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MILLISECOND REACTIONS TO ECONOMIC EVENTS:

From data to alpha with LMAX Group

November 2024

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The LMAX Group portfolio includes LMAX Exchange, LMAX Global and LMAX Digital.

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Summary

Microsecond order book data from LMAX Exchange provides actionable insights for investors around US inflation, payrolls and Fed event dates.

We are able to document substantial and predictable pricing reactions of four key currency pairs - EUR/USD, AUD/USD, USD/JPY, USD/MXN - to data surprises.

In one million simulations of price moves to event dates since October 2019, we find prices move between +/- 0.2% to 0.4% on average within the first one hour.

These price moves manifest themselves considerably quicker than in equity markets, highlighting the importance of high frequency data.

LMAX Exchange data shows that a third of the total price action occurs within two seconds of release, with this proportion highest for AUD/USD, and lowest for USD/MXN.

Sub second, there are also common price trends, most notably after Fed meetings. Investors exploiting these moves could capture 90% of subsequent price changes.

Fed outcomes affect all currency pairs considerably, but especially EUR/USD and AUD/USD. US inflation is relatively more important for USD/JPY and USD/MXN.

Economic events matter for markets

There is considerable evidence of excess price action around event days. This generates trading opportunities that investors dedicate significant attention to, which in turn creates sizeable volatility. For example, overnight forward vols in EUR/USD on NFP release dates over the last 3 months have been over 70% higher than on non-event days (Table 1). Event analyses seek to cut through this noise.

Table 1: Average Overnight Forward Vols on Event Days vs Non-Event Days

	EUR/USD	USD/JPY	GBP/USD
Event Weight	1.73	1.79	1.40
Current Implied O/N Fwd Vol	11.1vol	18.7vol	10.9vol
Market Implied Return Add On (%)	0.20%	0.35%	0.14%
Market Implied Return Add On, 3m Average (%)	0.22%	0.50%	0.19%

Source: Macro Hive

Event-based analyses are typically done at daily level. Data from the last five years shows significant add-ons in daily returns, especially around US inflation, employment and Fed meeting dates (Table 2). They also show considerable variations across assets, with daily returns up to two times higher for the USD/JPY than the EUR/USD. For example, on CPI days, USD/JPY moves by an additional 0.41% relative to non-event days compared to EUR/USD moving by an additional 0.22%.

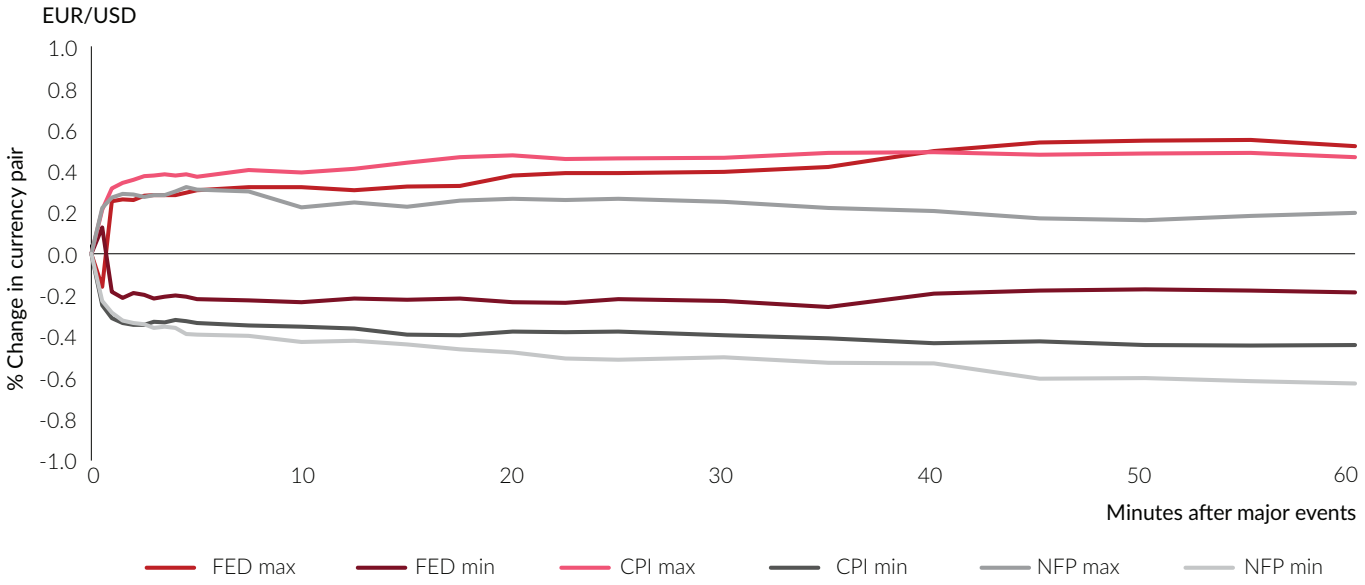
Table 2: Excess Daily Returns Around Key US Events

	EUR/USD		USD/JPY		GBP/USD	
	Add on	**T-Stat**	**Add on**	**T-Stat**	**Add on**	**T-Stat**
CPI	0.22%	3.32	0.32%	3.97	0.41%	4.38
Payrolls	0.17%	3.05	0.17%	2.04	0.29%	2.99
Fed	0.12%	1.81	0.21%	1.99	0.27%	2.3

Source: Macro Hive

Where intraday data is available, analysis at best offers a minute-by-minute insight into historical price moves. Data from Bloomberg for EUR/USD shows considerable minimum and maximum price deviations at longer intervals around key US events (Chart 1). Crucially, it also shows that the dynamics are predominantly confined to the first few minutes after the event.

Chart 1: Min and Max EUR/USD Price Changes after Key US Data Releases



Source: MacroHive, BBG

As such, the most important price information for investors is likely to be found within the first minute interval. High frequency LMAX Exchange order book data, which provides insights into prices and trading volumes at a microsecond level, fill a key gap in the pricing dynamics of currency pairs immediately preceding and succeeding events dates.

LMAX Exchange data provides sub-one second insights

The LMAX Exchange data used in this paper contains microsecond order book information on EUR/USD, AUD/USD, USD/JPY and USD/MXN from October 2019 to June 2024. Specifically, it contains data on quantities, orders, and bid/ask prices – from which we calculate mid-prices for the analysis. In total, the dataset contains 44bn rows, or roughly 279 gigabytes of data.

Given the size of the dataset, we take advantage of parallel computing to filter out unnecessary data. This significantly reduces computation, especially on operations such as sorting and grouping the data, which we use for our intervals. Our intervals are defined as: every 100ms from ±0-1s, every 1s from ±1-30s and every 5s from ±30-60s, which yields 91 intervals around each event time.

To retrieve the closest relevant mid-price, we find the most recent trade which occurs on or just before an interval. On the given data, most mid-prices are taken 500ms or less before the interval. However, there are a small number of exceptions which are several seconds from the interval. This is due to the lack of more recent trading activity. Despite this, our analysis is not affected, since there is little price action around these and there are very few instances in the data.

Methodology

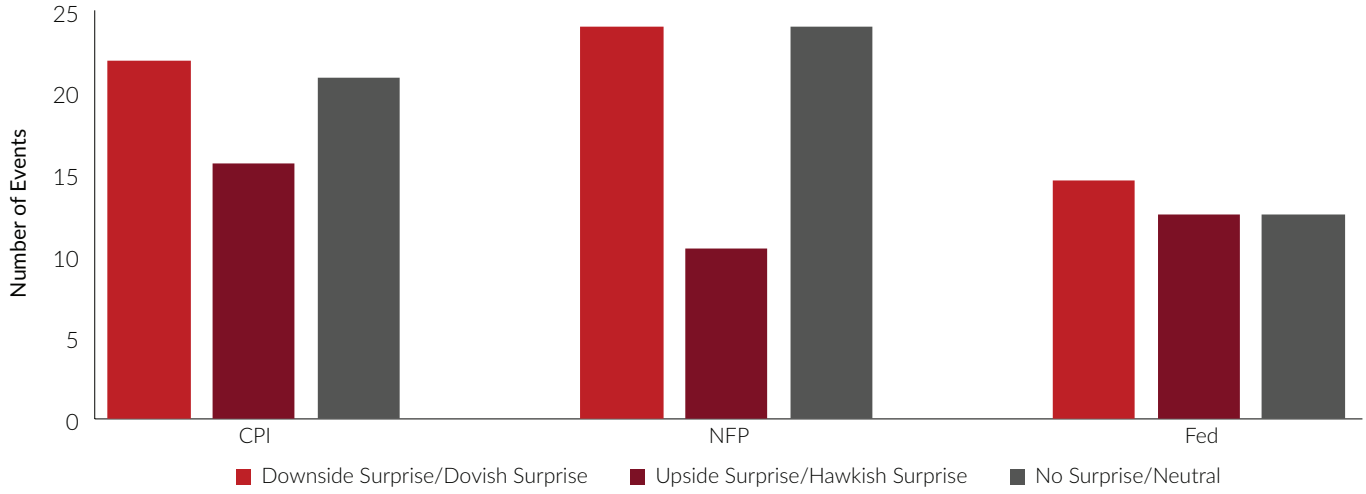
Our focus is on the first sixty seconds around CPI, NFP and Fed meeting events from October 2019 to June 2024.

We classify three outcomes per event. For CPI and NFP, these are: (i) an upside surprise; (ii) a downside surprise, and (iii) no surprise. An upside surprise in CPI occurs when monthly core inflation exceeds consensus, and vice versa for a downside surprise. Meanwhile, deviations of actual from consensus of above (below) one standard deviation from the mean reflect an upside (downside) surprise in payrolls. These definitions are consistent with similar classifications on data providers like Bloomberg.

For Fed meetings, we instead use our extensive in-house knowledge to classify FOMC meeting outcomes as neutral, dovish or hawkish based on market expectation pre- and post-release. For example, an expected cut of 50bps to tackle inflation might be considered hawkish, but if the Fed signals no future cuts when markets were expecting continued tightening, the outcome would be net dovish relative to expectations.

Once events are categorised by outcomes, we investigate the price response of all four currency pairs. As price levels have varied considerably over the last five years, we standardised prices to take a value of zero on the nearest microsecond before each event release. This allows us to capture the relative price moves going into and out of each event, by outcome. Chart 2 shows the number of events by each outcome. Included in the sample are 56 CPI and NFP events, and 38 Fed meetings.

Chart 2: Number of Events by Outcomes



Source: MacroHive

Our strategy allows us to aggregate price responses to various event outcomes. As a result, we are able to run Monte Carlo simulations to expand the range of likely price responses in a significantly larger sample size. Specifically, we run one million simulations for each event, by each outcome and for all four currencies[1]. We then map the average price response alongside confidence intervals that represent the 25th and 75th percentile responses. Removing outliers, we are left with the most likely price trajectories to different outcomes within a one-minute interval around releases.

