Seeking Optimal ETF Execution in Electronic Markets

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Exchange-traded funds (ETFs) have been, since their inception, a revolutionary change for investors and those in the investing business. There are a few key characteristics of ETFs that attract investors, either for new portions of their portfolios or for transitions of their entire investment strategies. Notable are transparency, exchange listing, tax efficiency, and lower fees (Abner [2013]).

- *Transparency*. ETFs make their portfolio publicly available daily, thus eliminating style drift to create the basis for an arbitrage that keeps the trading price close to fund value.
- *Exchange listing*. The key advantages of exchange listing are: 1) standardization 2) and liquidity and intraday trading. Standardization provides a tremendous benefit to holding multiasset portfolios within the same account structure. Listing a product on an exchange and creating a standardized format provides access to a wide variety of market participants and increases liquidity to a level that could not have been previously achieved. This has also helped to decrease trading spreads.
- *Tax efficiency*. Due to their in-kind creation and redemption process, the delivery and receipt of ETF shares into

and out of a portfolio are not considered taxable events.
- *Lower fees*. ETFs have considerably lower expense ratios compared with their mutual fund counterparts.

Because of these ETF advantages, the sheer number of exchange-traded products (ETPs) and assets under management (AUM) has grown dramatically over the past four years, as shown in Exhibit 1. Since the beginning of 2010 to March 2014, the number of ETPs has grown 45%—to 5,102 different funds. ETP growth is truly an indication of the tremendous amount of change occurring in the asset management industry.

It has been observed (Rosenblatt Securities [2014]) that while outflows from mutual funds have reached $150 billion since May 2010 (the flash crash), $400 billion flowed into U.S. equity ETPs during the same post-flash crash period.

AVAILABLE ETF LIQUIDITY

Despite the rapid growth in assets under management held in ETFs, average daily exchange-traded volumes have stalled and now appear to be in decline. Trading venues such as Nasdaq, NYSE, and BATS have responded to this decline with various measures, including new order types, trading

Global ETF Assets and the Number of ETPs by Year Since 2000

incentives, and even a "new" exchange, with NASDAQ OMX's re-launch of its PSX exchange as an ETF-focused venue (Stone [2013]).

On this basis, it looks as if ETFs' waning liquidity is becoming a major problem. But this overlooks a crucial distinction between ETFs and many other assets: the fact that ETF liquidity is accessible in two distinct flavors—the "exchange" variety and the "underlying." This distinction arises because ETFs actually interact with two markets: the secondary on-exchange market and the primary (creation/redemption) market.

As a result, what is on the screen is not the complete liquidity picture. A trader wishing to buy an ETF can approach an authorized participant and request a block price. If the authorized participant is part of a program trading desk, it will typically buy the constituents of the ETF basket and derive a price from that transaction for the buyer. On the settlement date, the authorized participant will deliver the constituents to the manager of the ETF, who will then issue (or create) the requisite additional ETF shares and issue the participant with an ETF certificate for delivery to the end customer. In the case of redemptions, the same process essentially operates in reverse. Exhibit 2 shows illustrations of the creation and redemption workflows. This process is possible because the liquidity of

an ETF's constituents is the primary driver of its own liquidity.

Apart from straightforward availability, there are other advantages to tapping this "created on the fly" liquidity. One of the most important aspects is market impact. Unlike individual stocks, an authorized participant may not be competing directly with the buyer for liquidity in an ETF. This is because although the market maker may be buying the underlying basket, this activity won't necessarily drive the ETF price because it will be diffused through all the basket constituents. Alternatively, the market maker may back out the other side as part of a statistical arbitrage play, in which case it may not drive the ETF price either. Contrast this to the situation for a stock, where if a market maker is selling a block of shares, it will almost certainly be buying that block back. This probably won't happen directly on a share-for-share basis—it may, for example, be offset in the futures market instead—but eventually, in some way, the equivalent of the block of stock sold to the original buyer will be bought back.

