

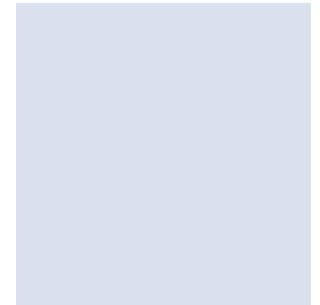
FX Algos

Market functioning

ECB FXCG Meeting

September 2019

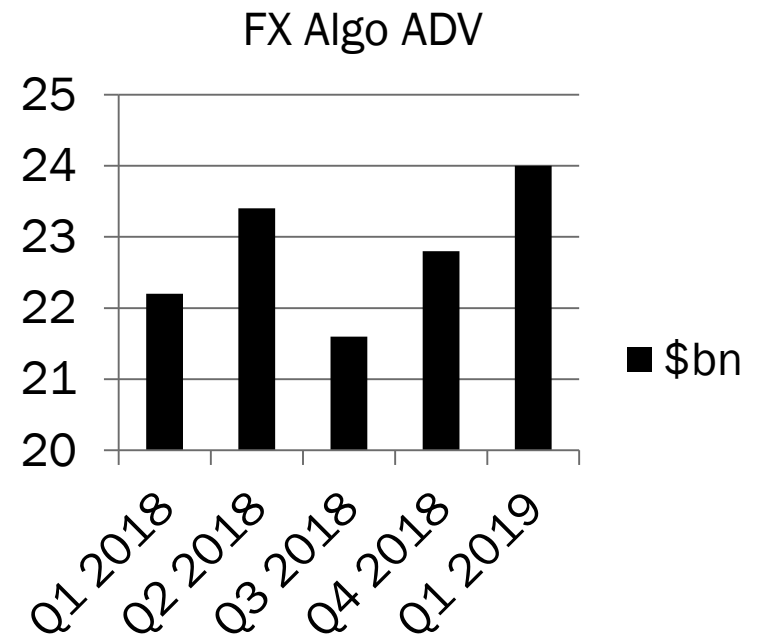
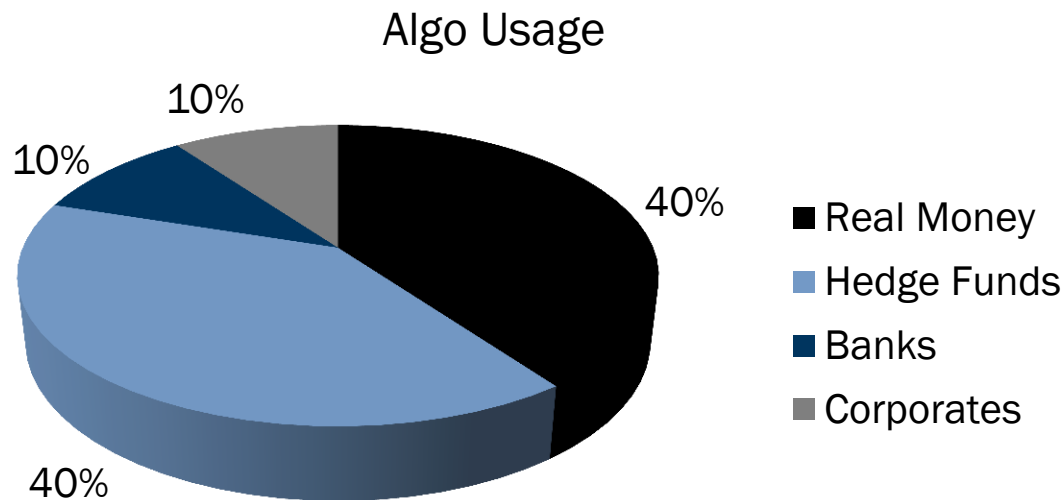
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The Market for FX Algos

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



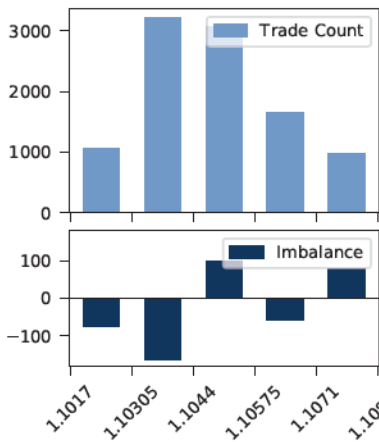
Algo behaviour

Algo function in illiquid conditions and distressed markets

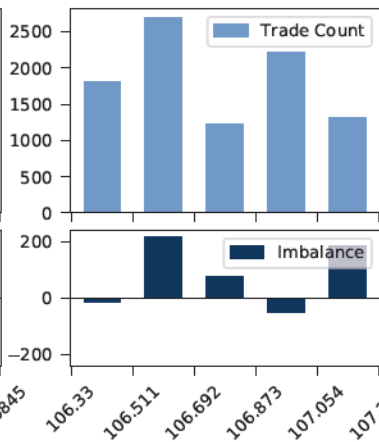
Heat map showing time-weighted average touch spread in pips by time of day for G10, Deliverable EM and NDF³ crosses (using 5th September primary markets data)