[1] We assume that price responses are normally distributed with a mean and standard deviation equal to those observed in our sample from 2019-2024.

Results

Across all three events, we observe non-zero price responses to data surprises. The largest reactions are generated by dovish Fed events, with prices rising 0.2% within the first sixty seconds, equivalent to 60% of the total hourly price rise (Chart 3, C & D). Moreover, the confidence intervals do not overlap with price reactions around hawkish FOMC meetings, indicating a predictable difference between the two[2].

Downside surprises in CPI and NFP also induce positive EUR/USD price responses (Chart 3, A & B). Lower payrolls indicate worsening growth prospects, which is negative USD (i.e. positive EUR/USD). Similarly, lower-than-expected inflation lowers the Federal Funds rate in expectation, which again is negative USD and positive EUR/USD. These stories hold for all currency pairs, although in reverse for USD/JPY and USD/MXN given the change in base currency. Charts for the other three currencies are contained within the Appendix (Charts 6-8).

Chart 3: EUR/USD Responses to Economic Surprises

Chart 3A

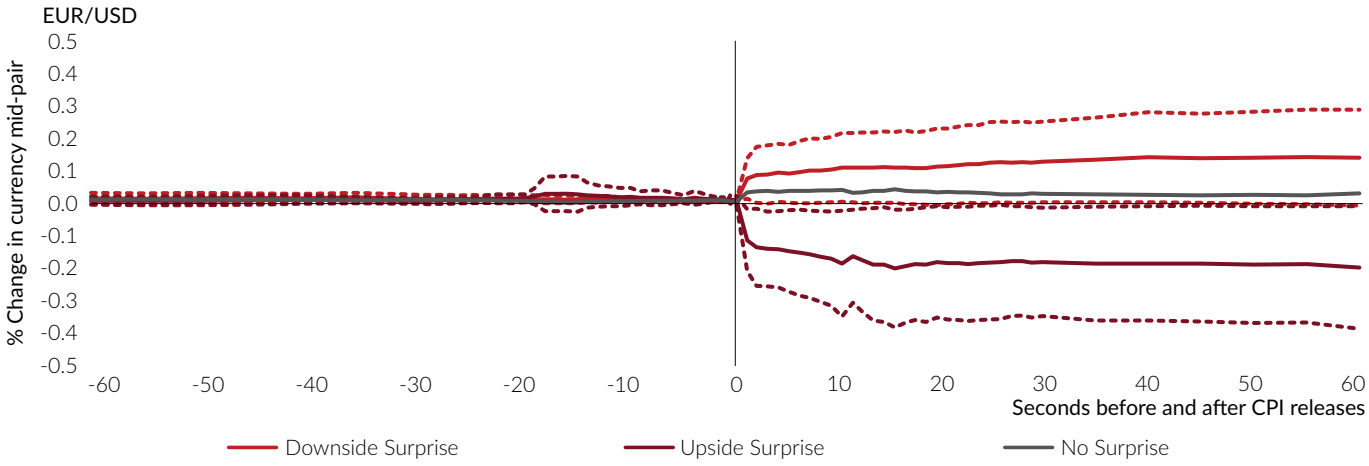
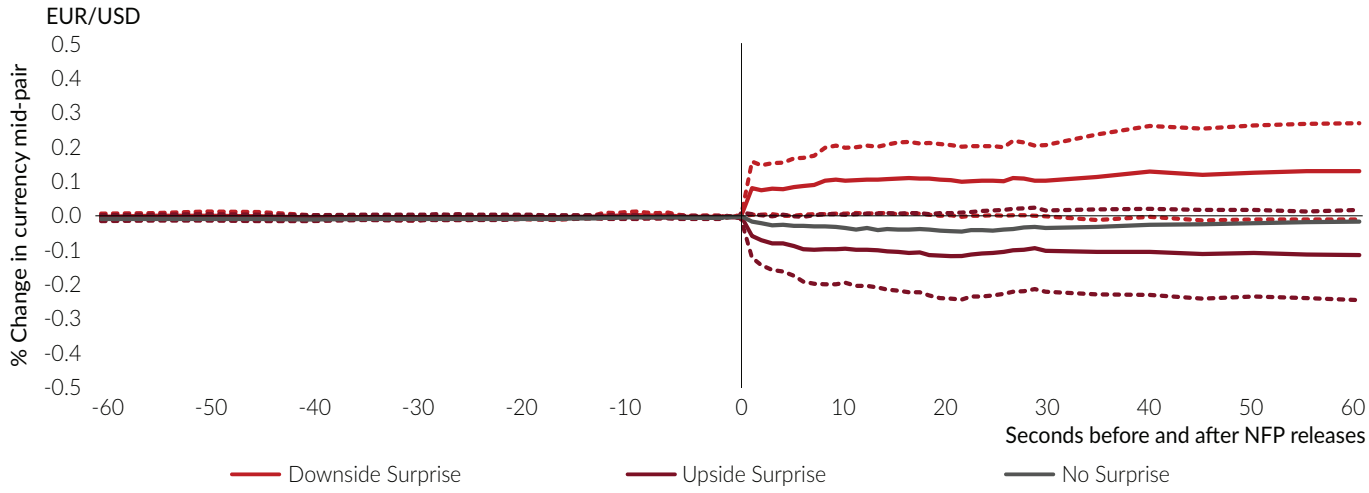


Chart 3B



[2] The difference is not statistically significant at a 10% level.

Chart 3C

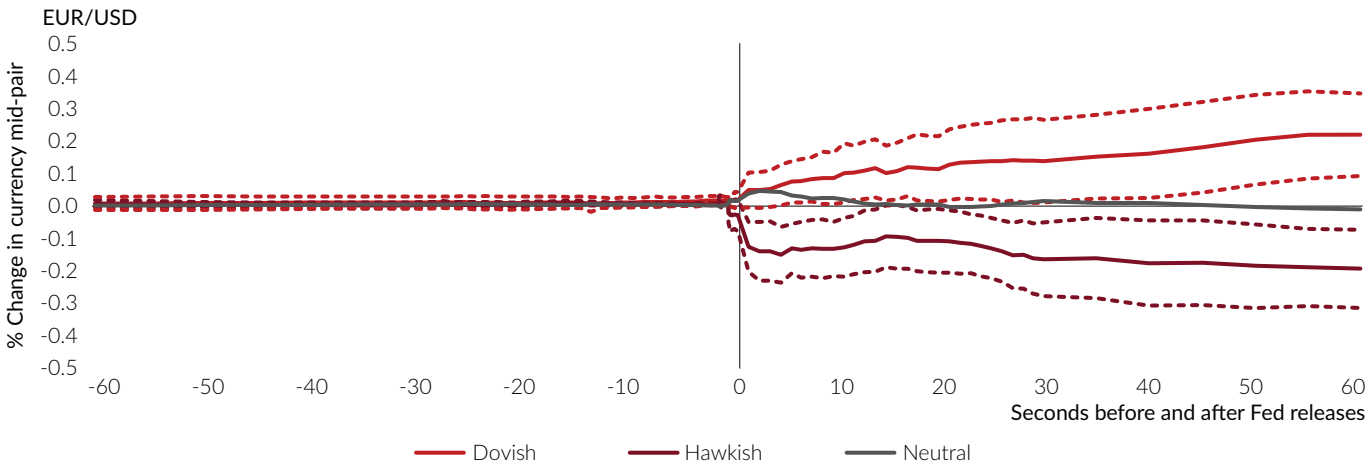
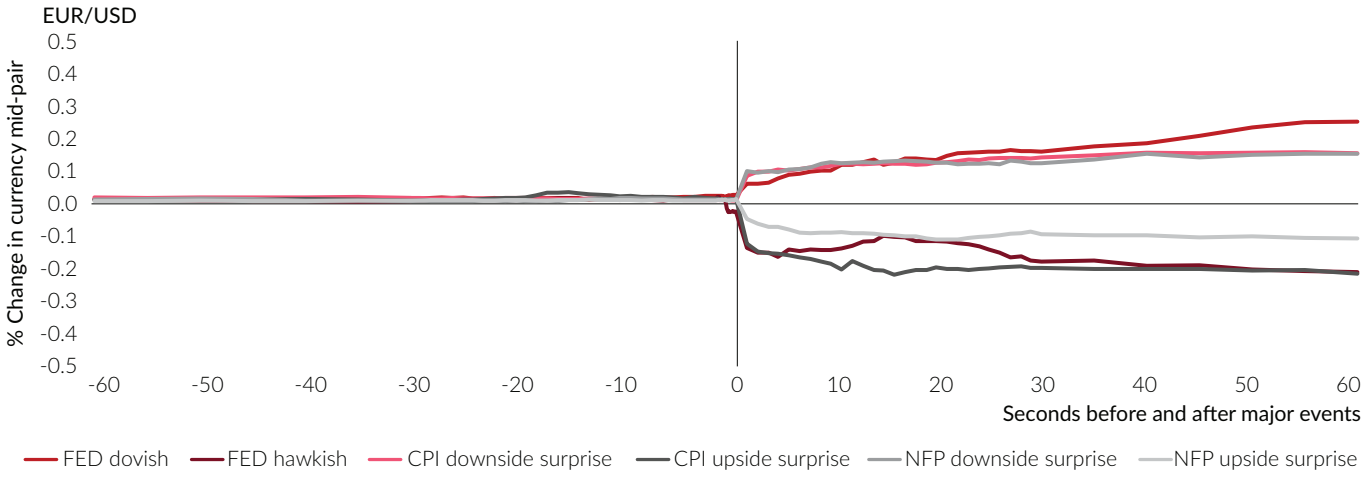


Chart 3D



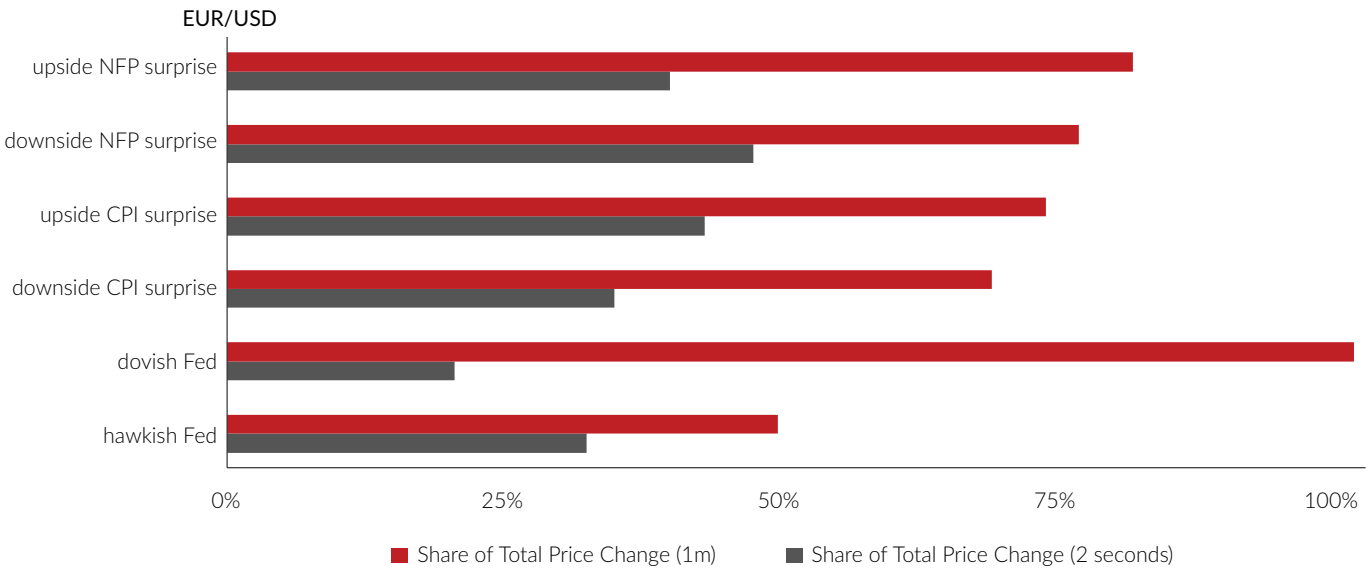
The benefit of higher frequency data is the ability to react to price moves more quickly. From our simulations, non-overlapping intervals indicate that, on the majority of occasions, if prices rise in the first sixty seconds following a downside or upside surprise, they are likely to continue to do so for most of the next hour. Indeed, trades placed within the first sixty seconds are still likely to capture at least 25% of the total expected price move in the next hour (Chart 4, A).

