to retrace all of its appreciation in this cycle and remains broadly overvalued against global currencies. Bearish USD trend breakouts have become more short-lived, and the USD also saw a sizable uptrend after the 2024 US election to end the year.



Exhibit 7: Bullish continuation signals for global currencies have underperformed in recent years amid persistently strong USD

Event analysis signal hit ratio and # of signals

	Hit ratio since 2008	# of signals since 2008	Hit ratio since 2020	# of signals since 2020
Bearish Continuation	58%	549	55%	201
Bearish Contrarian	54%	158	55%	42
Bullish Continuation	52%	181	31%	49
Bullish Contrarian	56%	117	65%	26

Source: BofA Global Research, Bloomberg. Data up to Mar 2025.

BofA GLOBAL RESEARCH

Technical Matrix

The Technical Matrix is a table of technical indicators (See our report: [Technical Explained: In 2024, get to know technical strategy 05 January 2024](#)) and BofA positioning analysis (See our report: [Global Rates and FX Primer: 01 October 2018](#)) that look at trend following and reversal signals.

The BofA G10 FX positioning analysis model with MAA, UD and RS

Our positioning analysis model gauges positioning using three proprietary indicators: Moving Average Aggregator (MAA), Up/Down volatility (UD) and Residual Skew (RS).

The daily MAA is the average of the 28 binary conditions given by comparing various short and long simple moving average pairs (SMA), such as whether the 50d SMA is above or below the 200d SMA (See Exhibit 8 footer for full list of SMAs). For many investors, a conventional bullish signal for a currency pair occurs when: the short-dated moving average is crossing above the long-dated moving average. The MAA reaches 100% when 28 moving average pairs are bullish, while it reaches 0% when 28 pairs are bearish. Similarly, the MAA is at 50% when 14 out of 28 pairs are bullish and 14 other pairs are bearish. A high (low) percentage of buy signals suggests long (short) positioning in the pair is quite heavy.

We construct Up/Down vol indicator as a spread of realized volatility between up and down days over the past month. Higher volatility in direction of the trend is bullish, while significant volatility against the trend is bearish. For the Technical Matrix, we normalize UD such that a high (low) value corresponds with greater down (up) vol, so that low values of UD may be interpreted as low positioning.

Following the intuition of the Event analysis, we construct Residual put Skew indicator as a residual of a regression of weekly changes in 1m 25d risk reversals (% atm) on weekly changes in spot over 6 month rolling window. Using a normalized cumulative sum of these residuals over the previous month, we get a measure of contrarian and trend-following signals from skew. We then take the 1-year percentile to normalize the RS indicator. Low RS values reflect light positioning and excess demand for calls, while high values reflect excess demand for puts and relatively stretched long positioning.

Trend continuation and reversals with positioning analysis

We consider a pair to be in uptrend if the MAA is above 60%, and in downtrend if the MAA is below 40%. The positioning analysis shows uptrend reversal signal if MAA, UD and RS are all above 80, and uptrend continuation signal if MAA is above 60 while UD and RS are below 50. The model shows downtrend reversal signal if MAA, UD, and RS are all below 20 and downtrend continuation signal if MAA is below 40 while UD and RS are above 50.

Exhibit 8 shows the trend determined by MAA in the Positioning Trend column. The Bullish/Bearish column indicates the signals from MAA, UD, and RS. It shows “Bullish” (in green) if positioning analysis has uptrend continuation or downtrend reversal signals for the pair, and “Bearish” (in red) if positioning analysis has downtrend continuation or uptrend reversal signals for the pair. The column shows “Slightly Bullish” or “Slightly Bearish” (in yellow) if only one of UD or RS indicators supports the signal. In the example

as of March 24 2025 (Exhibit 8), the Bullish / Bearish positioning column shows trend continuation signals for higher GBPUSD, lower USD/CHF, and lower USD/NOK. Outside of USD/G10 pairs, we see trend continuation signals for lower AUD/NZD, higher GBP/CHF, lower USD/MXN, and higher USD/KRW.

Exhibit 8: Trend continuation remains bearish USD vs GBP, CHF, and NOK; USD downtrends vs CHF and NOK see higher risk of unwinds

Technical matrix with positioning analysis and key levels to watch

		Spot	Positioning Trend	Bullish / Bearish	ADX Trend	Bollinger Bands	Next Support	Next Resistance	Trigger Level	Take-profit Level
USD	EURUSD	1.0841	↑	No Signal	Uptrend	None	1.0804	1.1214	1.0700	1.0997
	USDJPY	149.77	↓	No Signal	Range	None	148.13	150.77	150.65	142.04
	GBPUSD	1.2951	↑	Bullish	Uptrend	None	1.2924	1.3434	1.2788	1.3245
	AUDUSD	0.6299	↓	No Signal	Range	None	0.6170	0.6290	0.6303	0.6005
	USDCHF	0.8811	↓	Bearish	Downtrend	None	0.8813	0.8900	0.8814	0.8532
	USDCAD	1.4318	↑	No Signal	Uptrend	None	1.4343	1.4467	1.4317	1.4770
	NZDUSD	0.5739	↔	No Signal	Range	None	0.5690	0.5733		
	USDSEK	10.11	↓	No Signal	Downtrend	None	9.9796	10.4925	10.63	9.85
	USDNOK	10.49	↓	Bearish	Downtrend	None	10.3916	10.8269	10.96	10.49
EUR	EURGBP	0.8371	↑	No Signal	Transition	None	0.8358	0.8382	0.8370	0.8461
	EURJPY	162.37	↑	No Signal	Range	None	161.02	162.45	162.19	168.10
	EURAUD	1.7212	↑	Slightly Bearish	Uptrend	None	1.7184	1.7419	1.6661	1.7393
	EURCHF	0.9552	↑	No Signal	Transition	None	0.9483	0.9568	0.9462	0.9716
	EURCAD	1.5522	↑	No Signal	Uptrend	None	1.5335	1.5857	1.5025	1.5522
	EURNZD	1.8892	↑	Slightly Bearish	Uptrend	None	1.8649	1.9169	1.8405	1.9260
	EURSEK	10.96	↓	No Signal	Downtrend	None	10.8842	11.2258	11.28	10.72
	EURNOK	11.37	↓	No Signal	Transition	Lower	11.2625	11.5953	11.73	11.18
G10 Cross	AUDJPY	94.33	↓	No Signal	Downtrend	None	90.15	95.47	95.06	89.65
	AUDNZD	1.0976	↓	Bearish	Transition	None	1.0957	1.1010	1.1025	1.0840
	AUDCAD	0.9018	↔	No Signal	Range	None	0.9009	0.9020		
	NOKSEK	0.9637	↓	No Signal	Uptrend	None	0.9626	0.9709	0.9638	0.9225
	CADJPY	104.60	↓	No Signal	Downtrend	None	101.38	105.84	105.25	99.52
	GBPJPY	193.96	↔	No Signal	Range	None	193.23	194.11		
	NZDJPY	85.95	↓	No Signal	Transition	None	83.07	86.35	85.95	81.35
	GBPCHE	1.1411	↑	Bullish	Range	None	1.1326	1.1678	1.1317	1.1687
EM	USDMXN	20.17	↓	Bearish	Range	None	19.7310	20.3773	20.17	19.27
	USDBRL	5.7283	↓	No Signal	Range	None	5.7134	5.7950	5.7638	5.4848
	USDZAR	18.12	↓	No Signal	Range	None	17.9335	18.1210	18.19	17.48
	EURPLN	4.1812	↓	No Signal	Transition	None	4.1272	4.1922	4.1862	4.0407
	EURHUF	397.94	↓	Slightly Bullish	Transition	None	395.68	399.69	402.16	391.14
	USDKRW	1467	↑	Bullish	Range	None	1450.18	1486.85	1442	1519
	USDINR	85.64	↔	No Signal	Transition	Lower	85.30	85.77		
	USDCNH	7.2587	↓	No Signal	Range	None	7.2211	7.2741	7.2594	7.1113

