Algo Toolbox Series

Barracuda:
Liquidity capture combining dark aggregation with lit trading

2023

Liquidnet

Barracuda: Liquidity capture combining dark aggregation with lit trading

Key takeaways

- **Liquidnet Barracuda** is a liquidity-seeking algorithm that combines dark aggregation with lit trading.
- Barracuda achieves **high rates of participation with wide liquidity reach** across the dark market, with market impact savings from its block executions of 10.0 bps. Overall, it's market impact is far below the expected impact cost.
- **Barracuda outperforms** a 10% POV transactions cost model by 17.4 bps. Barracuda delivers strong results against major performance metrics. It outperforms the interval VWAP by 4.8 bps, achieves a participation rate of 65.5% of lit market volumes, and has a slippage versus arrival of just -4.9 bps.
- Barracuda's opportunistic logic drives its liquidity capture in lit markets and complements its core dark aggregator. Orders that were eligible for opportunistic liquidity capture outperformed those that were not, with a better performance versus arrival and interval VWAP.

Source: Unless otherwise expressly stated, all stats in this paper refers to the Liquidnet analysis of EMEA Barracuda orders, January 2023 to August 2023. Bloomberg market data.

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Introduction

Liquidnet Barracuda is a liquidity-seeking algorithm that combines dark aggregation with opportunistic lit trading. Barracuda uses Liquidnet's flagship dark aggregation logic to source liquidity across conditional and dark venues, including in the Liquidnet pool. Barracuda's lit component scales its participation dynamically based on market conditions, speeding up to capture liquidity when advantageous. Lit participation ensures consistent liquidity capture, complementing Barracuda's core activity in the dark markets. Barracuda's aggressiveness across both its lit and dark components is configurable, allowing traders to balance speed of execution against potential for market impact.

Barracuda delivers strong performance

Liquidnet analysed all Barracuda orders in EMEA from January 1, 2023 to August 31, 2023. Barracuda's performance versus arrival price was -4.9 bps, well under half the prevailing average spread of 11.3 bps and significantly below expected impact cost of 22.3 bps. Barracuda outperformed the interval VWAP by 4.8 bps, indicating efficient and well-timed sourcing of dark liquidity. The algorithm achieved a participation rate of 65.5% of lit market volumes, demonstrating its ability to source liquidity expediently and favourably without incurring significant market impact.

Table 1
Order Characteristics and Performance

Order Characteristics		Performance	
# Orders	27,297	vs. arrival (bps)	-4.92
Traded Notional ($)	8,589,762,871	vs. expected cost (bps)	+17.38
Avg. order size (%ADV)	6.8%	vs. interval VWAP (bps)	+4.78
Avg. spread (bps)	11.3	vs. eligible interval VWAP (bps)	-1.67
Avg. duration (min)	63.5	vs. PWP 10% (bps)	-3.16
Avg. participation rate	65.5%	vs. Close (bps)	-2.81
Interval return (bps)	-10.7		
Expected cost vs. arrival (bps)	22.3		

Source: Liquidnet analysis of EMEA Barracuda orders, January 2023 to August 2023. Bloomberg market data.

As a liquidity-seeking algorithm, Barracuda sources liquidity in the dark market. This includes the Liquidnet pool, other conditional venues, and dark MTFs, periodic auctions and SI's, enabling it to achieve high rates of participation relative to lit market volumes. If these orders were to have been executed in the lit markets alone, it is reasonable to expect they would have incurred significant market impact. Liquidnet's internal transactions cost model's projected cost versus arrival on Barracuda orders was 22.3 bps, significantly above Barracuda's realized implementation shortfall of 4.9 bps. Further, to minimize that potential market impact, many of these orders may have been worked in the market over several days. This would have increased susceptibility to price risk, something many traders might not consider suitable, especially for flow with elevated embedded alpha.