Crucially, however, the LMAX Exchange data identifies significant price changes between 1-2 seconds after the event. It suggests, on average, that trades made around the two second interval would not only get insights into the direction of future price moves, but also benefit from considerable future price changes. For example, the average USD/MXN price change after just two seconds following a hawkish FOMC meetings captures just 20% of the total expected price move in the subsequent hour (Chart 4, B)[3].

[3] In this example, the USD/MXN drops by an average of 44bps one hour after a hawkish Fed meeting. Typically, just 8bps happen within the first two seconds, which leaves a further 80% decline over the next hour (in expectations).

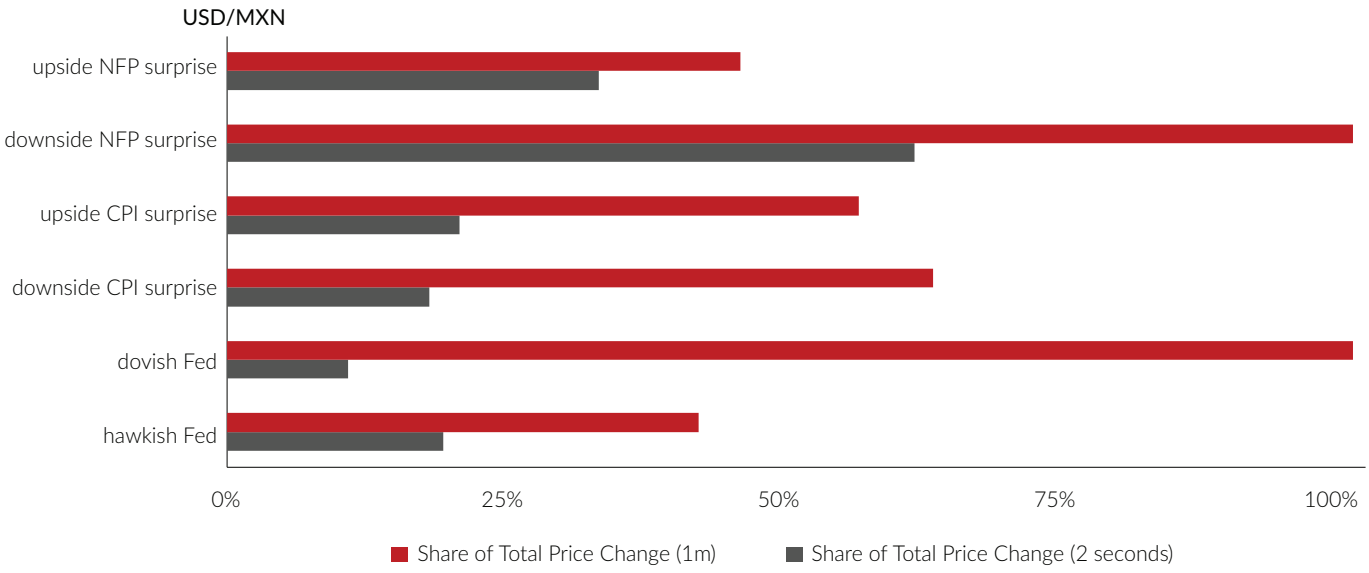
Chart 4: Short-Term Moves Predict Medium-Term Ones

Chart 4A



Source: MacroHive, LMAX Exchange

Chart 4B



Further disaggregation to the within-second level generates considerable noise. Even with large confidence intervals, there is significant overlap in the price reactions around different event outcomes. Statistically, this makes it hard to elicit a trading strategy.

That said, our simulations of the LMAX Exchange data do identify relatively sizeable and predictable average price moves for all four currency pairs within one second of FOMC meetings (Chart 5). The dynamics also accord with subsequent price moves in the minutes and hours following the event.

For example, a hawkish Fed statement leads to an immediate 3-4bps decline in EUR/USD and AUD/USD. This decline persists, and even extends throughout the first second interval. As shown previously in Charts 1 and 3C, EUR/USD then continues to decline for the next hour.

This persistent and immediate decline in prices following FOMC meetings suggests considerable potential to exploit predictable pricing dynamics. Trading on an initial price decline of around 2-3bps within the first 0.2 seconds would, in expectation, see prices fall a further 30-40bps over the next hour. This would allow traders to capture over 90% of the total price change following Fed meetings.

Similar patterns are less clear in the immediate aftermath of CPI and NFP event. Downside surprises in inflation do, on average, lead to a higher AUD/USD within the first second, although the increase is less than one basis point. The same is true following an upside surprise in NFP for USD/MXN. After these events, it appears better placed to observe price action between one- to two-seconds post-release, which subsequently predicts future price moves. These charts are contained within the Appendix (Chart 9).

