



SIX Swiss Exchange

Trading InfoSnack #10: The Rule of Three: Analysing the Best Execution Optimisation Problem

3 May 2022

The Rule of Three

In the comprehension of any narrative, the principle of ‘the rule of three’ proposes that a trio of segments, events or characters are more effective in the construction, communication & cognition of its key concepts. This is because three is not only rythmic and conscise, but it also represents the smallest number of data points acceptable for pattern recognition. Utilising the ‘rule of three’ to draw insights from the complex optimisation problem, that is order routing to achieve Best Execution, is no less compelling.

As such, we leverage a ‘rule of three’ framework to draw insights on the complex optimisation problem that is order routing to achieve Best Execution. In defining this optimisation problem, we acknowledge three key factors that impact the order routing decision, namely: (i) orderbook state (ii) likelihood of execution; and (iii) execution performance. Conjointly these three factors represent the beginning (orderbook state), middle (likelihood of execution), and end (execution performance) of the order routing lifecycle. When applying a ‘rule of three’ framework to the optimisation problem outlined above, we derive some interesting insights across all three core factors that in turn provide a more complete picture of the pro’s and con’s of prioritising one venue over another when posting liquidity. Integrating insights from orderbook state, likelihood of execution and execution performance, we summarise that venues that rank highly across all three key factors will be integral to successful order routing strategies.

1. Orderbook State

Whilst the classic aggregated view of average orderbook state compares EBBO Presence and Depth across venues¹, market participants will have differing views of pre-trade EBBO based on how they consume market data and construct EBBO. Taking this into account, a ‘realised’ depiction of how the market views and acts on prevailing EBBO orderbook states across venues can be observed by examining how specific EBBO price level executions are distributed across venues. In other words, on average how many, and which venues exhibit trading activity in order for specific EBBO price levels to be consumed. Chart 01 below, provides such a view.

Chart 01 - Order Book State: Distribution of EBBO price level executions across venues

| % Share of EBBO Executions | | Number of venues with trades at an EBBO price level | | | | | |
|---------------------------------|------|---|-------|-------|-------|--------|--------|
| | | 1 | 2 | 3 | 4 | 5 | Total |
| | | 28.6% | 24.9% | 23.0% | 16.8% | 6.8% | 100.0% |
| Trading venues | XSWX | 23.2% | 16.6% | 13.9% | 9.5% | 3.6% | 66.9% |
| | CHIX | 3.4% | 5.7% | 5.5% | 3.8% | 1.4% | 19.8% |
| | BATE | 0.6% | 1.1% | 2.1% | 1.8% | 0.7% | 6.5% |
| | AQXE | 1.1% | 1.1% | 1.1% | 0.9% | 0.7% | 4.8% |
| | TRQX | 0.2% | 0.3% | 0.4% | 0.8% | 0.4% | 2.1% |
| Cumulative % of EBBO Executions | | 28.6% | 53.5% | 76.5% | 93.3% | 100.0% | 100.0% |

Data sources: BMLL, SIX | Securities: Swiss Equities (Blue Chips) | Sample period: 03 Jan 2022 - 31 Mar 2022

¹ In March 2022, SIX was the top ranked venue for both dual-sided EBBO presence (81%) and depth at EBBO (CHF 120k) in SLI securities. The next ranked venue showed average dual-sided EBBO presence of 65% and EBBO depth of CHF 30k depth.
Source: BMLL

