

Global Rates and FX Primer

FX Volatility Dashboard Primer

Primer

Unveil the mystery of FX vol

We recently launched the [FX Volatility Dashboard](#), a visualization tool that provides daily end-of-day snapshot of the market dynamic for FX vols. According to the latest BIS Triennial Central Bank Survey, daily turnover for the FX options only accounted for 4% of the entire global FX market in 2019. However, unlike FX spot prices, FX implied volatilities tend to fluctuate much more drastically during critical market-moving events, potentially allowing investors to capture higher returns at a lower cost.

We believe it is imperative for investors to be able to understand and identify the biggest dislocations for FX vols with a holistic and effective visualization tool. As a result, we introduce the dashboards to provide clear at-a-glance vol market update, as well as help clients identify the latest dislocations in FX volatilities across currency pairs and tenors.

Exhibit 1: FX Volatility Dashboard

A screenshot of the interactive visualization tool to identify the dislocations in FX vol market

Implied Volatility Levels (Cell Color Shows Intensity of Im - Re Vol Spread)										?
Category	Currency	1M Implied		3M Implied		6M Implied		1Y Implied		
G10	EURUSD	4.8	+0.97	5.1	+0.68	5.2	+0.03	5.5	-0.25	
	USDJPY	5.6	-0.26	5.9	+0.52	6.1	+0.86	6.3	+0.92	
	GBPUSD	7.0	-0.62	7.2	+0.39	7.4	+0.64	7.6	+0.29	
	AUDUSD	9.1	+0.82	8.9	+0.32	9.1	+0.45	9.4	+0.17	
	NZDUSD	9.4	+0.19	9.5	-0.23	9.5	-0.34	9.7	-0.10	
	USDCAD	6.7	-0.63	6.8	-1.14	6.8	-0.47	6.8	+0.05	
	USDCHF	6.1	-0.16	6.2	-0.29	6.3	-0.10	6.3	-0.18	
	USDNOK	10.1	-0.07	10.6	-0.74	10.8	-0.41	10.9	-1.06	
	USDSEK	7.4	+0.72	7.7	+0.73	8.0	-0.41	8.3	-0.41	
	EUR-pairs	EURJPY	5.8	+0.22	6.0	+1.05	6.3	+1.32	6.8	+1.34
EURGBP		5.4	-0.31	5.6	+0.68	5.8	+0.59	6.0	-0.11	
EURAUD		6.9	+0.42	6.9	+0.20	7.1	+0.96	7.5	+0.83	
EURNZD		7.5	+0.95	7.5	-0.02	7.5	+0.18	7.8	+0.51	
EURCAD		6.0	+0.10	6.1	-0.62	6.2	-0.14	6.4	+0.31	
EURCHF		3.9	-0.79	4.1	-0.19	4.3	+0.64	4.7	+1.04	
EURNOK		8.0	+0.41	8.2	-0.76	8.3	+0.51	8.5	-0.10	
EURSEK		4.3	+0.12	4.7	+0.85	5.1	+0.72	5.5	+0.56	
G10 cross	NOKSEK	7.1	+0.60	7.2	+0.08	7.2	+0.69	7.2	+0.03	
	AUDJPY	9.6	+1.38	9.6	+0.36	9.9	+1.75	10.2	+1.47	
	AUDNZD	5.3	+1.83	5.1	+0.91	5.1	+1.13	5.2	-0.89	
	AUDCAD	6.3	+1.76	6.4	+1.04	6.6	+0.63	6.8	+0.56	
EM	USDMXN	10.5	+3.22	10.8	+3.03	11.1	+2.03	11.3	+0.21	
	USDBRL	15.7	-0.35	16.3	+0.29	16.9	+1.13	17.6	+0.69	
	USDZAR	15.3	+2.09	15.5	+1.35	15.7	+2.29	15.8	+1.89	
	USDCNY	3.9	+1.30	4.1	+1.37	4.6	+1.63	5.0	+1.19	
	USDINR	4.7	+0.98	5.1	+1.27	5.6	+0.97	6.1	+1.30	
	USD RUB	9.4	+2.53	9.9	+3.39	10.6	+2.74	11.4	+1.07	

Implied - Realized Vol

Source: BofA Securities, BofA Global Research

Cheap -3.00 Rich +3.00

Source: BofA Global Research. Exhibit shows dashboard snapshot with data as of October 1st, 2021.

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06 October 2021

G10 FX Strategy
Global

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Refer to important disclosures on page 15 to 17. Analyst Certification on page 14. 12332998

Timestamp: 06 October 2021 01:00AM EDT

FX Volatility Dashboard

We recently introduced the [FX Volatility Dashboard](#), a visualization tool that provides daily end-of-day snapshot of the market dynamic for FX vols. The aim of the dashboard is to provide clear at-a-glance vol market update, as well as help clients identify the latest dislocations in FX volatilities across currency pairs and tenors.

There are currently five dashboards encompassing different aspects of FX vol:

1. Volatility
2. Vol changes
3. Term structure
4. Risk reversals
5. Correlations

In this publication, we provide thorough description for all of the components in the five dashboards, using historical screenshots of the dashboard components to help with explanation of the functionality. We also illustrate how investors can formulate own market views using this visualization tool. Lastly, we will continue to iteratively add improvements and enhancements to the FX Volatility Dashboard over the next several planned phases.

Volatility Dashboard

The volatility dashboard shows the latest available end-of-day implied vol level and spread versus realized vol across major currency pairs in G10 and EM at a glance. The heatmap table displays the implied vol levels for the 1m, 3m, 6m, and 1y tenors, and the same-tenor implied-realized vol spread is shown to the right side in each cell (Exhibit 2).

In addition, the heatmap table shades each cell by the magnitude of the implied-realized vol spread. Cells with more positive spread (implied over realized) close to or above +3 are colored in darker orange, suggesting the implied vol is expensive relative to realized vol. In contrast, cells with more negative spread (implied below realized) close to or below -3 are colored in darker teal, suggesting implied vol is cheap relative to realized vol.

At a glance, Exhibit 2 (a historical snapshot as of July 30, 2021) shows that the front-end implied vols are broadly cheap. The cheapness extends to the 3m and 6m tenors for USD/G10 pairs but less so for EUR-pairs and G10 crosses. USDRUB is the exception where front-end implied vols are expensive relative to realized vols.