Chart 5: Within-Second Price Moves Identify Fed Meetings as Most Important

Chart 5A

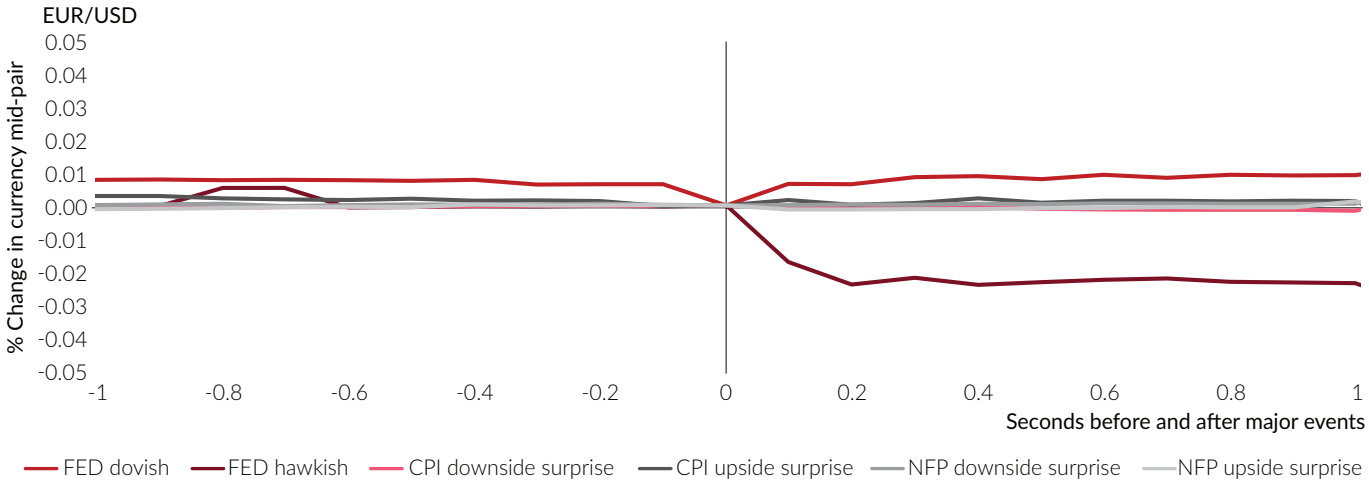


Chart 5B

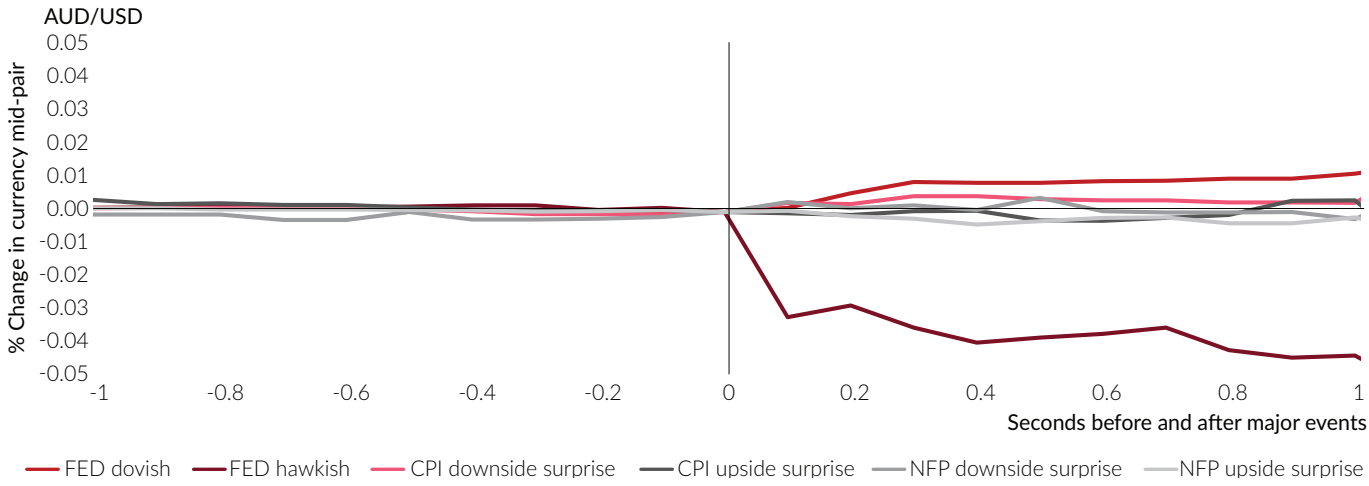


Chart 5C

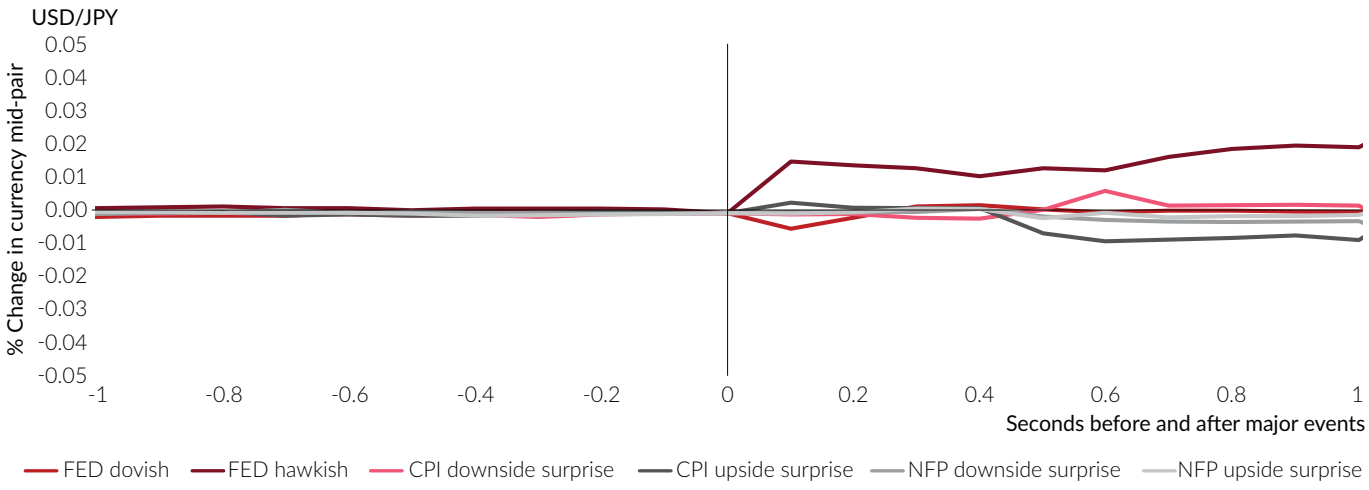
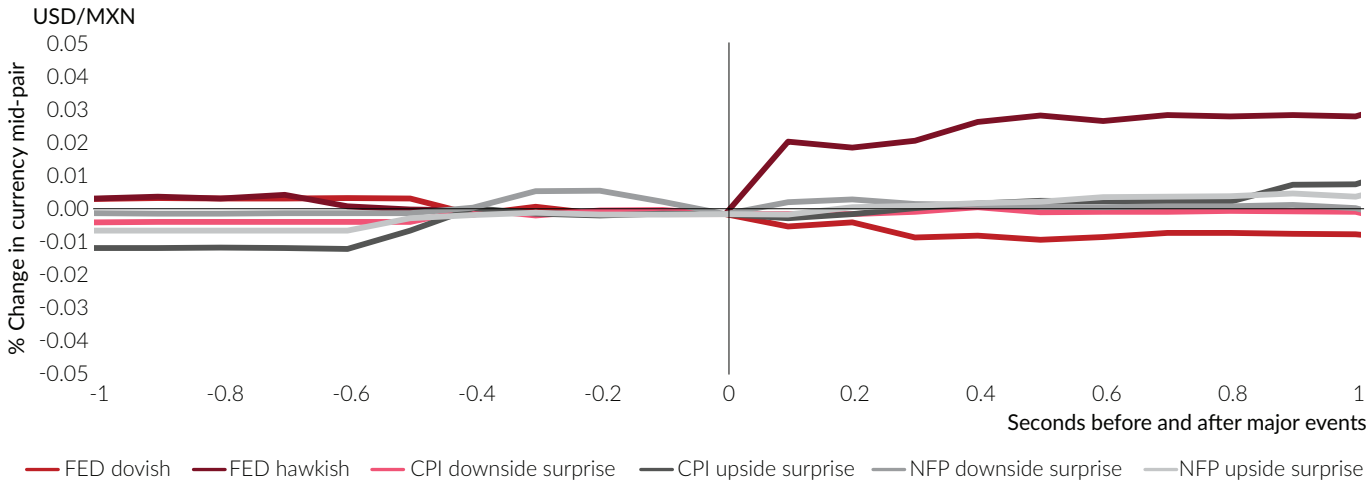


Chart 5D



Millisecond-by-millisecond

Our analysis shows that sub-second level price action contains valuable insights in the immediate aftermath of key US event. Most notably, hawkish Fed meetings predict non- trivial declines in both EUR/USD and AUD/USD.

Uniquely, LMAX Exchange data allows us to hone in further on millisecond-by-millisecond pricing dynamics. Chart 6A plots the median, 25th and 75th percentile EUR/USD price responses to dovish and hawkish Fed meetings, based on one million simulations. There are three main takeaways. Firstly, we find that prices begin to decline after just 4ms following a hawkish Fed meeting. This decline accelerates between 30-50ms until reaching -2bps, after which prices fall more gradually for the next hour. The EUR/USD fall within 0.05 seconds represents only 5% of the total average price decline after hawkish Fed meetings. Next, confidence intervals show that prices fall on at least 75% of occasions after hawkish Fed events. By the same token, prices rise following dovish meetings on around three quarters of simulations. This suggests false positives - i.e. an immediate EUR/USD decline incorrectly signals a hawkish outcome when, ex-post, it was a dovish one – are very unlikely.

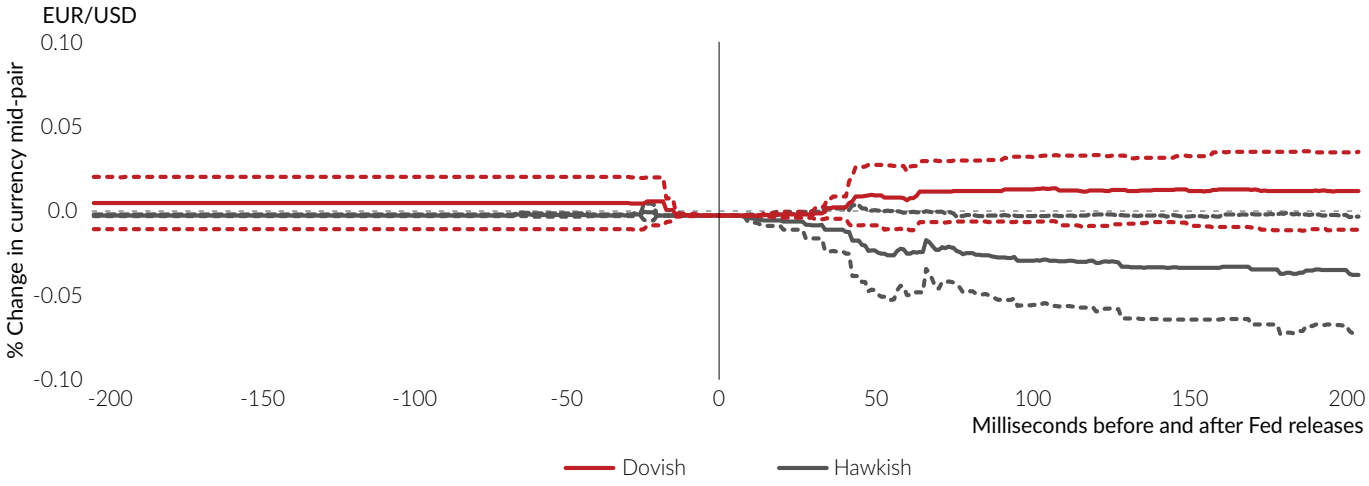
Lastly, and an extension of the above, simulations allow us to derive critical thresholds in the EUR/USD that traders can use to instantaneously identify hawkish Fed meetings with great certainty[4].

Chart 6B contains those thresholds at intervals of up to 50ms after Fed meetings. Intuitively, it shows that price declines greater than -3bps within 0.05 seconds are excellent predictors of hawkish Fed meetings. Trades placed on price moves exceeding this threshold capture, on average, 85-95% of the subsequent EUR/USD decline in the next hour.

In our simulations, declines of more than 3bps happen on 40% of hawkish simulations, meaning considerable and predictable price declines can be regularly captured after just 0.01-0.05 seconds using LMAX Exchange data. By comparison, trades placed after two seconds would capture just 33% of subsequent price declines.

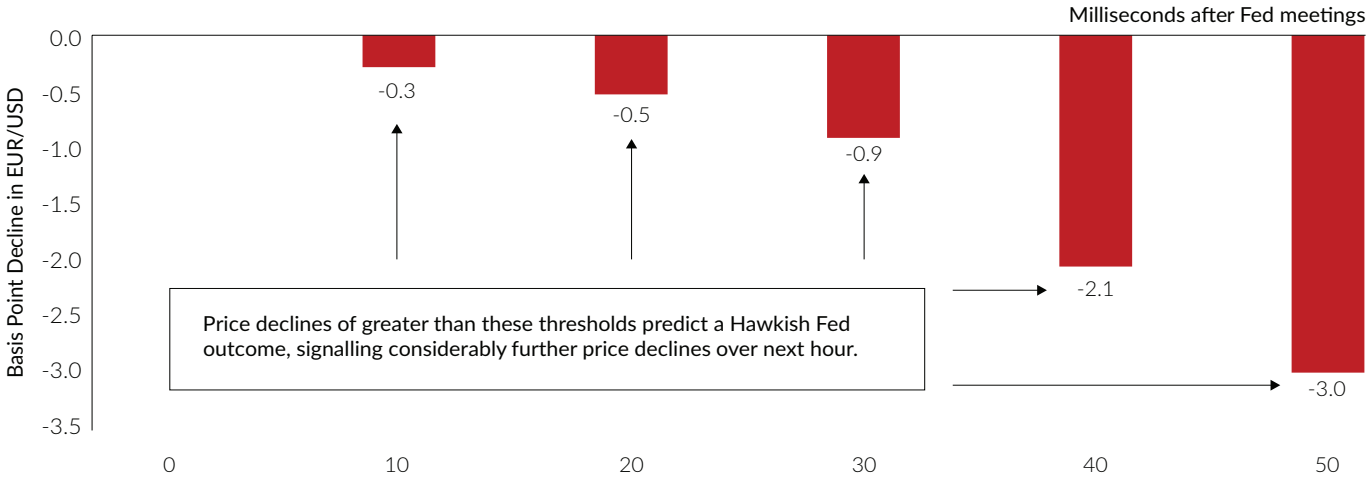
Chart 6A: EUR/USD Dynamics at 1ms

Chart 6A



[4] That is, these price declines fall outside of the 75% confidence interval of both an average Fed meeting and a dovish Fed meeting.

Chart 6B



Source: MacroHive, LMAX Exchange

Trading volumes

Charts 7A-7D present the evolution of EUR/USD trading volumes (price times quantity) after Fed meetings. After 10 seconds, there is little difference in the average volume traded (Chart 7A). However, trading volumes increase at a faster pace following hawkish meetings, especially in the first five seconds (Chart 7B). The difference is most notable between one and four seconds, with roughly 40% of total trading volumes materialising in the first four seconds after hawkish meetings compared to just 28% after dovish ones (Chart 7C).