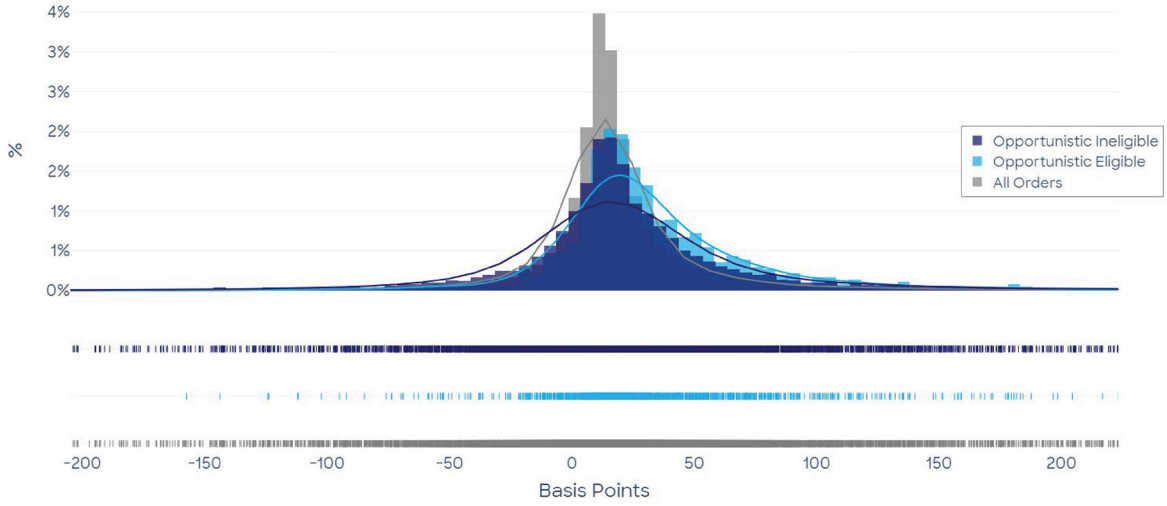
Table 2
Performance vs. Expected Cost

Performance vs. Expected Cost	All	Opportunistic Ineligible	Opportunistic Eligible
Average (bps) Equal Weighted	+19.78	+27.62	+34.43
Average (bps) Value Weighted	+17.38	+19.02	+29.95
Standard Deviation	77.43	118.82	53.66
Skewness	22.41	16.95	4.31

Source: Liquidnet analysis of EMEA Barracuda orders, January 2023 to August 2023. Bloomberg market data.

The distribution of Barracuda's performance versus expected cost has a noted positive skew, indicating that among orders completed relatively close to arrival price, there tends to be more outperforming rather than underperforming trades. As will be explored later in this paper, there are significant performance differences depending on whether orders would have been eligible for opportunistic liquidity capture. In addition to better headline performance versus expected cost, those orders that were eligible had a standard deviation of 55% lower than those that were ineligible, indicating lower levels of tail risk.

Figure 1
Performance vs. Expected Costs



Source: Liquidnet analysis of EMEA Barracuda orders, January 2023 to August 2023. Bloomberg market data.

When used by Members, Barracuda receives unique access to the Liquidnet pool

At Barracuda's core is Liquidnet's flagship dark liquidity-seeking logic which also underpins the Liquidnet Dark algorithm. Barracuda receives buy-side access to the Liquidnet pool, in addition to extensive reach across EMEA conditional and dark venues. Key innovations include our price protection model, which offers short term protection against volatile market movements, and dynamic minimum quantity, which caters dark minimum execution size for symbol specific characteristics.

Table 3

Barracuda Venue Analysis	% of Total	Avg. Fill Size ($)	Avg. Fill Size (% LIS)	Market Impact Savings (bps)	Spread Savings (bps)
Dark MTF	33.4%	14,763	96%	4.2	4.4
Liquidnet	18.1%	308,998	311%	10.3	6.3
Primary Exchange	15.3%	5,186	38%		5.6
Periodic Auction	12.8%	8,562	26%	3.4	5.1
Conditional	10.6%	60,401	339%	9.5	6.4
Lit MTF	7.9%	3,418	2%		3.3
ELP SI	1.1%	7,339	6%	3.1	1.1
Bank SI	0.7%	18,343	15%	3.6	3.8
RFQ	0.1%	14,729	14%	3.5	9.5
Total	**100%**	**10,581**	**134%**	**6.2**	**5.1**

Source: Liquidnet analysis of EMEA Barracuda orders, January 2023 to August 2023. Bloomberg market data.

Barracuda is first and foremost a dark liquidity-seeking algorithm, with 77% of the notional transacted in the dark and 29% completed on conditional venues. Furthermore, when buy-side users access Liquidnet directly via Barracuda, other Liquidnet algorithms or via the Liquidnet front-end application, they, on average, see higher average executions sizes and greater savings relative to access via a sell-side broker.[1] Barracuda achieved average fill sizes in the Liquidnet pool of $309K and 3.1x LIS. Fill size in Liquidnet was over five times greater than the fill size achieved in outbound conditional venues. These results are driven by the benefits of accessing Liquidnet directly as a buy-side customer. Transacting in block size in the dark using Barracuda's dark aggregator results in significant market impact savings relative to trading that segment of the order over time in lit markets. Barracuda executions in Liquidnet saved clients 10.3 basis points of market impact that they would have otherwise incurred. The savings associated with fills on outbound conditional venues was 9.5 bps. Aggregated total savings of all dark executions averaged 6.2 bps.