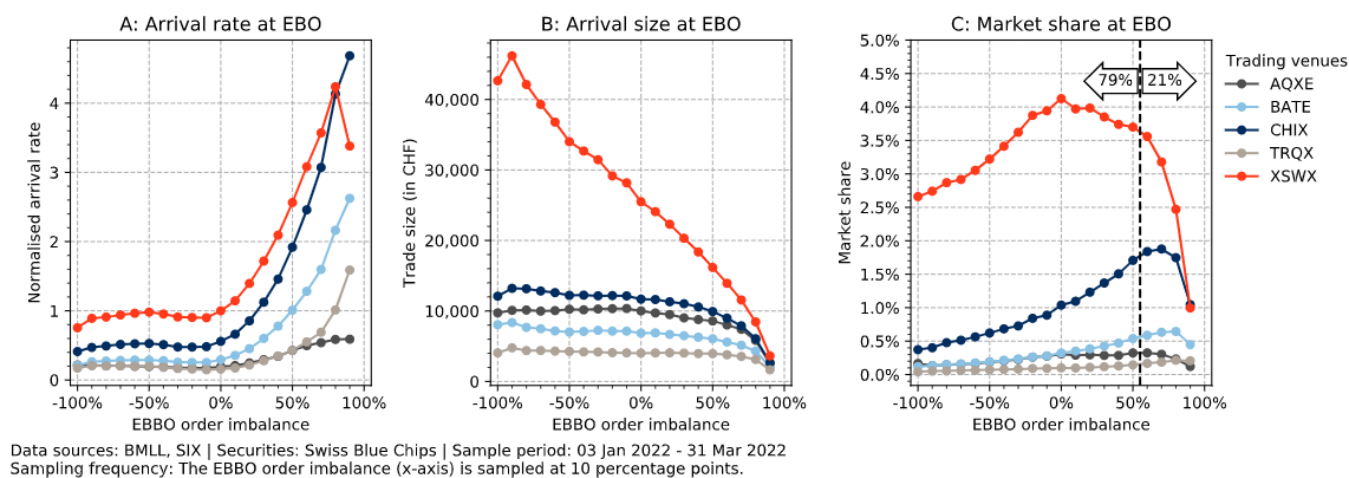
In terms of reading Chart 01 above, the numbered columns (1 to 5) indicate the number of venues across which executions have occurred to exhaust discrete EBO price levels. As such, column 1 indicates the proportion of turnover executed where discrete EBO price levels were consumed on only one venue. Conversely, column 5 indicates the proportion of turnover executed where executions to consume discrete EBO price levels occurred across five venues. Furthermore, the rows and blue shading indicate which venues show the highest activity in each scenario (e.g. in Column 3 the three venues with the highest share when discrete EBO prices levels are consumed across three venues are SIX, CBOE-CXE and CBOE-BXE). When analysing Chart 01 three key observations emerge; (i) that EBO price level exhaustion occurs on only one venue for 29% of turnover executed²; (ii) when discrete EBO price level exhaustion occurs on only one venue, the primary exchange has a circa 80% share of these executions³; and (iii) circa 77% of turnover is executed when discrete EBO price levels are consumed exhausted across a maximum of three venues.. Such observations provide useful insight into how and where market participants trade in response to prevailing orderbook states over time.

2. Likelihood of Execution

Whilst the observations in the previous section provide a clue on what likelihood of execution may be across venues, to get a more robust picture we need to assess order dynamics on a per venue basis. Whilst it is common to look at passive liquidity metrics in assessing likelihood of execution when posting liquidity (such as the historical fill probability or queue dynamics of resting orders), our analysis instead focusses on the dynamics of contra liquidity that interacts with resting orders to drive execution behaviour.

As such, in Chart 02 below we analyse the arrival rate, arrival size and market share of incoming aggressive orders that arrive to interact with passive sell orders at EBO. In doing so, we examine the magnitude of arrival dynamics of aggressive buy orders (Chart 02, y-axis) and plot these according to the direction and magnitude of the prevailing consolidated order book imbalance or 'OBI' (Chart 02, x-axis), per venue. A strong positive (*negative*) OBI illustrates that resting buy (*sell*) orders outweigh resting sell (*buy*) orders and this implies that a price increase (*decrease*) is likely.

Chart 02 - Likelihood of Execution: Aggressive order arrival rate, size and share across venues for SLI equities traded at EBO



² Chart 01, Column 1: Cumulative % of EBO executions

³ Chart 01, Column 1: XSWX % divided by Cumulative % of EBO executions

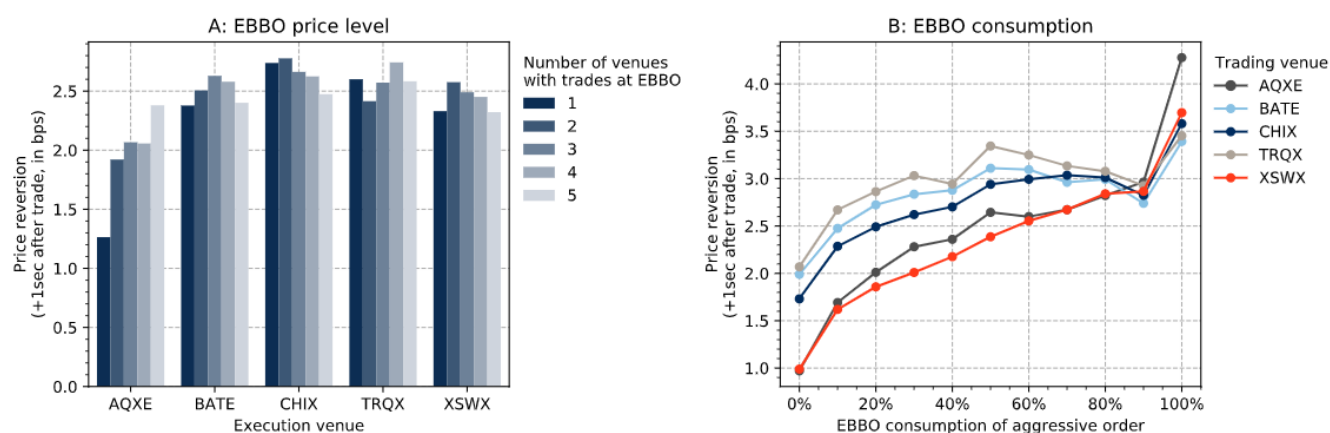
With reference to Chart 02 above, the key observations are: (i) that the primary exchange exhibits a significantly higher aggressive order arrival rate (Chart 02-A; 1.5x to 3x higher), arrival size (Chart 02-B; 2.5x to 4x higher) and market share of arriving aggressive orders (Chart 02-C; 4x to 7x higher) than MTFs for all OBI states except when the OBI is strongly positive; (ii) that the aggressive order arrival rate increases across all venues as the OBI transitions to a strongly positive state; and (iii) that there is convergence in aggressive order arrival size and the market share of arriving aggressive orders when the OBI is strongly positive. However, as indicated on Chart 02-C, the proportion of turnover executed in a strongly positive OBI state is approximately only 20% of the market total.