Sub-second, we see trading activity picks up almost immediately after Fed meeting. Between 50-70ms mark, trading volumes are higher after hawkish Fed meetings. The difference is then reversed between 70-100ms (Chart 7D).

Chart 7A

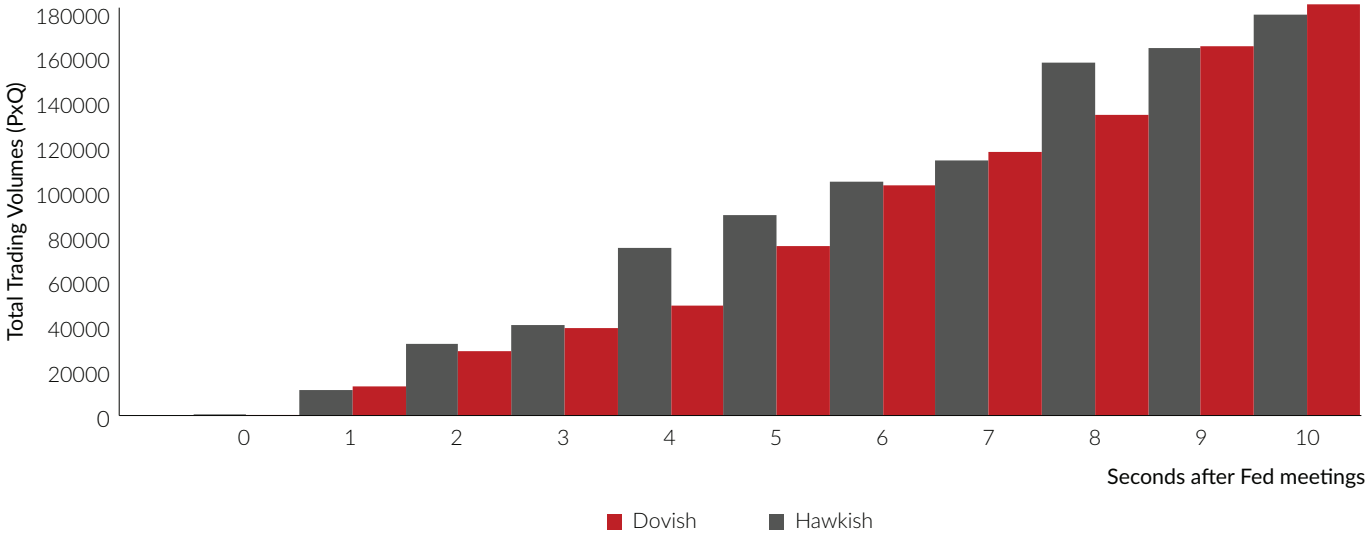


Chart 7B

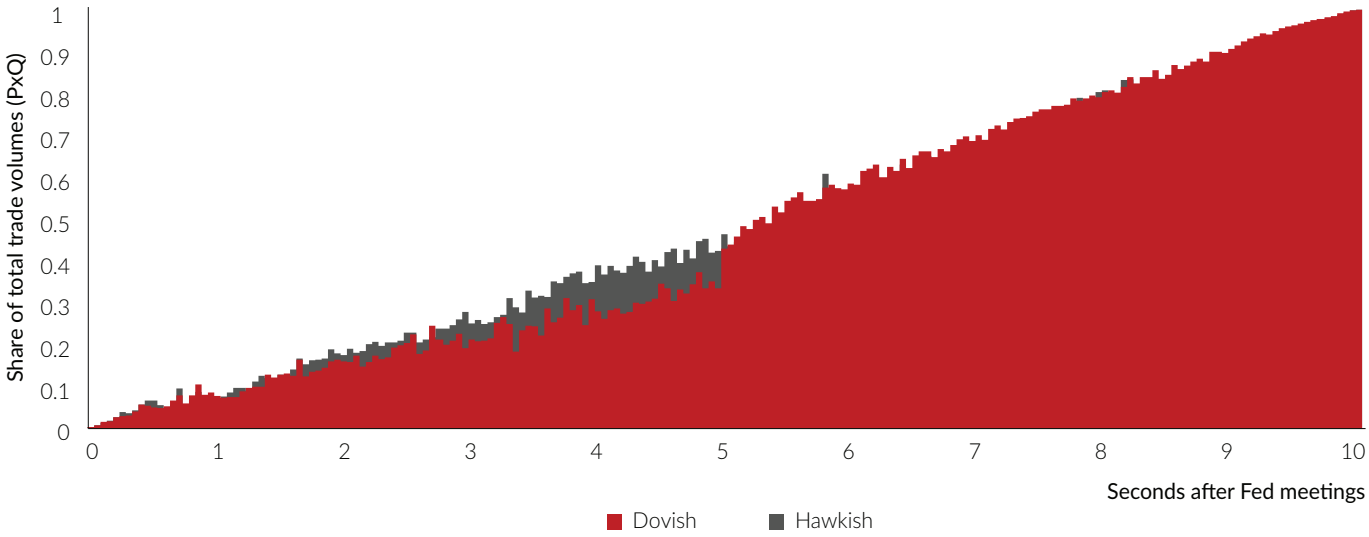


Chart 7C

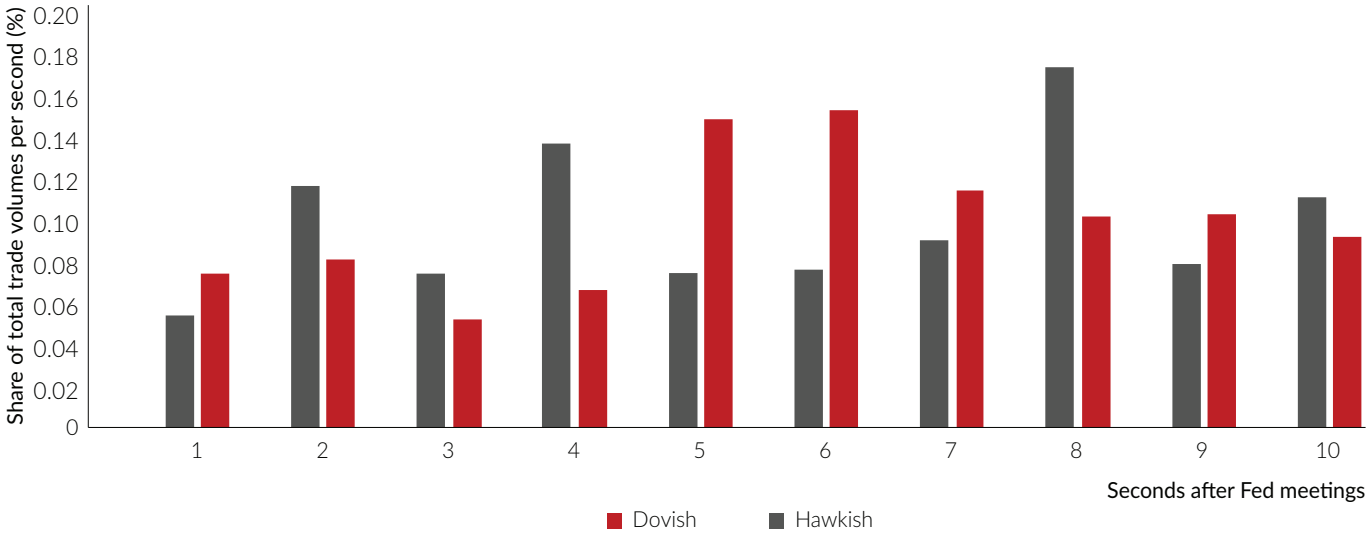
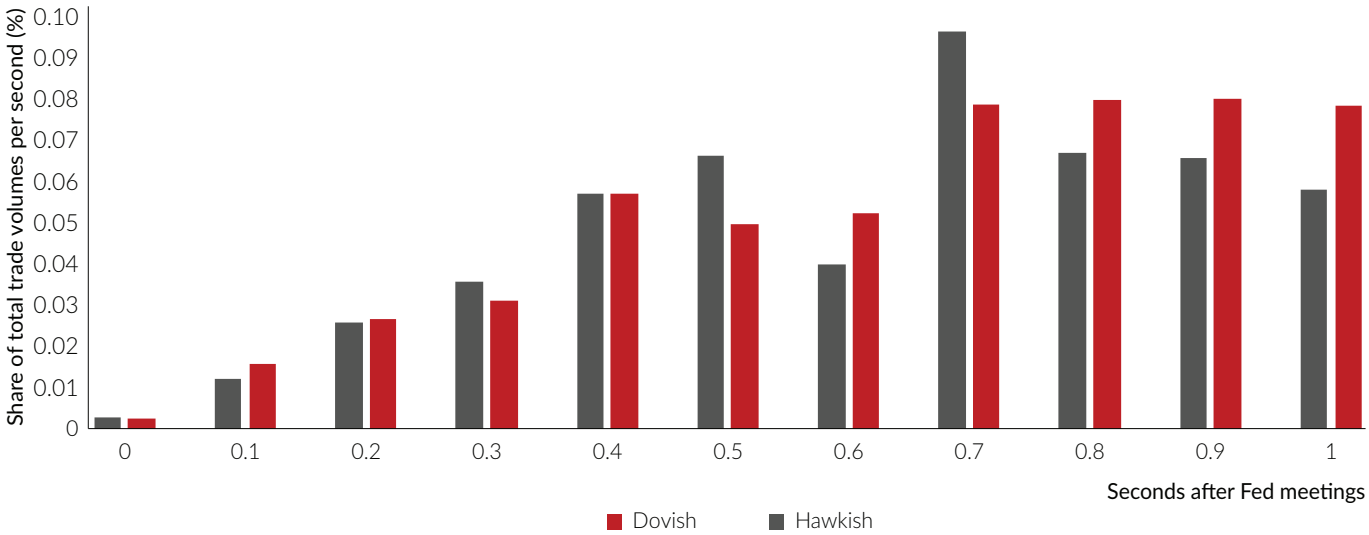


Chart 7D



Conclusion

Currency markets manifest price moves around event dates much more quickly than in equities. After US CPI events, only half of the total price action in the S&P500 materialises in the first hour and 25% within the first minute. In FX markets, nearly 50% of the action occurs within 30 seconds.

Using LMAX Exchange data, we show there is important information to be gleaned within the first thirty seconds. Specifically, the biggest indicator of pricing behaviour occurs within 1-2 seconds of the event. Waiting until then allows traders still to capture nearly 75% of the total price moves in the next hour.

That said, after hawkish Fed meetings, there are even actionable insights within a second. Prices move, on average, 2-3bps in the first 0.2 seconds post-release. These moves persist, and then extend up to 30bps further over the next 60 minutes, opening up the potential for profitable trading strategies.

