SECURITIES DIVISION

FX Algos

Market functioning

ECB FXCG Meeting

September 2019

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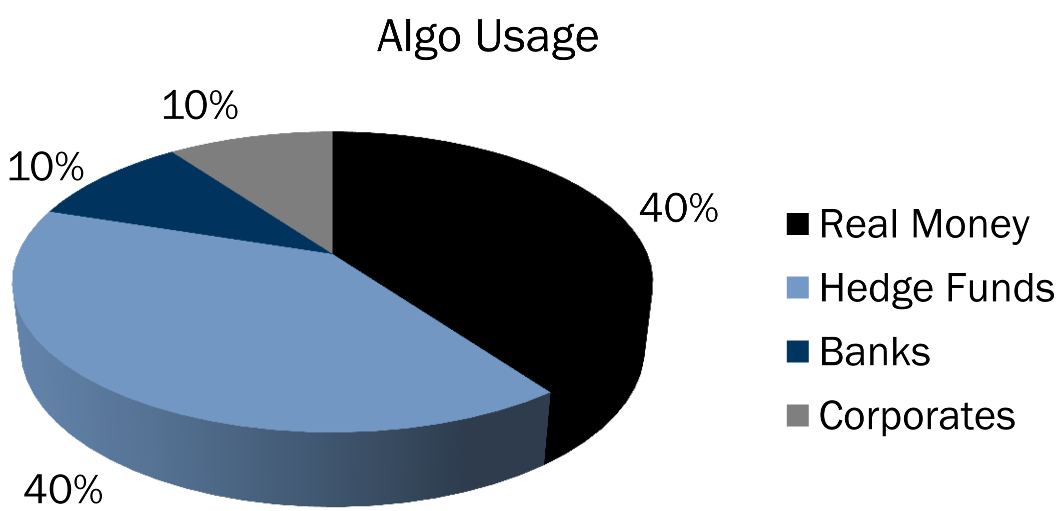
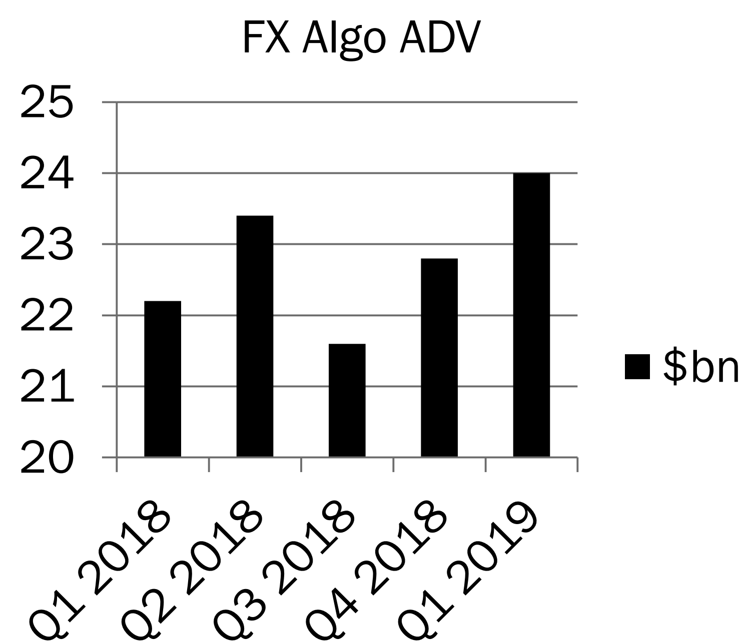
The Market for FX Algos

Total Volume Estimate

- Estimates of the total volume traded via FX algos can be attempted from
  - (limited) wallet share statistics from multi-dealer platforms where FX algos are offered
  - Participation in market surveys
  - Published studies such as by Greenwich Associates
- Using a combination of these approaches, we estimate
  - ADV: $20-25bn
  - Split: largely real money and hedge fund





