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The basic idea of both dark pools and dark order types is not new. For certain orders, openly displaying an intent to trade could cause market impact by giving predatory traders a low-priced option on a stock. By reducing the cost of this option through the narrowing of spreads, the introduction of decimalized trading exacerbated this effect. These changes, combined with evolving technology, led to the creation of a variety of venues designed to eliminate the signal of a large order. The new venues used both market-structure mechanisms and the composition of their user base to deal with this problem.

Two market structures, non-displayed quotes and minimum size, became fairly ubiquitous in the segment of alternative trading systems known as dark pools. While non-displayed quotes are relatively constant, the concept of a minimum volume is open to various interpretations. When it is trader-defined, minimum volume refers to the order size that a potential contra must achieve to interact with that trader's order. For example, if a trader sets his minimum volume to be 10,000, he or she would not interact with any order smaller than 10,000 shares.

This article examines the thought processes involved in determining how to use minimum size. While orders may differ greatly in their need for size filtering, there are some common themes that can help practitioners think about the problem.

WHAT HAPPENS TO MY ORDER WHEN IT INTERACTS WITH SMALL ORDERS?

The first question for a trader is: Is there a risk in interacting with numerous small order flows? Our research shows that, at the very least, it depends. Many practitioners believe that statistical arbitrage ("stat arb") and automatic market-making flows are, to some degree, toxic. While there is a concern that predatory pinging to uncover "dark" orders, combined with manipulation of the NBBO, is a key issue, there is anecdotal evidence to suggest that the more prevalent problem is in interacting with flows with a short-term risk profile.[1] When a stat-arb participant or automated market-maker is on the other side of an institutional trade, they will quickly try to exit their position if prices begin to trend. For an institutional participant, this may create a greater demand imbalance and more price impact, as the short-term trader turns to the same side of the market as the institution.

But, what happens if a trader interacts with other small flows? To look at this issue, we reviewed orders in the BIDS ATS over a six-month period from February to July 2008. It is important to note that the

composition of these flows was 69% agency vs. 31% principal, meaning that the majority of the orders represented smaller "natural" liquidity. To look at the possible price degradation resulting from executing against multiple small flows, we reviewed orders with 10 executions during the sample period.

Ten thousand orders were randomly selected, and the percentage change between the price of the initial execution and each subsequent execution of that order was measured. We call this percentage change "drift." Negative drifts indicate that the trader bought the stock at a price higher than the initial trade price or sold at a price lower than the initial trade price. Positive drifts indicate a price improvement vs. the initial trade. The drifts were then placed into bins with other drifts at the same level (i.e., the differences between the first trade and the second trade for an order were placed into the Drift_1 bin, and the differences between the first trade and the third trade were placed into the Drift_2 bin). The average at each level is shown in Exhibit 1. All figures are expressed as percentages.

A Wilcoxon Signed Rank Test[2] was performed to determine whether the median of the drifts at each level was statistically different from zero (see Appendix 1). In all cases with the exception of the first drift, there is insignificant evidence to reject the null (i.e., that the true median drift is 0) and support our alternate that there is drift (either positive or negative) at the classic 5% level. Even in the case of the first drift, the result is not practically meaningful, as the average drift is –0.00273% and the median drift is 0 to 5 decimal places.

Because the null cannot be proven, we also examined confidence intervals (see Appendix 2). The results indicate that with 99.99% confidence (this is expressed as 100% in the output), we can assume that the median drift is in a band around 0 that is smaller than five decimal places on either side. Again, any drift would be negligible enough to be irrelevant to the practitioner.

These results indicate that it makes sense to interact with both large and small flows in a pool that has little or no toxic flow because there is little evidence of leakage. It is extremely important, however, for practitioners to understand exactly what type of order flow they are interacting with. While we do not have a direct comparison, we believe the limited presence of automated market-making and stat-arb flows contributed to the observed results.

HOW DO I OPTIMIZE MY USE OF MINIMUM VOLUME IN A PARTICULAR MARKET OR VENUE?

In cases where a dark pool may contain order flows that have the potential for toxicity, traders may wish to use a minimum volume. Since they will not interact with flows smaller than the specified size, this generally prevents the negative effects of interacting with both predatory traders and participants with short-term risk profiles. This, however, comes at the cost of reducing the available liquidity. To quantify this effect, we examine the volume that is lost when a minimum volume is used.

We characterize this dilemma as "Volume at Risk." By calculating the sum of all volume that is routed to a particular venue, we can determine what minimum volume misses a given percentage of the available liquidity in that market. We use cumulative order volume because traders can typically aggregate contra flows. Because of the high frequency of data available, we believe it is fair to use historical information in determining this threshold level. This non-parametric approach is easy for both a market center to review and the practitioner to understand.

While looking at specific thresholds such as 5% is useful for broad-based descriptions of markets, we believe the equity trader is more interested in a slightly different application of the concept. Instead of exploring how much volume is missed at a given threshold, we look at how much volume is missed at a given share value for a minimum volume. Traders can then determine the following: "If I set my minimum volume at 'm,' how much volume will I miss?" Defining "m" as minimum volume (in shares) gives the following simple calculation.

$$\frac{\Sigma v}{\Sigma v + \Sigma V} = \text{Volume@Risk}$$

EXHIBIT 1
Average Price Drift

DRIFT_1	DRIFT_2	DRIFT_3	DRIFT_4	DRIFT_5	DRIFT_6	DRIFT_7	DRIFT_8	DRIFT_9
–0.00273%	0.00520%	0.00696%	0.00750%	0.00782%	0.00905%	0.00759%	0.00537%	0.00481%

where

v = orders with volume < m
V = orders with volume > or = m

Say that a trader places a minimum volume of 10,000 shares on his order and submits it to a market center with the order profile shown in Exhibit 2.