Data as of 03/24/25. Source: BofA Global Research, Bloomberg.

Positioning uptrend has MAA > 60, downtrend MAA < 40. Positioning uptrend reversal likely if MAA/UD/RS > 80, continuation likely if UD, RS < 50. Positioning downtrend reversal likely if MAA/UD/RS < 20, and continuation likely if UD, RS > 50. UD and RS are 1y percentile and MAA is in %.

Positioning is bullish (green) if matrix shows downtrend reversal or uptrend continuation; Positioning is bearish (red) if matrix shows uptrend reversal or downtrend continuation.

Positioning is slightly bullish or slightly bearish (yellow) if only one of UD or RS supports the signal.

ADX downtrend if ADX > 25 and DMI+ is below DMI-. ADX uptrend if ADX > 25 and DMI+ is above DMI-. ADX shows Transition if ADX is between 20 and 25, and Range if ADX < 20. Cells in the ADX Trend column are colored with more intensity if the ADX trend signal matches the positioning signal. 14-day lookback is used for the ADX indicators.

The Bollinger Bands column shows 'Upper' if spot is above the +2 std bollinger band, and 'Lower' if spot is below the -2 std band. 20-day SMA is used for Bollinger indicators.

Cells in Next Support and Next Resistance columns are colored if spot is within 0.5% of the support or resistance level.

For pairs in an existing uptrend or downtrend according to MAA, the Trigger Level shows the hypothetical spot level that would neutralize the existing trend in the next 2 weeks. The Take-profit Level shows the hypothetical spot level in the next 2 weeks that would suggest the trend has become too stretched according to the 2y z-score of the spot vs 50d SMA ratio.

For pairs current not in a prominent MAA trend, the Trigger Level shows the hypothetical spot level that would form a trend for the pair in the next two weeks. Pairs currently not in a prominent MAA trend would not have a Take-profit Level.

BofA GLOBAL RESEARCH

How well do trend-following and reversal signals perform over time

The positioning analysis is by no means a systematic strategy. However, many trend-following CTAs operate under a similar mindset – chasing after trends as they form and exit positions as trend become too stretched or flips to the opposite side. In FX, trend-following strategies tend to perform better when the USD exhibits strong trending behaviors. Exhibit 9 shows over the past decade, FX trend factor has had the best



performance in 2014 and 2022. Both are years where the USD saw prolonged uptrends as investors looked to own the USD ahead of a new Fed hiking cycle.

To the contrary, trend-following strategies underperformed in 2023 as the USD spent more time trading sideways with MAA hovering between 40 and 60 (i.e. neutral trend in positioning analysis, Exhibit 10) and FX volatility was limited. In 2025, FX trend-followers have also underperformed year-to-date. But unlike 2023, volatility has been a lot higher. Trend-followers enter 2025 with long USD positions built up from Q4 2024. Quick trend reversal for the USD amid rising FX vol led to underperformance for trend-following strategies this year.

Exhibit 9: Trend factor has performed poorly so far in 2025

Trend factor performance by year

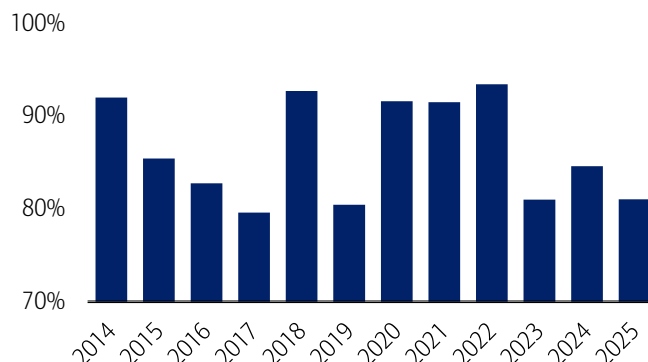
	Return	Vol	Sharpe
2014	7.1%	3.0%	2.4
2015	2.7%	4.9%	0.6
2016	-2.6%	2.7%	-1.0
2017	0.5%	2.8%	0.2
2018	0.2%	4.6%	0.0
2019	-1.0%	2.7%	-0.4
2020	1.4%	4.7%	0.3
2021	-3.9%	3.5%	-1.1
2022	4.5%	4.6%	1.0
2023	-1.6%	2.1%	-0.8
2024	0.0%	2.8%	0.0
2025	-1.6%	5.1%	-0.3

Source: BofA Global Research, Bloomberg. 2025 is up to March.

BofA GLOBAL RESEARCH

Exhibit 10: USD is less trendy so far in 2025 as uptrend to end 2024 reversed into downtrend

% of times USD MAA showed prominent uptrend or downtrend by year



Source: BofA Global Research, Bloomberg. Chart shows % of times in each year that MAA was outside of the 40-60 range for the DXY index. 2025 is up to March.

BofA GLOBAL RESEARCH

Introduce take-profit and trigger levels for existing trend to neutralize

We recently introduced two additional concepts to complement our existing MAA-based trend framework. Often times, investors wonder what would be a hypothetical future spot price level that would cause a currency pair to exit an existing trend. Investors could start to unwind an existing directional trend-following position under two conditions: the trend either become too stretched on its own or near-term fluctuation is sufficiently large to cause the trend indicator to become neutral.

