SIX Swiss Exchange

Trading InfoSnack #14: Cluster-struck

7 November 2024

Cluster-struck

Quick Summary

- **Density-based clustering algorithms can be utilised to group trades into different types of trade clusters: single-trade-clusters, single-venue-clusters and multi-venue-clusters**
- **The contribution of each type of trade cluster to market share differs across venues, with circa 22% of ADT from trade clusters only occurring on the Primary**
- **In contrast, circa 80% of MTF market share is attributable to multi-venue-clusters**
- **Price-reversion differs across cluster-types with multi-venue-clusters exhibiting the worst volume-weighted mean +1second reversion (-3.3bps) compared to single-trade-clusters (-1.4bps)**
- **Combined with the above, venue specific EBBO presence ahead of trade clusters is a useful metric for understanding order arrival dynamics across cluster-types, and therefore a useful input to passive order allocation strategies**

Introduction

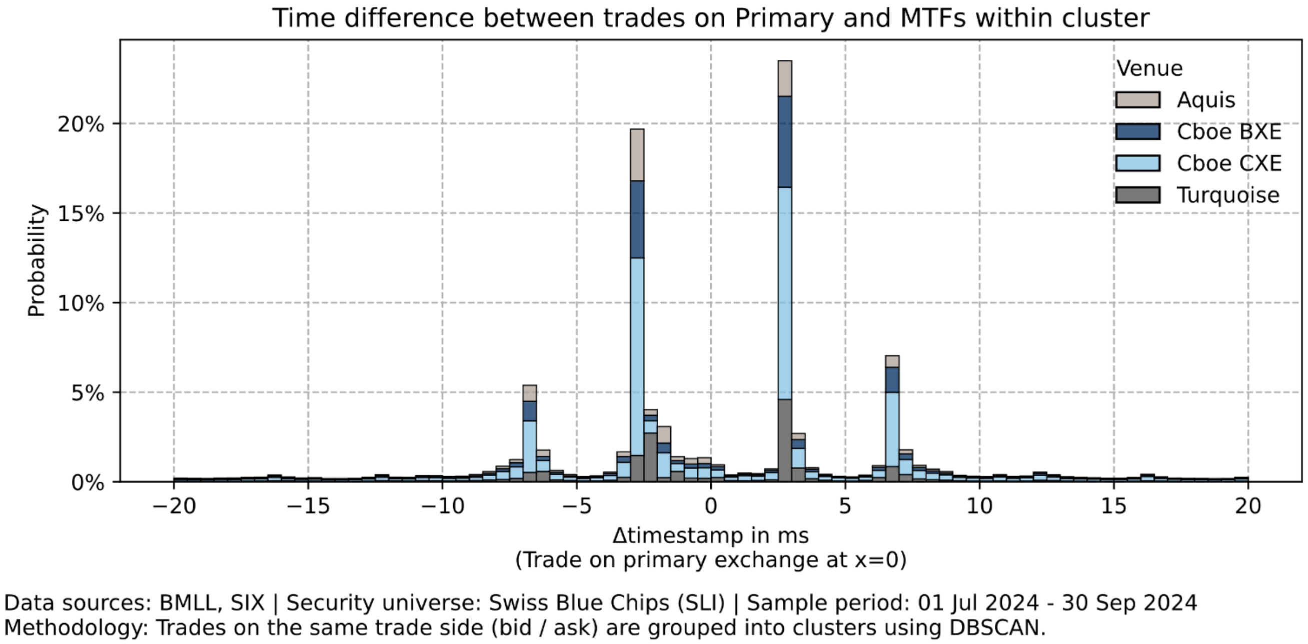
Trade clustering is an observable phenomena in equity trading. Often trading activity can occur in discrete clusters of trades, driven by a common prevailing orderbook state. The detection and definition of such clusters into multi-venue trade clusters, single-venue trade clusters and single-venue trades (i.e. no clustering effect) provides a simple and objective way of: (i) de-constructing venue market share according to trade cluster type, (ii) analysing for trading activity uniqueness across venues, (iii) analysing toxicity across cluster types and (iv) benchmarking passive order allocation across venues. Additionally, we examine the relationship between market share, EBBO presence and EBBO depth across venues.