Algo behaviour

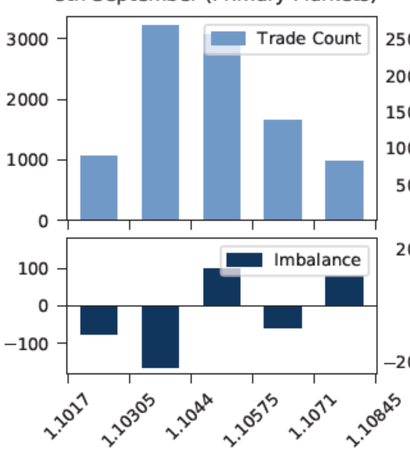
Algo function in illiquid conditions and distressed markets

Heat map showing time-weighted average touch spread in pips by time of day for G10, Deliverable EM and NDF[3] crosses (using 5th September primary markets data)

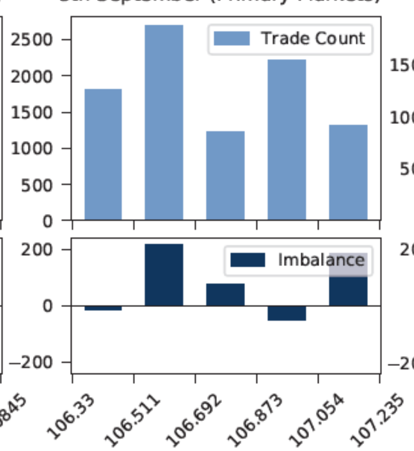
Time (LDN)	EURUSD	USDJPY	GBPUSD	USDCHF	USDCAD	AUDUSD	NZDUSD	EURNOK	EURSEK	EURDKK	USDCNH	USDSGD	USDHKD
00:00-01:00	1.0	1.1	2.9	1.6	2.1	0.9	1.8	71.1	73.0	13.8	21.3	1.7	12.3
01:00-02:00	0.9	0.8	2.7	1.3	1.8	0.9	1.6	47.4	47.9	15.0	9.4	1.6	5.2
02:00-03:00	0.8	0.9	2.8	1.3	1.8	1.0	1.6	56.1	39.4	15.0	7.1	1.6	5.0
03:00-04:00	0.8	0.8	2.5	1.1	1.6	0.9	1.4	53.6	60.1	15.0	4.3	1.6	3.3
04:00-05:00	0.8	0.8	2.7	1.1	1.7	0.9	1.4	37.9	59.9	15.0	4.7	1.4	3.4
05:00-06:00	0.8	0.7	2.5	1.0	1.6	0.8	1.3	29.7	54.0	12.0	4.9	1.5	2.9
06:00-07:00	0.8	0.9	2.8	1.4	1.6	0.8	1.4	45.9	42.4	5.9	4.8	1.5	2.6
07:00-08:00	0.8	0.9	2.3	1.2	1.7	0.8	1.4	31.9	23.8	5.5	3.7	1.7	2.7
08:00-09:00	0.8	0.9	2.2	1.2	1.6	0.9	1.3	33.5	39.1	2.5	3.7	1.5	1.9
09:00-10:00	0.8	0.9	2.0	1.2	1.6	0.8	1.4	26.9	24.6	2.9	4.0	1.8	2.3
10:00-11:00	0.8	0.9	1.9	1.1	1.4	0.9	1.5	27.7	24.7	3.4	4.2	1.6	2.0
11:00-12:00	0.7	0.9	2.0	1.2	1.5	0.9	1.4	30.0	26.0	3.7	4.1	1.8	3.0
12:00-13:00	0.8	0.8	1.9	1.2	1.6	0.9	1.4	26.7	22.2	2.2	5.0	2.0	2.6
13:00-14:00	0.8	0.9	2.3	1.3	1.6	0.9	1.3	30.0	24.4	3.7	5.3	2.1	2.9
14:00-15:00	0.8	0.9	1.9	1.1	1.4	0.8	1.2	25.2	22.2	2.9	5.5	2.0	3.2
15:00-16:00	0.8	0.8	1.8	1.2	1.5	0.8	1.3	27.4	23.4	6.1	5.7	1.9	4.2
16:00-17:00	0.7	0.8	1.9	1.2	1.5	0.9	1.3	23.4	27.2	3.7	5.1	2.0	3.4
17:00-18:00	0.7	0.8	2.1	1.1	1.5	1.0	1.2	25.9	26.0	3.0	5.8	1.9	5.0
18:00-19:00	0.8	0.9	2.2	1.2	1.7	1.0	1.3	28.6	28.0	3.0	5.4	2.1	3.4
19:00-20:00	0.7	0.8	2.2	1.1	1.5	1.0	1.3	25.8	31.0	3.0	6.2	2.0	6.3
20:00-21:00	0.9	0.9	2.1	1.2	1.6	0.9	1.7	36.9	34.0	3.0	7.1	2.3	6.0
21:00-22:00	0.9	1.1	3.2	1.3	1.9	1.2	1.8	60.4	49.6	3.5	4.4	2.1	3.3
22:00-23:00	2.3	5.2	13.6	8.2	5.4	3.1	4.7	177.5	100.5	6.0	44.9	14.1	5.3
23:00-24:00	1.2	1.3	3.1	1.9	2.3	1.8	2.3	104.8	100.0	6.0	33.7	4.0	4.3

