New CTrader Indices Validation

Report Date : 11 January 2024

Introduction

Due to delay-based exploits at the release of CTrader, new variations of 1s Volatility and Crash/Boom Indices are to be released in CTrader only, while the old indices should be removed from the new platform. The parameters of the upcoming indices are as below:

Volatility Indices

New Indices	Interest rate	Dividend Rate	Volatility	Pip Size	Starting Spot	Raw Spread
Volatility 15 (1s)	0	0	0.15	0.001	10,000	0.00378%
Volatility 30 (1s)	0	0	0.3	0.001	10,000	0.00755%
Volatility 90 (1s)	0	0	0.9	0.001	10,000	0.0227%

Crash/Boom Indices

New Indices	Jump Probability*	MDT	MUT	Pip Size	Starting Spot	Raw Spread
Crash 600	1/600 ≈ 0.00166666666	-5.619	0.00937373	0.001	10,000	0.00134%
Boom 600	1/600 ≈ 0.00166666666	-0.00938755	5.619	0.001	10,000	0.00134%
Crash 900	1/900 ≈ 0.00111111111	-5.619	0.00624569	0.001	10,000	0.00111%
Boom 900	1/900 ≈ 0.00111111111	-0.00625489	5.619	0.001	10,000	0.00111%

* Note that in production, Crash Boom Indices' probabilities are defined using `up_probability`. Counterintuitively, in the current implementation, `up_probability` represents the probability of going down. This is a minor issue, but can cause confusion in the future.

Data

The data in the following sections is taken from 20 Dec 2023 until 27 Dec 2023, approximately a week of data. The new indices were initialized for CT-UAT testing on 19 Dec 2023, but a FIX feed issue prevented new ticks from being created until it was fixed on 20 Dec 2023.

Summary

The findings are summarized as below.

Volatility Indices

1. The moments are within reasonable bounds around the expected values. In particular, the volatilities are correct up to 0.1% error.

2. The moments converge within 2-4 days.
3. The distributions appear to be normal, with further confirmation as skewness and excess kurtosis are close to 0.
4. The Metabase spread isn't as expected, there is rounding (to 2 d.p) on the raw half-spread in the production code. The dealing team has also set a 0.01% markup on CTrader (relative to spot).

1HZ15V	
	Volatility (%)
Theoretical	15.00
Feed	15.00
Relative Error (%)	0.00

1HZ30V	
	Volatility (%)
Theoretical	30.00
Feed	29.99
Relative Error (%)	0.03

1HZ90V	
	Volatility (%)
Theoretical	90.00
Feed	89.96
Relative Error (%)	0.05

Crash/Boom Indices

1. The recovered parameters and the volatilities are within reasonable bounds of the simulated values
2. The moments and parameters tend to converge within 2-4 days.
3. The step/jump distributions are folded normal.
4. The Metabase spread is as expected. The dealing team has also set a 0.01% markup on CTrader (relative to spot).
5. A leverage of 1:400 (similar to existing CB indices) results in a Negative Balance Adjustment per Total Trades rate between 0.004% to 0.0045%.

CRASH600			
	Frequency of Jumps (%)	**Size of Jumps (%)**	**Volatility (%)**
Theoretical	0.166670	0.099985	27.880000
Feed	0.155752	0.100881	26.993745
Relative Error (%)	6.550674	-0.895546	3.178819

CRASH900			
	Frequency of Jumps (%)	**Size of Jumps (%)**	**Volatility (%)**
Theoretical	0.111110	0.099785	22.765339
Feed	0.113078	0.098135	22.663997
Relative Error (%)	-1.771539	1.654004	0.445160

BOOM600			
	Frequency of Jumps (%)	**Size of Jumps (%)**	**Volatility (%)**
Theoretical	0.166670	0.100132	27.889700
Feed	0.165761	0.101432	28.164462
Relative Error (%)	0.545553	-1.298288	-0.985174

BOOM900			
	Frequency of Jumps (%)	**Size of Jumps (%)**	**Volatility (%)**
Theoretical	0.111110	0.100132	22.817200
Feed	0.108319	0.096454	21.913187
Relative Error (%)	2.512023	3.673521	3.961982

Conclusion

The new CTrader indices are behaving as expected in terms of spot dynamics. The spreads, however, differ from the expected values due to production implementation & CTrader limitations.