Exhibit 2: Heatmap table for the Volatility dashboard

Heatmap table shows level of implied vols with im-re vol spread to the right side as well as in the background cell coloring

Implied Volatility Levels (Cell Color Shows Intensity of Im - Re Vol Spread)									
Category	Currency	1M Implied		3M Implied		6M Implied		1Y Implied	
G10	EURUSD	5.2	+0.49	5.4	-0.27	5.5	-0.41	5.9	-0.09
	USDJPY	5.3	-0.59	5.5	-0.03	5.8	+0.54	6.1	+0.67
	GBPUSD	6.5	-0.35	6.7	+0.07	6.9	+0.41	7.2	-0.58
	AUDUSD	8.7	+0.59	8.8	+0.25	9.0	-0.35	9.3	-0.06
	NZDUSD	9.2	-0.98	9.1	-1.02	9.3	-1.14	9.6	-0.25
	USDCAD	6.8	-2.47	6.8	-0.51	6.8	+0.15	6.8	+0.39
	USDCHF	5.5	-0.88	5.8	-0.87	6.0	-0.84	6.2	-0.30
	USDNOK	11.4	-2.17	11.2	-0.82	11.2	-0.54	11.2	-1.21
	USDSEK	7.8	+1.18	8.0	-1.03	8.2	-0.83	8.4	-0.61
EUR-pairs	EURJPY	5.4	-0.42	5.7	+0.30	6.0	+0.73	6.6	+0.93
	EURGBP	5.2	-0.30	5.4	+0.13	5.5	+0.33	5.9	-0.54
	EURAUD	6.7	-0.46	7.0	+1.15	7.1	+0.66	7.5	+0.94
	EURNZD	7.2	-1.80	7.4	-0.39	7.4	-0.16	7.8	+0.35
	EURCAD	5.6	-2.46	5.9	-0.08	5.9	-0.17	6.3	+0.29
	EURCHF	3.4	-0.41	3.8	+0.60	4.1	+0.39	4.7	+1.24
	EURNOK	8.3	-2.97	8.3	-0.03	8.2	+0.03	8.4	-0.54
	EURSEK	4.2	+0.79	4.8	+0.42	5.1	+0.66	5.5	+0.26
G10 cross	NOKSEK	7.8	-1.93	7.5	+0.68	7.3	+0.17	7.3	-0.22
	AUDJPY	9.0	-1.50	9.2	+0.88	9.4	+0.61	9.7	+0.98
	AUDNZD	4.9	+0.02	4.9	+0.45	4.9	+0.68	4.9	+0.52
	AUDCAD	5.9	+0.63	6.2	+0.67	6.4	-0.19	6.8	+0.30
EM	USDMXN	10.3	+0.90	10.8	+0.48	11.0	-0.56	11.2	-1.27
	USDBRL	16.4	-3.04	16.6	+0.59	16.5	-0.22	16.6	-1.11
	USDZAR	14.0	-2.17	14.3	+0.22	14.8	+0.55	15.2	+0.34
	USDCNY	4.2	+0.59	4.5	+0.91	4.8	+1.43	5.2	+1.18
	USDINR	4.8	+1.42	5.3	+1.11	5.7	+0.24	6.2	+1.20
	USD RUB	9.7	+2.37	10.6	+3.41	11.3	+2.19	12.1	+0.68

Source: BofA Securities, BofA Global Research

Implied - Realized Vol

Cheap -3.00 Rich +3.00

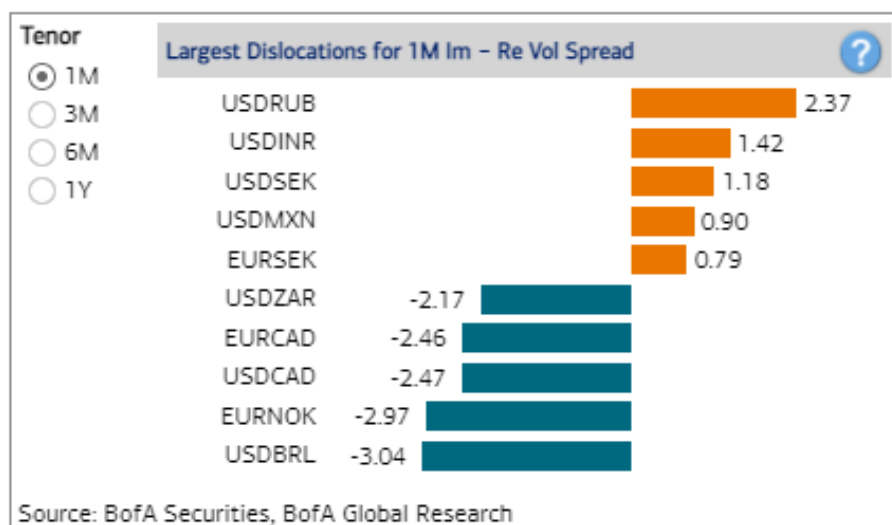
Source: BofA Global Research. Exhibit shows dashboard snapshot with data as of July 30th, 2021. Realized vols are calculated as standard deviation of the last 21, 63, 130, and 260 end-of-day spot returns respectively for the 1m, 3m, 6m, and 1y tenors.

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The Volatility page also provides users with a bar chart to summarize the top and bottom largest implied-realized volatility spreads. At the 1m tenor, USDRUB has the most expensive implied vol that is 2.37 vols above realized vol, while USDBRL is the cheapest with implied more than 3 vols below realized (Exhibit 3). Looking at this chart allows the user to analyze pairs with the most extreme shades from the heatmap table.

Exhibit 3: Top & bottom 5 vol spreads for the day

USDRUB is the most expensive and USDBRL is the cheapest at the 1m tenor



Source: BofA Global Research. Exhibit shows dashboard snapshot with data as of July 30th, 2021. Realized vols are calculated as standard deviation of the last 21, 63, 130, and 260 end-of-day spot returns respectively for the 1m, 3m, 6m, and 1y tenors.

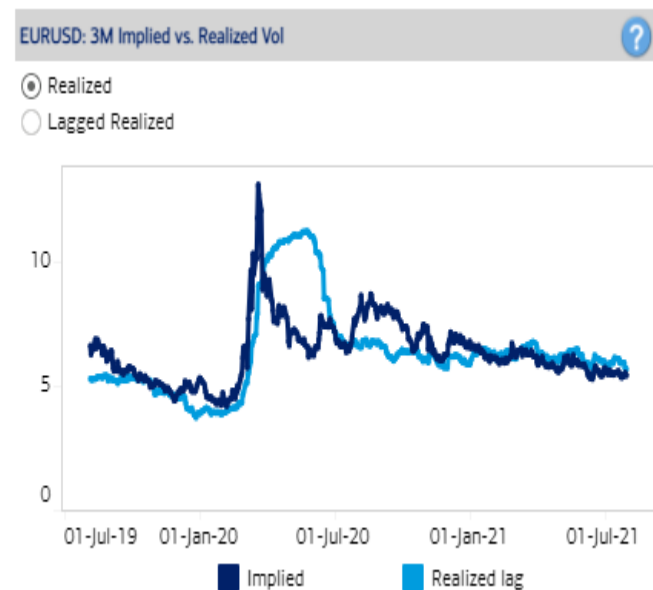
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When the user clicks on any cell from the heatmap table, the line chart would update with the corresponding tenor and currency to show historical values for both implied and realized vol (Exhibit 4). The user has the option to show the ex-post realized vol to compare the same-period values for implied versus realized vols (Exhibit 5).