Defining Trade Clusters

Trade clusters can be defined as a group of trades that typically occur as a burst of multiple trades within a short time-window. Such clusters of trading activity can occur either solely on one venue (single-venue-cluster), or be distributed across multiple venues (multi-venue-cluster) within the defined time-window. Whilst opining on the causal factors for trade-clustering is complex and not considered in this analysis, it can still be inferred that trades that occur together within a short time-horizon are most likely the result of algorithmic order placement strategies (both principal and agency) reacting to certain trading signals, orderbook states or orderbook state changes. Similarly, trades that occur in isolation (single-trade-cluster) within a defined time-window are also of significance given they are seemingly unique, and hence less likely to be algorithmic in nature.

In order to examine trade clustering across venues (both the primary and MTFs), we utilised a density-based clustering algorithm (DBSCAN or Density-Based Spatial Clustering of Applications with Noise) to group trades into clusters and then plotted a time-distribution of the probability of trades (within clusters) occurring on MTFs as a time-offset to trades occurring on the Primary Exchange (T=0) within clusters (as per Chart 1.0 below). When examining this chart it can be easily observed that trades on MTFs occur both pre and post trading activity on the Primary (T=0), with the 4 distinct peaks aligning with the fibre (outside peaks) and microwave (inside peaks) latencies between Zurich and London. It is evident that the highest density of trading activity occurs largely within the geographical roundtrip latency time between Zurich and London (i.e. 14ms), with 84% of trades occurring within 20ms time-window (i.e. +/- 10ms of trades occurring on the Primary Exchange).

Chart 1.0 – Time distribution of trades on MTFs relative to trades on the Primary within trade clusters



Analysing Cluster Type Dynamics

The sorting of trades into clusters utilising a density-based clustering algorithm, allows us to categorise clusters as either; single-trade-clusters (i.e. only one trade), single-venue-clusters (i.e. multiple trades only occurring on a single venue) or multi-venue-clusters (i.e. multiple trades occurring on multiple venues). Further to this, as per Table 1.0 below, we are then able to derive some insight into the dynamics of trade clusters namely; the mean duration of the different cluster types (in milliseconds) and the mean time between clusters (in seconds). From the table below, it is logical to observe that single-trade-clusters have a mean duration of zero given that they are only as long as a single trade occurring. Single-venue-clusters have a mean duration of 2.7ms, with 75% of them having a duration of 0.7ms or less. On the other hand multi-venue-clusters have a mean duration of 5.6ms, with 75% of clusters having a duration of 6.9ms (i.e. approximately equivalent to the one-way fibre latency between Zurich and London) or less.

In addition to this the average time between clusters is greater than 30 seconds for all cluster types. The implication of these dynamics for liquidity posting are that to interact with single-trade-clusters and single-venue-clusters, orders would need to be placed ahead of the cluster start in order to participate in resulting order executions. Technically, for multi-venue-clusters, a trading participant could detect the start of a cluster and route orders utilising microwave to maximise the chance to participate in the resulting order executions.

Table 1.0 - Distribution of the duration of clusters and idle time between clusters (time elapsed between end of a cluster to start of the next cluster)

	Duration of cluster (in milliseconds)						Time to next cluster (in seconds)					
Cluster	**mean**	**min**	**25%**	**50%**	**75%**	**max**	**mean**	**min**	**25%**	**50%**	**75%**	**max**
Single-trade	0.0	0.0	0.0	0.0	0.0	0	35.0	0.0	2.4	11.9	37.9	10,506
Single-venue	2.7	0.0	0.0	0.1	0.7	515	33.2	0.0	1.5	9.6	34.6	10,496
Multi-venue	5.6	0.0	2.7	2.8	6.9	707	33.3	0.0	1.6	10.6	36.9	10,204

Data sources: BMLL, SIX | Security universe: Swiss Blue Chips (SLI) | Sample period: 01 Jul 2024 – 30 Sep 2024

Utilising Cluster Types to De-Construct Market Share

Raw market share can be viewed as a high-level, 'historical' proxy for the likelihood of execution across trading venues. Whilst it offers an aggregrated 'realised' approximation of net-orderbook states, it doesn't offer context on the nature of liquidity interactions and execution experience across venues. Furthermore, other metrics such as Effective Market Share (EMS) bias venues that exhibit early liquidity removal during the life-span of a price-level and discount subsequent liquidity removal across other venues – thus don't consider the full picture in terms of liquidity dynamics.