[1] Liquidnet analysis of pool executions over H1 2023 shows average execution sizes of $1.1M for buy-side indications, $930K for buy-side algos vs. $550K for sell-side

Opportunistic lit logic supplements core dark aggregator

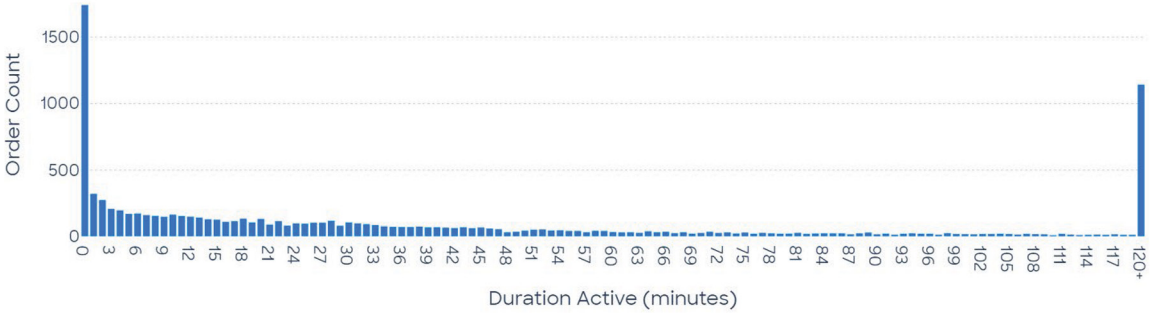
Barracuda's lit component operates alongside the dark aggregator and, on average, is responsible for 23% of the notional traded on a typical order. The Barracuda lit algorithm operates within participation rate bands, adjustable by urgency, and will generally not cross the spread to take liquidity unless certain conditions have been satisfied. When this occurs, the algorithm will behave opportunistically, taking some of the liquidity available at the far touch. This ensures the algorithm behaves most aggressively in situations where market conditions are best suited toward liquidity capture, and vice versa when the situation does not suit. The three criteria are spread compression, elevated far touch size, and satisfactory fair value.

Liquidnet analysed all Barracuda orders in EMEA, from January 1, 2023 to August 31, 2023, to evaluate the impact of these signals. Only orders with a duration of over 30 minutes were considered to ensure the signals had a reasonable time to activate and ultimately influence the order. Each order was segmented into one-minute bins, and each bin evaluated as to whether each signal would have been in force at that time.[2]

Spread Compression

Spreads are considered compressed if they fall below the 25th percentile of trailing levels, as determined by the distribution of the average spreads of the one-minute bins over the previous seven calendar days. The distribution below, and similarly for those that follow for the other signals, shows the duration in minutes during which the signal would have been active over the order's life. 82.3% of orders see the spread signal activated during some point in their life, with an average active duration of 57 minutes and a standard deviation of 73 minutes. Spreads tend to experience some intra-order volatility and so it is unsurprising that they pass through the 25th percentile threshold, on at least a few occasions, for the majority of orders. Furthermore, on days that have, for example, elevated liquidity or are higher volume relative to the preceding days, this state may persist for significant amounts of time. Compared with the signals below, the spread signal is the most easily satisfied, serving as a guardrail to the opportunistic logic rather than a wholesale constraint on the algorithm's opportunistic behaviour more generally.

Figure 2
Spread Compression Signal Active



Source: Liquidnet analysis of EMEA Barracuda orders with a duration greater than 30 minutes, January 2023 to August 2023. Bloomberg market data.

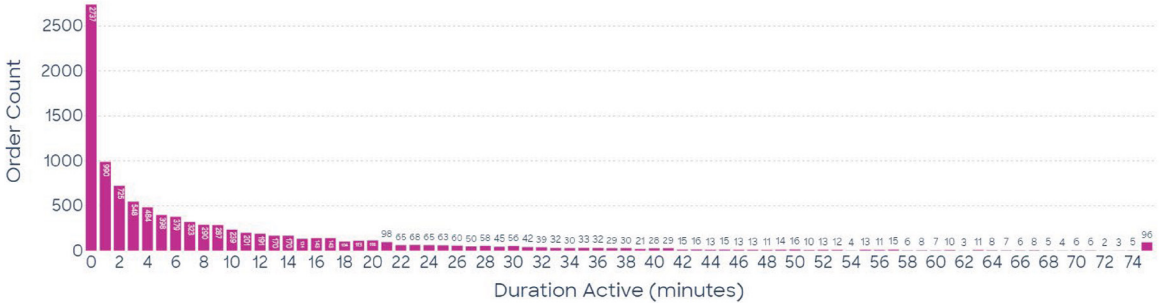
The analysis has shown that the length of time during which the spread signal would have been active is uncorrelated with better performance versus arrival. For each incremental percentage point of the order's life in which the signal was active, performance versus arrival price decreased marginally by .02 bps.[3] This indicates the function of the signal as a guardrail against unnecessary spread cost should the opportunistic logic otherwise activate while spreads are unsuitably wide.