For example, Exhibit 5 shows that owning 3m EURUSD implied vol in the first two months of 2020 would have performed given the unprecedented Covid-19 shock. However, for the rest of year 2020, persistent risk premium has caused the 3m EURUSD implied vol to remain above ex-post realized vol.

Exhibit 4: Implied and realized vol time series plot

Dashboard plots implied and realized vols based on user selection from the heatmap

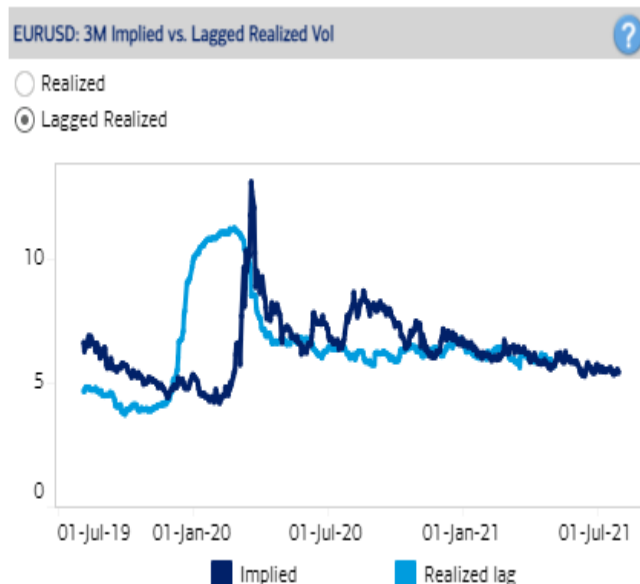


Source: BofA Securities, BofA Global Research

Source: BofA Global Research. Exhibit shows dashboard snapshot with data as of July 30th, 2021.
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Exhibit 5: Implied and ex-post realized vol time series plot

User may also show the time series plot of ex-post realized vol



Source: BofA Securities, BofA Global Research

Source: BofA Global Research. Exhibit shows dashboard snapshot with data as of July 30th, 2021.
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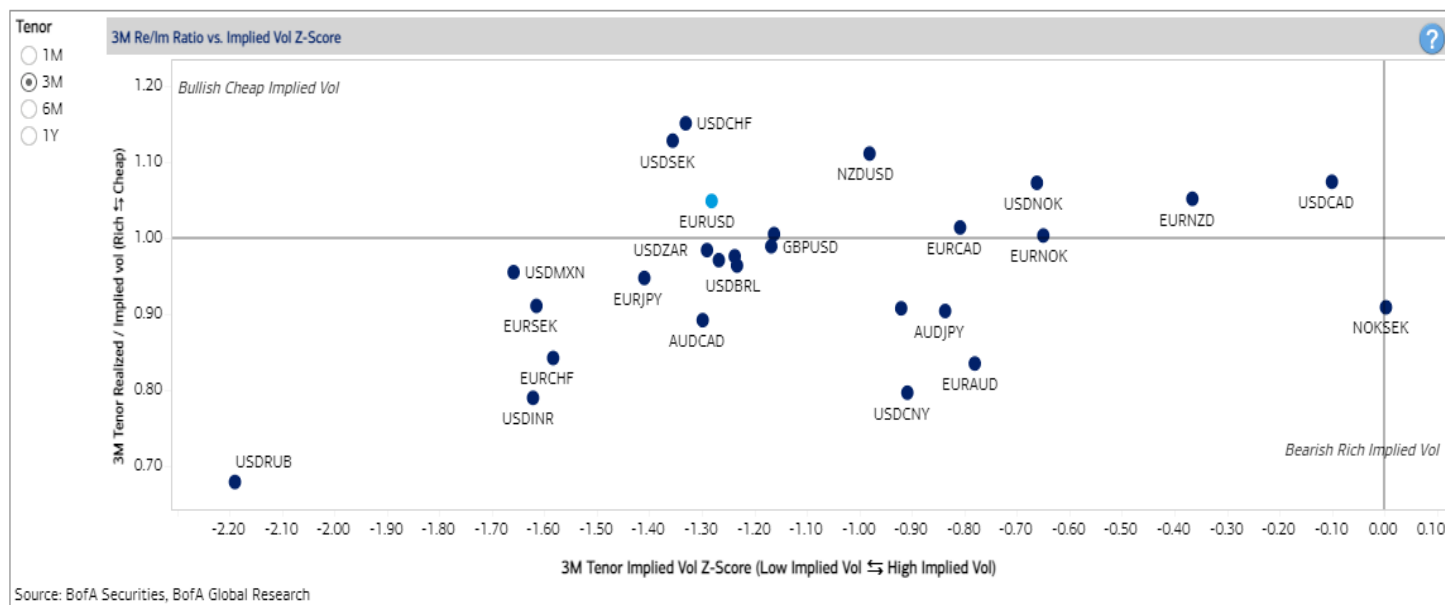
Lastly, the Volatility page shows a scatterplot where the x-axis is the 1y z-score of the implied vol and the y-axis shows the realized/implied vol ratio (Exhibit 6). The scatterplot would also update with the corresponding tenor and currency when the user selects a cell from the heatmap table.

The top-left quadrant of the scatterplot contains currency pairs that are cheap, since the implied vol z-score is low and implied vol is below realized vol. To the contrary, the bottom-right quadrant shows currency pairs with expensive implied vol, as the z-score is high and implied vol is above realized.

Exhibit 6 shows most of the currency pairs have negative implied vol z-scores, as at a 1y lookback current level of implied vols is low compared to 2020. NOKSEK is the standout expensive pair as implied vol z-score is close to zero and realized/implied vol ratio is below 1.

Exhibit 6: Im/Re vol ratio vs implied vol z-score scatterplot

Top-left quadrant is bullish cheap implied vols; bottom-right quadrant is bearish expensive implied vols



Source: BofA Global Research. Exhibit shows dashboard snapshot with data as of July 30th, 2021.