Another consideration is the difference between the settlement price of an ETF bought in the market with a market on close (MOC) order and the settlement price of an ETF created on the fly from its constituents. An MOC order on an ETF does not have to settle at the

ETP Creation and Redemption Workflows
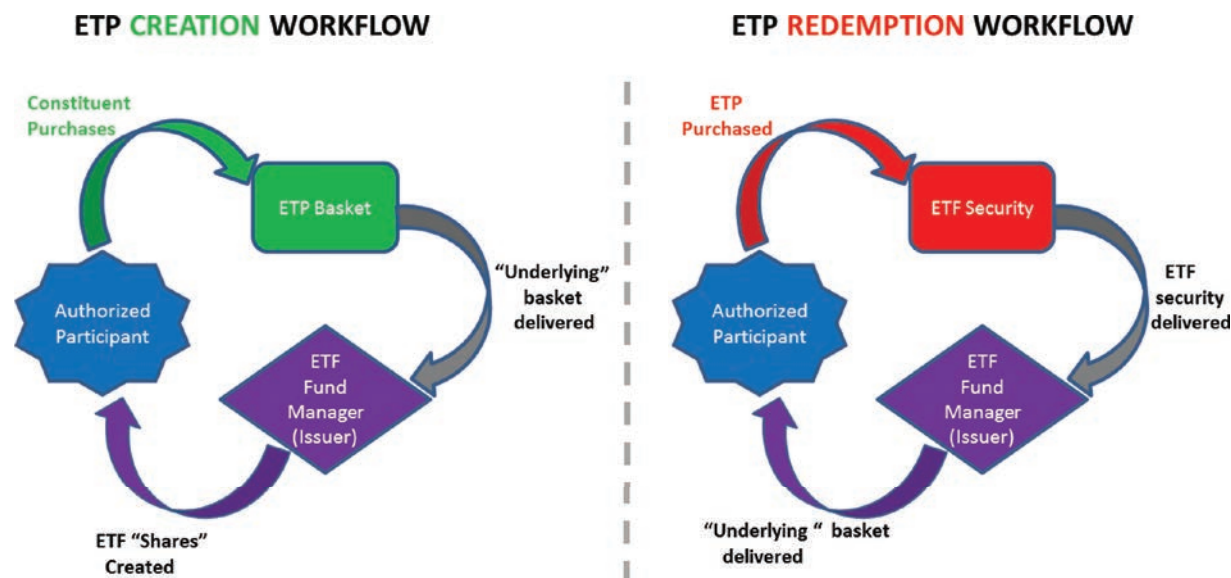
Notes: *In the ETP creation workflow, the authorized participant (AP) purchases the constituent shares, creates the ETF basket, and delivers to the ETF issuer. The ETF issuer delivers the requisite number of ETF shares to the AP. The ETP redemption workflow works similarly to the creation workflow except that the AP delivers the ETF shares to the issuer and receives the underlying basket.*

net asset value of the fund. However, if an MOC order is placed for all the constituents in the ETF basket, which is submitted to the fund manager to create new ETF shares, then these shares will settle at the closing net asset value of the fund. The two instances are essentially decoupled because the settlement price of the ETF can be at a premium or discount to the net asset value.

The third and perhaps most important advantage to tapping on-the-fly ETF liquidity is execution timing and its implications for market impact and workflow efficiency. A large ETF order might take several days to complete if just executed on-exchange. By accessing additional on-the-fly liquidity, it may be possible to complete the order far more quickly, perhaps (depending on the liquidity of the ETF's constituents) in a single day. The scale of the potential additional liquidity opportunity can be gauged from Exhibit 3's data on ETPs.

Best of Both Worlds

Although being able to tap two potential sources of ETF liquidity is clearly valuable, the biggest value-add comes from knowing (given the trader's individual order circumstances) the most opportune moment to

tap which liquidity source. Fluctuating liquidity in the ETF (as traded on-exchange) and its constituents is one factor that determines its relative price premium/discount. For example, if an ETF has one or more components that are illiquid, then this will be reflected as a discount in the ETF price, because somebody has to assume that illiquid component risk in order to make a price in the ETF. This and other factors—for instance, arbitrage activity (which can also create additional liquidity; see Exhibit 4) and idiosyncrasies such as the MOC orders mentioned earlier—mean that the ETF/constituent premium/discount is continually fluctuating. This can result in significant price improvement for the trader who is able to spot the optimal moment to tap the respective markets.

Volatility and Volume

The uniqueness of ETFs is also evident in the volatility–volume relationship. To study this relationship, we compute the linear regression between $\log(\text{spread} \times \sqrt{\text{ADV}})$ and $\log(\text{price} \times \text{volatility})$, where spread and price are thrown in to normalize securities of different scales.