We prefer to use up/down vol and residual option skew to gauge whether a spot trend is stretched. In practice, many investors use simpler metrics such as spot price vs moving average ratio. Our past work on FX Value factor also suggest market tends to fade an existing directional move once spot deviates too much from short-term moving averages ([FX Watch, 17 March 2025](#)). As a result, we introduced the concept of take-profit level. For pairs currently in a downtrend ($MAA < 40$), the take-profit level would be the hypothetical spot level that would cause the 2y z-score of the spot vs 50d SMA ratio to fall beyond -2.0, if the currency pair linearly moved from current spot to the hypothetical take-profit level in the next two weeks. For pairs currently in an uptrend ($MAA > 60$), the take-profit level would be the hypothetical spot level that would cause the 2y z-score of the spot vs 50d SMA ratio to rise beyond +2.0, if the currency pair linearly moved from current spot to the hypothetical take-profit level in the next two weeks. A recent example from Exhibit 7 would be USDNOK. While the positioning trend remains bearish USDNOK, the ratio of 10.49 spot price vs 50d SMA price of 11.07 at the time has fallen below -2 z-scores. As a result the matrix shows 10.49 as the take-profit level for the USDNOK downtrend.

To the contrary, the trigger level shows a spot level against prevailing trend that would serve to neutralize the trend if spot price reaches it in the next 2 weeks. Specifically, for pairs currently in a downtrend ($MAA < 40$), the trigger level is the hypothetical spot level

that would reverse the trend to neutral (MAA rising to 40) if the currency pair linearly rose from current spot to this hypothetical trigger level in the next two weeks.

Similarly, for pairs currently in an uptrend (MAA > 60), the trigger level would be the hypothetical spot level that would reverse the trend to neutral (MAA falling to 60) if the currency pair linearly fell from current spot to this hypothetical trigger level in the next two weeks. An example from Exhibit 7 would be USDCHF. A downtrend has formed for this pair in March 2025, but spot selloff was unable to break below the 200d SMA. The downtrend started to lose steam and the trigger level suggest short positions would be unwound if spot price does not see further decline in the next 2 weeks.

In Exhibit 7 if the prevailing spot price is within 0.1% of either the take-profit or trigger levels, the corresponding cells would be colored in grey.

Trending and mean-reversion technical signals

In addition to MAA, UD, and RS, the technical analysts in the industry have also derived other indicators that we could use to support the positioning analysis signals. For the Technical Matrix, we employ the ADX (Average Directional Movement) and Bollinger Bands indicators. To learn more about a variety of technical strategies, please see Technicals Explained primer (see our report: [Technicals Explained: In 2024, get to know technical strategy 05 January 2024](#)), as well as our Quantifying Technicals publications for the ADX (see our report: [Quantifying Technicals: 25 April 2022](#)) and Bollinger indicators (see our report: [Quantifying Technicals: 24 January 2022](#)).

Use ADX Trend in addition to the positioning trend

The ADX is determined by a secondary indicator called DMI (Directional Movement Index). The DMI consists of two lines: DMI Plus and DMI Minus. The DMI Plus line tends to move higher on rising prices, while the DMI Minus line tends to move higher on falling prices. When the DMI Plus crosses above the DMI Minus, the start of a new uptrend is formed. In contrary, when the DMI Minus crosses above the DMI Plus, the start of a new downtrend is formed.

The ADX is a combination of the DMI lines and is used to define the path of prices as range bound or trending. Rising ADX indicates the current trend is gaining strength, while falling ADX indicates the current trend is weakening. When the ADX is below 20, the Technical Matrix ADX column would show “Range”, suggesting the pair does not have prominent trend. When the ADX is between 20 and 25, the Technical Matrix shows “Transition” (in grey), suggesting the pair may be transitioning between up and down trends. When the ADX is above 25, the Technical Matrix shows either “Uptrend” (in green) or “Downtrend” (in red) depending on whether DMI Plus is above or below DMI Minus. The “Uptrend” and “Downtrend” cells in this column would have more intense coloring if the ADX trend is in the same direction as the MAA trend (Positioning Trend column). As the ADX and DMI indicators in the Technical Matrix are calculated using 14-day open-high-low-close (OHLC) spot prices, the ADX trend may appear to be different at times with the trend determined by the longer-dated MAA, as the MAA positioning trend is determined by moving average crossings (through 200d SMA).

Use Bollinger Bands as another directional signal

The Bollinger Band consists of three lines: a moving average of price, two standard deviations above the moving average and two standard deviations below. For the Technical Matrix, we calculate Bollinger bands with a 20-day simple moving average. The bands often serve as an estimate of support and resistance levels. When markets are range bound, prices tend to trade between the bands. But when spot is edging close to the bands or breaks out of the Bollinger range, a more significant trend would form. As a result, the Bollinger Bands column in the Technical Matrix shows “Lower” (in red) when the spot price is below the lower band and “Upper” (in green) when the spot price is above the upper band. It should also be noted that when the bands are narrow relative to

the past and prices break out through a band then a new trend and trade in the direction of the breakout is signaled. We would examine the Bollinger band in conjunction with the Bullish/Bearish signals from positioning analysis.

Key levels to watch: Next Support and Next Resistance

Finally, the Technical Matrix uses 50d SMA, 100d SMA, 200d SMA, 1y high and low, 2y high and low, 1y 38.2%, 50%, and 61.8% Fibonacci retracement levels to determine the next support and resistance levels that investors should consider. Cells in these columns are colored in grey if the displayed spot price is within 0.5% from the next support and resistance levels.

CARS Signals

In 2022, we released the CARS (Cross-Asset Regime Switching) model (see our report: [FX Viewpoint: CARS model: weekly FX cross-asset drivers 22 June 2022](#)). It is a systematic model that makes weekly buy/sell decisions for G10 currencies based on cross-asset: equity, rates, and commodity factors (Exhibit 11).

Identify macro shock periods to weather volatility

The CARS model classifies each week as either normal or one with a “macro shock”. The model defines a “macro shock” as sharp declines in at least one of the following cross asset factors: equity returns, global yields or commodity prices. Conceptually, if the market expects an economic slowdown ahead, the equities fall as growth slows, yields fall as monetary policy becomes more dovish and commodity falls amid slower demand. The model assumes G10 FX behaves differently when there are macro shocks. The market is typically trend-following and accumulates long positions in normal times (also known as “risk-on”), which may be quickly unwound during a flight to quality or a “risk-off” episode during a macro shock.

Our macro-shock component not only gains from the “flight-to-quality” behavior exhibited during periods of systematic shocks, but also helps the model reduce the potential loss from retracement and volatility that tends to occur with systematic shocks as well.