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Vol Change Dashboard

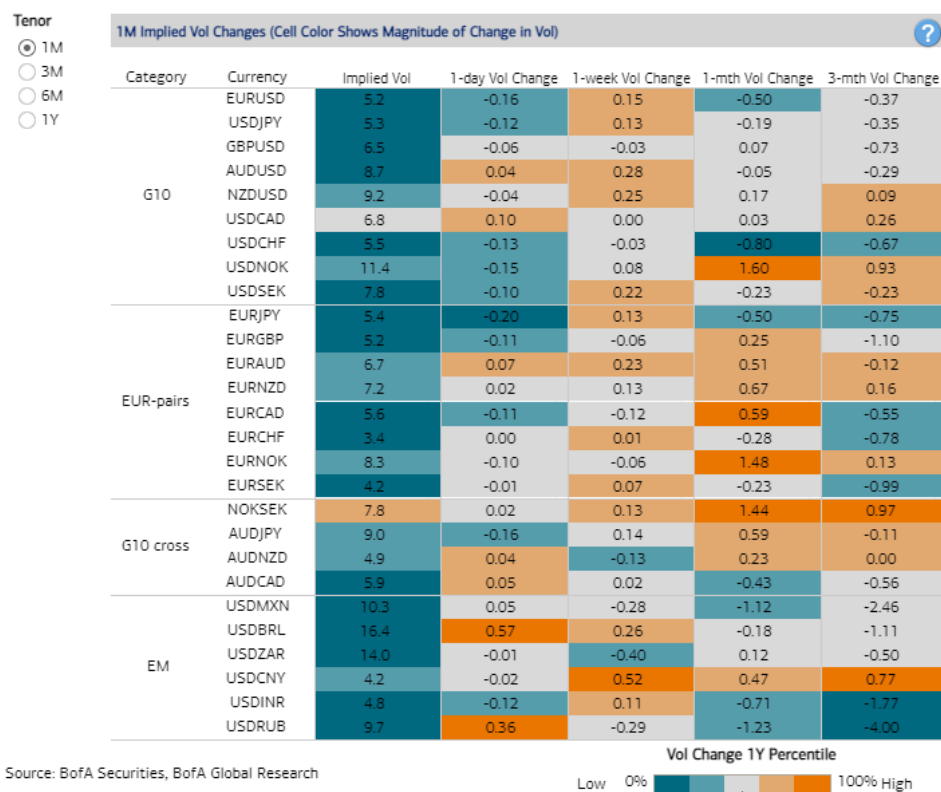
The Vol Change dashboard identifies currency pairs with the biggest movements in implied vols at the 1-day, 1-week, 1-month, and 3-month horizons for different tenors. Each cell in the heatmap table is colored by the 1y percentile of the vol change (Exhibit 7). The level of implied vol is also provided in the heatmap table for reference purpose and the implied vol column is colored by its own 1y percentile.

Exhibit 7 (a historical snapshot as of July 30, 2021) shows most of the currency pairs' implied vols are colored in darker teal except for NOKSEK, which is colored in orange. The result is consistent with the scatterplot from the Volatility dashboard (Exhibit 6). The front-end tenors of the heatmap table show that many of the 1m implied vols have risen over the past week. However, levels of implied vols have declined compared to the previous day.

It is also notable that implied vols for NOK have idiosyncratically risen over the past month, as shown by the 1-month vol increases for USDNOK, EURNOK, and NOKSEK.

Exhibit 7: Heatmap table for the Vol Change dashboard

Table shows the change in implied vol for each currency at different horizons and colors each cell based on the 1y percentile of the latest implied vol change



Source: BofA Securities, BofA Global Research

Source: BofA Global Research. Exhibit shows dashboard snapshot with data as of July 30th, 2021.

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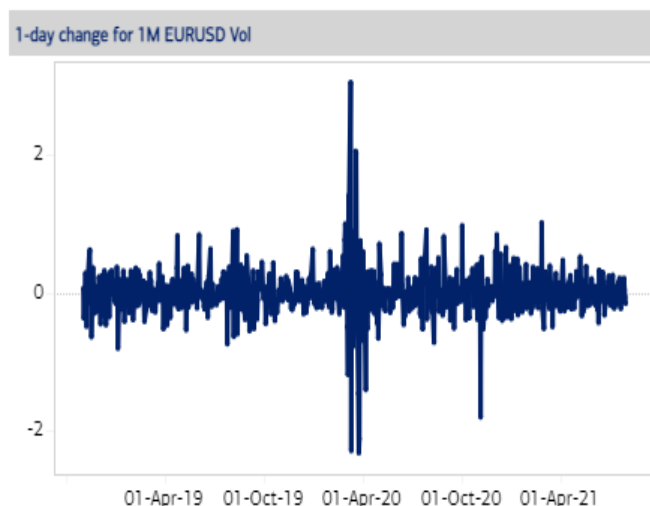
The Vol Change dashboard also has the interactivity that allows users to see historical vol change values when the corresponding cell is selected in the heatmap table. Exhibit 8 shows the biggest 1-day vol changes for 1m EURUSD implied vol occurred during March to April of 2020, amid heightened Covid-19 shock. A few notable events stand out from the time series plot of volatility changes. First, the 1m EURUSD implied vol had declined during November 2020 after the US election. Second, the 1m EURUSD implied vol had risen at the end of February 2021 amid “unhealthy” pickup in US yields.

Lastly, a bar chart that summarizes the biggest vol change from the heatmap table is also available on this dashboard. Exhibit 9 shows USDBRL implied vol had the biggest 1-day increase at the 1m tenor, while 1m EURJPY implied vol had the biggest 1-day decline, based on the 1y percentile of the vol change.



Exhibit 8: Time series plot of implied vol change

User may also show the time series plot of vol change by selecting different cells from the heatmap table

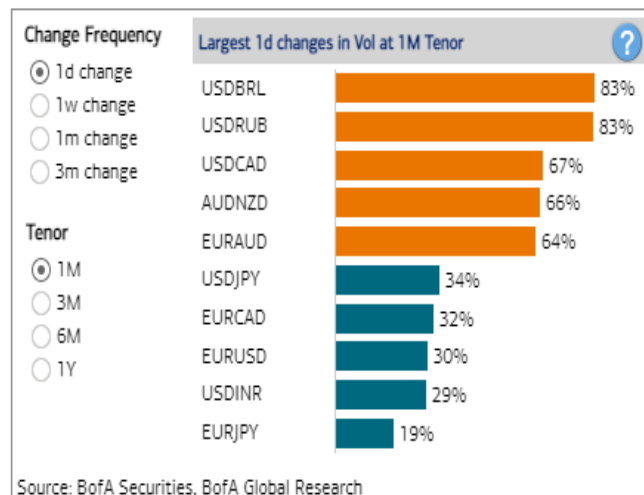


Source: BofA Securities, BofA Global Research

Source: BofA Global Research. Exhibit shows dashboard snapshot with data as of July 30th, 2021.
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Exhibit 9: Top & bottom 5 vol changes for the day

Bar chart shows the top and bottom 5 vol changes: highest 1-day rise of 1m implied vol was in USDBRL