Appendix

Chart 8: AUD/USD Responses to Economic Surprises

Chart 8A

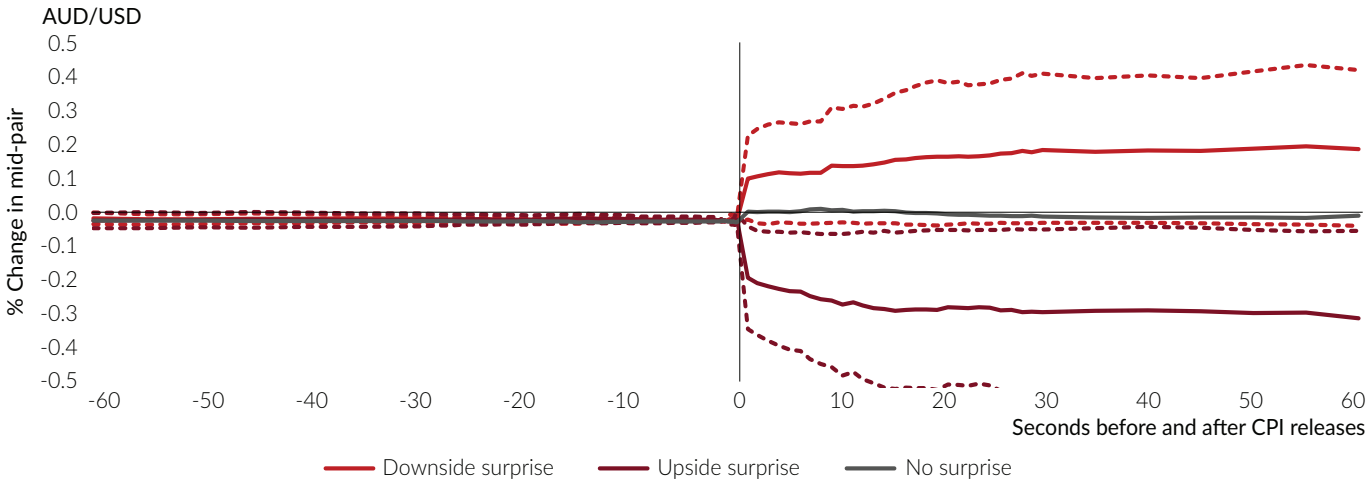


Chart 8B

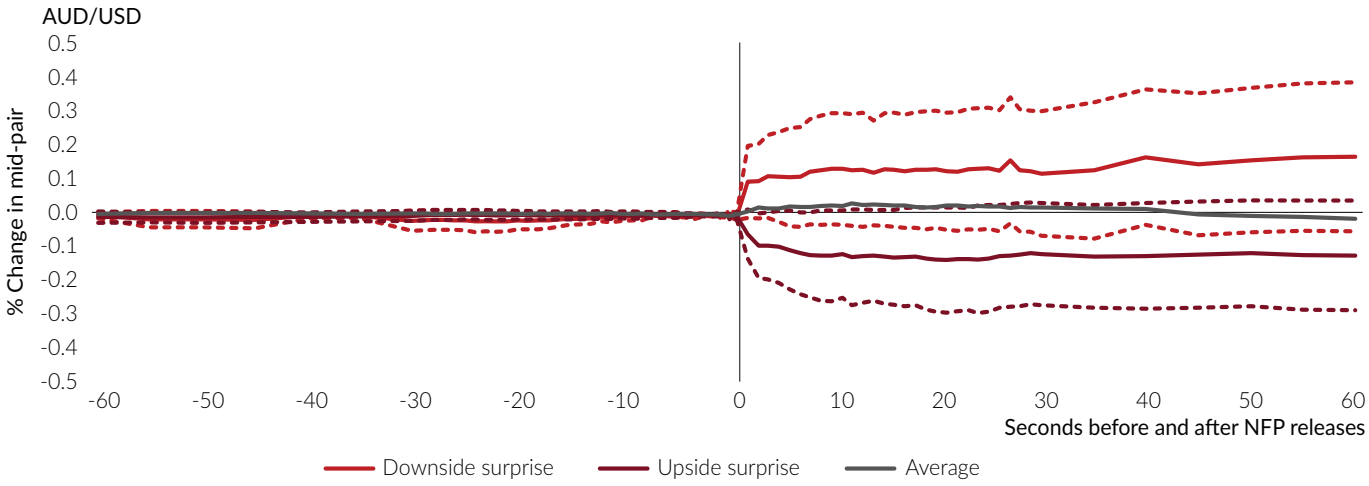


Chart 8C

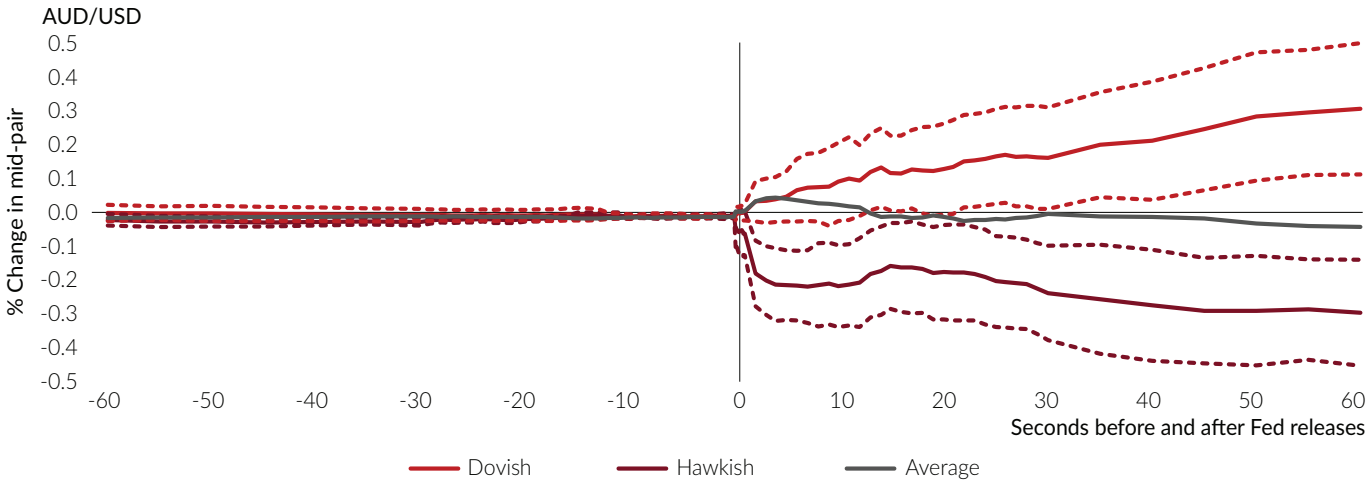


Chart 8D

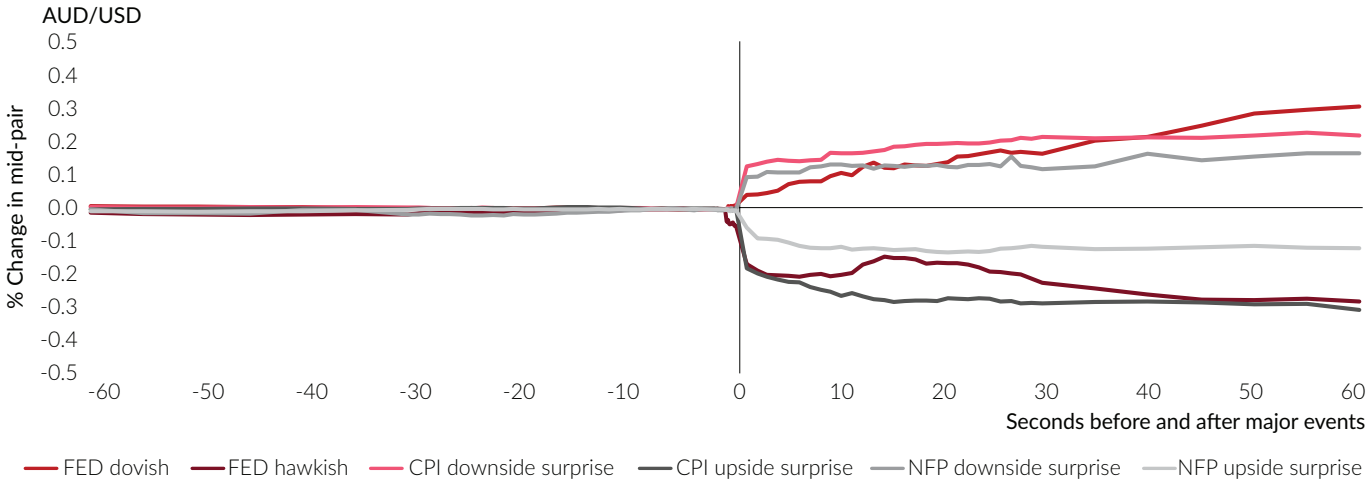


Chart 9: USD/JPY Responses to Economic Surprises

Chart 9A

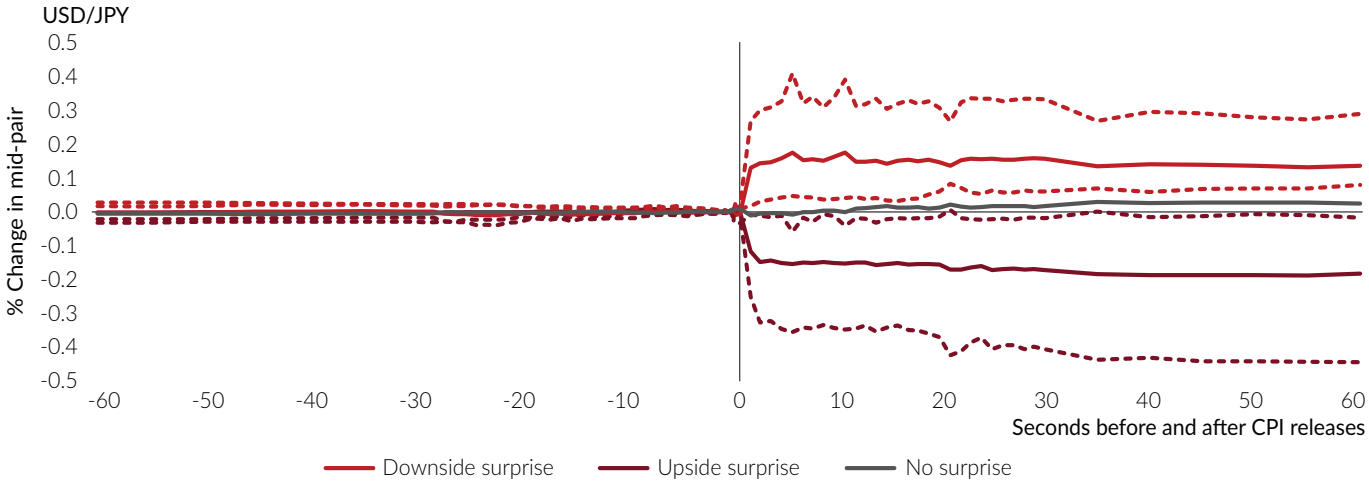