Time (LDN)	USDTHB	USDTRY	EURCZK	EURHUF	EURPLN	EURRON	USDZAR	USDMXN	USDIDR	USDINR	USDKRW	USDMYR	USDPHP	USDTWD
00:00-01:00	5.0	77.5	12.0	56.3	23.8	62.4	197.3	47.2	41.7	11.2	289.0	73.6	17.0	3.4
01:00-02:00	7.7	65.0	12.0	51.0	20.8	60.0	199.7	52.8	28.0	50.1	27.4	112.1	7.9	3.3
02:00-03:00	8.5	65.2	12.0	43.4	11.9	60.0	197.5	67.3	7.6	4.9	17.6	82.3	3.5	1.5
03:00-04:00	7.2	68.2	12.0	47.4	24.9	60.0	158.9	91.0	5.1	8.9	17.8	70.0	3.2	0.9
04:00-05:00	7.9	67.5	12.0	43.9	34.6	60.0	137.4	95.7	5.2	3.7	17.0	70.0	1.9	0.6
05:00-06:00	7.4	57.8	12.0	44.4	34.9	60.0	165.6	87.5	3.2	1.2	19.0	69.2	2.7	0.8
06:00-07:00	8.8	44.1	13.4	36.5	32.3	47.7	171.4	77.5	3.6	1.3	18.9	61.6	2.8	0.7
07:00-08:00	6.7	50.4	20.2	23.5	18.6	32.6	108.6	76.9	3.0	1.2	18.6	52.2	2.0	0.7
08:00-09:00	7.5	31.4	13.4	14.4	15.6	12.1	91.5	77.8	4.2	1.3	26.0	60.0	2.1	0.6
09:00-10:00	7.0	30.0	13.0	9.3	13.4	11.8	66.7	71.8	6.6	1.2	28.5	50.6	1.8	0.7
10:00-11:00	6.2	31.7	12.5	10.8	13.6	12.6	84.7	79.0	7.6	1.3	28.6	34.9	4.2	0.8
11:00-12:00	4.5	29.8	9.8	15.2	16.7	15.5	77.6	70.3	15.8	1.4	44.8	53.8	4.7	0.6
12:00-13:00	8.8	31.5	7.7	10.3	17.0	12.9	86.2	59.2	8.8	1.9	41.7	61.4	6.1	0.8
13:00-14:00	8.3	32.9	8.9	12.2	12.8	11.0	90.4	53.8	6.7	1.9	44.3	62.4	2.3	0.8
14:00-15:00	7.5	31.5	7.5	9.5	13.8	9.7	82.8	43.0	6.1	1.6	49.6	43.1	2.5	1.1
15:00-16:00	7.2	35.1	12.2	10.5	18.1	21.5	92.5	41.0	4.7	1.8	43.0	25.0	2.2	0.7
16:00-17:00	8.1	34.3	14.4	18.2	17.9	22.2	86.3	36.7	4.1	2.0	42.1	21.8	1.7	1.1
17:00-18:00	9.2	35.3	12.5	16.0	15.7	19.0	81.6	33.5	5.7	1.1	31.2	16.7	3.9	0.7
18:00-19:00	10.1	35.0	11.8	15.7	14.1	10.3	88.6	37.0	3.7	3.6	37.3	30.0	5.1	1.1
19:00-20:00	11.7	32.5	12.0	13.0	16.9	10.0	96.6	33.3	3.0	3.5	46.6	31.9	5.1	1.1
20:00-21:00	12.9	38.1	11.0	13.7	17.0	23.3	82.3	38.1	3.6	3.1	79.3	50.0	6.0	0.8
21:00-22:00	13.6	38.4	12.8	17.3	25.9	25.0	66.2	80.7	4.1	5.0	38.6	50.0	9.0	1.4
22:00-23:00	16.9	136.6	50.4	35.2	45.5	31.5	224.8	246.7	10.0	6.0	250.0	50.0	24.3	2.0
23:00-24:00	18.6	90.0	26.3	29.8	32.1	20.0	374.7	113.4	10.0	6.0	406.8	50.0	25.0	2.0