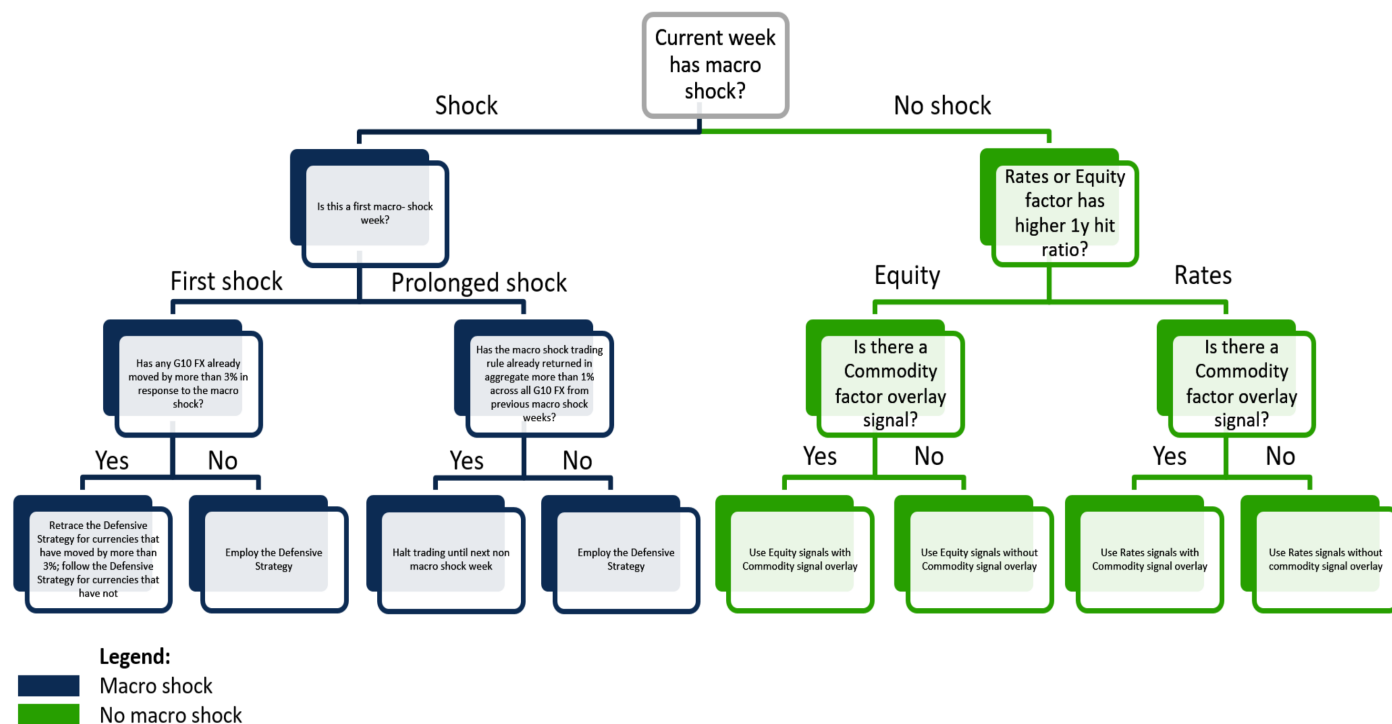
Performance-based cross-asset factor selection for normal weeks

In normal weeks, ie, without a macro shock, the CARS model is designed to determine whether to prioritize the equity risk factor or the rates risk factor to trade G10 FX based on the 1y rolling performance of each. In addition, we introduce a commodity factor overlay to the equity vs rates factor selection process. The “normal week” cross-asset component improves upon our existing models by considering commodities as a driver for FX and assuming a dynamic relationship between FX and other asset classes over time.



Exhibit 11: The CARS model uses weekly trading rules based on different regimes

Graphic representation of the macro-shock and the cross-asset components for the CARS model



Defensive Strategy: for the CARS model, we define the defensive strategy as the act of buying JPY and CHF vs the USD, and selling rest of G10 FX vs the USD.

Source: BofA Global Research, Bloomberg

BofA GLOBAL RESEARCH

Recent CARS model performance

Performance for the model has notably picked up over the past 6 months. Exhibit 12 shows the model's performance has improved both in terms of hit ratio of weekly signals and Sharpe ratio of cumulative returns. Breaking down signal performance by factors, Exhibit 13 shows the equity factor has contributed to most of the model's recent outperformance.

Since the US election, the model notably shifted out of a rates regime into equity regime and started to generate weekly bullish/bearish signals for FX based on based on global equity market performances. The model exited rates regime in a timely manner, as it has occurred around the same time as the Fed paused rate cuts and market attentions shifted towards US tariffs. Equity factor had outperformed rates factor in our backtest, so exiting the rates-driven regime to an extent helped with the overall model performance. The USD's rally amid US equity rally in Q4 2024 and subsequently selling off amid lower US equities in Q1 2025 explains the equity factor's outperformance.

Exhibit 12: Recent 6m model performance has been better than in the past

Model performance in recent history

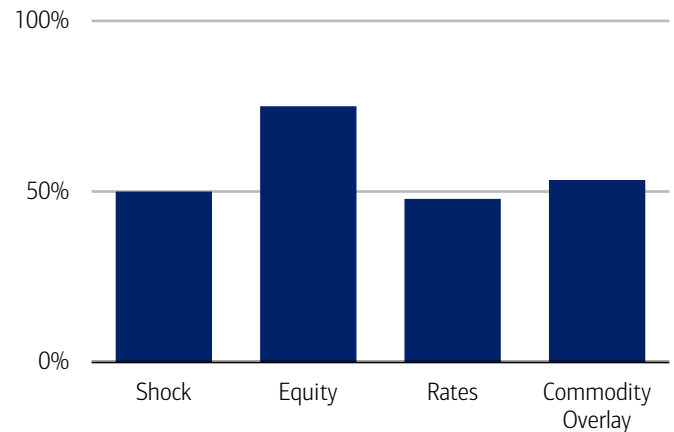
	hit ratio	Sharpe ratio
3m	69%	2.5
6m	71%	2.9
1y	55%	1.1
5y	56%	0.6

Source: BofA Global Research, Bloomberg. The performance at 5y lookback includes backtested performance from 2020 to June 2022.

BofA GLOBAL RESEARCH

Exhibit 13: Equity factor contributed to model performance

1y hit ratio of CARS model subcomponents



Source: BofA Global Research, Bloomberg

BofA GLOBAL RESEARCH

Normal weeks: FX signals depend on cross-asset drivers

Every week, the CARS model produces a dashboard showing the latest bullish/bearish signals for G10 FX and the cross-asset stylized statistics. Exhibit 14 shows an example of how the dashboard would look for a no-macro shock week. The week of February 24, 2025 was a normal week with the equity factor having a greater 1y rolling hit ratio than the rates factor hit ratio. As a result, CARS was bullish CHF and NOK vs the AUD and NZD as the back of 1-week equity performance divergence. From February 24 to March 3, the USD broadly weakened vs European currencies but still rallied vs AUD and NZD.

Exhibit 14: Model was bullish CHF and NOK vs bearish AUD and NZD on relative equity performance

CARS signals for rates regime week as of February 24 2025

Currency	Bullish/Bearish	Equity	Rates	Commodity	Global regime	Values
EUR		3	10	6	Commodity z-score	-0.1
JPY		5	1	8	Performing factor	Equity
GBP		7	4	7		
AUD	Bearish	9	3	3		
CAD		6	6	2	USD Equity	8
CHF	Bullish	1	9	9	USD Rates	8
NZD	Bearish	10	7	4		
SEK		4	5	5		
NOK	Bullish	2	2	1		

Source: BofA Global Research, Bloomberg. The Equity ranking is ordered by 5y z-score of 1-week equity return. The Rates ranking is ordered by 5y z-score of 1-week rate change and level of 2y swap rate. The Commodity ranking is ordered by 52-week FX correlation with BCOM. The Commodity z-score is the 1y z-score of 1-week BCOM Index return.