[2] Note the determination as to whether each signal would have been in force was modelled by Liquidnet and does not rely on realized historic order data due to data access restrictions. Furthermore, the definitions of each signal may deviate from those used in live trading by Liquidnet's third-party broker partners due to limitations around data and information available to Liquidnet. As such, the analysis of performance that follows should be considered as models or projections based on simulated historic behaviour of the algorithm around the signals, as defined in the paper, which will deviate from the exact signals used during trading by Liquidnet's broker partners. In the discussions of signal duration, the periods are not necessarily sequential and could occur and reoccur throughout the order life.
[3] Evaluated using linear regression: perf vs. arrival = 3.0811 - 0.0242 * pct order life with a R2 of .00005. The low R2 indicates no causality in the result, which is not unexpected given the wide range of factors that influence the implementation shortfall of an order.

Elevated Touch Size

The far touch size is considered elevated if the quantity posted exceeds the 90th percentile of recent levels, as determined by the distribution of the average far touch size of each one-minute bin over the trailing seven calendar days.

Figure 3
Elevated Far Touch Signal Active



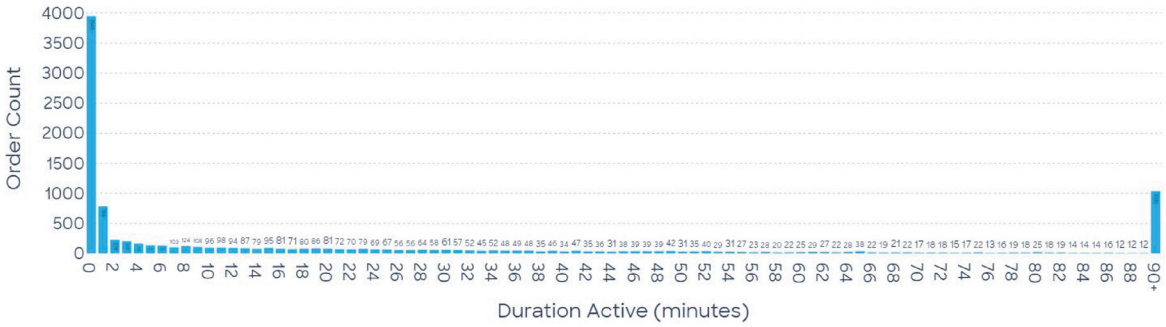
Source: Liquidnet analysis of EMEA Barracuda orders with a duration greater than 30 minutes, January 2023 to August 2023. Bloomberg market data.

On average, the touch size was elevated for 13 minutes with a standard deviation of 17 minutes, and was active for at least one minute during 73% of orders. Given the higher 90th percentile threshold for the signal, it activates less often than spread compression, providing another constraint on Barracuda's opportunistic logic. When considered alone, the signal is not correlated with order performance versus arrival price.[4] However, in practice, the signal is only used in conjunction with the others, providing an important speed bump and ensuring the algorithm only behaves aggressively when there is significant liquidity available to absorb the increase in participation rate, even if the other signals suggest advantageous conditions otherwise.

Fair Value

This analysis considered a name to be fairly valued if its intra-order price performance was favourable relative to that of a basket of correlated stocks, as determined by Liquidnet Investment Analytics. That is, the price performance of a buy must trend below that of the correlated basket, and vice versa for sells. Performance was determined using the relative price performance from order arrival time using the VWAP price of both the name in question and that of the correlated basket over each one-minute bin.

Figure 4
Fair Value Signal Active



Source: Liquidnet analysis of EMEA Barracuda orders with a duration greater than 30 minutes, January 2023 to August 2023. Bloomberg market data.

The signal activated for at least one minute on 61% of orders for an average duration of 51 minutes with a standard deviation of 73 minutes. Fair value is the most difficult condition to satisfy, however, when it does activate, it tends to persist as exemplified by the long tail in the distribution in Figure 4 above. Individually, activation of the fair value signal has a small positive correlation with order performance versus arrival price, with each incremental percentage point of signal duration improving performance versus arrival by 0.02 basis points.[5]

[4] Evaluated using linear regression: perf vs. arrival = 2.4009 – 0.0046 * pct order life with a R2 of .0000004. The low R2 indicates no causality in the result, which is not unexpected given the wide range of factors that influence the implementation shortfall of an order.
[5] Evaluated using Linear regression: perf vs. arrival = 1.9562 + 0.0183 * pct order life with a R2 of .00006. The low R2 indicates no causality in the result, which is not unexpected given the wide range of factors that influence the implementation shortfall of an order.