Source: BofA Global Research. Exhibit shows dashboard snapshot with data as of July 30th, 2021.
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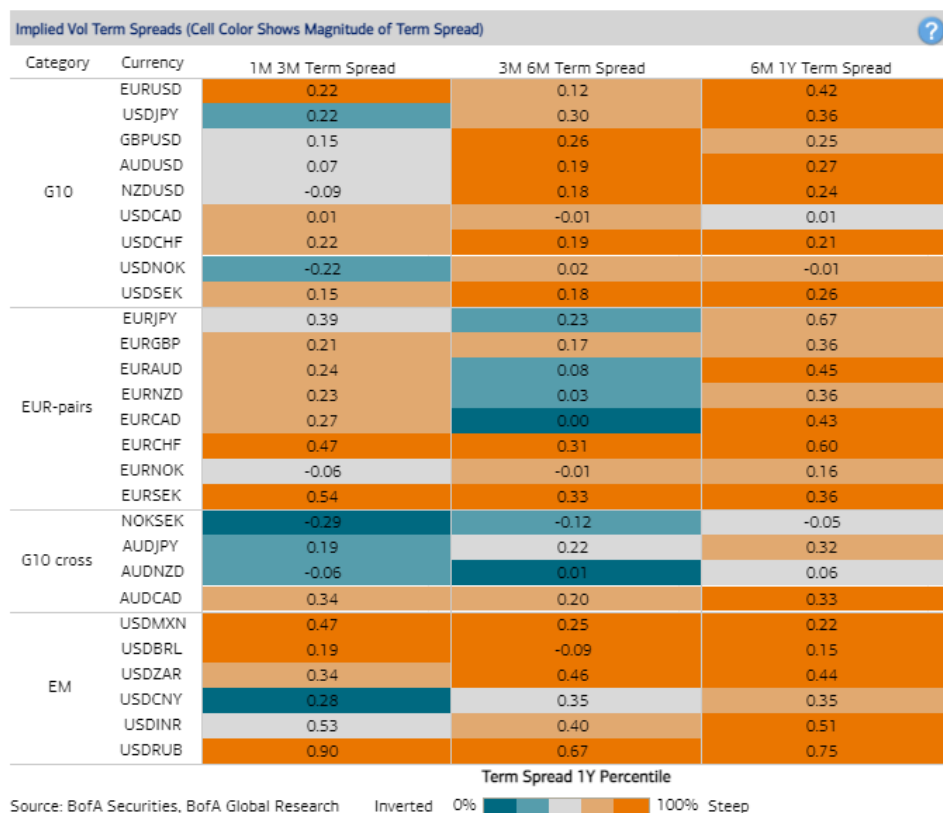
Term Structure Dashboard

The Term Structure dashboard identifies the biggest dislocations among term spreads of implied vols. The heatmap table shows the 1m3m, 3m6m, 6m1y implied vol term premium for different currency pairs, and colors each cell by the term spread's 1y percentile.

Exhibit 10 (a historical snapshot as of July 30, 2021) shows the term structure is broadly steep at the 6m1y back-end part of the vol curve across all currency pairs. However, the front-end vols are relatively high for NOKSEK and USDCNY. It is also notable that implied vol for EUR/G10 pairs are steep at the 1m3m front-end but relatively flat at the 3m6m portion of the curve.

Exhibit 10: Heatmap table for Term Structure dashboard

Table shows the term spread for implied vols at different tenors and colors each cell by the term spread's 1y percentile



Source: BofA Global Research. Exhibit shows dashboard snapshot with data as of July 30th, 2021.

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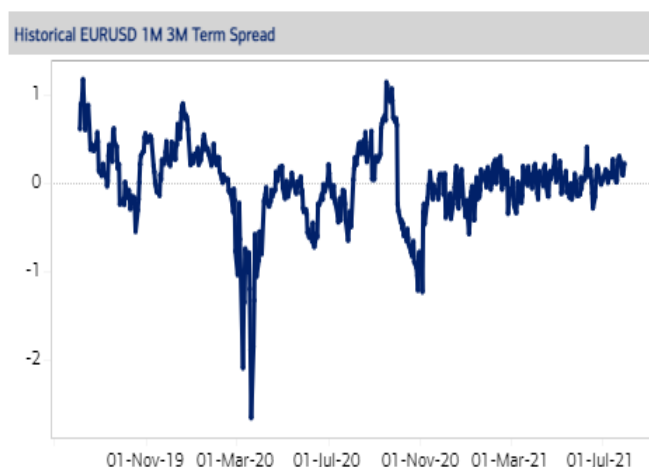
When the user selects specific cells from the heatmap table, the historical time series line chart would update to reflect the selected tenor and currency pair (Exhibit 11). Exhibit 11 shows the front-end EURUSD implied vol was the most inverted during the March Covid-19 shock, as global investors expected uncertainty to persist in the near-term. Several months later in 2020, the EURUSD volatility curve had inverted again in September and October just before the US election.

Similar to other dashboards, the bar chart summarizes the most and the least steep term spreads from the heatmap table. Exhibit 12 shows 1m3m term premium is the most steep for EURSEK, and most flat or inverted for USDCNY, based on the 1y percentile of the term spread.



Exhibit 11: Time series plot of term spread

User may also show the time series plot of term spread by selecting different cells from the heatmap table



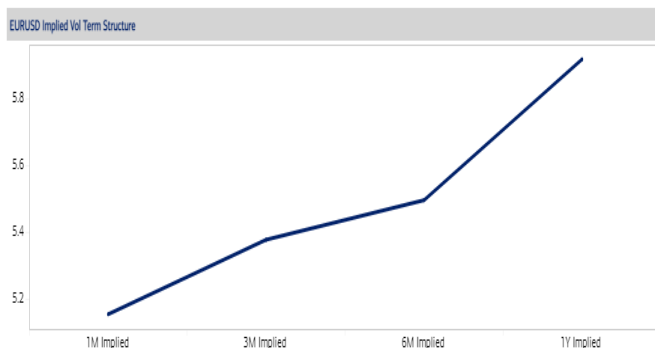
Source: BofA Securities, BofA Global Research

Source: BofA Global Research. Exhibit shows dashboard snapshot with data as of July 30th, 2021.
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The dashboard also includes a plot of the term structure with four liquid tenors along the vol curve (1m, 3m, 6m, and 1y). The plot updates as different cells are selected from the heatmap table. Exhibit 13 shows the term structure is broadly steep for EURUSD implied vols.