Validation Results

Volatility Indices (15, 30, 90)

1. Moments

The expected moments are as below:

	drift	**vol**	**skew**	**E. kurtosis**
1HZ15V	0	0.15	0	0
1HZ30V	0	0.30	0	0
1HZ90V	0	0.90	0	0

Checking the log returns, we see that:

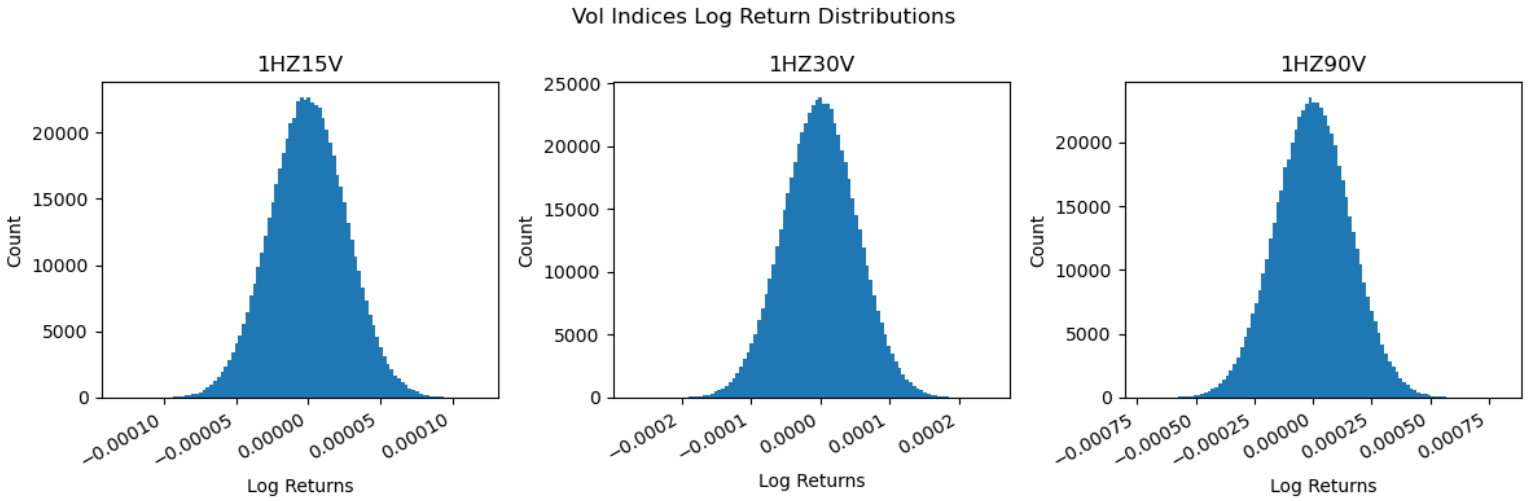
	drift	**vol**	**skew**	**E. kurtosis**
1HZ15V	0.0000000018	0.1499948755	-0.0041817503	-0.0071978491
1HZ30V	0.0000000023	0.2999224852	0.0010976339	-0.0049743854
1HZ90V	0.0000003691	0.8995600495	-0.0003049375	0.0058023249

2. Convergence of Moments

We also see the rate of convergence of the moments:

3. Log Return Distributions

We expect the distributions of log returns to look like a roughly centered normal distribution. Indeed, we see that is the case



4. Spread Checks (Metabase)

We observe there was a difference between the expected spread percentage and the spread percentage of the Ctrader/Metabase Feed. There were multiple reasons this was occurring:

- The production code below (Link) results in differences between the Metabase spread and the expected spreads as there is rounding off in the half-spreads:

```
my $spread = $spot * sqrt($volatility**2 * 2 / $_SECS_PER_YEAR) *
$spread_multiplier;
my $y      = POSIX::floor(POSIX::log10($spread));
my $x      = $spread / (10**$y);
my $s      = max(2, round($x / 2) * 2);
```

```
$latest_value->{spread}          = $s * 10**$y;
```

- The half-spread of Ctrader is the Metabase half-spread + a markup of 0.01% of the spot price (the 0.01% markup is rounded off to 3 dp), added by the Dealing team. Note that it is a magnitude higher than the actual base spread as CTrader settings for percentage spread is limited to 0.01% at minimum. Refer to slack message here.