BofA GLOBAL RESEARCH

Macro-shock weeks: model would trades G10 FX in a risk-off fashion

As macro-shock and normal weeks are mutually exclusive, a different dashboard shows signals for normal weeks. Exhibit 15 shows an example of how the dashboard would look for a macro-shock week. The week of March 17, 2025, CARS model moved to the macro shock regime since the US equity risk-off in March has exceeded -1 z-scores in the model. For the subsequent week, the model looked to stay bullish USD vs the cyclically-sensitive G10 currencies.



Exhibit 15: The model generated a macro shock signal for March 17 2025 as US equity sold off

CARS signals for a macro-shock week as of March 17 2025

Currency	Bullish/Bearish	Equity Shock	Rates Shock	Global regime	z-score
EUR	Bearish	0.5	-0.1	Commodity Shock	0.5
JPY	Bullish	-0.8	-2.1	S&P 500	-1.3
GBP	Bearish	0.1	0.0	US Treasury	0.9
AUD	Bearish	-1.2	-0.1		
CAD	Bearish	-0.7	0.0		
CHF	Bullish	1.4	0.0		
NZD	Bearish	-1.6	0.5		
SEK	Bearish	0.1	0.0		
NOK	Bearish	0.1	0.2		

Source: BofA Global Research, Bloomberg. This "macro shock" example is from March 17 2025.

The chart shows bull/bear signals for G10 FX versus the USD based on cross-asset shocks. Factor cells are colored in red if equity/rates z-scores are below -1 and commodity z-score is below -2.

BofA GLOBAL RESEARCH



Interactive Time Zone

Breaking down currency performance by time zones can help investors better understand the sources of key flows. For example, private cross-border portfolio investment flows or reserve rebalancing related flows at any given time can be important drivers of FX movement. In addition, as FX is traded around the clock, understanding price action by currency and time zone can be useful for investors considering strategic hedges or expressing a directional view.

Split a 24-hour day to regional America, Europe, and Asia time zones

In our weekly FX Quant Insight report, we present an interactive Tableau dashboard that allows investors to examine currency cumulative returns vs the USD at different lookback periods, currency groupings, and time zones. Hours are shown in Coordinated Universal Time (UTC). We define America time zone as 1pm-12am UTC (9am-8pm EDT), Europe time zone as between 8am-1pm UTC (4am-9am EDT), and Asia time zone as between 12am to 8am UTC (8pm-4am EDT). The report also has a heatmap table (Exhibit 17) that shows cumulative returns over the selected horizon on a more granular 3-hour intervals (Exhibit 17).

Introduce a wider range of currencies to explore time zone effect

The first iteration of the dashboard only allowed readers to explore the interactive time zone dashboard for USD/G10 pairs. Recently, we have expanded the range of currencies to include EUR/G10 pairs once EUR is selected under the “Base” radio button, as well as major G10-crosses and EM FX under the “Other” choice for Base (Exhibit 16).

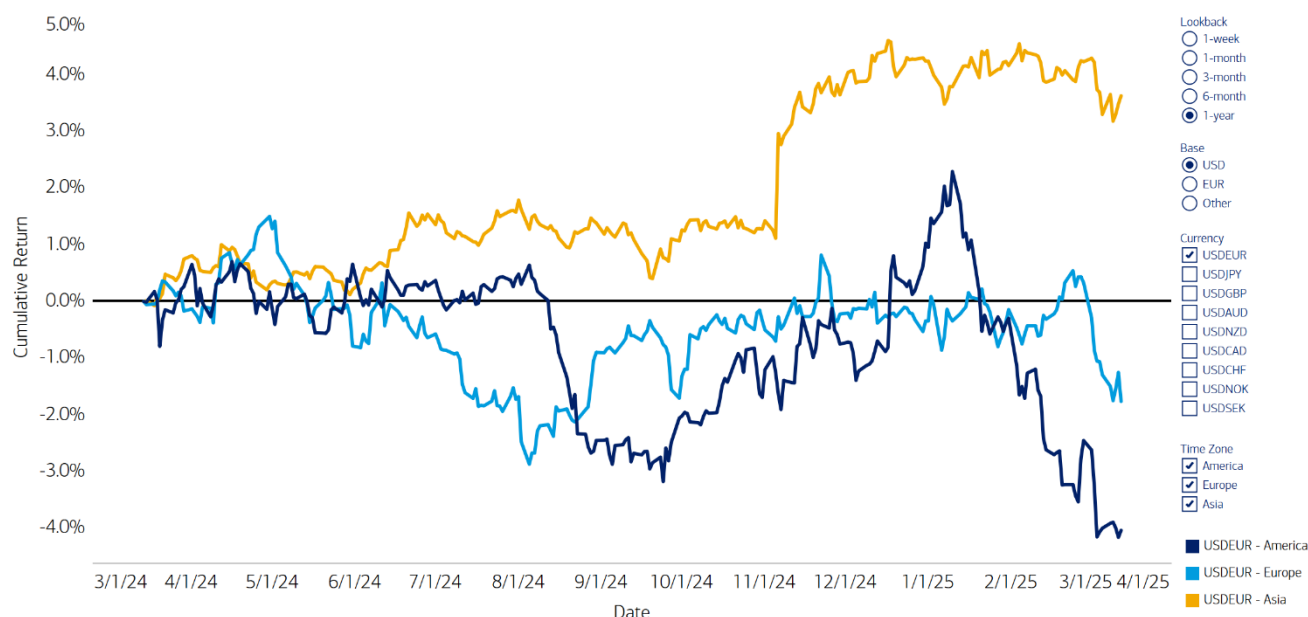
US-based investors drive USD weaker vs EUR and JPY

Exhibit 16 shows since the 2024 US election, US-based investors have been driving the EURUSD trend reversal. To the contrary, Asia-based investors bought USD vs EUR after the election and has yet to fully pare back the USD long. Exhibit 17 shows biggest intraday USDJPY selloffs have also occurred during US trading hours (12pm-3pm UTC), for a cumulative loss of -6.3% over the past year, as US-based investors grew more concerned with the US growth slowdown.



Exhibit 16: US-based investors are driving the USD weaker; Asia-based investors remained long USD vs EUR

For readers of the web-formatted version of this report, access interactive features of the visualization by clicking on the image. Use the Google Chrome or Microsoft Edge browser for the best experience



We denote America time zone as between 1pm to 12am UTC, Europe time zone as between 8am to 1pm UTC, and Asia time zone as between 12am to 8am UTC.

Source: BofA Global Research. As of March 17 2025.

