Liquidity Charge® & Price Reversals: Is High Frequency Trading Adding Insult to Injury?

Investment Research | QSG Equity Research Team

Over the last decade, we've witnessed unprecedented fragmentation in the destinations where US equity trading takes place. Equity traders have responded by breaking orders into ever smaller individual trades that better relate to the liquidity offered by the broad array of execution venues. This parceling activity and the price 'footprint' from the individual trades creates a potential signal of the trader's intentions. An emerging breed of information arbitrageurs, leveraging high-frequency trading (HFT) techniques and sophisticated pattern recognition software, are aggressively scanning the market for these signs. This new predatory competition for liquidity is increasing the cumulative price concessions incurred by many institutional orders and are generating significant post-trade price reversals in the largest 'impact' orders. An analysis technique developed by QSG confirms that orders suffering the largest charges for liquidity are routinely reversing 25% of that price impact within 5 minutes of the order's completion. This study is the first of its kind and introduces analysis methods that will help equity managers address this challenge head on.

Introduction

Benjamin Franklin gave us the famous axiom "in this world nothing is certain but death and taxes." Most seasoned equity managers would likely add trading costs to the list. The price impact of acquiring or liquidating a stock position stands as a considerable hurdle for many equity managers to get the most out of their best ideas. Yet, in many ways much like death and taxes, there is a sense of benign neglect when it comes to dealing directly with the impact of these costs. Given the perceived difficulties of taking specific action, many accomplished managers dismiss transaction costs as a necessary evil and something best addressed by unpleasant compliance requirements and an occasional quarterly 'TCA' report. Fortunately, due to the efforts of firms like QSG, there has been thoughtful research into the core drivers of trading costs and the development of analytics that improve decision making. These solutions are arriving just in time, as the impact of innovations and changing market structure of the electronic equity marketplace threaten to take a significantly larger bite out of equity manager returns.

Equity markets have undergone unprecedented fragmentation in the last decade." From the days of the oligopoly of the NYSE, AMEX and NASDAQ, equity traders are now confronted by more that 40 execution venues to choose from. This increase in competition for transaction volume has fueled incentives that have changed the economics of market makers. In this new world, the challenges of picking up the high-volume pennies that reward them for providing liquidity has given way to new forms of price speculation. The dramatic improvements in technology and communications speed have created a new breed of arbitrageur that leverage high-frequency trading (HFT) techniques with the goal of predicting the direction of prices by running millions of micro-second executions through sophisticated pattern recognition software. To exploit the signals generated from these systems, an 'anticipatory' position must be established. Of course, that means that if a large buy order is moving prices higher, the move by the HFT trader is not to add liquidity, but to acquire it in anticipation of selling it back to the buyer at a higher price. This evolution in market structure creates both an opportunity and a manageable challenge for institutional equity managers.

The system-wide impact of the decimalization of stock prices has indeed delivered the benefit of decreases in the size of bid/ask spreads. This advantage leads to significant cost savings to those retail investors whose liquidity demands are well within the resting liquidity of the marketplace. However, this benefit is substantially diluted for institutional size orders. The smaller average order sizes that have resulted from the narrowing spreads have spawned the development of algorithmic trading systems which rely on computerized techniques to parse larger orders and manage the distribution of these 'child' orders across time and destination. The substantial increase in the sheer number of individual executions required to complete an institutional order has resulted in some interesting consequences. The advantages of smaller spreads evaporate if the cumulative impact, seen and unseen, of the number of required executions move prices more than the spreads of old.

For example, instead of paying the classic 12.5 cent spread for a single execution of 10,000 shares prior to decimalization, the same 10,000 shares could result in 50 or more individual executions given today's average trade size. The successive penny spreads of the individual trades could result in higher prices for the subsequent trades in the order, resulting in much higher cumulative costs than the small spread would suggest. This parceling activity and the 'footprint' it creates also risks signaling the market to the trader's intentions. This information leakage could compound the costs as predatory orderflow competes for the natural liquidity and begins to have price impacts of its own. With a penny spread in the example the cost advantage, though diluted, may be intact. What if the spread in the example widens to 2 cents a share? As Hamlet said, "Ay, there's the rub."