The following values are from the Metabase feed, which is only affected by No 1.

	Expected Relative Spread (%)	Observed Mean Relative Spread (%)
1HZ15V	0.00378	0.0040098042
1HZ30V	0.00755	0.0079900081
1HZ90V	0.02270	0.0174182164

Crash/Boom Indices (600, 900)

1. Moments

There aren't any defined expected moments, so we would just like the drift to be as low as possible

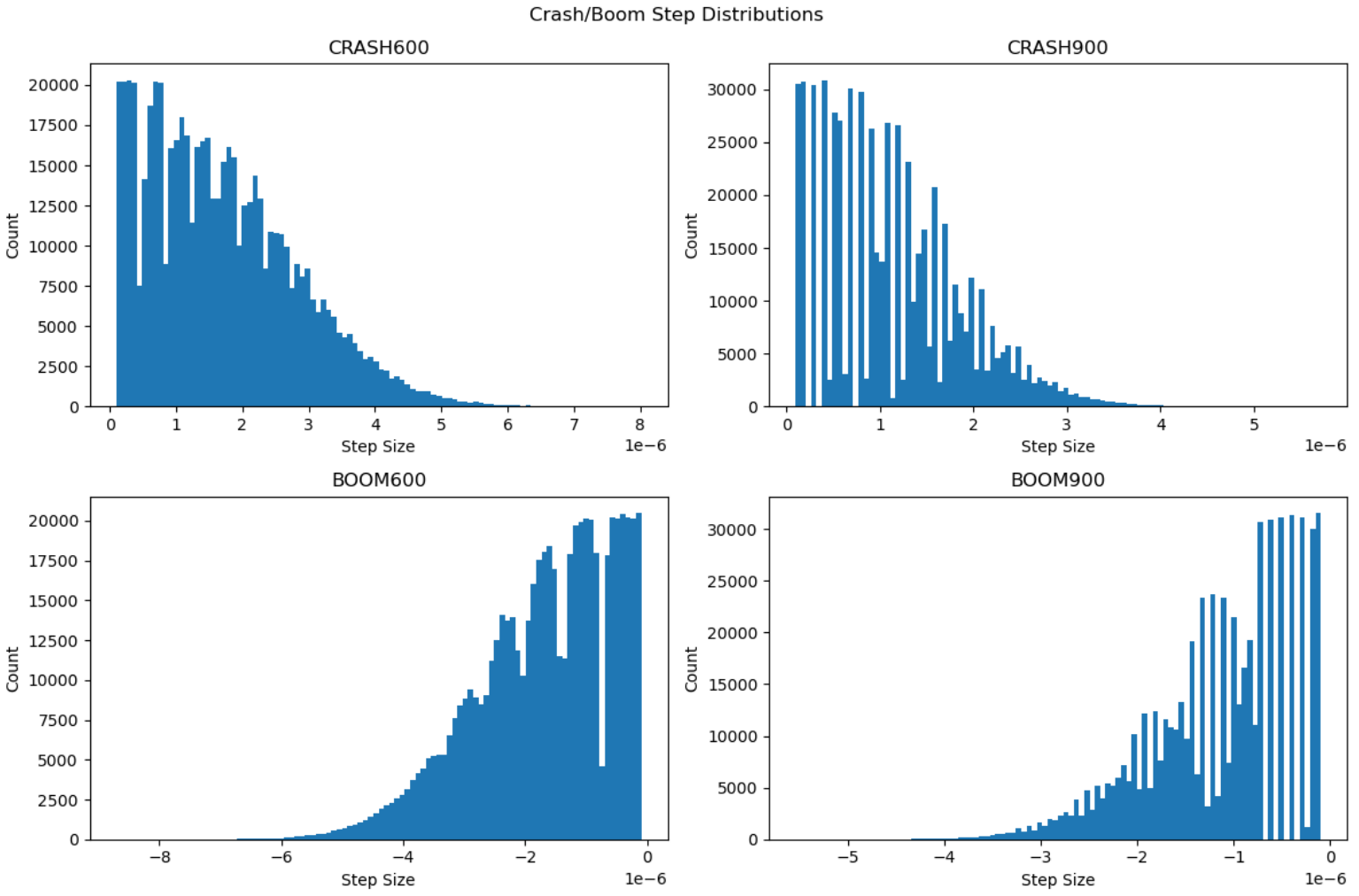
	drift	vol	skew	E. kurtosis
CRASH600	0.0000000937	0.2699374526	-36.7113107779	1529.0721655398
CRASH900	0.0000000012	0.2266399688	-44.8474603616	2331.5825487707
BOOM600	0.0000000081	0.2816446211	36.2615120397	1489.4099570317
BOOM900	-0.0000000696	0.2191318674	46.0937410403	2458.8352900648