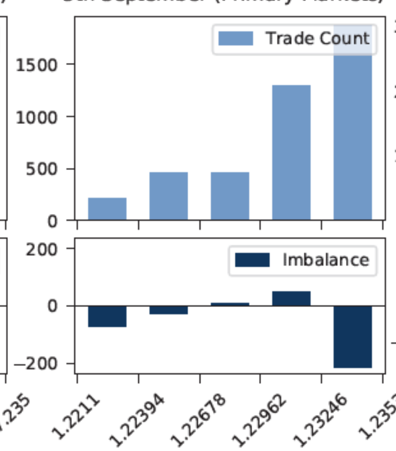
EURUSD Trade Counts vs. Rate for 5th September (Primary Markets)[2]



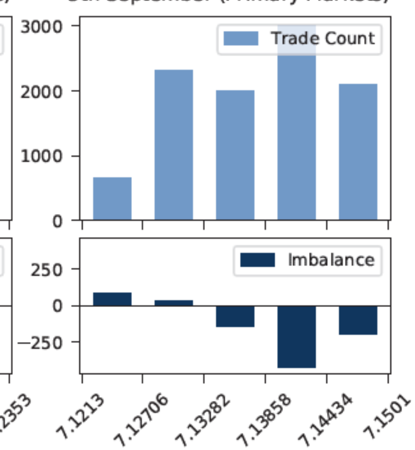
USDJPY Trade Counts vs. Rate for 5th September (Primary Markets)[2]



GBPUSD Trade Counts vs. Rate for 5th September (Primary Markets)[2]



USDCNH Trade Counts vs. Rate for 5th September (Primary Markets)[2]



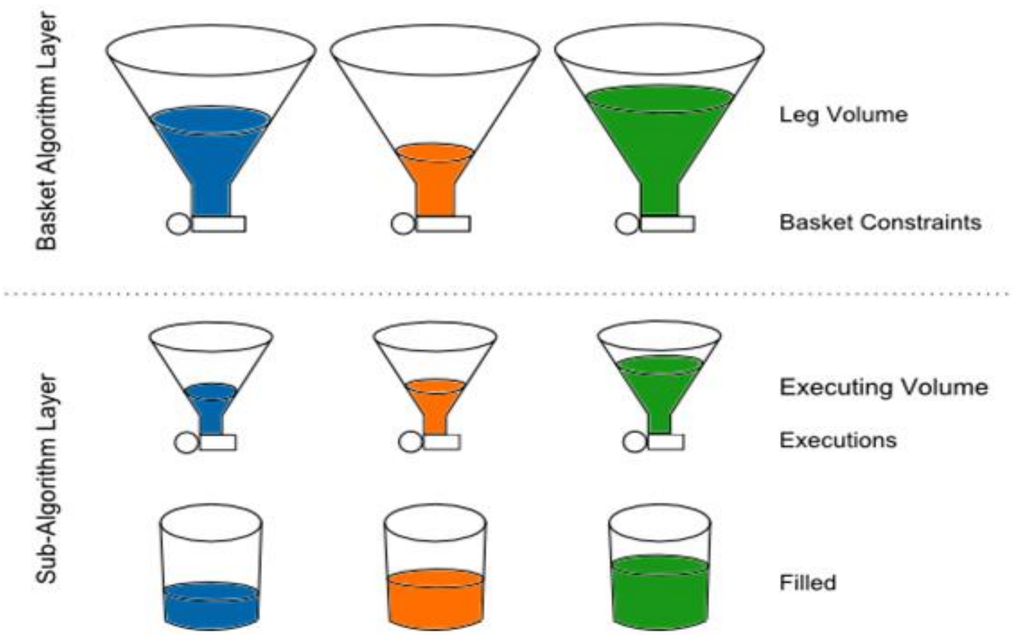
- Significant intra-day variation in market spreads and imbalance between market paids and givens are typical even in normal markets
- Algos must constantly react to changing conditions