How does traditional trading analysis deal with these new realities? Not very well. Traditional TCA measures are focused on comparing the average execution price of an order to a series of benchmark prices. Common benchmark prices are the VWAP for the day or the trading interval, the price when the order 'arrived' to the market, or a theoretical participation benchmark (the average price of acquiring the order shares at X% where X, the participation rate, is often 10% or 20% of the volume). The 'trading cost' is then calculated as the difference between the benchmark price and the average price of the completed order. These benchmark measures offer no way to disentangle the influence that the order's executions, and those of the competing orders, had on the stock's price. A portion of those competing orders may be the result of real-time HFT models that have detected the trading interest asymmetries and have moved to exploit them. To understand the impact of these new challenges, QSG developed the analysis techniques that are delivered on the T-Cost Pro® trading research platform.

One aspect of the challenge presented by HFT competition was outlined in our research publication 'Beware of the VWAP Trap.' This study revealed that significantly higher impact costs and trading velocity are often incurred for VWAP algorithms when compared to Arrival Price algorithms, especially when applied to liquid, low price stocks. This is contrary to the popular perception that VWAP strategies reduce trading costs. The results suggested that High Frequency Trading strategies are materially contributing to these increased costs. The report also illustrated that the increased order parceling related to VWAP strategies has negative ramifications, including increased tick risk, larger statistical footprints and the possibility of costly trading spirals.

Execution Differential	The entire order's shortfall from Arrival Price, or the price at which the order was acknowledged electronically by the executing broker.
Cumulative Liquidity Charge	The portion of Execution Differential attributed to the cumulative impact of price concessions paid by the algorithm for liquidity and can therefore be only negative or zero.
Timing Consequence	The residual portion of Execution Differential after accounting for Liquidity Charge, which is attributed to the price impact of exogenous order flow over the execution horizon and can therefore be negative or positive.

In this report we extend our unique analysis of key drivers of trading costs by analyzing the relationship between an order's impact on prices and subsequent price reversal.

QSG's ability to isolate the Liquidity Charge®, the cumulative price impact specifically resulting from an order's individual executions, is essential to this analysis. This measure was developed by QSG to extend the value of benchmark analysis by explicitly separating trading costs into those related to the order under review and those resulting from the competing orders over the execution period. Through the tick-based analysis of each individual execution of an order, QSG determines whether a price concession was required to make the trade. These concessions provide an important insight into the liquidity dynamics that exist during the execution of an order.

Large or increasing numbers of concessions are indications of a deteriorating liquidity environment. Such a scenario would be consistent with an order that was competing with a motivated competitor on the same side of the market. We suggest that HFT strategies mimic this behavior once they've recognized an exploitable pattern in a stock. Unlike competing orders from a traditional investor, HFT orders don't represent a long-term commitment to the position. Consequently, a successful HFT strategy will offset the position if the imbalances that create price changes recede. Since uncertainty surrounds this exact point, the HFT strategy may be required to rapidly reverse the position after the orders responsible for the exploitable signal are completed. Given the short-term nature of the strategy, these offsetting positions themselves may require concessions to be executed. From the perspective of the order being analyzed, the concessions resulting from an HFT exiting a position would create a quick price reversal for the stock. The focus of our research is to examine whether there is evidence of significant price reversals after orders with large price concessions (liquidity charges) are completed.

Background, Methodology & Data

It is important to make a distinction between the explicit price impact calculation utilized in this analysis and the way that many in the industry characterize trading 'impact.' Some practitioners refer to 'impact' as the entire difference from an arrival price benchmark. This misrepresentation is often reinforced by the many 'impact cost models' offered by brokers which purport to forecast the realized execution costs for an order. Not only is this a misnomer of the goal of the model, but most of the models are constructed to provide a +/- price variance corridor rather than a point estimate. For the purposes of this report, we will consider impact cost as the price changes that result specifically from the individual executions required to complete an order.