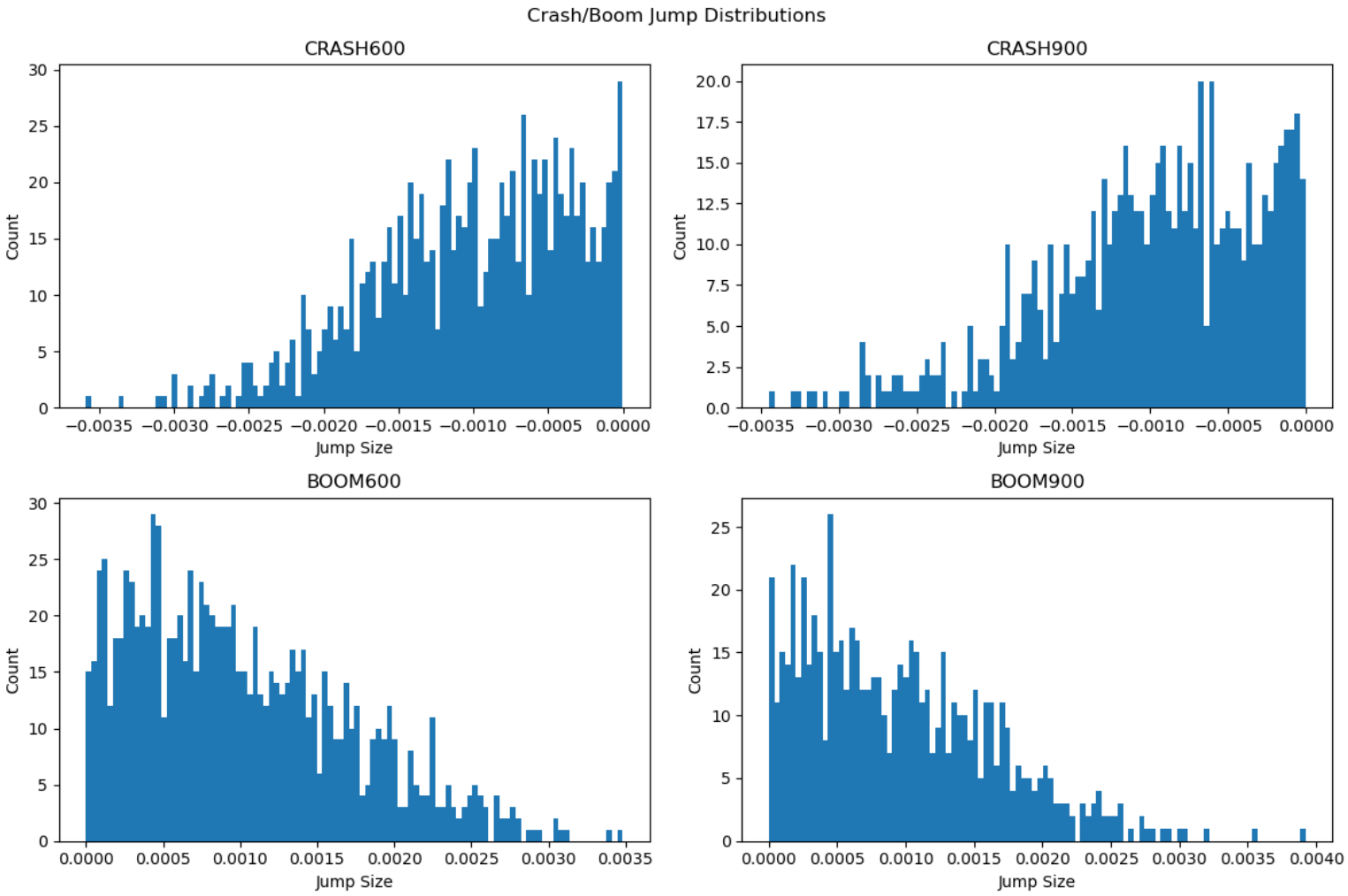
2. Convergence of Moments

We also see the rate of convergence of the moments. They tend to stabilize within 2-4 days (unless a particularly large jump occurs):

3. Step/Jump Distributions

The distributions of the steps/jumps should both look like folded normal distributions. There aren't enough points to get a full shape, but they resemble what we expect.