Time (LDN)	EURUSD	USDJPY	GBPUSD	USDCAD	AUDUSD	NZDUSD	EURNOK	EURSEK	EURDKK	USDCNH	USDSGD	USDHKD	USDTHB	USDTRY	EURCZK	EURHUF	EURPLN	EURRON	USDZAR	USDMXN	USDIDR	USDINR	USDKRW	USDMYR	USDPHP	USDTHD	
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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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

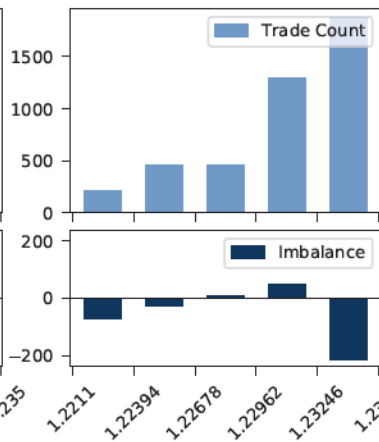
EURUSD Trade Counts vs. Rate for 5th September (Primary Markets)²



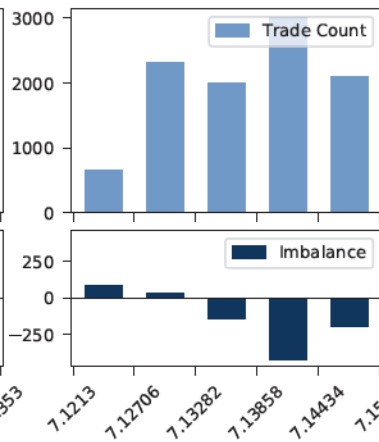
USDJPY Trade Counts vs. Rate for 5th September (Primary Markets)²



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 paid 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

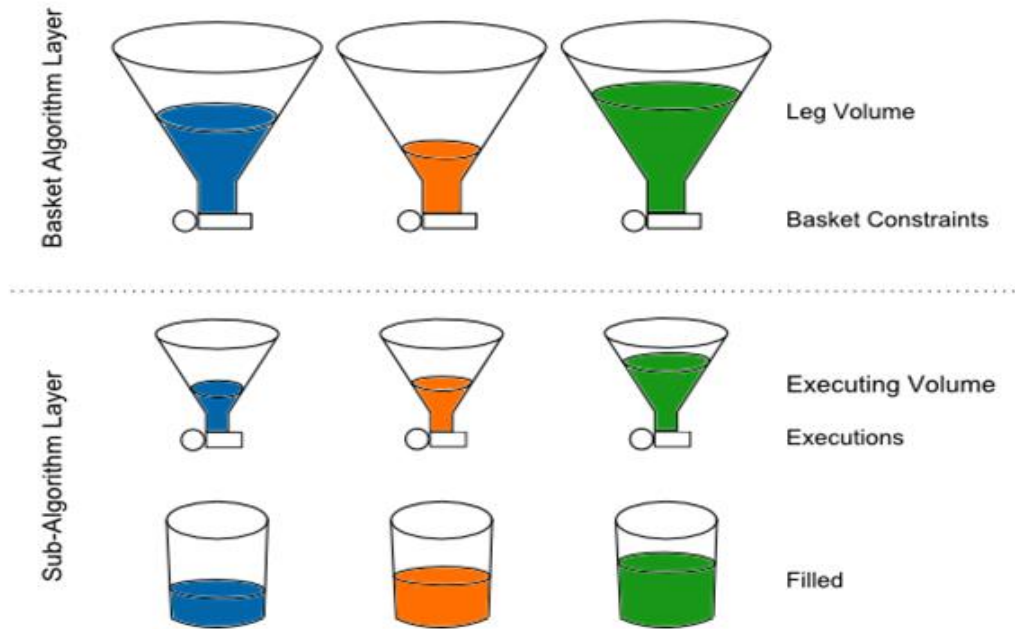
Source: GS FX SMM Engineering (Securities Division), EBS, Reuters

² Imbalances show the number of paid minus the number of givens within each price range. Trade counts, paid 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.

