

Trading Series



Trading Series Part 1:

The Evolution of Trading - From Quarters to Pennies and Beyond

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Trading Series Part 2:

Trading Costs Are Very Real - Perspectives For Global Equity Investors

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Trading Series Part 3:

Choosing an Implementation Strategy - When and How to Outsource Trading

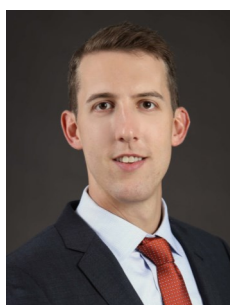
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Trading Series Part 1: The Evolution of Trading — From Quarters to Pennies and Beyond



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The structure of U.S. equity markets has recently been cast into the spotlight of national attention over renewed worries of nefarious activity and bad actors associated with high-frequency trading (HFT). While the current state of the markets certainly bears careful inspection, this evaluation must be done in a holistic fashion to more fully understand where we are today and how we arrived at this point. Stock markets have been continuously evolving since their earliest iterations and at no point in history has the pace of that change been faster than the last two decades. The current market is dominated by rapid, fragmented, and electronic execution, a framework within which high-frequency trading has come to play a significant role. But is this necessarily a bad thing, as some are quick to accuse? Are markets too fast or too complex to allow the institutional and retail investor a fair shake? Is the U.S. stock market truly “rigged?”

To be clear, both retail and institutional investors have benefitted from the following changes in the markets:

- Lower trading costs through significantly lower bid/ask spreads and commissions; and
- Faster execution facilitated by highly electronic and automated markets.

However, these changes also pose certain risks, namely:

- Increasing complexity, primarily due to greater speed and fragmentation of markets; and
- Potential systemic risk from unchecked or insufficiently tested trading algorithms.

Brief History of Markets and Market Making

To understand where we are today, it makes sense to take a step back and look at some of the changes that have occurred over the last two decades. Up until the mid-1990s, U.S. stock-market volumes were heavily concentrated at the New York Stock Exchange (NYSE) and subsequently the NASDAQ. Orders on these exchanges were facilitated by a middleman who was either tasked with matching orders to buy and sell (NYSE specialists), or by continuously providing offers to buy and sell stocks from their own inventory (NASDAQ dealers). In exchange for providing this service, the market maker was paid a “spread,” or the difference between the price at which a stock

is bought and sold. As stock prices, at the time, were quoted in increments of 1/8 of a dollar, this spread amounted to a minimum of \$0.125 per share. Trading in NYSE-listed stocks was a relatively slow, human-controlled process, requiring the manual operation of a floor broker.

Major changes started in 1997, when the SEC amended the Order Handling Rules (OHR) to include the Limit Order Display Rule requiring market makers to display all outstanding limit orders. This, in combination with Regulation Alternative Trading System (or Reg ATS, for short) in 1998, legitimizing off-exchange, order-matching systems, introduced both competition and transparency to what was once a largely opaque system. Minimum bid/ask spreads rapidly narrowed following these two changes, beginning with a drop to \$0.0625 (1/16s) in 1999 and culminating with the move to \$0.01 (decimalization) in 2001. Bid/ask spreads became even smaller with the growth in off-exchange volume via electronic crossing networks (ECNs), which offered faster execution at tighter spreads. Average order sizes decreased rapidly to less than 500 shares from about 1500 shares in 1997, primarily because dealers and participants were now much less willing to put large orders on display. To make money in this competitive, automated, and transparent world, market makers had to execute many more smaller orders at much narrower spreads to be profitable. This model proved to be much better suited to computers than humans. Figures 1 and 2 demonstrate the rapid decline in order size and spreads since 1994.