EXHIBIT 3
**Liquidity as Measured by the Underlying Basket Liquidity for Different ADV Buckets**

30-Day Exchange-Traded ADV	Total ETPs in Sample	Total Member Liquidity > Exchange ETP Liquidity	Percent Member Liquidity > Exchange Liquidity	Percent Added Liquidity that Creation/Redemption could Represent
20MM–36MM	8	0	0%	18%
10MM–20MM	17	4	24%	29%
5MM–10MM	18	7	39%	45%
1MM–5MM	77	35	45%	49%
0.5MM–1MM	64	22	34%	31%

Note: The underlying basket liquidity is highest for ETPs in the 1MM–5MM ADV bucket.
Source: Bloomberg.

EXHIBIT 4
ETF Available Liquidity
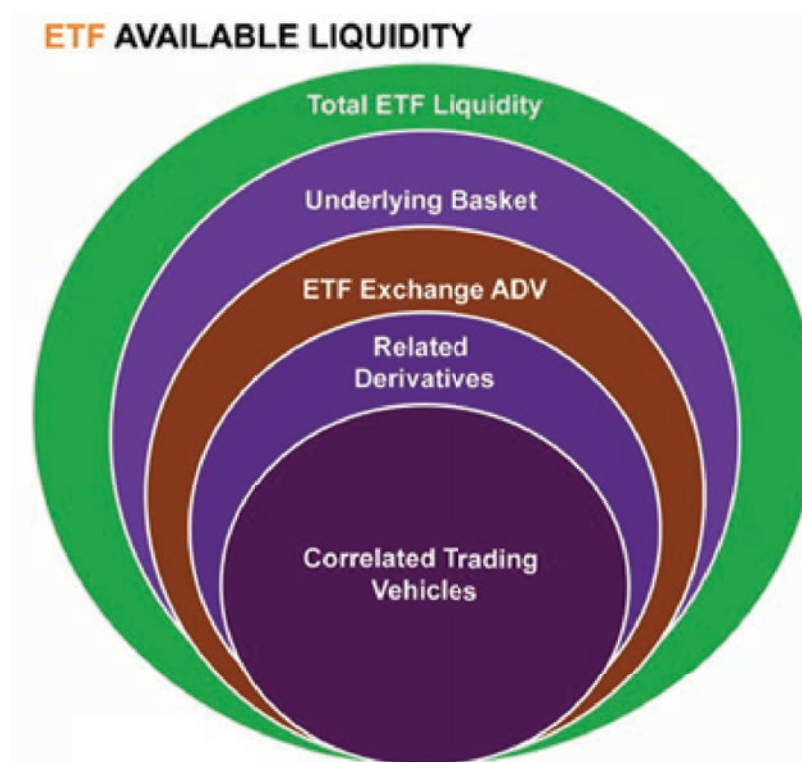
Note: Available liquidity comprises the liquidity of the underlying basket, the secondary market liquidity, related derivatives, and correlated trading vehicles.
Source: Abner [2013].

For U.S. common stocks (black circles in Exhibit 5), we find that the regression slope is close to one (1.03, to be precise) with $R^2 = 0.72$, which implies
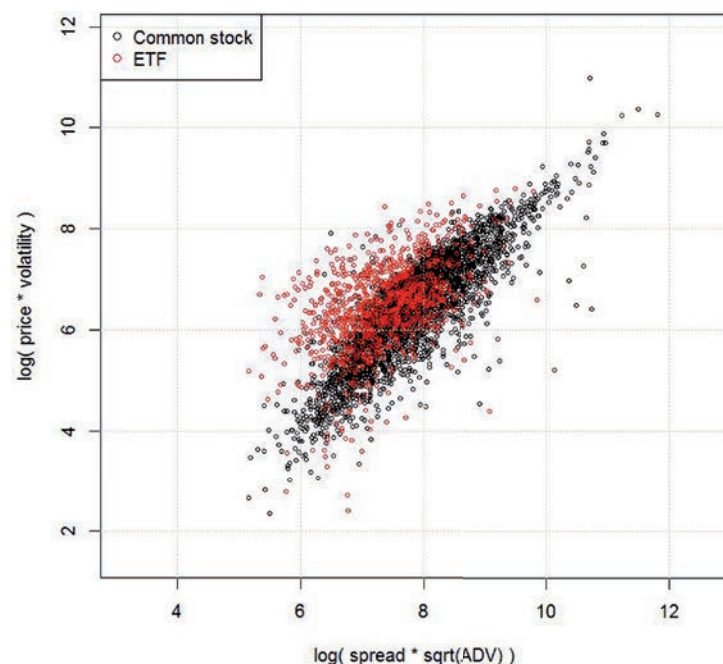
$$\text{Price} \times \text{Volatility} \propto \text{Spread} \times \sqrt{\text{ADV}}$$

This result is in line with the view that the trading volume and spread is the major source of volatility and that the volume plays the role of time in random walk.