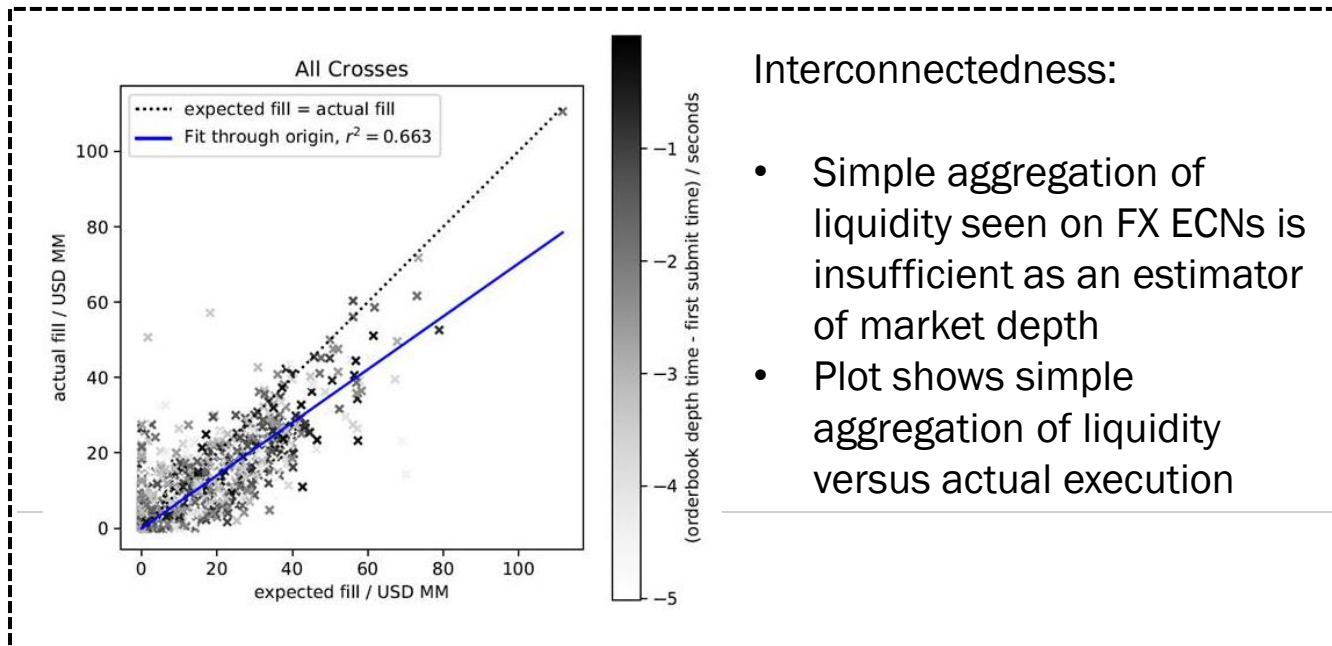
Risks to market functioning

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



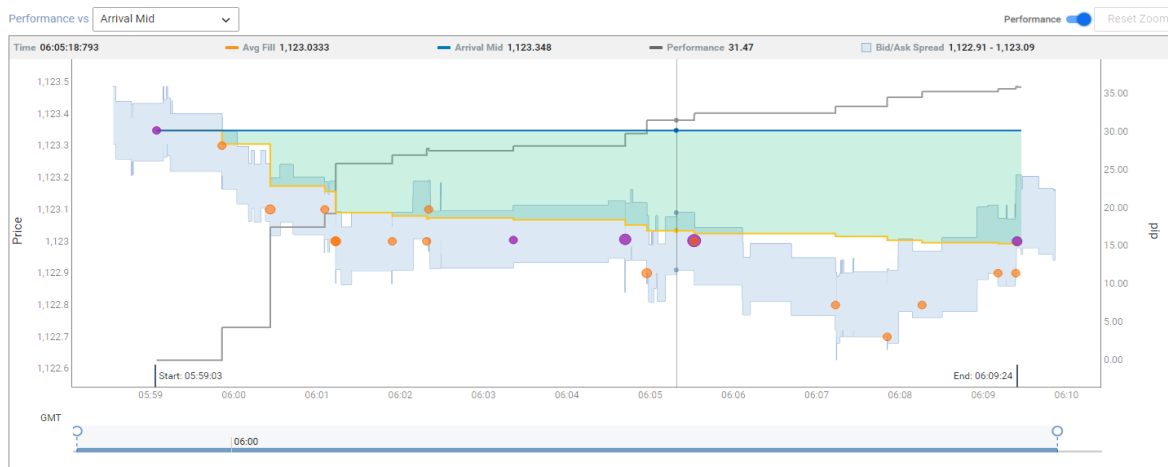
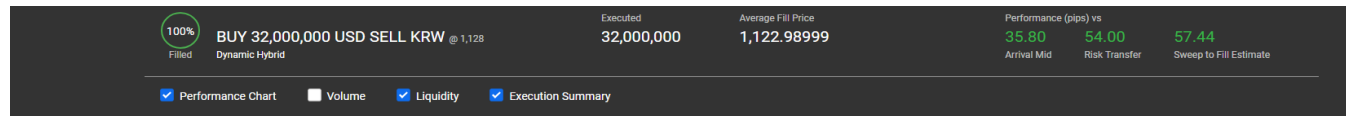
Interconnectedness:

- 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.