BofA GLOBAL RESEARCH

Exhibit 17: JPY demand has been highest in US trading hours (12pm-3pm UTC) over the past year

For readers of the web-formatted version of this report, access interactive features of the visualization by clicking on the image. Use the Google Chrome or Microsoft Edge browser for the best experience

	0am-3am	3am-6am	6am-9am	9am-12pm	12pm-3pm	3pm-6pm	6pm-9pm	9pm-0am
USDEUR	1.0%	2.3%	-2.7%	0.2%	-1.2%	0.9%	-0.9%	-1.7%
USDJPY	3.3%	-4.0%	1.0%	2.3%	-6.3%	1.4%	0.7%	-2.5%
USDGBP	1.8%	2.7%	-2.0%	0.1%	-0.9%	-1.9%	-2.1%	-1.0%
USDAUD	-1.2%	3.1%	-0.9%	-0.1%	0.3%	2.0%	0.8%	0.0%
USDNZD	2.2%	5.1%	-4.4%	3.0%	-1.3%	-0.1%	0.0%	-0.4%
USDCAD	2.1%	2.6%	-1.1%	0.9%	1.0%	-1.9%	2.6%	-1.9%
USDCHF	0.8%	-1.0%	0.1%	1.4%	-1.9%	0.8%	-0.5%	-1.4%
USDNOK	1.6%	3.0%	-4.1%	-2.8%	3.4%	0.7%	-2.7%	0.2%
USDSEK	-1.4%	-1.0%	2.4%	-4.5%	2.8%	1.2%	-2.8%	-0.7%

Hours are as of UTC. Currency pairs with greater loss over the lookback period are colored in darker red. Currency pairs with greater gain over the lookback period are colored in darker green. We denote America time zone as between 1pm to 12am UTC, Europe time zone as between 8am to 1pm UTC, and Asia time zone as between 12am to 8am UTC.

Source: BofA Global Research. As of March 17 2025.

BofA GLOBAL RESEARCH

Disclosures

Important Disclosures

BofA Global Research personnel (including the analyst(s) responsible for this report) receive compensation based upon, among other factors, the overall profitability of Bank of America Corporation, including profits derived from investment banking. The analyst(s) responsible for this report may also receive compensation based upon, among other factors, the overall profitability of the Bank's sales and trading businesses relating to the class of securities or financial instruments for which such analyst is responsible. BofA Securities fixed income analysts regularly interact with sales and trading desk personnel in connection with their research, including to ascertain pricing and liquidity in the fixed income markets.

Other Important Disclosures

Prices are indicative and for information purposes only. Except as otherwise stated in the report, for any recommendation in relation to an equity security, the price referenced is the publicly traded price of the security as of close of business on the day prior to the date of the report or, if the report is published during intraday trading, the price referenced is indicative of the traded price as of the date and time of the report and in relation to a debt security (including equity preferred and CDS), prices are indicative as of the date and time of the report and are from various sources including BofA Securities trading desks.

The date and time of completion of the production of any recommendation in this report shall be the date and time of dissemination of this report as recorded in the report timestamp.

This report may refer to fixed income securities or other financial instruments that may not be offered or sold in one or more states or jurisdictions, or to certain categories of investors, including retail investors. Readers of this report are advised that any discussion, recommendation or other mention of such instruments is not a solicitation or offer to transact in such instruments. Investors should contact their BofA Securities representative or Merrill Global Wealth Management financial advisor for information relating to such instruments. Rule 144A securities may be offered or sold only to persons in the U.S. who are Qualified Institutional Buyers within the meaning of Rule 144A under the Securities Act of 1933, as amended. SECURITIES OR OTHER FINANCIAL INSTRUMENTS DISCUSSED HEREIN MAY BE RATED BELOW INVESTMENT GRADE AND SHOULD THEREFORE ONLY BE CONSIDERED FOR INCLUSION IN ACCOUNTS QUALIFIED FOR SPECULATIVE INVESTMENT.

Recipients who are not institutional investors or market professionals should seek the advice of their independent financial advisor before considering information in this report in connection with any investment decision, or for a necessary explanation of its contents.

The securities or other financial instruments discussed in this report may be traded over-the-counter. Retail sales and/or distribution of this report may be made only in states where these instruments are exempt from registration or have been qualified for sale.

Officers of BofAS or one or more of its affiliates (other than research analysts) may have a financial interest in securities of the issuer(s) or in related investments.

This report, and the securities or other financial instruments discussed herein, may not be eligible for distribution or sale in all countries or to certain categories of investors, including retail investors.

Refer to [BofA Global Research policies relating to conflicts of interest](#).

"BofA Securities" includes BofA Securities, Inc. ("BofAS") and its affiliates. Investors should contact their BofA Securities representative or Merrill Global Wealth Management financial advisor if they have questions concerning this report or concerning the appropriateness of any investment idea described herein for such investor. "BofA Securities" is a global brand for BofA Global Research.

Information relating to Non-US affiliates of BofA Securities and Distribution of Affiliate Research Reports:

BofAS and/or Merrill Lynch, Pierce, Fenner & Smith Incorporated ("MLPF&S") may in the future distribute, information of the following non-US affiliates in the US (short name: legal name, regulator): Merrill Lynch (South Africa): Merrill Lynch South Africa (Pty) Ltd., regulated by The Financial Service Board; MLI (UK): Merrill Lynch International, regulated by the Financial Conduct Authority (FCA) and the Prudential Regulation Authority (PRA); BofASE (France): BofA Securities Europe SA is authorized by the Autorité de Contrôle Prudentiel et de Résolution (ACPR) and regulated by the ACPR and the Autorité des Marchés Financiers (AMF). BofA Securities Europe SA ("BofASE") with registered address at 51, rue La Boétie, 75008 Paris is registered under no 842 602 690 RCS Paris. In accordance with the provisions of French Code Monétaire et Financier (Monetary and Financial Code), BofASE is an établissement de crédit et d'investissement (credit and investment institution) that is authorised and supervised by the European Central Bank and the Autorité de Contrôle Prudentiel et de Résolution (ACPR) and regulated by the ACPR and the Autorité des Marchés Financiers. BofASE's share capital can be found at www.bofam.com/BofASEdisclaimer; BofA Europe (Milan): Bank of America Europe Designated Activity Company, Milan Branch, regulated by the Bank of Italy, the European Central Bank (ECB) and the Central Bank of Ireland (CBI); BofA Europe (Frankfurt): Bank of America Europe Designated Activity Company, Frankfurt Branch regulated by BaFin, the ECB and the CBI; BofA Europe (Madrid): Bank of America Europe Designated Activity Company, Sucursal en España, regulated by the Bank of Spain, the ECB and the CBI; Merrill Lynch (Australia): Merrill Lynch Equities (Australia) Limited, regulated by the Australian Securities and Investments Commission; Merrill Lynch (Hong Kong): Merrill Lynch (Asia Pacific) Limited, regulated by the Hong Kong Securities and Futures Commission (HKSF); Merrill Lynch (Singapore): Merrill Lynch (Singapore) Pte Ltd, regulated by the Monetary Authority of Singapore (MAS); Merrill Lynch (Canada): Merrill Lynch Canada Inc, regulated by the Canadian Investment Regulatory Organization; Merrill Lynch (Mexico): Merrill Lynch Mexico, SA de CV, Casa de Bolsa, regulated by the Comisión Nacional Bancaria y de Valores; BofAS Japan: BofA Securities Japan Co., Ltd., regulated by the Financial Services Agency; Merrill Lynch (Seoul): Merrill Lynch International, LLC Seoul Branch, regulated by the Financial Supervisory Service; Merrill Lynch (Taiwan): Merrill Lynch Securities (Taiwan) Ltd., regulated by the Securities and Futures Bureau; BofAS India: BofA Securities India Limited, regulated by the Securities and Exchange Board of India (SEBI); Merrill Lynch (Israel): Merrill Lynch Israel Limited, regulated by Israel Securities Authority; Merrill Lynch (DIFC): Merrill Lynch International (DIFC Branch), regulated by the Dubai Financial Services Authority (DFSA); Merrill Lynch (Brazil): Merrill Lynch S.A. Corretora de Títulos e Valores Mobiliários, regulated by Comissão de Valores Mobiliários; Merrill Lynch KSA Company: Merrill Lynch Kingdom of Saudi Arabia Company, regulated by the Capital Market Authority. This information: has been approved for publication and is distributed in the United Kingdom (UK) to professional clients and eligible counterparties (as each is defined in the rules of the FCA and the PRA) by MLI (UK), which is authorized by the PRA and regulated by the FCA and the PRA - details about the extent of our regulation by the FCA and PRA are available from us on request; has been approved for publication and is distributed in the European Economic Area (EEA) by BofASE (France), which is authorized by the ACPR and regulated by the ACPR and the AMF; has been considered and distributed in Japan by BofAS Japan, a registered securities dealer under the Financial Instruments and Exchange Act in Japan, or its permitted affiliates; is issued and distributed in Hong Kong by Merrill Lynch (Hong Kong) which is regulated by HKSF; is issued and distributed in Taiwan by Merrill Lynch (Taiwan); is issued and distributed in India by BofAS India; and is issued and distributed in Singapore to institutional investors and/or accredited investors (each as defined under the Financial Advisers Regulations) by Merrill Lynch (Singapore) (Company Registration No 198602883D). Merrill Lynch (Singapore) is regulated by MAS. Merrill Lynch Equities (Australia) Limited (ABN 65 006 276 795), AFS License 235132 (MLEA) distributes this information in Australia only to 'Wholesale' clients as defined by s.761G of the Corporations Act 2001. With the exception of Bank of America N.A., Australia Branch, neither MLEA nor any of its affiliates involved in preparing this information is an Authorised Deposit-Taking Institution under the Banking Act 1959 nor regulated by the Australian Prudential Regulation Authority. No approval is required for publication or distribution of this information in Brazil and its local distribution is by Merrill Lynch (Brazil) in accordance with applicable regulations. Merrill Lynch (DIFC) is authorized and regulated by the DFSA. Information prepared and issued by Merrill Lynch (DIFC) is done so in accordance with the requirements of the DFSA conduct of business rules. BofA Europe (Frankfurt) distributes this information in Germany and is regulated by BaFin, the ECB and the CBI. BofA Securities entities, including BofA Europe and BofASE (France), may outsource/delegate the marketing and/or provision of certain research services or aspects of research services to other branches or members of the BofA Securities group. You may be contacted by a different BofA Securities entity acting for and on behalf of your service provider where permitted by applicable law. This does not change your service provider. Please refer to the [Electronic Communications Disclaimers](#) for further information.

This information has been prepared and issued by BofAS and/or one or more of its non-US affiliates. The author(s) of this information may not be licensed to carry on regulated activities in your jurisdiction and, if not licensed, do not hold themselves out as being able to do so. BofAS and/or MLPF&S is the distributor of this information in the US and accepts full responsibility for information distributed to BofAS and/or MLPF&S clients in the US by its non-US affiliates. Any US person receiving this information and wishing to effect any transaction in any security discussed herein should do so through BofAS and/or MLPF&S and not such foreign affiliates. Hong Kong recipients of this information should contact Merrill Lynch (Asia Pacific) Limited in



respect of any matters relating to dealing in securities or provision of specific advice on securities or any other matters arising from, or in connection with, this information. Singapore recipients of this information should contact Merrill Lynch (Singapore) Pte Ltd in respect of any matters arising from, or in connection with, this information. For clients that are not accredited investors, expert investors or institutional investors Merrill Lynch (Singapore) Pte Ltd accepts full responsibility for the contents of this information distributed to such clients in Singapore.

General Investment Related Disclosures:

Taiwan Readers: Neither the information nor any opinion expressed herein constitutes an offer or a solicitation of an offer to transact in any securities or other financial instrument. No part of this report may be used or reproduced or quoted in any manner whatsoever in Taiwan by the press or any other person without the express written consent of BofA Securities.

This document provides general information only, and has been prepared for, and is intended for general distribution to, BofA Securities clients. Neither the information nor any opinion expressed constitutes an offer or an invitation to make an offer, to buy or sell any securities or other financial instrument or any derivative related to such securities or instruments (e.g., options, futures, warrants, and contracts for differences). This document is not intended to provide personal investment advice and it does not take into account the specific investment objectives, financial situation and the particular needs of, and is not directed to, any specific person(s). This document and its content do not constitute, and should not be considered to constitute, investment advice for purposes of ERISA, the US tax code, the Investment Advisers Act or otherwise. Investors should seek financial advice regarding the appropriateness of investing in financial instruments and implementing investment strategies discussed or recommended in this document and should understand that statements regarding future prospects may not be realized. Any decision to purchase or subscribe for securities in any offering must be based solely on existing public information on such security or the information in the prospectus or other offering document issued in connection with such offering, and not on this document.

Securities and other financial instruments referred to herein, or recommended, offered or sold by BofA Securities, are not insured by the Federal Deposit Insurance Corporation and are not deposits or other obligations of any insured depository institution (including, Bank of America, N.A.). Investments in general and, derivatives, in particular, involve numerous risks, including, among others, market risk, counterparty default risk and liquidity risk. No security, financial instrument or derivative is suitable for all investors. Digital assets are extremely speculative, volatile and are largely unregulated. In some cases, securities and other financial instruments may be difficult to value or sell and reliable information about the value or risks related to the security or financial instrument may be difficult to obtain. Investors should note that income from such securities and other financial instruments, if any, may fluctuate and that price or value of such securities and instruments may rise or fall and, in some cases, investors may lose their entire principal investment. Past performance is not necessarily a guide to future performance. Levels and basis for taxation may change.