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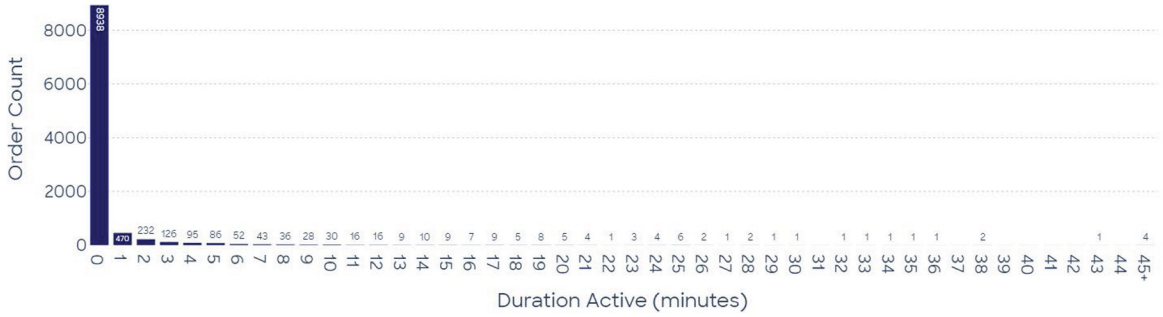
Opportunistic liquidity capture improves performance versus arrival

When all three signals are active simultaneously, Barracuda will cross the spread in lit markets and take some, but not all, of the liquidity available on the far touch in order to capitalize on the advantageous conditions. The three signals were simultaneously active for at least one minute during 1,329 (12.8%) orders. The average time in which the three signals were simultaneously active was 4.6 minutes, with a standard deviation of 6.0 minutes.

Figure 5
Three Signals Active



Source: Liquidnet analysis of EMEA Barracuda orders with a duration greater than 30 minutes, January 2023 to August 2023. Bloomberg market data.

Performance versus arrival for the sample of orders during which three signals were simultaneously active and were opportunistic eligible was +2.5 basis points, 10.4 basis points better than the ineligible sample. This performance improvement is highly statistically significant at a confidence level of 99%.[6]

Table 4

Characteristics	Eligible	Ineligible
# Orders	1,329	9,028
Traded notional ($)	615,284,076	2,978,285,956
Avg. order size (%ADV)	10.3%	11.4%
Avg. spread (bps)	11.7	14.7
Avg. duration (min)	161.2	154.4
Avg. participation rate	45.1%	52.0%
Interval return (bps)	-5.2	-17.8
Expected cost vs. arrival (bps)	27.4	26.9
Performance		
vs. Arrival (bps) Value Weighted	2.53	-7.87
vs. Arrival (bps) Equal Weighted	11.09	1.08
vs. Expected cost (bps)	29.95	19.02
vs. Interval VWAP (bps)	8.52	8.90
vs. Eligible interval VWAP (bps)	-0.98	-2.55
vs. PWP10% (bps)	34.87	-2.98
vs. Close (bps)	7.33	-3.37

Source: Liquidnet analysis of EMEA Barracuda orders with a duration greater than 30 minutes, January 2023 to August 2023. Bloomberg market data.

There is a positive relationship between increasing duration of signal activation and order performance versus arrival, with each incremental percentage point of duration improving performance versus arrival by 0.12 basis points.[7] When considered together, the magnitude of the performance impact of each of the three signals working in concert far exceeds that of any in isolation. To limit information leakage and potential market impact, opportunistic crossing of the spread ought to be constrained. In practice, the data suggests that while the fair value signal indicates moments of good relative value, the spread and touch size signals provide important guardrails that ensure the crossing of the spread occurs with lower risk, for example during times of tighter spreads, and with the greatest potential for benefit, for example in moments of high liquidity.

[6] Evaluated using a one-sided t-test with results of t = 6.7655 DoF = 2,721.3 p=8.1014E-12. CI99 = [6.5692, ∞]
[7] Evaluated using Linear regression: perf vs. arrival = 2.3047 + 0.1197 * pct order life with a R2 of .00005. The low R2 indicates no causality in the result, which is not unexpected given the wide range of factors that influence the implementation shortfall of an order.

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It is important to consider price trends following potential occurrences of opportunistic behaviour. This is to ensure there is not the sustained market impact or continuation in favourable price trends that might have tended toward a more passive approach. On a value-weighted basis, the eligible sample outperforms the ineligible sample against both the close and PWP10%. This is not the case using equal weighted averaging,[8] and the outperformance seen above is not statistically significant. The conflicting results suggest, firstly, that there is significant variability in post-trade price movement, offering reason to reduce price-risk, and secondly, that it is unclear how, if at all, the opportunistic behaviour is impacting post-trade price trends.