Almgren and Chriss (2000) proposed a theoretical decomposition of the shortfall from arrival price in their paper 'Optimal Execution of Portfolio Transactions.' The authors characterize the evolution of a stock's price during a trade into two exogenous factors: volatility and drift, and one endogenous factor: market impact. The authors make the assumption that volatility and drift occur randomly and independently of their trading, whereas market impact occurs as market participants begin to detect the order volume and adjust their bids/offers accordingly. They distinguish between two types of market impact: first, temporary impact or the temporary imbalances in supply and demand caused by trading, leading to temporary price movements away from equilibrium and second permanent impact or the changes in the "equilibrium" price due to their trading, which remain at least for the duration of the execution horizon. The authors approximate these 'market factors' by using inputs such as stock volatility, shares traded per time interval and trade duration. While these implicit components of 'impact' may appear intuitive, they are not directly observable. Due to the importance of preserving the specific dynamics at the point of each execution, the assumptions and errors associated with the approximations in the Almgren and Chriss technique leave us unable to leverage this well known theory in our investigation.

$$\sum(S_A - S_i)V_i = \sum(x_i) + TC$$

where for a buy order:

$\sum(S_A - S_i)$ = Execution Differential

$\sum(x_i)$ = Cumulative Liquidity Charge

TC = Timing Consequence, or the residual of Execution Differential after accounting for the order's Cumulative Liquidity Charge

S_i = an individual child order's execution price

S_A = the order's arrival price benchmark

V_i = volume executed on an individual child order

x_i = temporal impact of an individual child order's price concession over the execution horizon in units of dollar value (price concession x volume)

The methodology QSG employs to isolate the impact costs for an order are based on calculating three identities: Execution Differential, Liquidity Charge and Timing Consequence. The goal in calculating the three, is to deconstruct the Execution Differential into its two components: the price changes directly attributable to the order under review (Liquidity Charge) and the price changes resulting from all other executions during the trading interval (Timing Consequence).

Execution Differential is defined as the price difference between the arrival price (commonly the stock's price at the time the broker electronically acknowledges receipt of the order) and the average price of the executed order. This value is also referred to as the 'implementation shortfall', though this concept is open to interpretation as many choose to use reference prices prior to the order's arrival at the broker.

The Liquidity Charge is based on a patent-pending attribution technique developed by QSG. It represents the cumulative price impact specifically resulting from an order's individual executions. The calculation examines the market conditions related to each individual execution that comprises a completed order. This analysis is accomplished by matching each microsecond time-stamped execution to the trade and quote data for the security. Any price concessions directly related to the executions are identified and are accumulated over the life of the order. These cumulative concessions provide a unique insight into the liquidity dynamics that existed during the execution of an order.

Timing Consequence represents the price influence of all competing executions on the realized Execution Differential. By definition, Timing Consequence is the residual after the order's cumulative Liquidity Charge is deducted from the realized Execution Differential. The ability to isolate Timing Consequence is a valuable way to better analyze the short-term drift characteristics of a trade. The value of this measure can be positive or negative. When aggregated over time, by strategy, the short-term drift is a valuable input for calculating the strategy's execution 'alpha'. This interpretation appeals to an equity managers understanding that "impact is not alpha."

Our analysis of price reversals focuses on the price changes that occur immediately following completion of the order under review. Price reversals represent an unrealized cost and importantly for this study, may indicate behavior consistent with the reversal of competitive HFT orderflow. To investigate this behavior, we will calculate the price change from the last fill in an order to the price in the stock 5, 10, 15, 30 and 60 minutes later.

The first data set analyzed in this study is from QSG client executions from August 18, 2009 through January 21, 2010, representing almost 10,000 individual orders that exceeded 5% of the stock's average daily trading volume. The second specialty data set is derived from client execution data enriched with Dark Aggregation algorithm identifiers, representing 700 orders executed between September 10, 2009 and January 21, 2010.

Analysis Results

To examine whether there is evidence of significant price reversals after orders with large Liquidity Charges, we categorized the sample into quintiles based on cumulative Liquidity Charge (impact cost). The largest impact costs are in Q1 and the smallest in Q5. Figure 1 (see page 5) details the equal-weighted average Liquidity Charge in basis points for each quintile. Figure 2 (see page 5) illustrates the equal-weighted average price change for each of the quintiles across the five post-trade periods. Figures 3 and 4 (see page 5) show the same results, respectively, using cents per share of Liquidity Charge to quintile the trades.