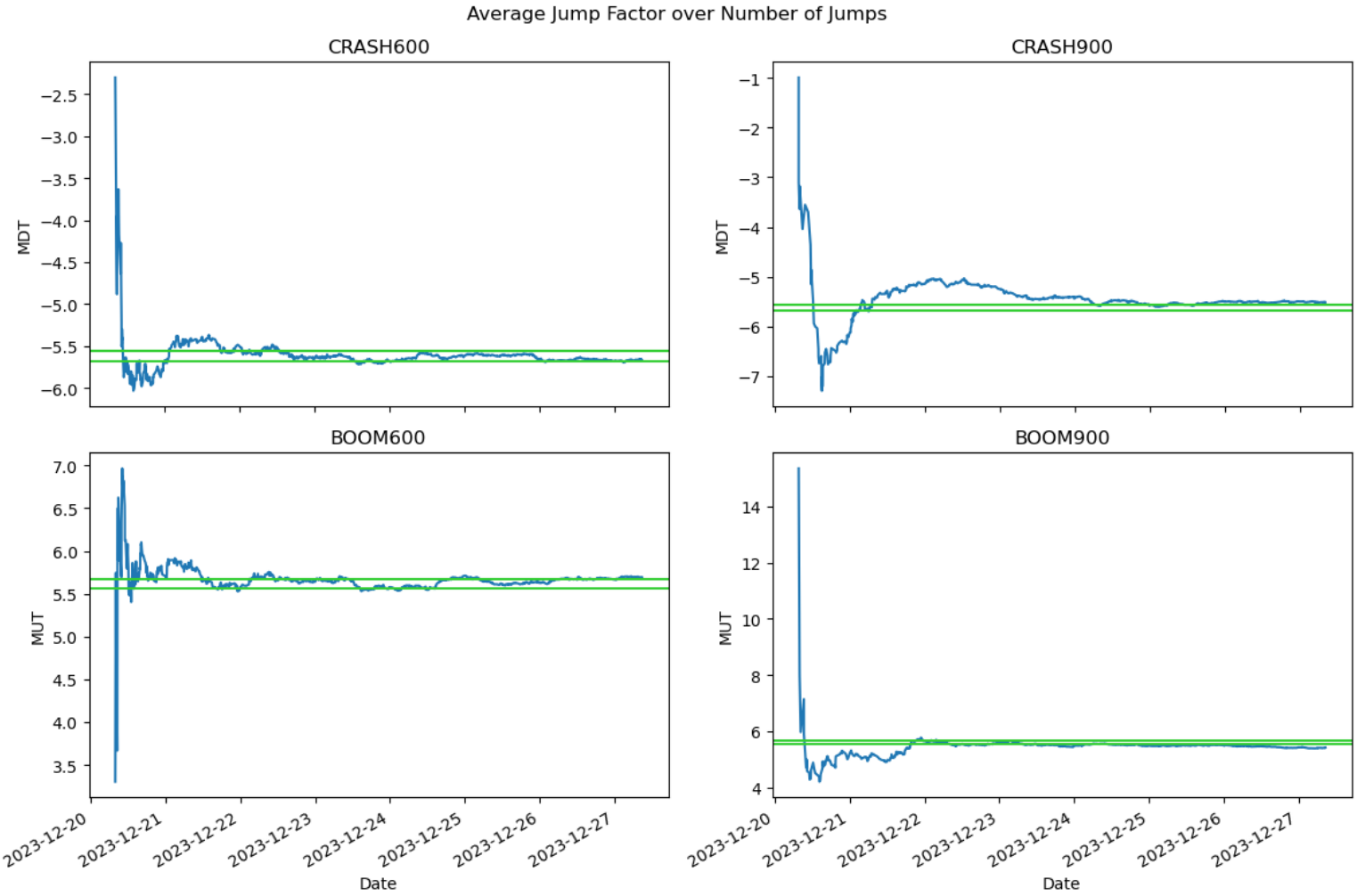
Jump/Step Parameters

CB jump factors/probability should be within reasonable bounds of the expected parameters as shown below. The graphs that follow demonstrate the factors calculated over time, with thresholds indicating the range of values in a 1% uncertainty around the actual value. The parameters tend to converge within 2 days