Exhibit 13: Term structure plot

User may also show the term structure plot by selecting different currency cells from the heatmap table



Source: BofA Securities, BofA Global Research

Source: BofA Global Research. Exhibit shows dashboard snapshot with data as of July 30th, 2021.
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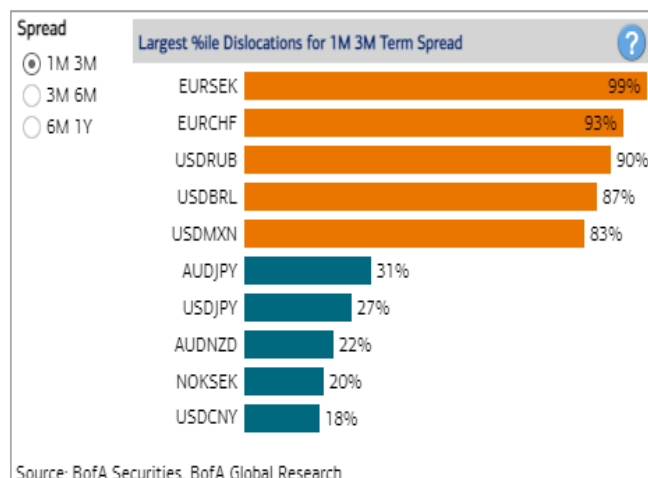
Lastly, this dashboard contains a forward volatility table that shows the forward-starting implied vols for the selected currency pair (Exhibit 14). The forward vols are calculated using available implied vol values at the 1m, 3m, 6m, and 1y tenors by applying the theoretical additive property of variances and are not representative of the FVA market prices.

Risk Reversal Dashboard

The risk reversal dashboard shows the latest end-of-day snapshot of 25-delta risk reversals at the 1m and 1y tenors. It displays both the value of the risk reversal as well as the risk-reversal/ATM implied vol ratio (Exhibit 15). Each cell is colored by the respective 1y percentile of the RR value or RR/ATM vol ratio.

Exhibit 12: Biggest dislocations in term spread

Bar chart shows the top and bottom 5 term spreads; steepest 1m3m term spread was in EURSEK



Source: BofA Securities, BofA Global Research

Source: BofA Global Research. Exhibit shows dashboard snapshot with data as of July 30th, 2021.
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Exhibit 14: Forward volatility table

Table shows the forward-starting implied volatility for selected currency

Forward Vol Table: EURUSD			
Select Currency			
EURUSD			
Base Tenor	Forward Tenor		
1M	1M	5.98	
	2M	5.49	
	5M	5.56	
3M	3M	5.61	
	9M	6.09	
6M	6M	6.31	

Source: BofA Securities, BofA Global Research

Source: BofA Global Research. Exhibit shows dashboard snapshot with data as of July 30th, 2021.
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Exhibit 15 (a historical snapshot as of August 6, 2021) shows that 1m USDCAD and USDCHF risk reversals are both in favor of USD calls and the size of the premium for OTM USD calls is relatively high compared to the past year. To the contrary, although the 1m EURCHF and EURSEK risk reversal values are still positive, in terms of 1y percentile they are at the low end relative to the past year, signaling investor demand has been gradually moving toward OTM EUR puts against CHF and SEK.

Exhibit 15: Heatmap table for risk reversal dashboard

Table shows the 25-delta risk reversal for implied vols at 1m and 1y tenors and colors each cell by respective 1y percentile

Implied Risk Reversals (Cell Color Shows Magnitude of RR and RR/ATM Ratio In Terms of 1Y Percentile) ?

Category	Currency	1M RR	1M RR/ATM %	1Y RR	1Y RR/ATM %
G10	EURUSD	-0.10	-2%	-0.28	-5%
	USDJPY	-0.24	-4%	-0.75	-12%
	GBPUSD	-0.39	-7%	-0.93	-13%
	AUDUSD	-0.98	-12%	-1.60	-17%
	NZDUSD	-0.83	-9%	-1.45	-15%
	USDCAD	0.84	13%	0.97	14%
	USDCHF	0.10	2%	-0.46	-7%
	USDNOK	1.59	15%	2.43	22%
	USDSEK	0.79	11%	1.32	16%
EUR-pairs	EURJPY	-0.58	-11%	-1.22	-18%
	EURGBP	0.29	6%	0.45	8%
	EURAUD	0.76	12%	1.01	13%
	EURNZD	0.72	10%	0.96	12%
	EURCAD	0.64	12%	0.49	8%
	EURCHF	0.05	2%	-0.65	-14%
	EURNOK	1.27	16%	2.09	25%
	EURSEK	0.37	9%	0.92	17%
G10 cross	NOKSEK	-0.74	-10%	-1.13	-16%
	AUDJPY	-1.42	-17%	-2.60	-27%
	AUDNZD	0.00	0%	0.02	0%
	AUDCAD	-0.29	-5%	-0.74	-11%
EM	USDMXN	2.19	22%	2.84	26%
	USDBRL	2.40	13%	3.14	18%
	USDZAR	2.46	17%	3.10	20%
	USDCNY	0.45	11%	1.02	19%
	USDINR	0.59	13%	1.18	19%
	USD RUB	2.27	24%	3.50	30%

Source: BofA Securities, BofA Global Research

RR & RR/ATM Vol 1Y Percentile

Low 0% 100% High

Source: BofA Global Research. Exhibit shows dashboard snapshot with data as of August 6th, 2021.

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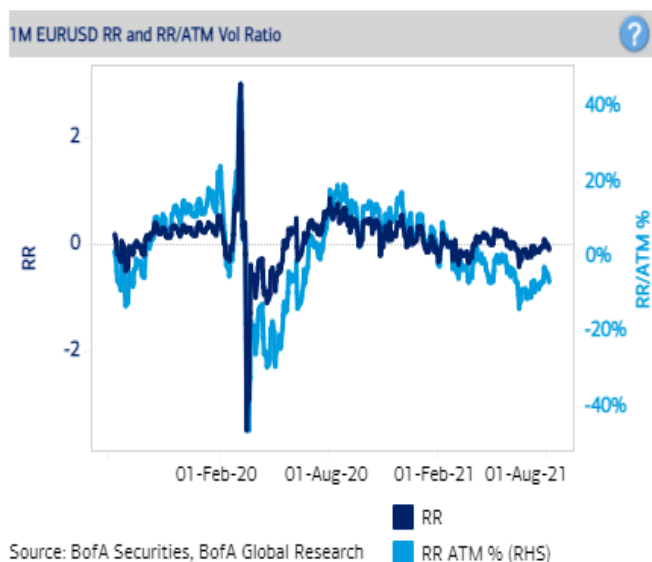
The time series plot shows historical values of the risk reversal and RR/ATM vol ratio. It also updates when the user clicks on different currency pair and tenor combination from the heatmap table. Exhibit 16 shows that using 1m EURUSD RR as an example, the risk reversal saw the biggest decline during the March 2020 Covid-19 shock, where investors heavily bought USD calls against the EUR. Moreover since March 2021, 1m EURUSD RR has been relatively stable but 1m EURUSD ATM implied vol has been declining, leading to a more negative RR/ATM vol ratio for EURUSD.