Chart 9B

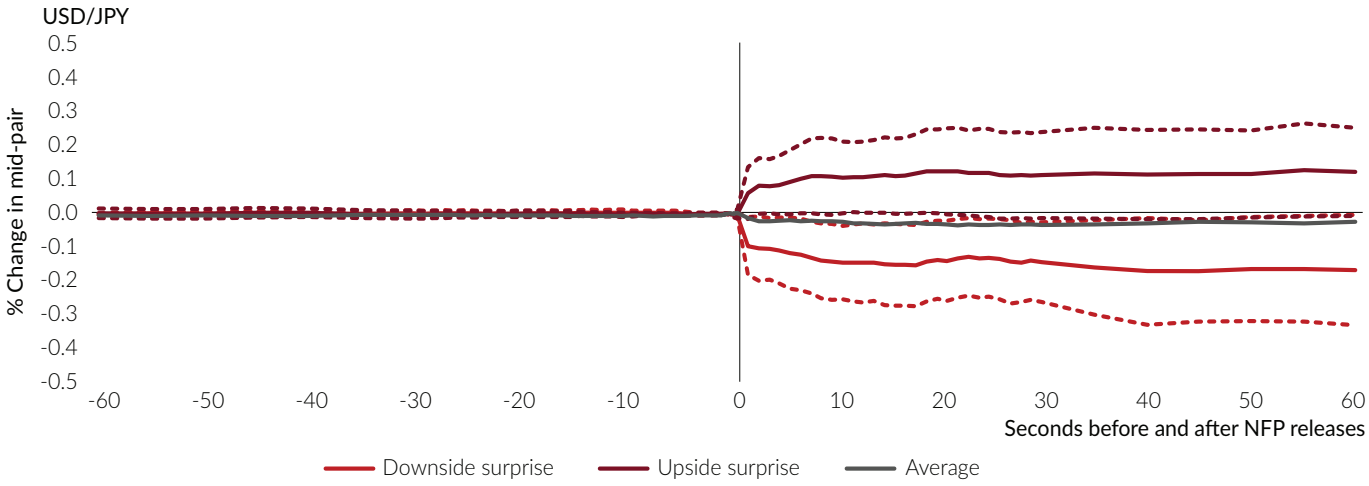


Chart 9C

Chart 9D

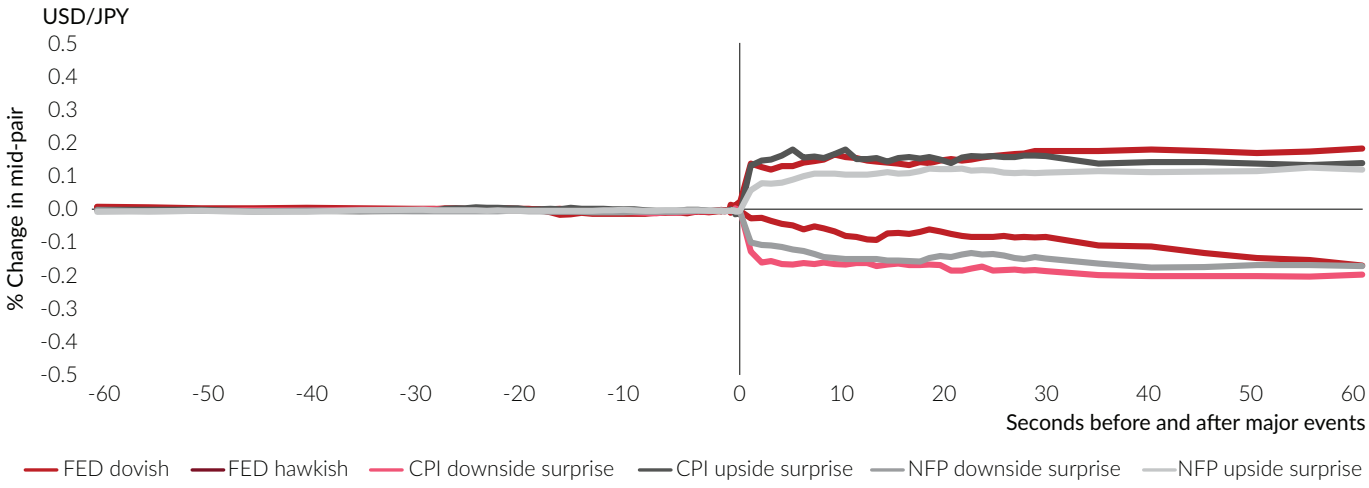


Chart 10: USD/MXN Responses to Economic Surprises

Chart 10A

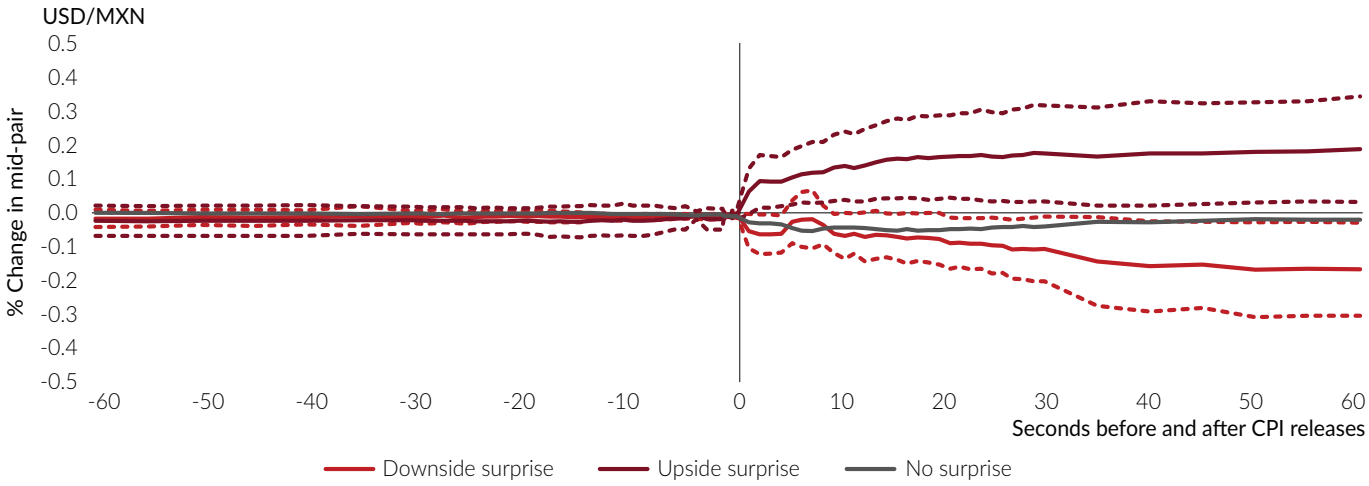


Chart 10B

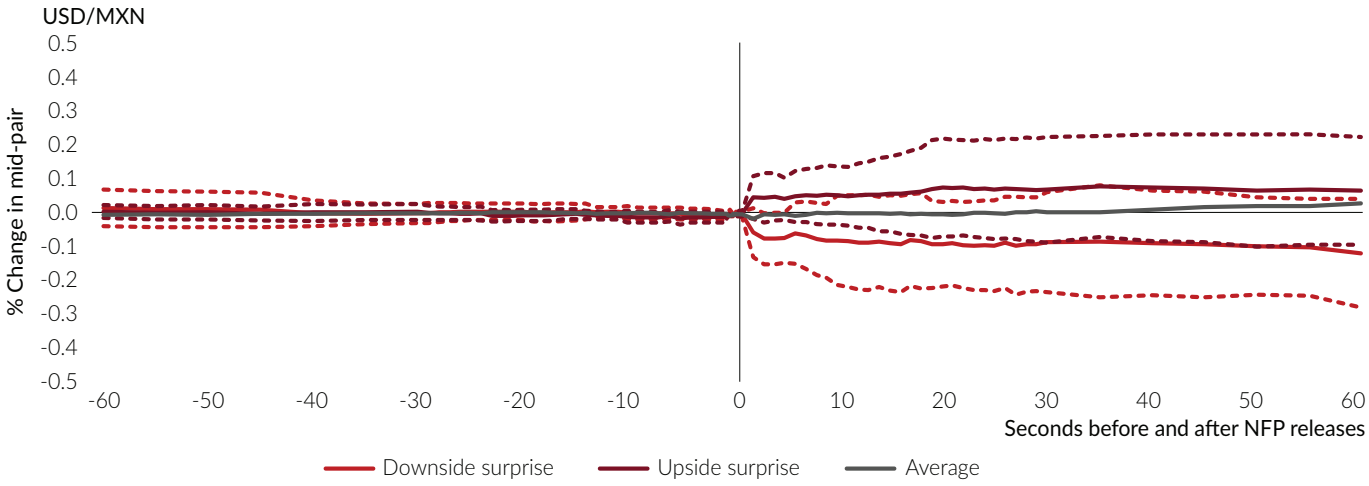


Chart 10C

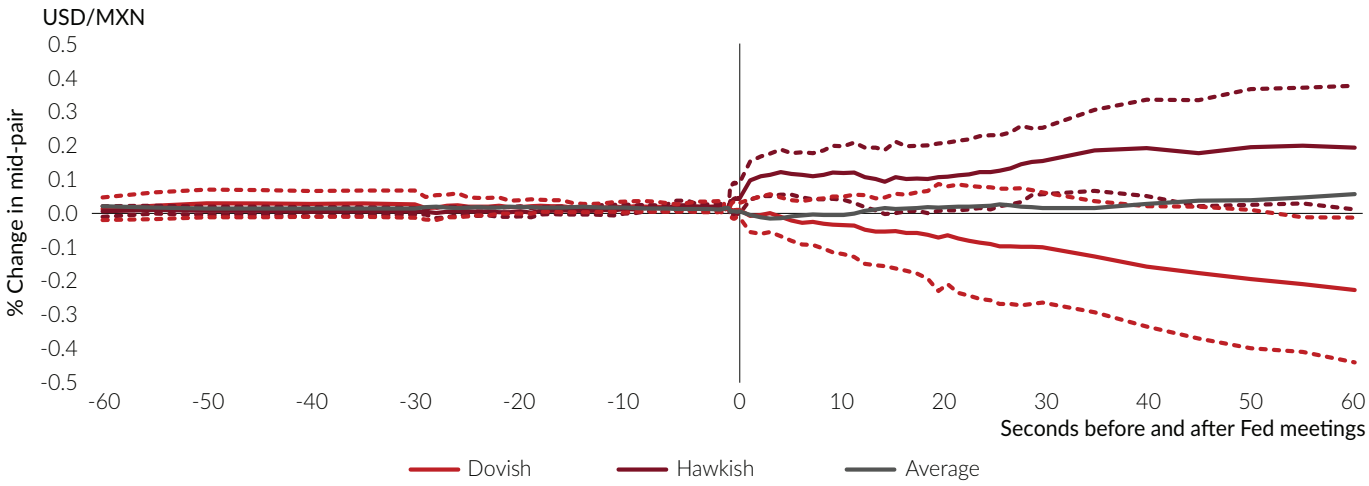


Chart 10D