	MDT	MUT	Jump Probability
CRASH600	-5.6190000000	0.0093737306	0.0016666667
CRASH900	-5.6190000000	0.0062456807	0.0011111111
BOOM600	-0.0093875464	5.6190000000	0.0016666667
BOOM900	-0.0062548810	5.6190000000	0.0011111111

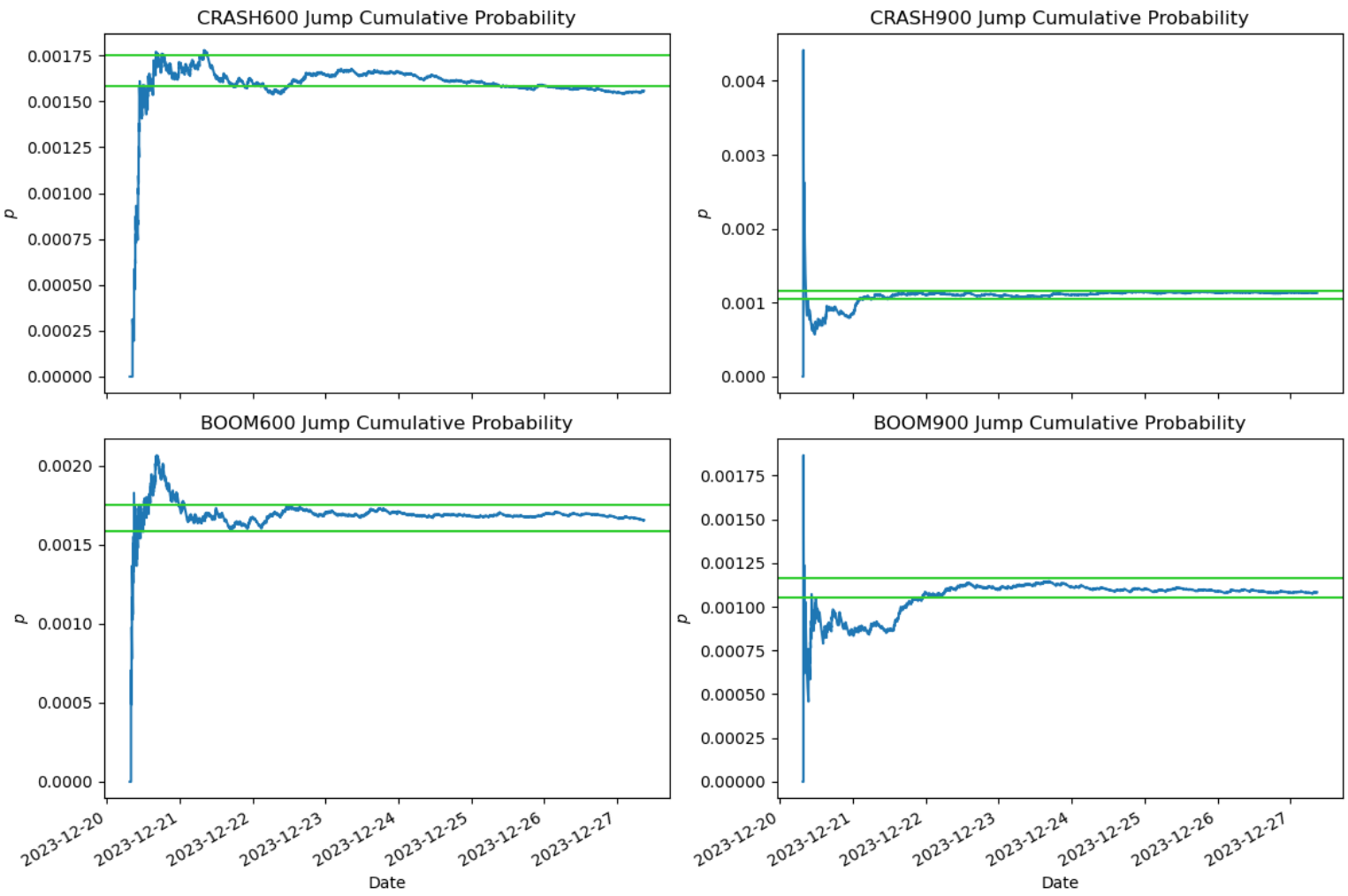
Jump Factor (MDT/MUT)