Exhibit 17 shows the top and the bottom 5 most extreme 1y percentiles of RR/ATM vol ratios. It is notable that 1m USDCAD, EURCAD, and AUDCAD RR/ATM vol ratios are all above 80th percentile, signaling broad investor demand for OTM CAD puts.



Exhibit 16: Time series plot of risk reversal

User may also show the time series plot of risk reversal and RR/ATM vol by selecting different cells from the heatmap table



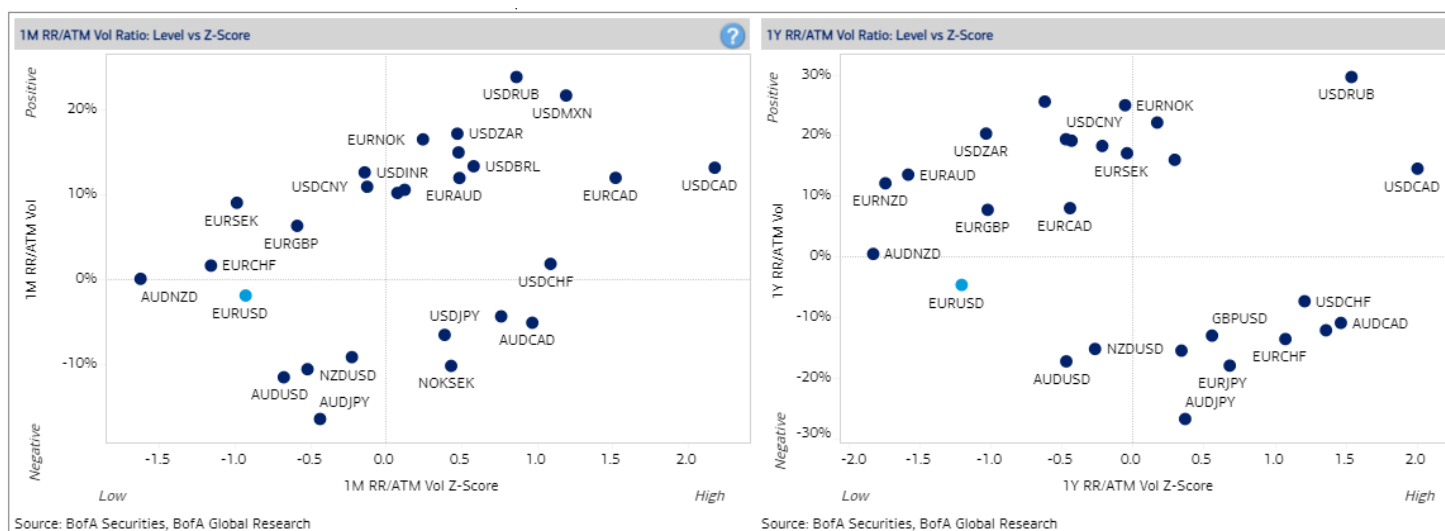
Source: BofA Global Research. Exhibit shows dashboard snapshot with data as of August 6th, 2021.
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Lastly, the risk reversal dashboard contains two scatterplots where the x-axis is the 1y z-score of the RR/ATM vol ratios, and the y-axis is the value of the RR-ATM vol ratio (Exhibit 18). The top-right quadrant contains currency pairs where both the RR/ATM vol value and z-score are high, while the bottom-left quadrant contains currency pairs where both the RR/ATM vol value and z-scores are low.

Looking at these data alone would suggest pairs in the top-right quadrant should see risk reversals decline while pairs in the bottom-left quadrant should see risk reversals rise. However, it is often the case that risk reversals drifted to extreme values due to changes in the fundamentals, so any mean-reversion in risk reversal should be considered in conjunction with the latest market themes and dynamics.

Exhibit 18: Scatterplot for RR/ATM vol z-score vs RR/ATM vol values

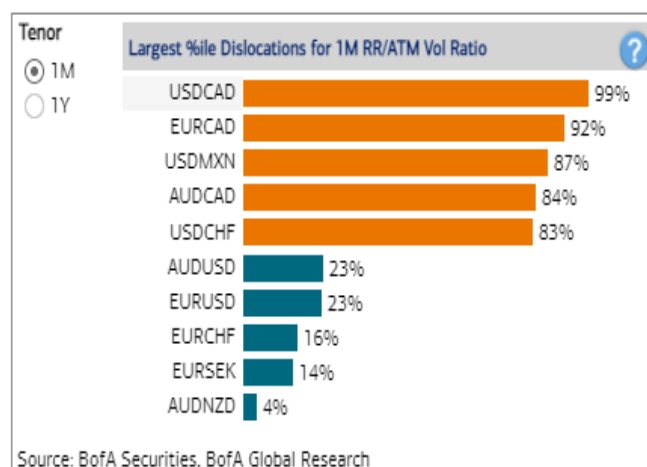
1m and 1y USDCAD RR are in favor of OTM USD calls and CAD puts



Source: BofA Global Research. Exhibit shows dashboard snapshot with data as of August 6th, 2021.

Exhibit 17: Biggest dislocations in risk reversal

Bar chart shows the top and bottom 5 most extreme RR/ATM vol ratio 1y percentiles: RR/ATM vol ratios are broadly for CAD puts



Source: BofA Global Research. Exhibit shows dashboard snapshot with data as of August 6th, 2021.
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Correlation Dashboard