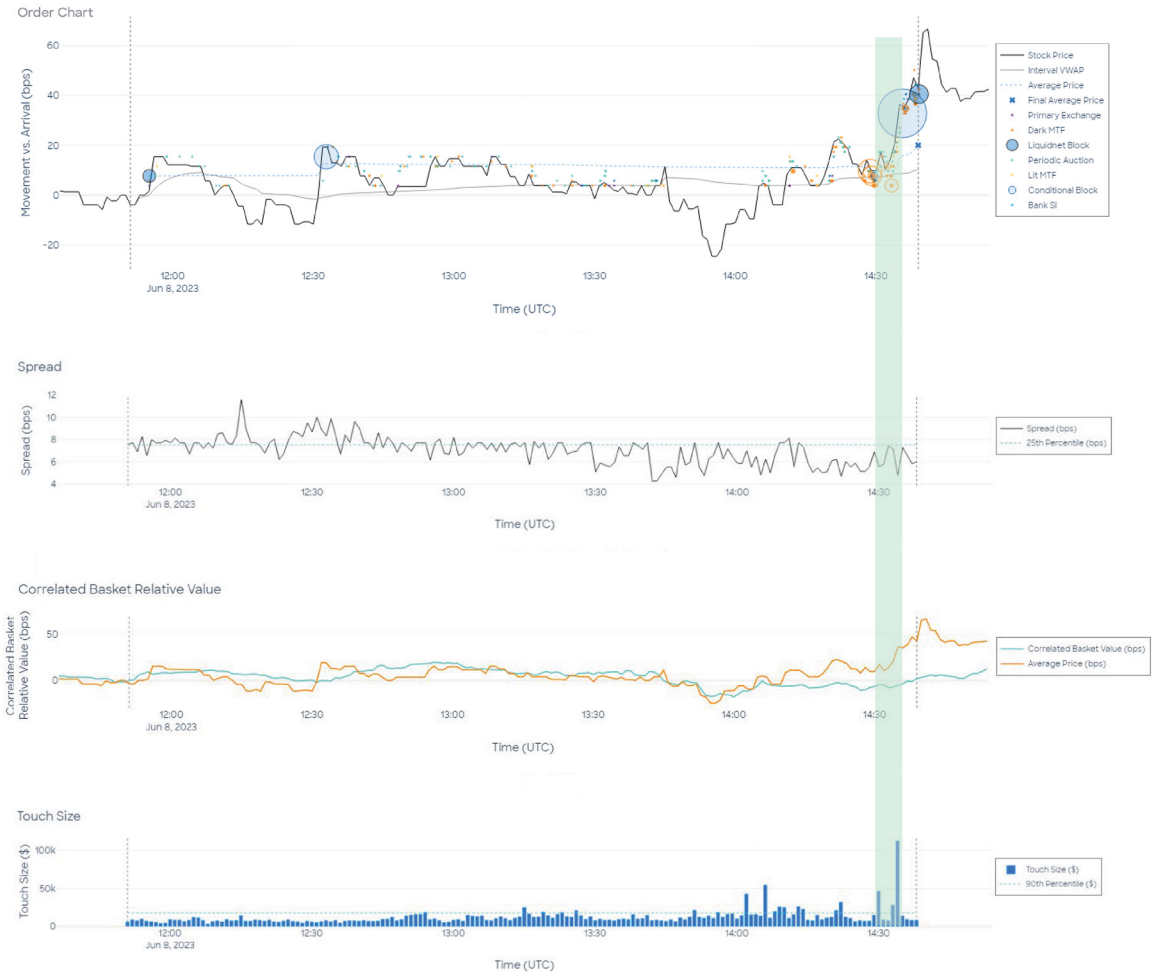
Overall, Barracuda offers the benefits of dark liquidity sourcing with the consistency of lit trading, with benefits to clients coming from both components. Relative to trading, the algorithm's dark fills over time in lit markets, the analysis has shown Barracuda delivers 6.2 bps of savings to clients. Furthermore, the opportunistic logic embedded within the algorithm's lit slices also yields benefits, saving clients 10.4 bps, on average, if it activates.

Barracuda is a powerful tool for traders to have in their toolboxes, as it can be configured to fit many uses cases, three of which are discussed below.

[8] Equal weighted performance versus the close is +32.7 bps (Ineligible) and +17.25 bps (Eligible) and versus PWP10% is +42.27 bps (Ineligible) and +25.34 bps (Eligible)

Case Studies

I. Liquidity Capture



In this $16M sell order of a UK Large Cap, Barracuda executed 44% of ADV at a participation rate of 62% over the course of a little over two and half hours. The order outperformed arrival by 20 bps and significantly outperformed the range of go-slow PWPs (5 - 15%) by over 2%, indicating the effectiveness of the aggressive approach. The algorithm sourced liquidity via a combination of Liquidnet blocks, conditional blocks, smaller dark fills, and lit market activity. Lit activity accelerated toward the end of order as spreads began to compress, touch sizes rose, and prices trended favourably relative to the correlated basket, satisfying the requirements for the algorithm's opportunistic logic to activate. The majority of the order (>95%) was completed in the dark markets, with lit activity offering a proactive complement during advantageous periods.