It's a different story for ETFs (light gray circles in Exhibit 5). We find the slope around 0.58 with $R^2 = 0.24$.

Exhibit 5
Volatility–Volume Relationship

Note: The black circles represent 3,700 U.S. common stocks, and the lighter circles are for 1,200 ETFs traded in the U.S.

Compared with common stocks, the volatility–volume relationship is much noisier, and volatility tends to be higher for the same ADV levels. This suggests that the volume cannot be the only major source in the volatility. For an ETF, the volatility comes not just from the trading of the ETF itself but also from the trading of its constituents.

TRADE COST

As electronic trading markets become more fragmented, the majority of large orders are executed via broker-provided execution algorithms. Typically, implementation shortfall trading algorithms are used to slice the parent order into many small ones and spread them out over the time horizon to minimize the slippage between average fill price and midquote of order entry, through striking the optimal balance between market impact and volatility risk.

Our study shows that trade costs of ETF orders are quite different from those of common stocks. As our previous study of trade cost in the U.S. equity market shows (Liu and Phadnis [2013]), order size is a big factor in determining final trade costs. In order to isolate the size factor from the effect of security type, which is our study's interest, we measured trade costs of ETF orders and common stock orders for various order size groups and compared them side by side within each group. The dataset of the study includes more than 100,000 orders trading U.S. common stocks and ETFs from clients of Bloomberg Tradebook from January 1, 2013, to December 31, 2013. Order sizes are calculated as shares divided by the average daily volume (ADV) of the security to reduce the bias of liquidity. These orders are broken down into a few order size groups: 0~1%, 1~3%, 3~10%, 10~30%, and 30~100%. The trade cost of each order is calculated as

$$Cost = S \times (P_{arrival})/P_{arrival} \tag{1}$$

where $P_{arrival}$ is the midpoint quote (average of bid and ask prices) at the point of order entry and P_{avg} is the average fill price of the order. S is the order side and has a value of +1 for buy orders and −1 for sell orders. All values are in basis points. Positive numbers mean underperforming against arrival price, while negative numbers mean outperforming against arrival price.

The trade cost distributions of orders per each group and security type are shown in Exhibit 6. The bottom and top of the box are the first and third quartiles, and the solid line in the middle of the box is the second quartile (the median). The median trade cost of order becomes higher with increased order size for both common stocks and ETFs. However, given the same order size group, median costs of ETF orders are significantly lower than those of common stocks with 95% confidence. Also, ETFs have tighter cost distribution (i.e., lower variance of trade cost) compared with common stocks. These data imply that ETFs have lower median market impact than common stock of the same order size due to the liquidity of the underlying basket, in addition to ETF liquidity displayed in the limit order book of the exchange. Therefore, those trading ETFs directly in exchanges can afford to be more aggressive in taking out liquidity without causing as much market impact as trading common stocks would.