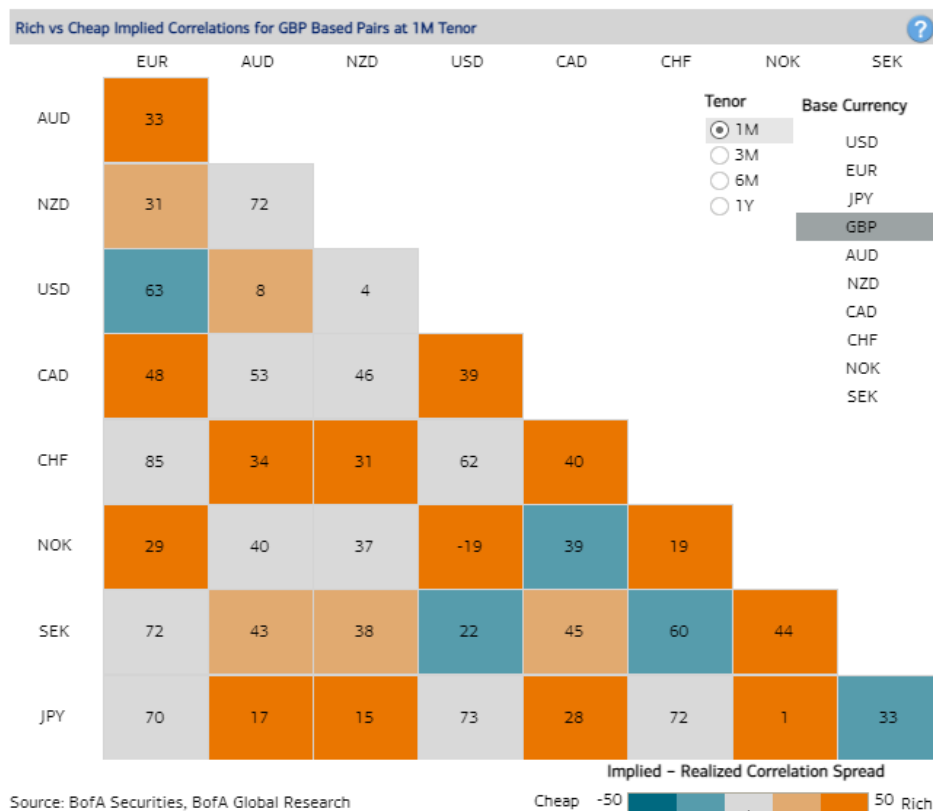
The Correlation dashboard identifies the biggest dislocations for G10 correlations. The heatmap table displays the levels of implied correlation with cells colored in implied-realized correlation spread for all possible correlation combinations across G10 FX.

The user should first select the tenor and the base correlation from the radio-button menus. The heatmap table would then update to show correlation pairs with two legs containing the base currency. For example, the top-left cell in Exhibit 19 (a historical snapshot as of July 30, 2021) shows the implied correlation for EURGBP-GBPAUD is 33 percent.

A cell is colored in darker orange if the implied-realized correlation spread is close to or above +50 percentage points, suggesting that the implied correlation is expensive relative to the realized correlation. To the contrary, the cells are colored in darker teal if the correlation spread is close to or below -50 percentage points, suggesting that the implied correlation is cheap. Exhibit 19 shows 1m GBP-based correlations are broadly expensive, meaning option investors are still pricing for GBP as the driver of G10 FX but it has not been reflected in the GBP/G10 spot market movements.

Exhibit 19: Heatmap table for Correlation dashboard

Heatmap table shows level of implied correlation with im-re correlation spread in the background cell coloring



Source: BofA Securities, BofA Global Research

Source: BofA Global Research. Exhibit shows dashboard snapshot with data as of July 30th, 2021. Realized correlation are calculated as Pearson's correlation of the last 21, 63, 130, and 260 end-of-day spot returns for two currency pairs sharing a same base currency, respectively for the 1m, 3m, 6m, and 1y tenors.

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Like all of the previous dashboards, the user can also see the historical implied and realized correlation time series when the corresponding cell is selected from the heatmap. Exhibit 20 (a historical snapshot as of July 30, 2021) shows implied and realized correlation for EURGBP-GBPAUD have historically tracked each other well but recently its realized correlation has declined into negative territory, widening the gap with implied correlation. The last time that the spread had been this wide occurred at

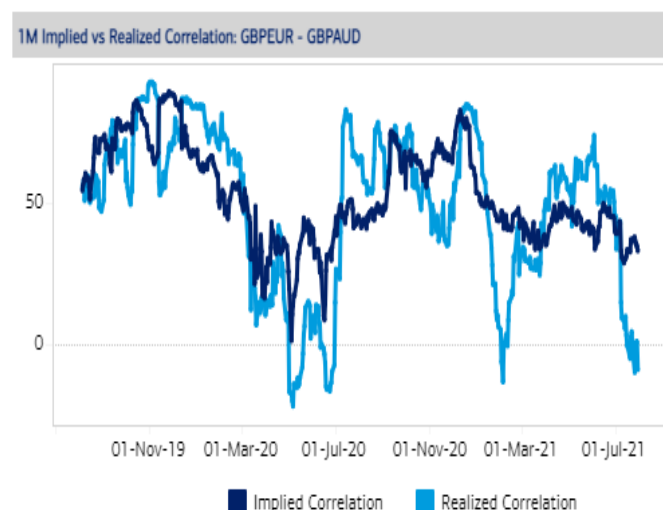


the end of February 2021. Subsequently, implied correlation had drifted down to catch up to realized correlation. The chart suggests that 1m GBPEUR-GBPAUD implied correlation may decline further from current level, according to its February analog. As GBP-based correlation declines, it suggests higher implied volatility for the EURAUD cross.

Lastly, the bar chart displays the top 5 most positive and the most negative implied-realized correlation spreads for correlation pairs where the EUR and USD are the base currencies. At the 1m tenor, EURCAD-EURJPY implied correlation is the richest, while 1m EURGBP-EURAUD implied correlation is the cheapest. It is also notable that this result is consistent with the fact that GBP-based correlations are generally expensive as shown from Exhibit 19 and Exhibit 20. Among the EUR-GBP-AUD triplet, the spot market is pricing EUR as the main driver, while option market is pricing GBP to be the driver, likely by inertia from prior Brexit shocks.

Exhibit 20: Time series plot for implied vs realized correlation

User may also show the time series plot of implied and realized correlations by selecting different cells from the heatmap table



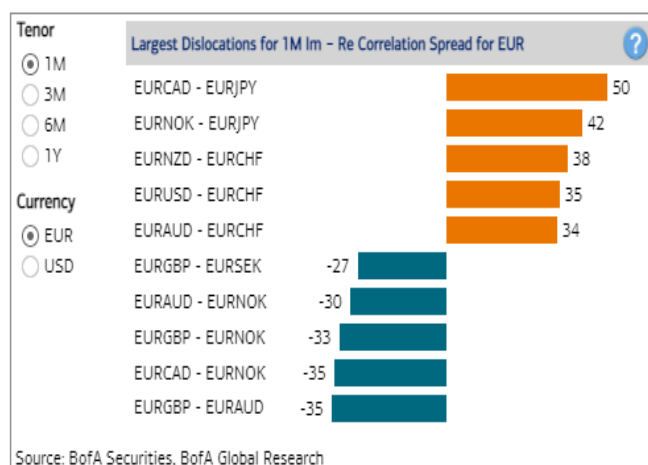
Source: BofA Securities, BofA Global Research

Source: BofA Global Research. Exhibit shows dashboard snapshot with data as of July 30th, 2021.

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Exhibit 21: Top & bottom 5 largest correlation spreads

Bar chart shows the top and bottom 5 most positive and most negative implied-realized correlation spreads for USD and EUR-based correlation pairs. 1m EURCAD-EURJPY implied correlation is expensive



Source: BofA Global Research. Exhibit shows dashboard snapshot with data as of July 30th, 2021.

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