The first result of note is the significantly large average Liquidity Charge for Quintile 1. This result is consistent with results we've published in past analyses, with Q1 having four times the impact of Q2. The story is made more dramatic as the price reversals for Q1 illustrate. Not only is the average reversal for Q1 double that of Q2, it continues to deteriorate an hour after the last trade is executed. The monotonic relationship between the quintiles in the order and magnitude of the subsequent price reversal suggests a strong relationship between the cumulative price concessions incurred by an order and post-trade price reversal. The results suggest that all liquidity is not created equal and that 'toxic' liquidity is a challenge for today's equity manager.

The previous results provide tangible evidence of toxic liquidity. The next part of our analysis illustrates a valuable way to use impact measures to evaluate dark aggregation algorithms. Dark aggregation algorithms are part of the next-generation of trading tools seeking to refine order parceling, pinging and crossing decisions. The results detailed here are the first in a series of algorithm research reports which examine the relative success of algorithmic trading techniques. In addition to the Liquidity Charge and price reversal evaluations we used earlier in the study, we compared the performance of these algorithms to a 20% Participation Weighted Price (PWP) benchmark. This simple VWAP style benchmark computes a theoretical price that could have been achieved by participating in 20% of every trade until the

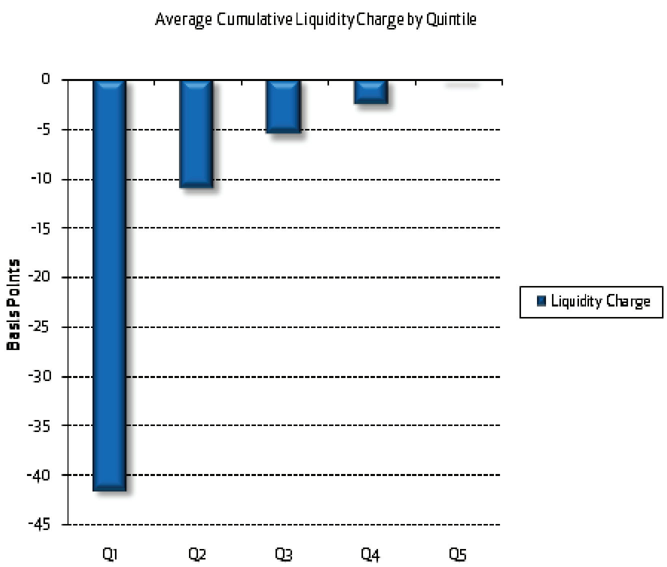

Figure 1: Shows the equal-weighted average Liquidity Charge of quintiled trade observations, by Liquidity Charge measured in basis points.

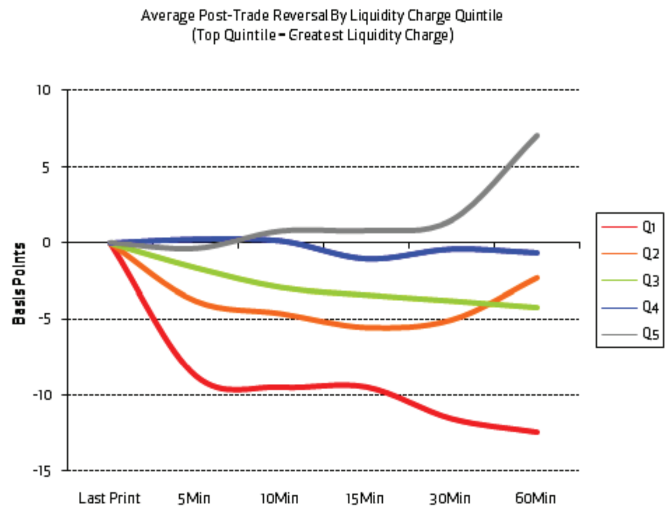

Figure 2: Shows the equal-weighted average subsequent price reversal of these quintiles.