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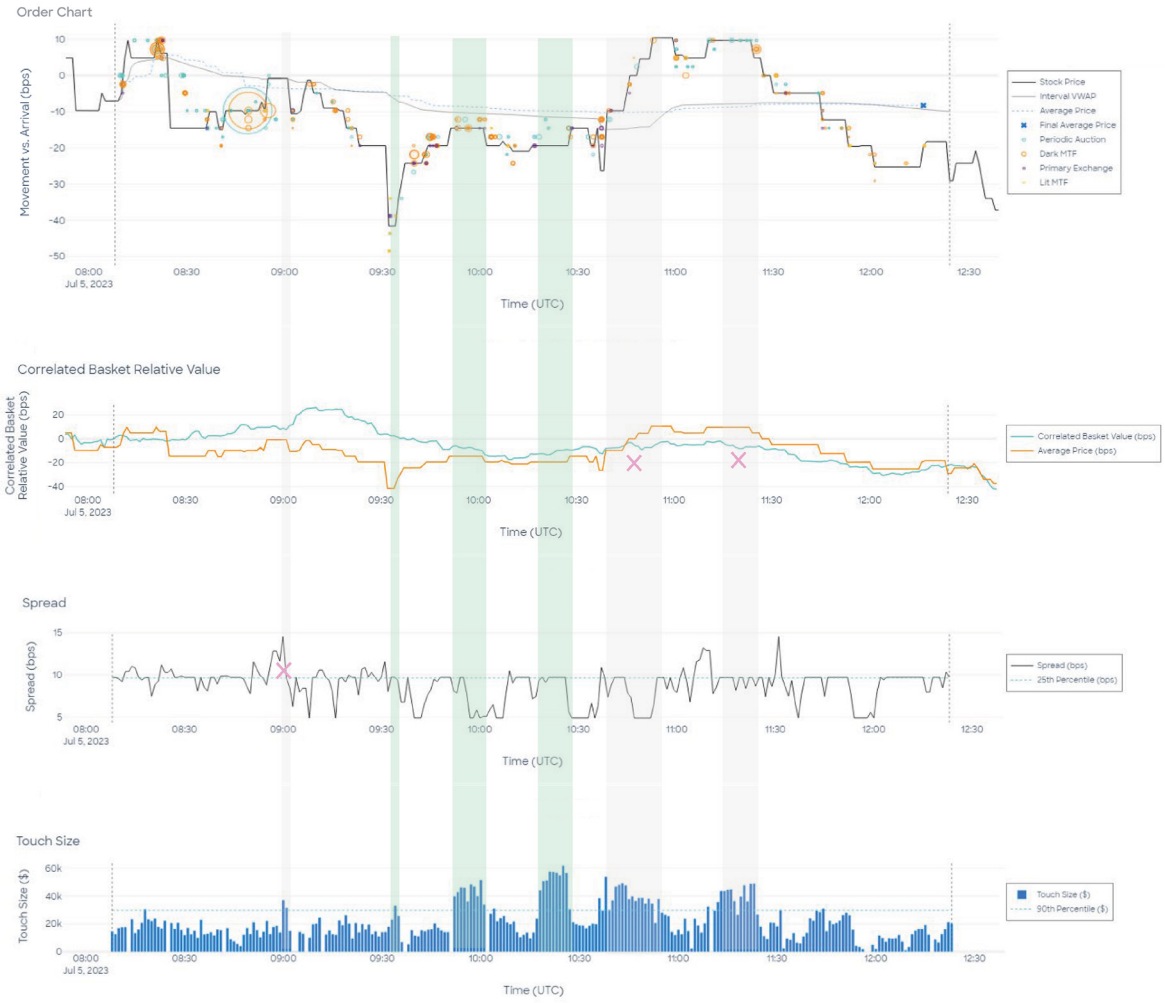
II. Complement Dark Activity



This buy order for $3M of a UK Mid Cap was traded throughout the morning, with Barracuda finding liquidity across various Dark MTFs, in periodic auctions, and in the lit markets. In the absence of significant conditional block activity in the name, lit activity becomes increasingly additive for its ability to increase liquidity capture and maintain a rate of participation the trader deems appropriate. 17% of the order was executed in lit markets, with the order beating arrival by 8.3 bps and slightly underperforming the interval VWAP (-2.5 bps). The lit executions were additive to order performance, achieving an average price 4 bps lower than that of the dark executions. There were four significant periods of elevated touch size during the orders, all of which coincided with acceptably compressed spreads. The latter periods, however, occurred following an upwards price movement that left the name considered overvalued, with limited lit activity during that time (passive fills could still have occurred, but largely did not). In this sense, the opportunistic logic can help overweight the algorithm's participation toward more favourable points during the order life, in a way that can be accretive to performance.