Trade Costs of ETFs for Various Order Sizes
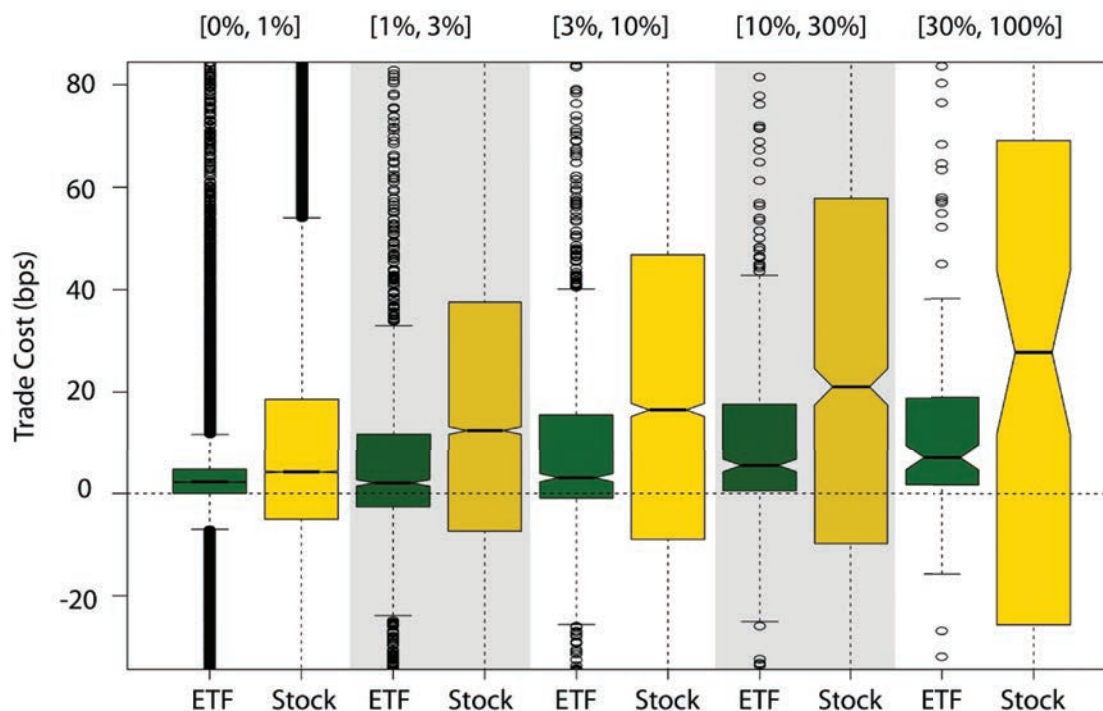
Notes: This notched-whisker box plot shows the trade costs of ETFs and common stocks for various order sizes, measured as percentage of ADV. The bottom and top bounds of the boxes are the first and third quartiles of the distribution, while solid lines in the middle of the boxes are median of the distribution. Notches drawn on the sides of the boxes represent the 95% confidence intervals of medians. Non-overlapping notches from neighboring distributions suggest that median trade costs of ETFs and stocks are significantly different. Upper and lower whiskers are the 75th percentile + 1.5 × Interquartile range and the 25th percentile − 1.5 × Interquartile range, respectively.

Algorithmic Trading versus Block Trading

We also statistically compared the ETF trade costs of implementation shortfall strategy with that of block trading, which was deemed an effective way to execute a large chunk of shares. A block trade was defined here as single trade with prints of more than 10,000 shares. We gathered all the ETF block prints from public market feeds of the U.S. equity market from January 1, 2013, to December 31, 2013. The trade cost of block trading was measured as follows:

$$Cost = S \times (P_{block} - P_{arrival})/P_{arrival} \qquad (2)$$

where side of trade S is inferred from whether block price is higher (buy) or lower (sell) than midquote and has value of +1 for buy and −1 for sell.

The trade cost distributions of trading algorithm and blocks for various order size groups are compared and shown in Exhibit 7. The cost distributions of block trading are much tighter than those of algorithmic trading for the entire order size group. For orders with sizes smaller than 1% of ADV, the median trade cost of algorithmic trading is lower than that of block trading, while for orders with sizes larger than 1% of ADV, block trading shows lower median cost. These results suggest that when traders have relatively large ETF orders, one should consider leveraging the block trading platform to source liquidity to achieve optimal execution. The rule of thumb to trade ETFs optimally is summarized in Exhibit 8.

OPTIMAL TRADING SOLUTION

As noted earlier, ETFs exhibit very different characteristics than do common stocks in terms of exchange-displayed liquidity, volume, volatility, and market