In contrast, the grouping of trades according to cluster type (as above), considers the full liquidity picture, and is more likely to group trades into clusters that result from a common rather than disperse view of orderbook state. This is due to the fact that 75% of clusters have a duration less than the one-way geographical latency between Zurich and London, which suggests that there is limited opportunity for owners of the orders involved in these trades to react to any new orderbook updates before the end of the trade cluster. It also provides an objective view of where liquidity needs to be posted to interact with single-trade-clusters and single-venue-clusters which together represent approximately 30% of total orderbook turnover as per Table 2.0 below.

Table 2.0 - Distribution of market share trades across clusters

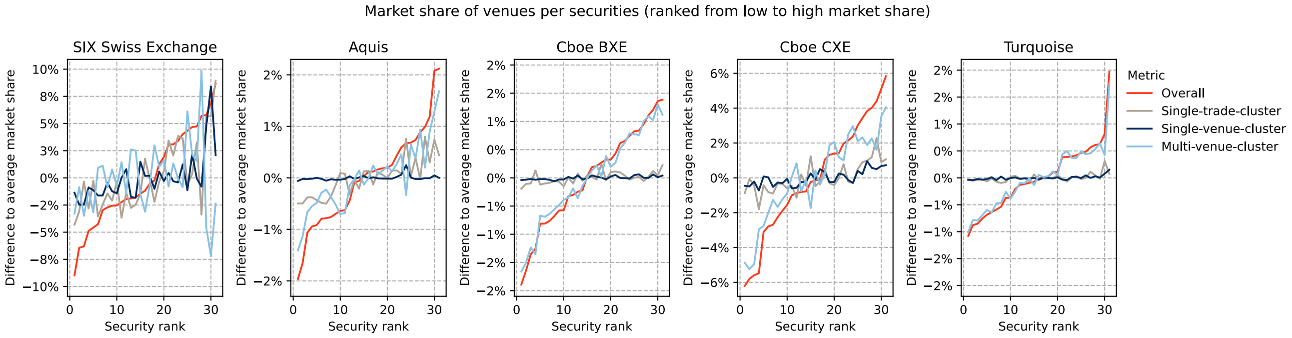
	Single-trade-cluster	Single-venue-cluster	Multi-venue-cluster	Total
SIX Swiss Exchange	15.2%	7.2%	44.3%	66.7%
Aquis	1.0%	0.1%	3.6%	4.7%
Cboe BXE	0.3%	0.1%	3.6%	4.0%
Cboe CXE	3.3%	1.1%	17.4%	21.8%
Turquoise	0.2%	0.1%	2.5%	2.8%
Total	20.0%	8.5%	71.4%	100.0%

Data sources: BMLL, SIX | Security universe: Swiss Blue Chips (SLI) | Sample period: 01 Jul 2024 – 30 Sep 2024

Cluster type differentiation of liquidity and execution performance across venues

Table 2.0 also illustrates that, with the exception of Aquis, multi-venue-clusters account for circa 80% of MTF's market share. Contrastingly, circa 35% of the Primary Exchange's market share is accounted for by single-trade-clusters and single-venue-clusters, which can be considered to possess a degree of uniqueness given they occur only on one venue. The differences in cluster type constituents making up a venues market share is highlighted clearly in Chart 2.0 below. This chart illustrates the deviation from the average market share for each of the 30 underlying securities Blue Chip securities in the SLI, broken into cluster type. Hence, cluster types can be utilised as tool to fingerprint liquidity differences between competing venues.