Compiled by GS FX SMM Engineering (Securities Division), as of Sep-19
Source: GS FX SMM Engineering (Securities Division), EBS, Reuters
[2] Imbalances show the number of paids minus the number of givens within each price range. Trade counts, paids and givens are calculated using data from the 24 hour period ending at midnight Hong Kong time.
[3] NDF data shown is for 1 month settlement dates and aggregates both on-SEF and off-SEF liquidity.

SECURITIES DIVISION

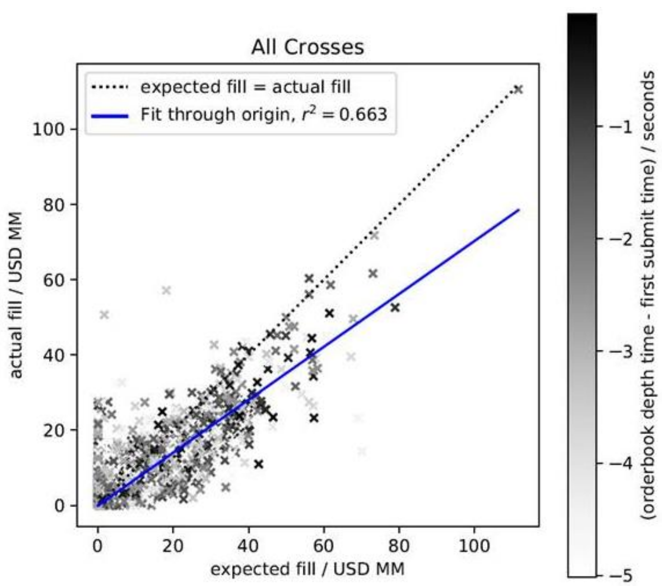
Risks to market functioning

Co-movement and interconnectedness



Co-movement:

- Algo execution during announcements, economic events, fixing windows
- Large executions in correlated illiquid currencies
- New portfolio algos offer ability to control correlated market impact by setting basket level limits and flow rate



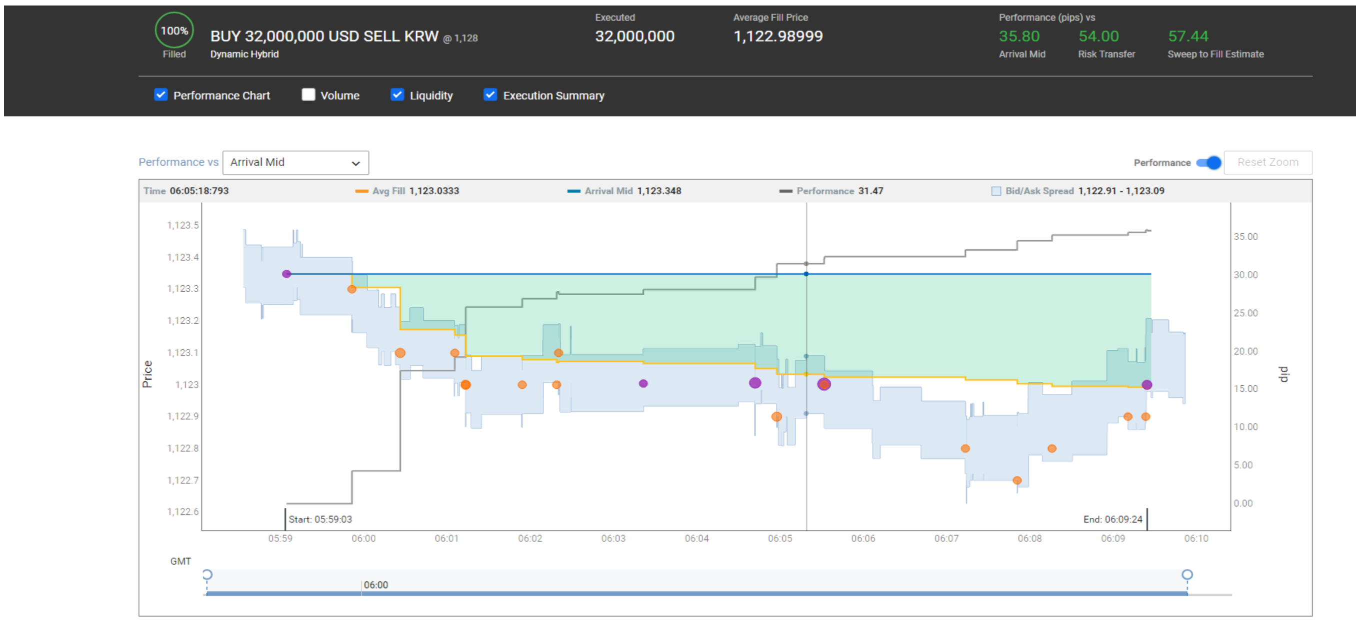
Interconnectedness:

- Simple aggregation of liquidity seen on FX ECNs is insufficient as an estimator of market depth
- Plot shows simple aggregation of liquidity versus actual execution

Transparency – algo provider

Pre-, Intra- and Post-trade tools, algo questionnaires

Example of real-time algo analytics provided by GS



Execution Summary by Venue Type

View all executions | Copy

VENUE NAME	MIC CODE	QUANTITY (USD)	QUANTITY (KRW)	% OF FILL	TAKING %	PROVIDING %
TOTAL		**32,120,000.00**	**36,070,439,760.00**	**100.00%**	**34.25%**	**65.75%**
INTERNAL		14,120,000.00	15,856,839,760.00	43.96%	3.11%	40.85%
GOLDMAN SACHS INTERNAL MATCHING	GSIM	14,120,000.00	15,856,839,760.00	43.96%	3.11%	40.85%
PRIMARY		18,000,000.00	20,213,600,000.00	56.04%	31.13%	24.91%
EBSX (NDF OFF SEF)	EBSX (NDF OFF SEF)	18,000,000.00	20,213,600,000.00	56.04%	31.13%	24.91%

- Demands on algo providers significantly greater than in the early years 2010-15.
  - pre-trade cost, liquidity, and algo duration estimates
  - live intra-trade performance analysis
  - algo provider AND third-party post-trade TCA reporting
  - FAQs

Compiled by GS FX SMM Engineering (Securities Division), as of Sep-19
Source: GS FX SMM Engineering (Securities Division)

Transparency – third-party

Third-party analytical tools

Example of BestX Ltd report on dummy algo data

- Third-party analytical tools are increasingly popular with algo users to standardize TCA and provide a performance report that is independent of the algo provider

  - In FX, the most widely used names include BestX, ITG, Tradefeedr, Bloomberg

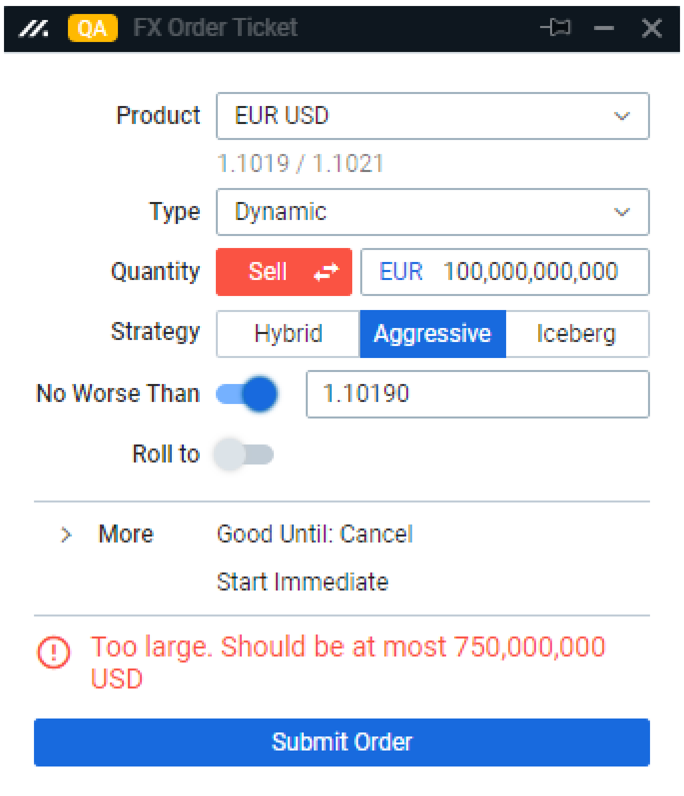
Compiled by GS FX SMM Engineering (Securities Division), as of Sep-19
Source: GS FX SMM Engineering (Securities Division), BestX Ltd