EXHIBIT 7

Trade Costs of Algorithmic Execution for ETFs for Various Order Sizes
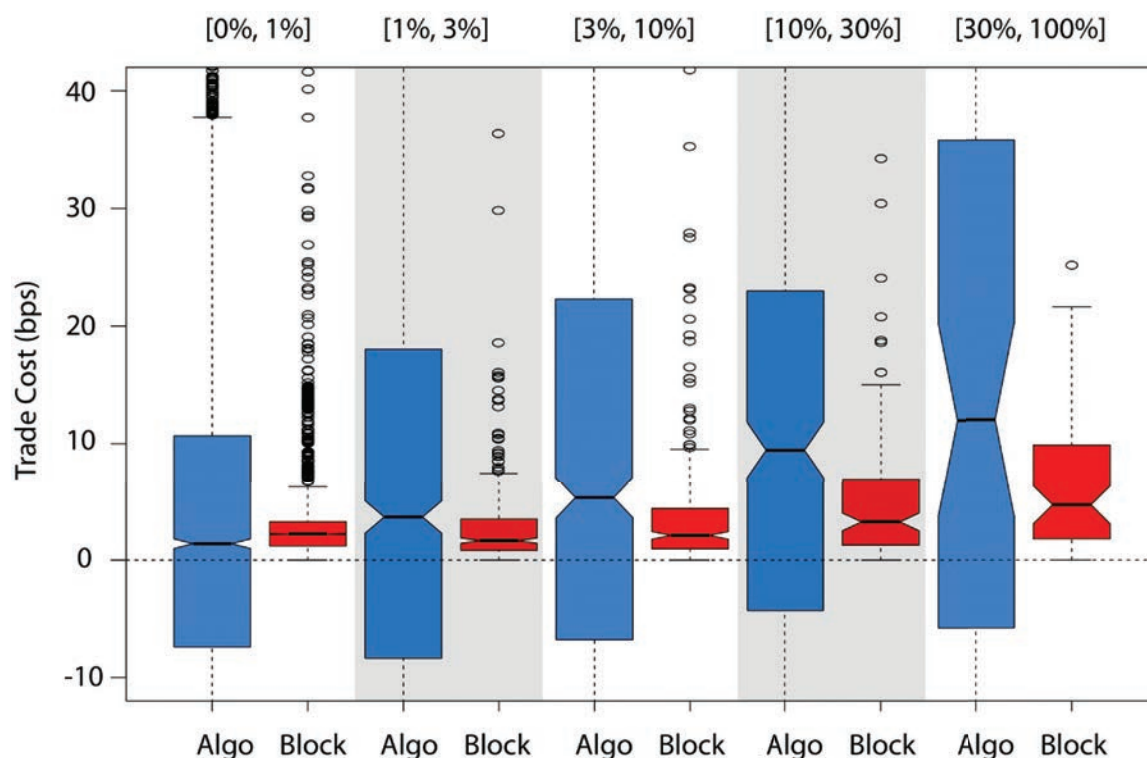
Notes: This notched-whisker box plot shows the trade costs of algorithmic execution and block trading of ETFs for various order sizes, measured as percentage of ADV. The bottom and top bounds of the boxes are the first and third quartiles of the distribution, while the solid lines in the middle of the boxes are median of the distribution. Notches on the sides of the boxes represent the 95% confidence intervals of medians. Non-overlapping notches from neighboring distributions suggest that median trade costs of trading algorithms and block trading are significantly different. Upper and lower whiskers are the 75th percentile + 1.5 × interquartile range and the 25th percentile − 1.5 × interquartile range, respectively.

EXHIBIT 8

Methods for Lower Median Cost for Different Order Sizes

Order Size/ADV	Optimal Method to Achieve Lower Median Cost
[0%, 1%]	Algorithmic Trading
[1%, ∞]	Block Trading

impact. What do all these differences add up to? Execution brokers should use a combination of ETF-specific algorithms to tap secondary-market liquidity and an electronic solution request for quotes (RFQ)-based solution to tap primary-market liquidity from market makers and authorized participants, as illustrated by Exhibit 9.

We believe that applying unmodified common stock execution techniques to ETFs will result in sub-optimal execution (Stone [2010]). At a macro level, an unmodified stock execution algorithm will often extend the trading horizon by overemphasizing stealth versus speed. ETFs can be traded more rapidly than stocks of similar liquidity, so, for example, a 60-minute execution strategy for a stock might be only a 20-minute execution strategy for an ETF.

Conversely, at the micro level, the picture is completely different, because the way ETF order books function actually makes the slower firing of orders beneficial. The key is for the ETF algorithm to pause before moving to the next price level in the order book, to allow liquidity at the existing price level to replenish,