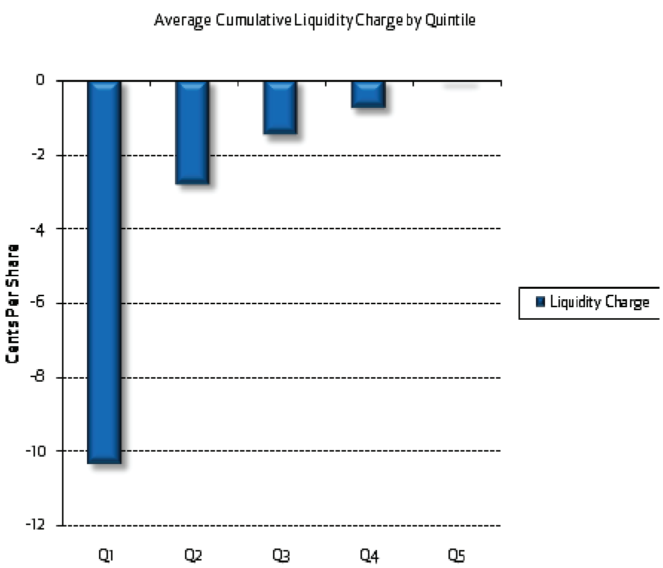

Figure 3: Illustrates the equal-weighted average Liquidity Charge of the quintiled trade observations, grouped by Liquidity Charge measured in cents per share.

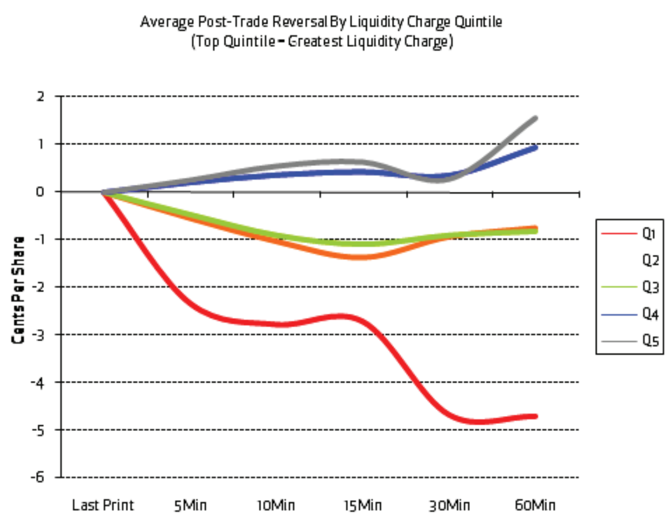

Figure 4: Shows the equal-weighted average subsequent price reversal of the quintiles in Figure 3.

order is complete. For more information on this benchmark, please see our last research note 'Beware of the VWAP Trap.' The dataset was constrained to the 1B – 10B market capitalization range and each trade was between 5% and 25% of the day's volume. There were 658 observations in total and results are value-weighted.

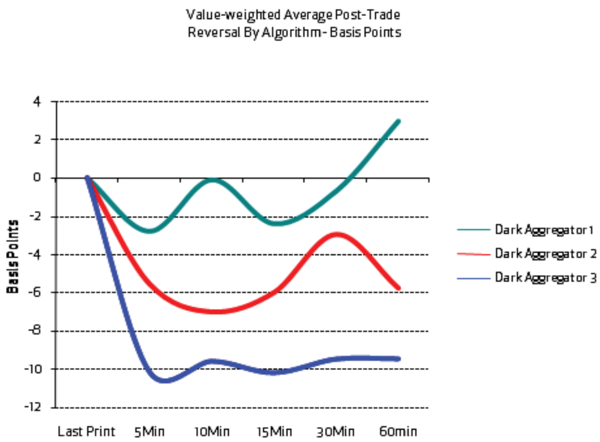

Figure 5: The value-weighted average subsequent price reversal following the completion of the trade for each of the three dark aggregators, in basis points.