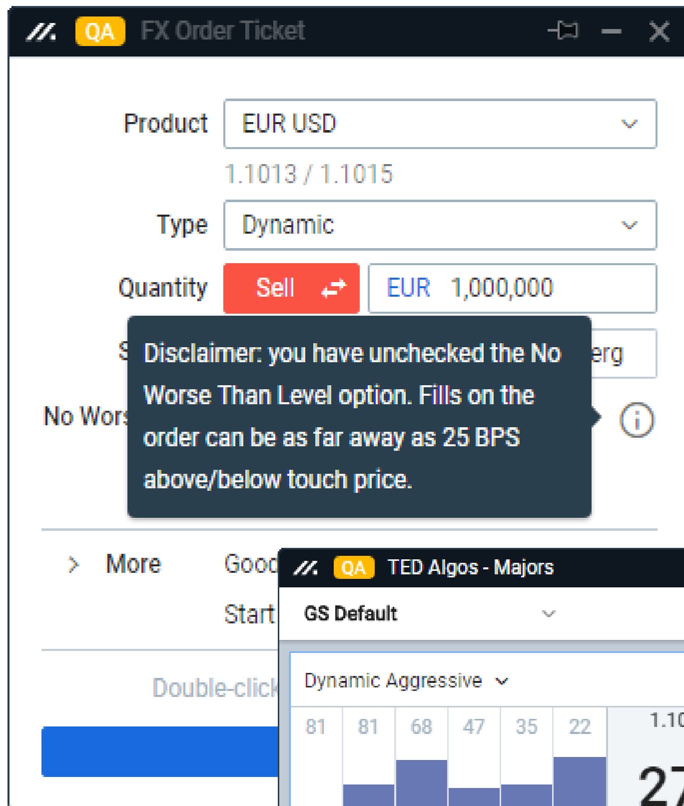
Safety measures

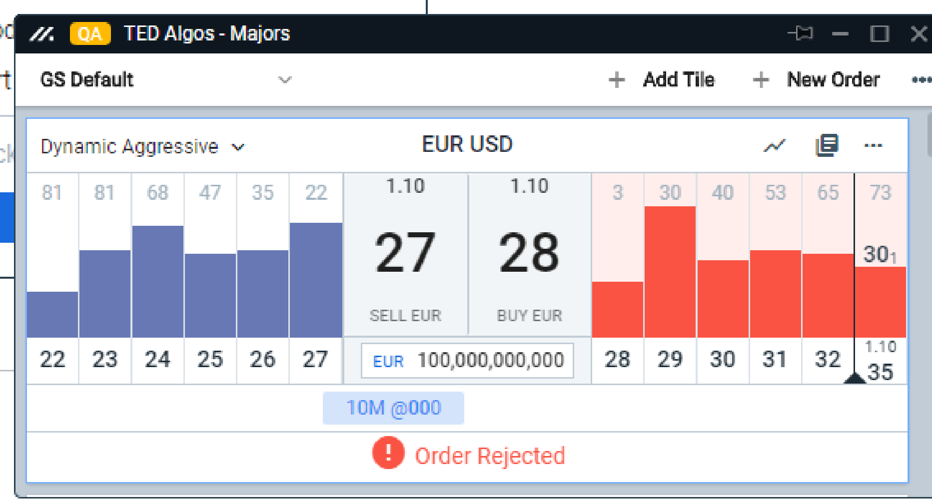
Global controls, fat-finger checks, disclaimers

- Client algos fall under a framework of automatic oversight that sits above and supervises all electronic execution to address regulatory and operational risks

- Fat-finger checks are performed on order entry on trade size and limit through market. These can be customized at client request.







The No Worse Than Level is a level beyond which the algo user is not willing to have the algo source liquidity.

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