	MUT	Empirical Jump Factor	Empirical Jump Size (%)
CRASH600	-5.619	-5.6693061274	-0.1008807143
CRASH900	-5.619	-5.5149995836	-0.0981350435
BOOM600	5.619	5.6918527303	0.1014320018
BOOM900	5.619	5.4126214319	0.0964541120



Jump Probabilities

	Jump Probability	Empirical Jump Probability
CRASH600	0.0016666667	0.0015575199
CRASH900	0.0011111111	0.0011307836
BOOM600	0.0016666667	0.0016576073
BOOM900	0.0011111111	0.0010831889



4. Spread Checks (Metabase)

We observe there was a difference between the expected spread percentage and the spread percentage of the Ctrader Feed. Metabase Feed spread does match the expected spread. The reason for the difference for the CTrader Feed is as follows

- The Metabase feed only considers the expected relative spread below, as a BE parameter. This is as expected.
- The half-spread of Ctrader is the Metabase half-spread + a markup of 0.01% of the spot price (the 0.01% markup is rounded off to 3 dp), added by the Dealing team. Note that it is a magnitude higher than the actual base spread as CTrader settings for percentage spread is limited to 0.01% at minimum. Refer to slack message here.

The following values are from the Metabase feed, which match the expected spread.

	Expected Relative Spread (%)	Observed Mean Relative Spread (%)
CRASH600	0.00134	0.0013399965
CRASH900	0.00111	0.0011100084
BOOM600	0.00134	0.0013399949
BOOM900	0.00111	0.0011099929

5. Negative Balance Simulation

Results given in the spreadsheet (thanks, Matthew).

In short, a leverage of 1:400 (similar to existing CB indices) results in a Negative Balance Adjustment per Total Trades rate between 0.004% to 0.0045%.