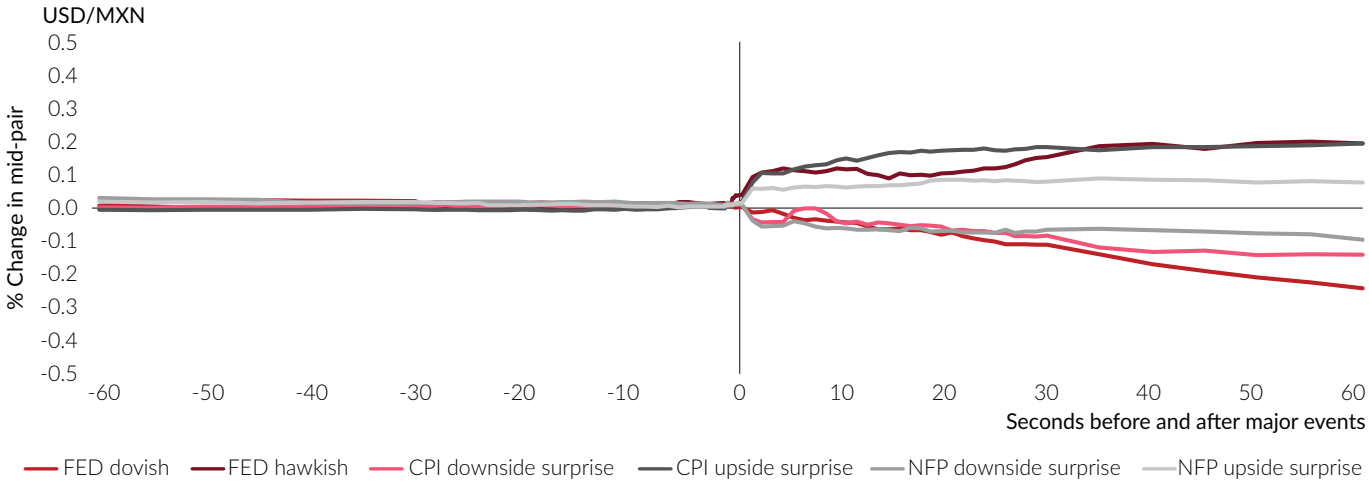


Chart 11: Five Second Price Moves Identify One- to Two-Second Window

Chart 11A

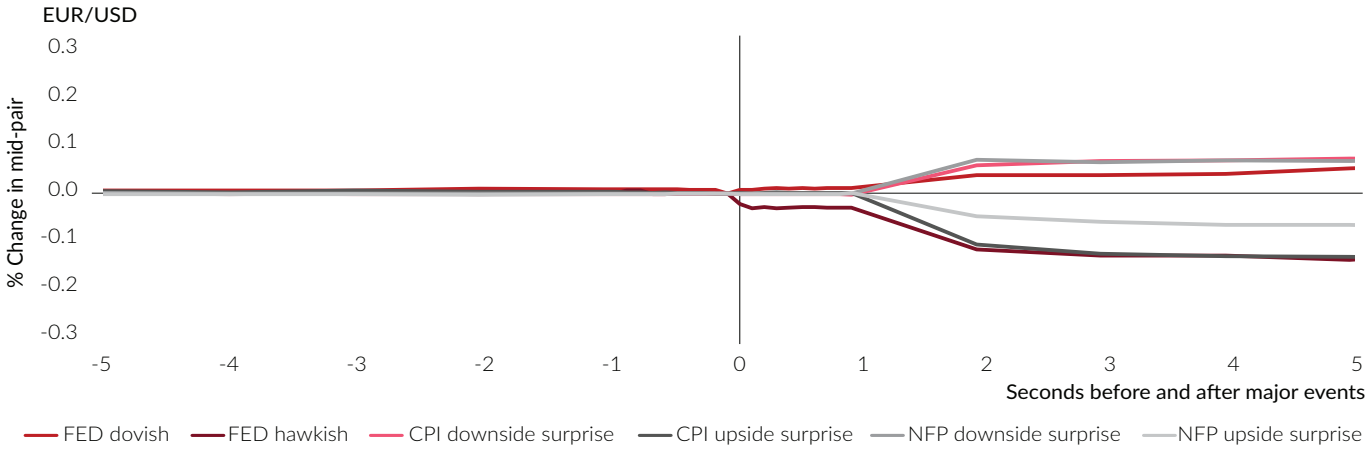


Chart 11B

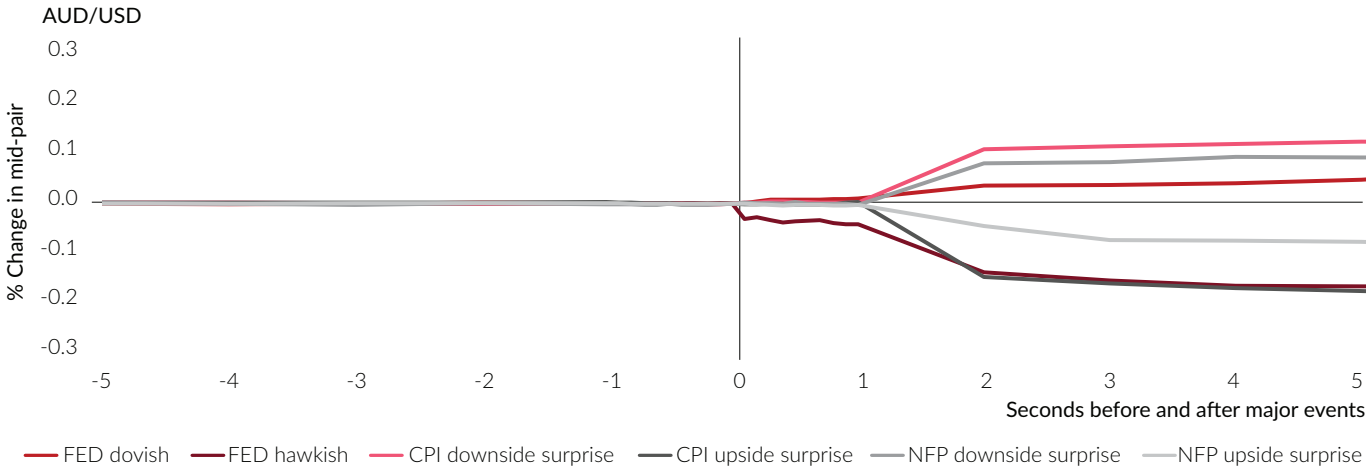


Chart 11C

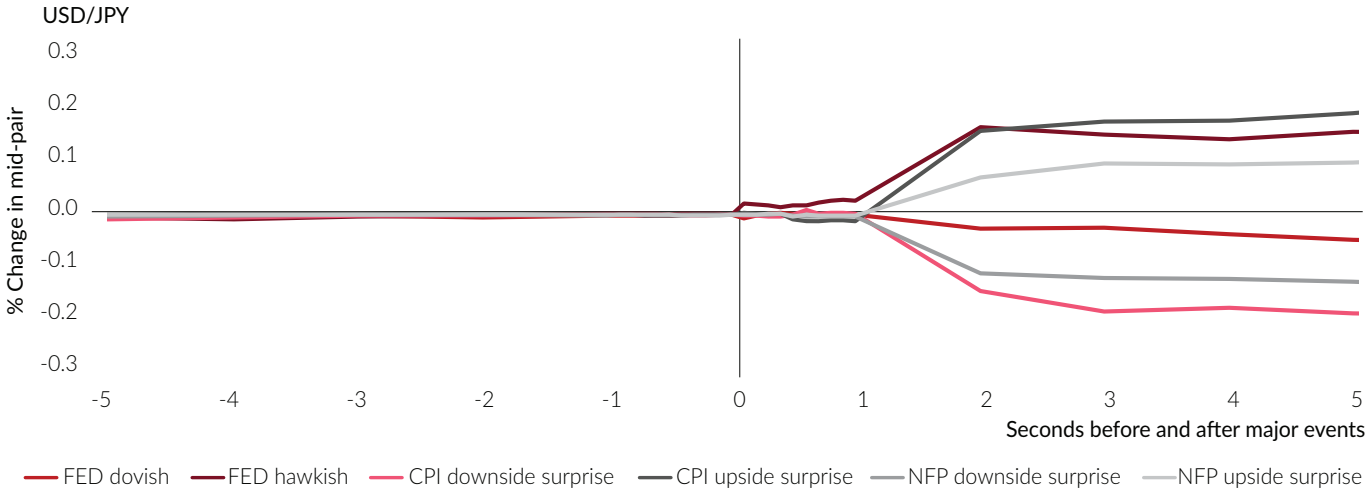
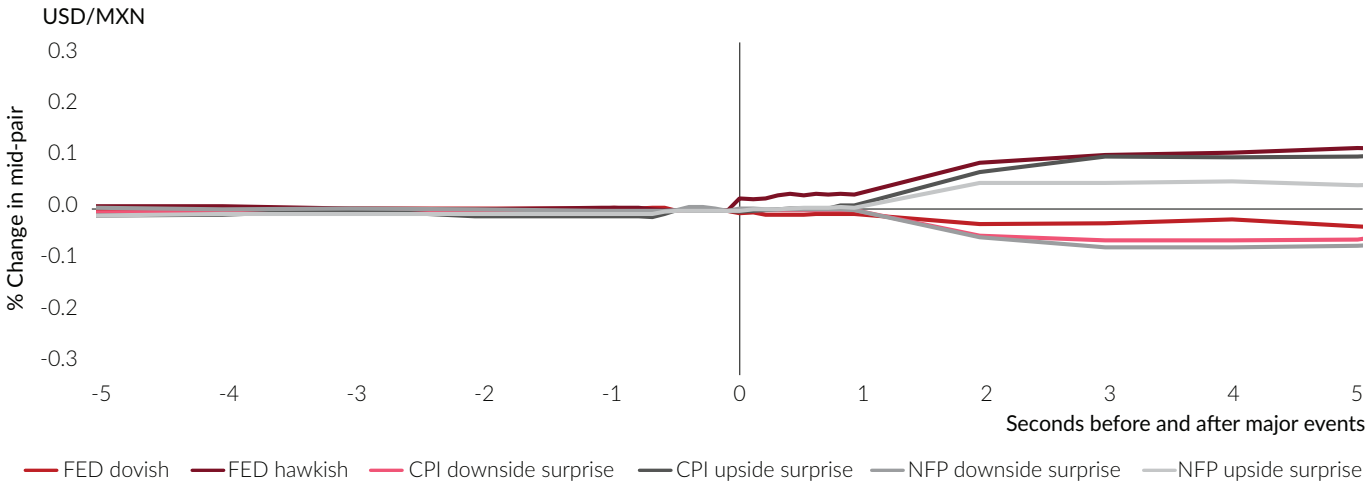


Chart 11D



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