Because a minimum volume was set, the trader loses roughly 3.4% of the volume in the venue. Given that this is a small amount of the overall liquidity in the venue, it may make sense for the trader to continue to use a 10,000-share minimum volume. If the trader was missing a significant portion of the volume in the venue, it would be necessary for the trader to reassess the chosen minimum volume.

An actual Volume at Risk profile for the BIDS ATS during the period covered in the drift study is shown in Exhibit 3.[3] The exhibit looks at the volume missed by a trader who places a minimum of 10,000 shares on his order. While there is a slight relationship between market cap and the available block liquidity, the difference is not significant.

We recognize that there are limitations to this concept. However, we believe that this method provides the trader with a simple, easy-to-understand estimate for determining what is lost when setting minimum volumes on their orders.

EXHIBIT 2
Volume at Risk: An Example

Order 1	10,000
Order 2	5,000
Order 3	500
Order 4	150,000
Order 5	200
All Volume	165,700
Volume "Missed" @ 10k	5,700
Volume at Risk	3.44%

SUMMARY

When considering minimum size, the trader must look at the possible drift caused by small order flow and the volume that is missed. This becomes a classic case of risk (i.e., negative drift) vs. reward (i.e., available volume). Only by looking at these factors together can the trader determine the correct minimum size to use. While it is important for traders to obtain quantitative information such as drift and volume at risk, it is equally important for them to have a qualitative understanding of the economics and strategy of a given execution venue. Pricing in particular can be an important factor in determining the type of flows that are resident in a particular venue. With this in mind, we suggest that traders use the following rules when setting their minimum volumes:

Use a higher minimum volume in the following circumstances:

- The estimated cost of trading (from pre-trade TCA estimate) is less than the sum of the observed historical drifts.
- The market has significant block liquidity.

Use lower minimum volume in the following circumstances:

- The estimated cost of trading (from pre-trade TCA estimate) is more than the sum of the observed historical drifts.
- The market has a significant amount of small non-toxic flows.

EXHIBIT 3
Volume at Risk: A Second Example

	Total	Small Cap	Mid Cap	Large Cap
All Volume	230,416,894,736	63,407,433,392	69,278,432,302	93,878,896,755
Volume "Missed" @ 10K	90,032,114,455	26,608,349,152	26,562,827,252	34,816,771,649
Volume at Risk	39.07%	41.96%	38.34%	37.09%

APPENDIX 1

Wilcoxon Signed Rank Test

DRIFT_1, DRIFT_2, DRIFT_3, DRIFT_4, DRIFT_5, DRIFT_6.
Test of median = 0.000000 versus median not = 0.000000.

N for N Test	Wilcoxon Statistic	P	Estimated Median
DRIFT_1 10000	3246 2507920.5	0.017	0.000000000
DRIFT_2 10000	4263 4686723.0	0.076	0.000000000
DRIFT_3 10000	4865 6010335.5	0.347	0.000000000
DRIFT_4 10000	5250 7027670.0	0.217	0.000000000
DRIFT_5 10000	5535 7829942.0	0.154	0.000000000
DRIFT_6 10000	5754 8479593.0	0.111	0.000000000
DRIFT_7 10000	5919 8853100.5	0.479	0.000000000
DRIFT_8 10000	6080 9231540.0	0.933	0.000000000
DRIFT_9 10000	6285 9849091.5	0.847	0.000000000

APPENDIX 2

Wilcoxon Signed Rank CI: DRIFT_1, DRIFT_2, DRIFT_3, DRIFT_4, DRIFT_5, DRIFT_6

Bin	N	Median	C.I.	Lower	Upper
DRIFT_1	10000	0.00000	100.0	0.00000	0.00000
DRIFT_2	10000	0.00000	100.0	0.00000	0.00000
DRIFT_3	10000	0.00000	100.0	0.00000	0.00000
DRIFT_4	10000	0.00000	100.0	0.00000	0.00000
DRIFT_5	10000	0.00000	100.0	0.00000	0.00000
DRIFT_6	10000	0.00000	100.0	0.00000	0.00000
DRIFT_7	10000	0.00000	100.0	0.00000	0.00000
DRIFT_8	10000	0.00000	100.0	0.00000	0.00000
DRIFT_9	10000	0.00000	100.0	0.00000	0.00000

ENDNOTES

[1]Rosenblatt Securities estimates that high-frequency trading is 50–66% of consolidated volume. "Breaking Down Market Volume, and Who's Driving It," September 2008.

[2]This test was chosen because the distribution of "returns" in the drift bins is not normal. The Wilcoxon Signed Rank Test is a non-parametric test that can compare the relationship between two related observations without making assumptions regarding the shape of the distribution.

[3]Volume at Risk is for a trader who sets a minimum volume of 10,000 shares. The data is from February to July 2008. Market cap is defined as follows:

Small 0–1 Billion $
Medium 1–5 Billion $
Large 5+ Billion $

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