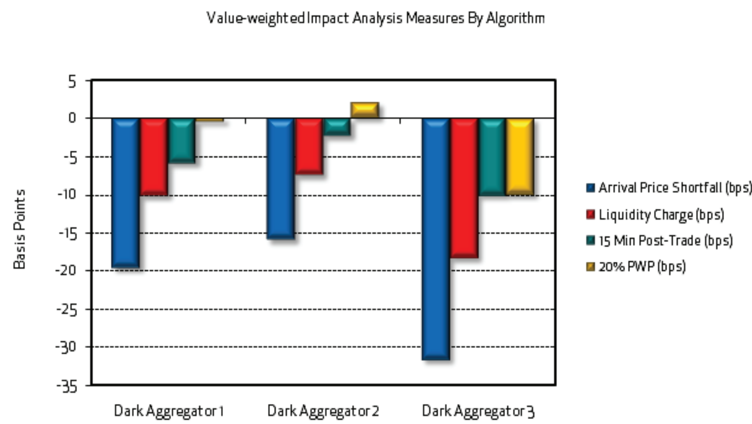

Figure 6: The value-weighted average shortfall from Arrival Price, cumulative Liquidity Charge, 15-minute price reversal and performance versus a 20% PWP benchmark for all three dark aggregators, in basis points.

As indicated in Figure 6 and Tables 1 and 2, an increase in average Liquidity Charge is a driving force across all three performance benchmarks: arrival price shortfall, 15-minute post-trade price reversal and shortfall from the 20% PWP. As the average Liquidity Charge increases from Dark Aggregator 1 to Dark Aggregator 3, the performance against the benchmarks suffers in synch. Dark Aggregator 3 incurs two times the Liquidity Charge and Shortfall, and a much higher post-trade reversal than Dark Aggregator 1. This confirms that there can be significant value in understanding which algorithms are best at minimizing impact and avoiding the toxic liquidity that draws HFT attention and results in additional trading costs.

AlgoType	Arrival Price Shortfall (bps)	Liquidity Charge (bps)	15 Min Post-Trade (bps)	20% PWP (bps)
Dark Aggregator 1	-16	-8	-2	2
Dark Aggregator 2	-20	-10	-6	-1
Dark Aggregator 3	-32	-18	-10	-10

Table 1: The value-weighted average shortfall from Arrival Price, cumulative Liquidity Charge, 15-minute price reversal and performance versus a 20% PWP benchmark for all three dark aggregators, in basis points.

AlgoType	Arrival Price Shortfall (cps)	Liquidity Charge (cps)	15 Min Post-Trade (cps)	20% PWP (cps)
Dark Aggregator 1	-5.1	-2.4	-0.8	0.6
Dark Aggregator 2	-7.1	-3.7	-2.2	-0.2
Dark Aggregator 3	-7.5	-4.3	-2.4	-2.4

Table 2: The value-weighted average shortfall from Arrival Price, cumulative Liquidity Charge, 15-minute price reversal and performance versus a 20% PWP benchmark for all three dark aggregators, in cents per share.

Table 3 displays revealing trade and parceling characteristics for the three dark aggregators. The equal-weighted average order size for each of the dark aggregators is 11%. The stocks traded by all three algorithms have, on average, similar spread sizes and similar interval participation rates. The notable divergence in the execution parceling characteristics is the average number of strikes (individual executions per order). QSG has published a number of research studies that document the positive relationship between high parceling ratios and impact costs. Executing more often invites increased exposure to 'adverse tick risk,' or the risk of incurring a price concession for liquidity. A significant increase in execution intensity during an interval is a favorite signal of many HFT algorithms. The 'Average Trade Size Ratio' measure compares the aggregators' average trade size to the market's average trade size over the trading interval. A ratio greater than 100% indicates execution sizes greater than the market average, which provide benefits including reducing the number of individual trades, reducing exposure to price concessions and lowering the chance of detection by HFT pattern detection algorithms.

AlgoType	Total Orders	Avg PctDV	Avg price	Avg Strikes	Avg Spread	Avg Participation Rate	Avg Trade Size Ratio
Dark Aggregator 1	172	11%	$ 43.44	55	$ 0.024	25%	1.20%
Dark Aggregator 2	350	11%	$ 41.29	93	$ 0.025	20%	1.10%
Dark Aggregator 3	136	11%	$ 29.57	190	$ 0.017	26%	1.12%

Table 3: Trade characteristics and parceling statistics for all three dark aggregators in the sample.