Chart 2.0 – Per security market share deviation (from the mean) for Swiss Blue Chips across venues



Data sources: BMLL, SIX | Security universe: Swiss Blue Chips (SLI) | Sample period: 01 Jul 2024 - 30 Sep 2024

Understanding trade clustering is not only relevant in detecting venue unique liquidity, but is also highly relevant for exeuction performace of executed passive orders. As per Table 3.0 below, the volume weighted +1 second average reversion of executed passive orders is worst for multi-venue-clusters (-3.3bps), better for single-venue-clusters (-2.6bps) and best for single-trade-clusters (-1.4bps).

Table 3.0 - Distribution of signed EBB/EBO price reversion of passive order executions by cluster type

Cluster type	Volume-weighted reversion (in bps)
Single-trade-cluster	-1.4
Single-venue-cluster	-2.6
Multi-venue-cluster	-3.3

Data sources: BMLL, SIX | Security universe: Swiss Blue Chips (SLI) | Sample period: 01 Jul 2024 – 30 Sep 2024

Utilising pre-cluster EBBO presence as a guide for passive order allocation

Undoubtedly the prevailing orderbook state (i.e. EBBO presence and depth) is a key factor in order routing decisions. As such, examining how liquidity is distributed (on average) across venues ahead of different trade cluster types provides a useful input to passive order allocation strategies. Table 4.0 below, illustrates the average EBBO presence of venues across trade cluster types. It highlights that compared to the Primary Exchange, there is significant variance in EBBO presence on MTFs ahead of different trade cluster-types. In particular, MTFs exhibit significantly lower EBBO presence ahead of single-trade-clusters and single-venue-clusters, relative to their EBBO presence ahead of multi-venue-clusters and indeed their overall EBBO presence.

Table 4.0 - EBBO presence before cluster of trades

	Single-trade-cluster	Single-venue-cluster	Multi-venue-cluster	Overall
SIX Swiss Exchange	75.3%	76.7%	87.1%	83.6%
Aquis	51.4%	33.0%	62.1%	57.4%
Cboe BXE	30.4%	17.7%	51.8%	44.3%
Cboe CXE	65.1%	47.4%	86.9%	78.8%
Turquoise	26.9%	16.5%	43.7%	37.8%

Data sources: BMLL, SIX | Security universe: Swiss Blue Chips (SLI) | Sample period: 01 Jul 2024 – 30 Sep 2024

As mentioned above, due to their short average duration (i.e. largely less than the one-way geographical latency between Zurich to London), trades within the same cluster are more likely to be influenced by a common preceeding view of order book state. With this in mind, higher and more consistent EBBO presence (and depth) ahead of each trade cluster type will influence aggressive order arrival dynamics per venue, observed trade clustering patterns and market share of cluster-types across venues. Hence, pre-cluster EBBO presence is a valid consideration in passive order placement decisions.

Conclusion

We demonstrate that the utilisation of a density-based clustering algorithm to group trades into single-trade-clusters, single-venue-clusters and multi-venue-clusters is a highly relevant approach to; de-construct observed market share, differentiate liquidity and execution performance dynamics and de-construct EBBO presence. It is shown that trade clusters are both discrete and are short-lived, typically with durations that are less than the one-way geographical latency between Zurich and London (i.e. 7ms). This suggests that order executions occurring within each trade cluster are influenced by a common view of the preceding orderbook state. We illustrate that each venues market share can be de-constructed by cluster-type, with circa 80% of MTF market share attributable to multi-venue-clusters, and up to 35% of Primary Exchange market share attributable to trade clusters which only occur on it. This is meaningful given that price-reversion differs across cluster-types with multi-venue-clusters exhibiting the worst volume-weighted mean +1 second reversion (-3.3bps) compared to single-trade-clusters (-1.4bps). Furthermore, venue specific EBBO presence ahead of trade clusters is a useful metric for understanding order arrival dynamics and resulting market share across cluster-types, and therefore when combined with the above, a useful input to passive order allocation strategies.

Food for thought.

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