Considering the above observations together, it can be postulated that the size of arriving aggressive order executions per-venue is influenced by its displayed depth (Chart 02-B) and that the per-venue variation in the rate of influx of aggressive orders in strongly positive OBI states is driven potentially by order flow seeking crumbling-quote or stale-price arbitrage opportunities.

3. Execution Performance

Whilst, the measurement of execution performance can be based on a number of different metrics and methodologies, a common interpretation is to observe price reversion at a given time after an execution. This can be used to detect the occurrence of adverse selection (i.e. where a stock was sold ahead of a price increase or bought ahead of a price decrease). Chart 03 below provides two alternative views of price reversion (measured in bps at 1 second after the trade) per venue.

Chart 03 - Execution Performance: Average price reversion for SLI equities traded at EBBO



Data sources: BMLL, SIX | Securities: Swiss Blue Chips | Sample period: 03 Jan 2022 - 31 Mar 2022
Sampling frequency: The EBBO consumption of aggressive orders (x-axis) is sampled at 10 percentage points.

Chart 03-A, measures price reversion based on how EBBO price level executions are distributed across venues. We apply the same methodology and distribution buckets for apportioning EBBO price level executions across venues as we do in Chart 01. We then analyse the reversion observed on a specific venue when it is present in each of the aforementioned distribution buckets⁴. When doing this, Chart 03-A presents the following observation: with the exception of Aquis, average reversion curves are broadly similar across venues. In contrast, Chart 03-B illustrates price reversion based on the proportion of total consolidated EBBO liquidity that has been consumed across the duration of discrete EBBO price levels. When viewing per venue price reversion in this way, it can be seen that if the proportion of liquidity being consumed is less than 60% of the total

⁴ i.e. when it was the sole venue that contributed to discrete EBBO price level exhaustion or when it was one of the two, three, four or five venues that participated in the exhaustion of discrete EBBO price levels.

consolidated liquidity displayed at a given EBBO price level, then executions on the primary exchange suffer less from adverse selection (i.e. have lower basis point reversion). However, if the proportion of liquidity being consumed is over 80% of the total consolidated liquidity at a given EBBO price level, then basis point price reversion is broadly similar across venues.

Considering both Chart 03-A and Chart 03-B together, it can be summarised that: (i) the level of per venue price reversion observed depends on perspective; (ii) that when a large proportion of a consolidated EBBO price level is consumed, that observed price reversion is broadly similar across venues; and (iii) that venue specific order book depth and the sequence of liquidity consumption across venues can influence observed price reversion.

Applying the Rule of Three:

In analysing the complex optimisation problem that is order routing to achieve 'Best Execution', it is important to acknowledge that market participants grapple with how best to integrate three core components into their order routing strategies namely; order book state, likelihood of execution and execution performance. This is an unenviable task, and something which our trading participants are much better placed to reconcile than ourselves. However, it can be easily observed above that the three core components must be analysed together (holistically), rather than in isolation, in order to derive the greatest insight. For example, if only execution performance was considered, then it might be hastily concluded that posting liquidity on one venue is superior to posting it on another (i.e. price reversion appears to be lower on Aquis or the Primary depending on how it is measured). However, when also incorporating metrics that analyse for order book state and likelihood of execution, a different picture emerges. This holistic picture begins to illustrate that for some venues a trade-off between execution performance and likelihood of execution exists, or for other venues that likelihood of execution increases when the orderbook state is indicative of a potential price change. As such, logic should dictate that preferencing venues that consistently rank highly across appropriate measures of all three factors (order book state, likelihood of execution and execution performance), will be integral to successful order routing strategies.

Food for thought.

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