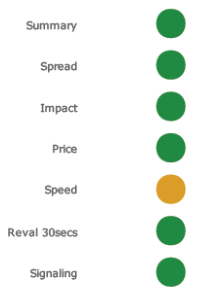
- pre-trade cost, liquidity, and algo duration estimates
- live intra-trade performance analysis
- algo provider AND third-party post-trade TCA reporting
- FAQs

Example of BestX Ltd report on dummy algo data

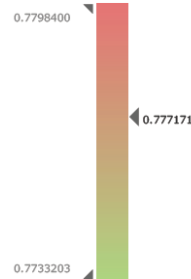


AUDUSD Buy AUD 431,250,000 @ 0.777171 - Oct 6, 2017 08:47:30 GMT

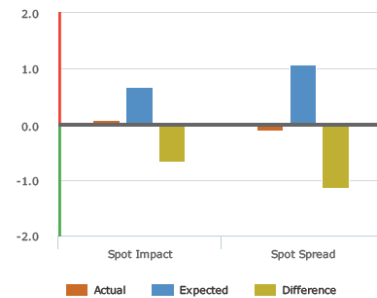
BestX Summary



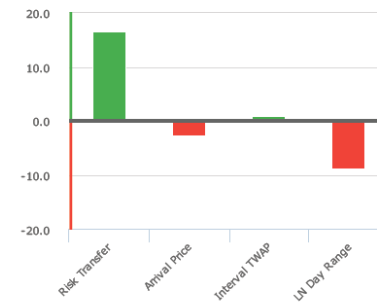
Day Range



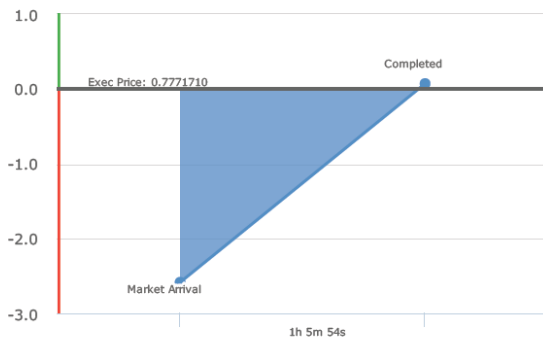
Spread & Impact Cost Bps



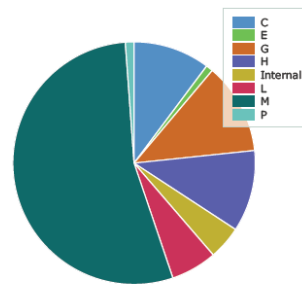
Perf Vs Benchmarks Bps



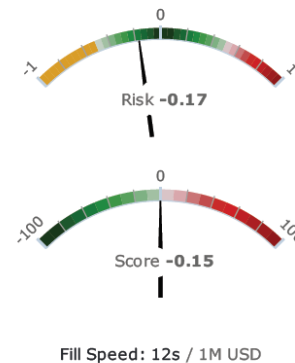
Implementation Shortfall Bps



Volume by Venue



Signaling Risk



- 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, Tradefedr, Bloomberg

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.

Product: EUR USD
 1.1019 / 1.1021
 Type: Dynamic
 Quantity: Sell EUR 100,000,000,000
 Strategy: Hybrid Aggressive Iceberg
 No Worse Than: 1.10190
 Roll to:

Good Until: Cancel
 Start Immediate

Too large. Should be at most 750,000,000 USD

Submit Order

Product: EUR USD
 1.1013 / 1.1015
 Type: Dynamic
 Quantity: Sell EUR 1,000,000
 Strategy: Hybrid Aggressive Iceberg
 No Worse Than:

Disclaimer: you have unchecked the No Worse Than Level option. Fills on the order can be as far away as 25 BPS above/below touch price.

Good Until: Cancel
 Start Immediate

Double-click

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

GS Default
 + Add Tile + New Order

Dynamic Aggressive EUR USD

81	81	68	47	35	22	1.10	1.10	3	30	40	53	65	73
						27	28						
						SELL EUR	BUY EUR						
22	23	24	25	26	27	EUR 100,000,000,000	28	29	30	31	32	1.10	35
10M @000													
Order Rejected													

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