Tapping Secondary-Market Liquidity and Primary-Market Liquidity (from market makers and authorized participants)
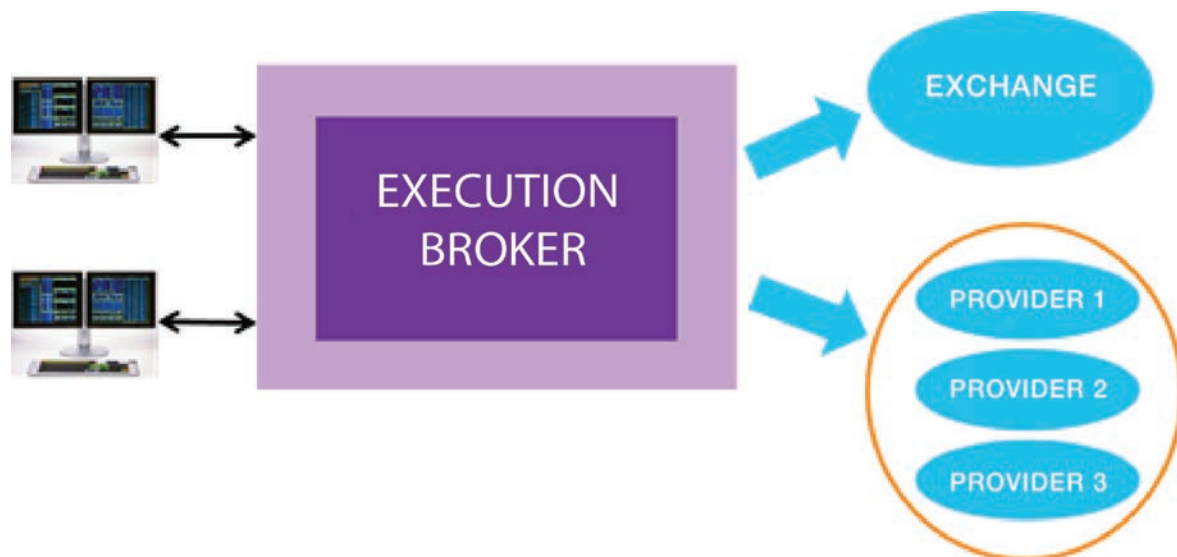
thus presenting an opportunity to trade again at a better price. By contrast, an execution algorithm that steps immediately to the next price level after clearing out the current level (or one that fires orders at multiple price levels simultaneously) will almost inevitably be overpaying/underselling.

We believe that brokers should incorporate *ETF-specific* execution algorithms to reflect the previously discussed characteristics, plus some sort of a short-term, ETF-specific price prediction model to provide a reliable indication of the immediate direction of the ETF that can help to determine whether a more/less aggressive trading stance is appropriate (i.e., if it is worth crossing the spread). Coupling these models with ETF-specific execution techniques will allow the broker to deliver more effective ETF executions.

We also believe that for executing large blocks anonymously, an RFQ (request for quotes) platform that will source ETF liquidity from multiple liquidity providers will best serve institutional clients. An ETF RFQ platform should have at least the following characteristics:

- *Aggregation.* The platform should electronically aggregate ETF liquidity from multiple liquidity providers and be integrated with algorithmic solutions to dynamically source best prices and liquidity and switch between an RFQ and an algorithm.
- *Anonymity.* The platform should be anonymous to minimize information leakage and protect the interests of institutional clients.
- *Analytics.* The platform should provide actionable statistical guidance on optimal execution strategies, as illustrated in Exhibit 10.
- *Audit Trail.* The platform should provide full order handling transparency in terms of order details and transaction logs. It should include relevant ETF benchmarks, such as Arrival INAV and LastFill INAV. It should also deliver interactive pre-trade and post-trade analytics with the same Arrival and LastFill INAV benchmarks captured by the order logs. Exhibit 11 shows samples of audit trails.

Putting it all together, Exhibit 12 shows screenshots of a potential ETF RFQ trading platform that gives institutional clients the ability to launch an RFQ ticket and enter a block quantity. After the request is submitted, liquidity is sourced from a diverse set of market makers and authorized participants to provide actionable quotes.

E X H I B I T   1 0
ETF Analytics

Notes: With a known estimated cost, illustrated by Equation (1), of executing with a suggested strategy, including the number of days required, illustrated by Equation (2), to trade a large order, a trader can make a decision to trade a block with a known price and market impact now or use a strategy to execute over a time period.