Futures and options are not appropriate for all investors. Such financial instruments may expire worthless. Before investing in futures or options, clients must receive the appropriate risk disclosure documents. Investment strategies explained in this report may not be appropriate at all times. Costs of such strategies do not include commission or margin expenses.

BofA Securities is aware that the implementation of the ideas expressed in this report may depend upon an investor's ability to "short" securities or other financial instruments and that such action may be limited by regulations prohibiting or restricting "shortselling" in many jurisdictions. Investors are urged to seek advice regarding the applicability of such regulations prior to executing any short idea contained in this report.

This report may contain a trading idea or recommendation which highlights a specific identified near-term catalyst or event impacting a security, issuer, industry sector or the market generally that presents a transaction opportunity, but does not have any impact on the analyst's particular "Overweight" or "Underweight" rating (which is based on a three month trade horizon). Trading ideas and recommendations may differ directionally from the analyst's rating on a security or issuer because they reflect the impact of a near-term catalyst or event.

Foreign currency rates of exchange may adversely affect the value, price or income of any security or financial instrument mentioned in this report. Investors in such securities and instruments effectively assume currency risk.

BofAS or one of its affiliates is a regular issuer of traded financial instruments linked to securities that may have been recommended in this report. BofAS or one of its affiliates may, at any time, hold a trading position (long or short) in the securities and financial instruments discussed in this report.

BofA Securities, through business units other than BofA Global Research, may have issued and may in the future issue trading ideas or recommendations that are inconsistent with, and reach different conclusions from, the information presented herein. Such ideas or recommendations may reflect different time frames, assumptions, views and analytical methods of the persons who prepared them, and BofA Securities is under no obligation to ensure that such other trading ideas or recommendations are brought to the attention of any recipient of this information.

In the event that the recipient received this information pursuant to a contract between the recipient and BofAS for the provision of research services for a separate fee, and in connection therewith BofAS may be deemed to be acting as an investment adviser, such status relates, if at all, solely to the person with whom BofAS has contracted directly and does not extend beyond the delivery of this report (unless otherwise agreed specifically in writing by BofAS). If such recipient uses the services of BofAS in connection with the sale or purchase of a security referred to herein, BofAS may act as principal for its own account or as agent for another person. BofAS is and continues to act solely as a broker-dealer in connection with the execution of any transactions, including transactions in any securities referred to herein.

Copyright and General Information:

Copyright 2025 Bank of America Corporation. All rights reserved. iQDatabase® is a registered service mark of Bank of America Corporation. This information is prepared for the use of BofA Securities clients and may not be redistributed, retransmitted or disclosed, in whole or in part, or in any form or manner, without the express written consent of BofA Securities. This document and its content is provided solely for informational purposes and cannot be used for training or developing artificial intelligence (AI) models or as an input in any AI application (collectively, an AI tool). Any attempt to utilize this document or any of its content in connection with an AI tool without explicit written permission from BofA Global Research is strictly prohibited. BofA Global Research information is distributed simultaneously to internal and client websites and other portals by BofA Securities and is not publicly-available material. Any unauthorized use or disclosure is prohibited. Receipt and review of this information constitutes your agreement not to redistribute, retransmit, or disclose to others the contents, opinions, conclusion, or information contained herein (including any investment recommendations, estimates or price targets) without first obtaining express permission from an authorized officer of BofA Securities.

Materials prepared by BofA Global Research personnel are based on public information. Facts and views presented in this material have not been reviewed by, and may not reflect information known to, professionals in other business areas of BofA Securities, including investment banking personnel. BofA Securities has established information barriers between BofA Global Research and certain business groups. As a result, BofA Securities does not disclose certain client relationships with, or compensation received from, such issuers. To the extent this material discusses any legal proceeding or issues, it has not been prepared as nor is it intended to express any legal conclusion, opinion or advice. Investors should consult their own legal advisers as to issues of law relating to the subject matter of this material. BofA Global Research personnel's knowledge of legal proceedings in which any BofA Securities entity and/or its directors, officers and employees may be plaintiffs, defendants, co-defendants or co-plaintiffs with or involving issuers mentioned in this material is based on public information. Facts and views presented in this material that relate to any such proceedings have not been reviewed by, discussed with, and may not reflect information known to, professionals in other business areas of BofA Securities in connection with the legal proceedings or matters relevant to such proceedings.

This information has been prepared independently of any issuer of securities mentioned herein and not in connection with any proposed offering of securities or as agent of any issuer of any securities. None of BofAS any of its affiliates or their research analysts has any authority whatsoever to make any representation or warranty on behalf of the issuer(s). BofA Global Research policy prohibits research personnel from disclosing a recommendation, investment rating, or investment thesis for review by an issuer prior to the publication of a research report containing such rating, recommendation or investment thesis.

Any information relating to sustainability in this material is limited as discussed herein and is not intended to provide a comprehensive view on any sustainability claim with respect to any issuer or security.

Any information relating to the tax status of financial instruments discussed herein is not intended to provide tax advice or to be used by anyone to provide tax advice. Investors are urged to seek tax advice based on their particular circumstances from an independent tax professional.

The information herein (other than disclosure information relating to BofA Securities and its affiliates) was obtained from various sources and we do not guarantee its accuracy. This information may contain links to third-party websites. BofA Securities is not responsible for the content of any third-party website or any linked content contained in a third-party website. Content contained on such third-party websites is not part of this information and is not incorporated by reference. The inclusion of a link does not imply any endorsement by or any affiliation with BofA Securities. Access to any third-party website is at your own risk, and you should always review the terms and privacy policies at third-party websites before submitting any personal information to them. BofA Securities is not responsible for such terms and privacy policies and expressly disclaims any liability for them.

All opinions, projections and estimates constitute the judgment of the author as of the date of publication and are subject to change without notice. Prices also are subject to change without notice. BofA Securities is under no obligation to update this information and BofA Securities ability to publish information on the subject issuer(s) in the future is subject to applicable quiet periods. You should therefore assume that BofA Securities will not update any fact, circumstance or opinion contained herein.

Certain outstanding reports or investment opinions relating to securities, financial instruments and/or issuers may no longer be current. Always refer to the most recent research report relating to an issuer prior to making an investment decision.

In some cases, an issuer may be classified as Restricted or may be Under Review or Extended Review. In each case, investors should consider any investment opinion relating to such issuer (or

its security and/or financial instruments) to be suspended or withdrawn and should not rely on the analyses and investment opinion(s) pertaining to such issuer (or its securities and/or financial instruments) nor should the analyses or opinion(s) be considered a solicitation of any kind. Sales persons and financial advisors affiliated with BofAS or any of its affiliates may not solicit purchases of securities or financial instruments that are Restricted or Under Review and may only solicit securities under Extended Review in accordance with firm policies. Neither BofA Securities nor any officer or employee of BofA Securities accepts any liability whatsoever for any direct, indirect or consequential damages or losses arising from any use of this information.