AlgoType	% Value Executed ADF	% Liquidity Charge From ADF
Dark Aggregator 1	67%	65%
Dark Aggregator 2	46%	46%
Dark Aggregator 3	51%	74%

Table 4: of value executed off-exchange and proportion of total price concessions accumulated from off-exchange prints for all three dark aggregators.

The increased fragmentation in execution venues and the quality of the liquidity offered by each venue is of special interest to our routine research activities. In Table 4, we segregate the executions to examine the characteristics of those that occurred off the traditional exchanges. This group of executions includes all of those identified as ADF (Alternative Display Facility) on the consolidated trade and quote data. This includes systematically internalized executions by a broker, executions crossed in electronic communication networks (ECNs), and crossed flow in any of the independent or broker-owned dark pools. Dark Aggregator 1 executes 67% of its value off-exchange, while 2 and 3 execute 46% and 51% of their value off-exchange, respectively. We've also calculated the percentage of the overall price concessions resulting from executions executed off exchange. Notably, 74% of Dark Aggregator 3's total price concessions came from off-exchange executions, while only 51% of its total value was executed off-exchange. This type of disproportionate impact reinforces concerns about the quality of liquidity and information leakage at certain venues. QSG has a growing number of clients who are receiving the data enrichment necessary to track the specific off-exchange venues where their executions are occurring. This includes internalized transactions executed by their brokers.

Conclusions

The complexities surrounding accurate evaluation and management of trading costs has discouraged many managers from taking meaningful action. Changes in the microstructure of equity markets and the emergence of HFT competitors have changed the nature and magnitude of transaction costs. Sophisticated pattern recognition algorithms now present a real return burden to active equity managers. It is for this reason that QSG developed the techniques necessary to uncover the costs associated with predatory HFT activity. As part of their effort to protect the value of their investment insights, managers need to acknowledge these costs and meet this challenge head on.

For equity managers of all types, large concessions for liquidity are a concern. Insult is added to injury if those costs are larger than necessary and then followed by a significant reversal in prices. Momentum managers are accustomed to encountering same side competition in their orders. The very nature of the price and information catalysts that drive these strategies reinforces this behavior. Larger than average liquidity charges may be a real result for such a strategy. Yet, even for these strategies, significantly larger concessions paired with large short-term reversals are not an indication of the fair competition of longer-horizon investors. However, this behavior is consistent with the price action associated with a non-investor competitor who has accumulated a position in the pursuit of a short-term gain, the goal of every successful HFT strategy.

As a technology driven response to fragmented markets, the dark aggregation algorithm addresses many of the logistical hurdles of gaining simultaneous access to multiple destinations. Our initial analysis suggests that many of the latency, information signaling and HFT challenges are not being adequately addressed by the solutions we reviewed. Our results suggest similar impact and reversal challenges for these solutions as those observed in our broader study. There is also evidence that there may be large differences between each solution's performance. This puts the burden on the user to accurately monitor the aggregator's performance to select the best provider.

Order anticipation strategies have long been a feature of equity markets. What have changed are the technology-fueled enhancements for improved pattern recognition, speed of execution and breadth of coverage. The decline in bid/ask spreads and exchange rebates have dramatically reduced the costs of carry for these strategies. In the same vein, it's naïve to accept that the risk adjusted returns and rebates of electronic market making are sufficient to consistently generate the billions of dollars in profits reported by HFT firms. The complexity of these interrelationships and their close proximity to legitimate market making activities will be a challenge for regulators to grapple with.

The appropriate response for enlightened equity managers is to arm their trading desks with tools that analyze and monitor their exposure to these challenges. Armed with a quick and accurate diagnosis, the trader can improve their execution techniques by avoiding the execution providers, algorithms and venues responsible for higher than necessary price concessions and subsequent price reversals. HFT strategies will continue to proliferate and generate consistent profits as long as they can hide in the shadows of a fragmented marketplace. There are significant performance advantages to the equity managers who avoid making a contribution to their success. It is increasingly clear that relying on traditional TCA solutions to identify and address this challenge is like bringing a knife to a gunfight.

For additional information, please contact:

QSG®
Quantitative Services Group LLC

qsgresearch@qsg.com

1560 Wall Street Suite 334
Naperville, IL 60563
PH 630.637.8088
FAX 630.637.8388
www.qsg.com