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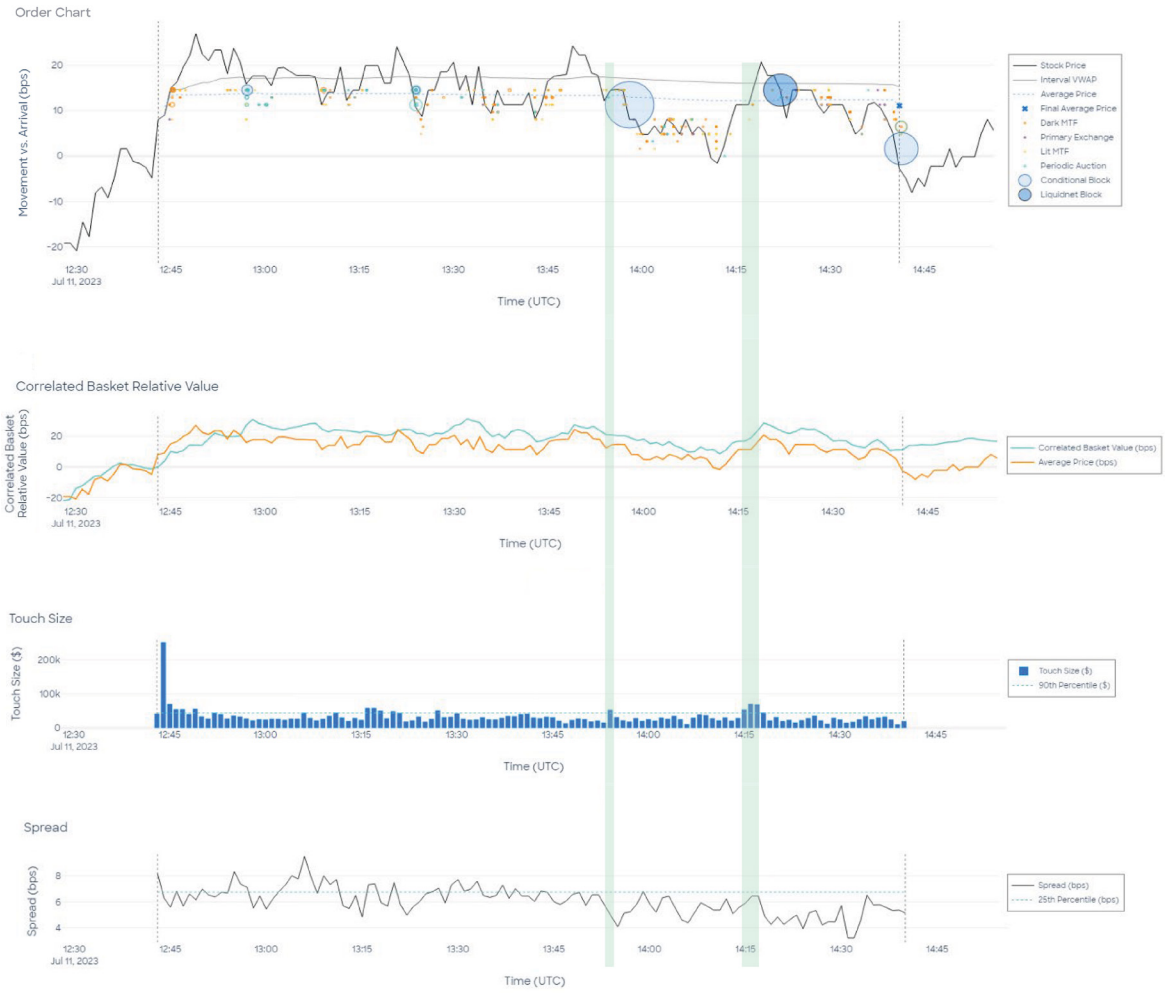
III. Speedbump Against Over-Aggressiveness



This was a $7M buy order of Spanish Mid Cap, where in the first minutes of the order, prices moved abruptly upwards, through the order's limit. The market had moved as well, and the name remained fairly valued during much of that time, but spreads were relatively wide and touch sizes had not changed. In these situations, the opportunistic logic will not activate ensuring participation rates remain as expected and demonstrating how the three signals working in concert can achieve a better outcome than any one alone. The name gradually reverted back toward arrival over the course of the afternoon, with three (3) large conditional blocks executing at more advantageous prices later in the order. In all, the Barracuda traded 20.3% of ADV over about 110 minutes, at a participation rate of 65% of lit market volumes, missing arrival by 11 basis points, but outperforming both the interval VWAP (+3.4 bps) and PWP15% (+81 bps).

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