Comparison to Existing Crash Boom													
Asset	NB/Trade	NB/Trade (%)	IV	Approx. Price		Leverage	Expected Price Change - 2sec	Expected Price Change (%) - 2sec	Ratio	MT5 Spread	Spread	Spread Points	Theoretical Mean Jump Size (%)
Crash 300	0.1785	0.00183%	100.0%	3,780.0100	3,780.4060	100	0.95198	0.0252%	0.42	0.01048%	0.3960	40	-0.26000000%
Boom 300	0.1160	0.00243%	100.0%	918.8210	918.9170	100	0.23140	0.0252%	0.41	0.01045%	0.0960	10	0.26067780%
Crash 500	0.3484	0.00412%	31.0%	3,892.5140	3,892.6730	400	0.30389	0.0078%	0.52	0.00408%	0.1590	16	-0.10000890%
Boom 500	0.2817	0.00423%	31.0%	4,656.6450	4,656.8250	400	0.36354	0.0078%	0.50	0.00387%	0.1800	18	0.10010900%
Crash 600	0.4125	0.00446%	27.8%	10,000.00		400	0.70030	0.0070%	0.19	0.00134%	0.1340	13	-0.10000890%
Boom 600	0.4213	0.00397%	27.7%	10,000.00		400	0.69718	0.0070%	0.19	0.00134%	0.1340	13	0.10010900%
Crash 900	0.3955	0.00403%	22.6%	10,000.00		400	0.56924	0.0057%	0.19	0.00111%	0.1110	11	-0.10000890%
Boom 900	0.4811	0.00460%	22.8%	10,000.00		400	0.57321	0.0057%	0.19	0.00111%	0.1110	11	0.10010900%
Crash 1000	0.4115	0.00427%	21.0%	6,590.4746	6,590.6993	400	0.34854	0.0053%	0.64	0.00341%	0.2247	22	-0.10000890%
Boom 1000	0.4469	0.00398%	21.0%	12,807.6726	12,808.1114	400	0.67734	0.0053%	0.65	0.00343%	0.4388	44	0.10010900%

Spread check based on 8th Jan 2024 feed data

Spread for crash/boom indices match spreads proposed here. However do not match exactly for vol indices, notably 1HZ90V as the observed spread is significantly lower than proposed spreads.

The discrepency is likely due to the operation performed by backend here.

	Expected Relative Spread (%)	Observed Mean Relative Spread (%)
CRASH600	0.00134	0.00134
CRASH900	0.00111	0.00111
BOOM600	0.00134	0.00134
BOOM900	0.00111	0.00111

	Expected Relative Spread (%)	Observed Mean Relative Spread (%)
1HZ15V	0.00378	0.003949
1HZ30V	0.00755	0.008307
1HZ90V	0.02270	0.016347

Verifying volatility of new indices based on CTrader feed

Data used was from 4th Jan 2024 to 9th Jan 2024. Volatility of new indices are in reasonable range.

To note, around 1 % to 1.8 % of Crash/Boom indices feed data contains NANs while Volatility indices do not have that issue.

```
Percentage NANs in CRASH600 data: 1.0386312016571067 %
Percentage NANs in CRASH900 data: 1.6714982900197541 %
Percentage NANs in BOOM600 data: 1.0538825393588065 %
Percentage NANs in BOOM900 data: 1.8530077549391812 %
Percentage NANs in 1HZ15V data: 0.0 %
Percentage NANs in 1HZ30V data: 0.0 %
Percentage NANs in 1HZ90V data: 0.0 %
```

	Expected Vol (%)	Observed Vol (%)
CRASH600	27.234934	26.608723

CRASH900	22.154598	22.253074
BOOM600	27.598570	27.908112
BOOM900	22.352271	23.253534

	Expected Vol (%)	Observed Vol (%)
1HZ15V	15	15.051919
1HZ30V	30	30.144464
1HZ90V	90	90.368265

	Expected Relative Spread (%)	Observed Mean Relative Spread (%)
CRASH600	0.00134	0.00134
CRASH900	0.00111	0.00111
BOOM600	0.00134	0.00134
BOOM900	0.00111	0.00111

	Expected Relative Spread (%)	Observed Mean Relative Spread (%)
1HZ15V	0.00378	0.003943
1HZ30V	0.00755	0.008301
1HZ90V	0.02270	0.017418

R&D effort needs to be in line with Deriv's vision and mission as formulated by our CEO. Therefore all R&D projects are carefully selected by our C-Level senior management represented by JY and Rakshit and resources for the projects are only allocated after review and shortlisting based on their vision and priorities.

In line with the standards and criterias set out by the CEO, the Model Validation team has validated the product/indices as documented in this report.