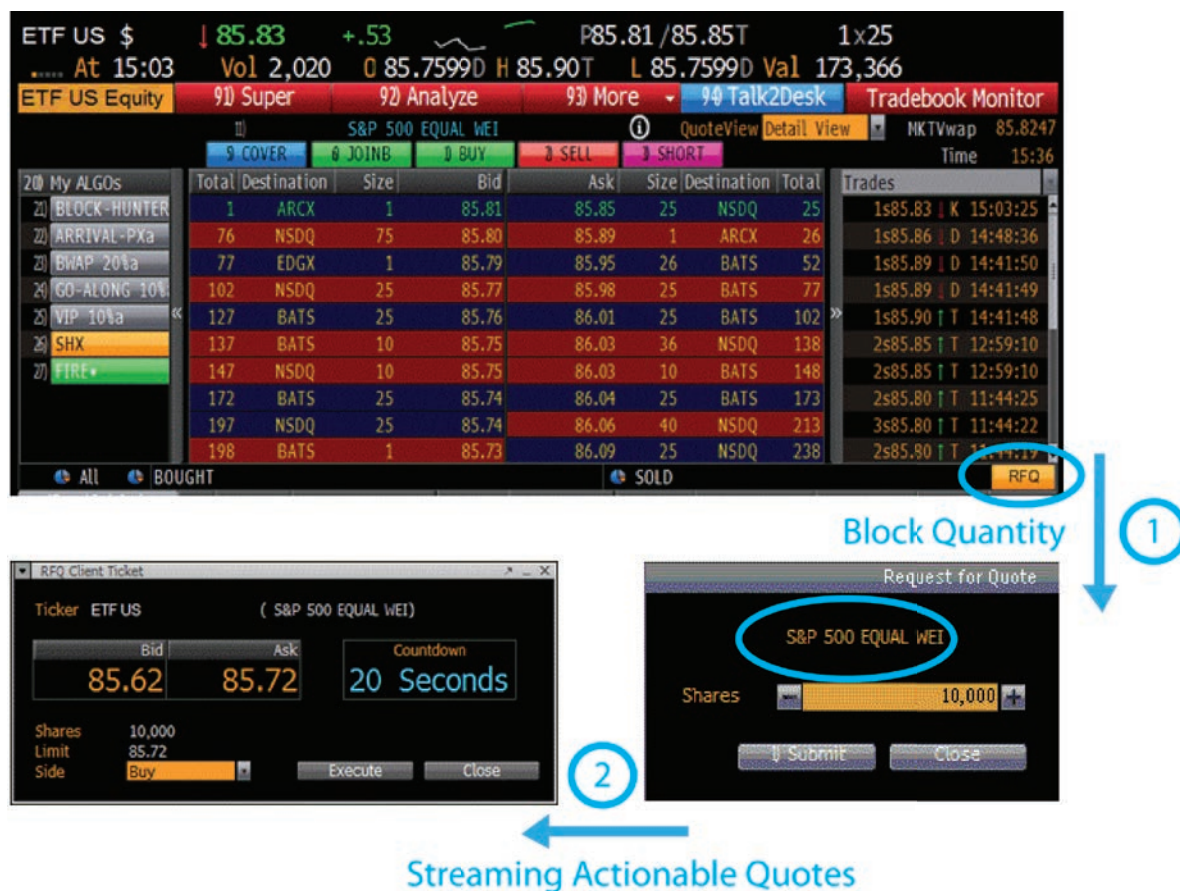# E X H I B I T   1 1
Sample Audit Trail of ETF Order Handling Details and Post-Trade Analytics

EXHIBIT 12
The ETF RFQ (Request-For-Quote) Platform

Notes: The ETF RFQ platform anonymously sources block liquidity from multiple providers. To initiate a request for quote, traders can click on the "RFQ" button on the bottom of the ETF single-security montage. The trader is prompted for the block quantity and the RFQ is sent to a diverse set of market makers who return two-sided quotes. The trader can then either decline or accept the bid or offer to consummate the trade.

CONCLUSION

One of the greatest challenges in the current market structure is that the most important insights are often buried beneath the data. In the case of ETFs, addressing that involves two steps:

1. Deciding when/where/how to tap primary market liquidity from authorized participants or when/where/how to tap secondary market on-exchange liquidity.
2. Being able to act upon the resulting decisions as quickly and efficiently as possible.

Practical experience shows that in the case of relatively small order size as a percentage of ADV, a combination of schedule-driven algorithms (such as TWAP, VWAP, or volume participation) and ETF-specific algorithms works well. The algorithms should minimize adverse impact, especially if on-exchange liquidity is thin.

For relatively large order sizes as a percentage of ADV, an electronic RFQ-based platform can obtain anonymous quotes on blocks from a network of liquidity providers, market makers, and authorized participants, minimizing market impact. Authorized participants can

initiate the ETF creation/redemption, which can then be delivered to the trading entity.

Individual circumstances vary considerably, but two execution strategies that make the best of both primary and secondary ETF liquidity are as follows:

- anonymously purchasing an initial block of ETFs from an ETF liquidity provider and putting the remainder of the order into an ETF-specific algorithm;
- starting in an ETF-specific algorithm and picking points at which to buy (sell) blocks of ETFs anonymously from (to) an ETF liquidity provider through an electronic RFQ-based platform.

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