Figure 1: Historical U.S. Order Size

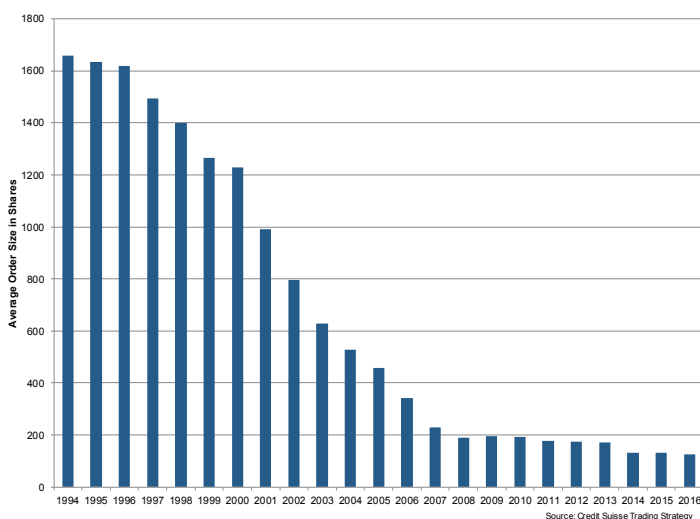
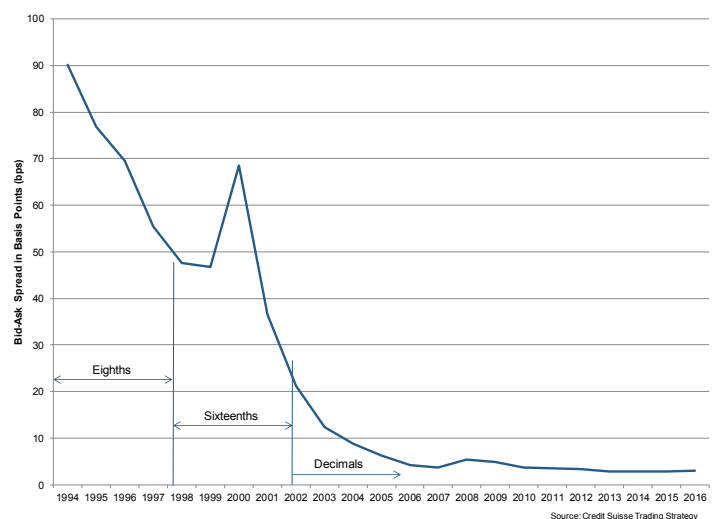


Figure 2: Consolidated U.S. Average Bid/Ask Spread



In 2005, Regulation National Market System (Reg NMS) was introduced, requiring routing between markets and forcing all market makers to honor the best displayed bid and ask across all venues. Until this point, trading in NYSE-listed companies was still dominated by the NYSE specialists. But protection of the so-called National Best Bid and Offer (NBBO) led to the trading of NYSE-listed stocks at outside venues and interconnection of the fragmented exchange markets. When an order was hit at any exchange, the remaining orders across other venues had to be cancelled to prevent duplication of buys and sells. This process required speed only a computer could provide in posting and cancelling thousands of orders per second as stocks traded throughout the day.

The net result of all of these changes is a market that today is incredibly fast-paced and also highly fragmented among many execution venues. Regional exchanges run by BATS/Edge, and others specializing in rapid electronic trading have grown to as much as 23% of market volume in 2016, with NASDAQ and NYSE holding 16 and 24%, respectively. The remaining 37% is comprised of off-exchange crossing at ECNs, internal crossing at broker/dealers, and in dark pools (broker-run crossing networks where orders to buy and sell are not publicly displayed so they can be matched without releasing information to the market at large).

A process that was once relatively slow and human-controlled has evolved to the point where computers and their algorithms have become imperative.

High-Frequency Trading

So what is high-frequency trading and where does it fit amidst all this change in today's market? HFT is a style of trading performed by firms that make use of sophisticated, computer-driven algorithms capable of processing thousands of orders per second. These firms typically have very short holding periods, trading into and out of names with little-to-no leverage and holding minimal positions overnight. For all of the strategies these traders employ, speed is paramount as their profits depend on being able to execute very-low-margin trades at very high volumes.

HFT firms typically fall into one of the following categories:

- **Market Making:** HFT firms naturally emerged as market makers in a world of razor-thin spreads and shrinking order sizes, largely displacing their historically manual and human-controlled predecessors. The majority of HFT

revenue is generated simply by facilitating trades in the market and capturing sub-penny bid/ask spreads in addition to rebates offered by many exchanges for providers of liquidity. This type of HFT-generated volume is almost certainly a benefit to the market-at-large, as it is adding liquidity to the system to allow faster, cheaper execution on even the smallest of orders.

- **Arbitrage:** In addition to market making, HFT shops take advantage of their speed of execution by finding and correcting short-term pricing dislocations across markets. These mispricing situations may arise from differences in price quotes for the same stock on multiple venues (latency arbitrage), where pairs or small groups of stocks that typically trade in tandem temporarily dislocate (statistical arbitrage), or any number of other scenarios. In all instances, the HFT firm will buy the relatively cheap stock or listing and sell short the overpriced one, closing out the position when the dislocation is corrected.
- **News Flow:** Along similar lines, the rapid trading of stocks and indexes immediately upon release of information is another area where the speed of HFT dominates as speed is paramount in being first to react. In combination with arbitrage trading, the rapid trading on news flow works to continuously bring the market back to equilibrium and to ensure that quoted prices always contain all available information. The net result here is a much more efficient market that is continuously offering more reliable pricing, to the benefit of all participants.
- **Pattern/Trend Trading:** Another HFT strategy involves identifying market patterns and trade flow to move ahead of other market participants. A simplified example is an algorithm designed to identify a significant buyer in an individual name, with the intent to buy ahead of that trader, driving the price of that stock up and then turning around and selling it back for a profit. This is a much more concerning area, especially for larger institutional investors who typically trade large blocks of stock. The state of current markets dictates that these large orders must be executed much more diligently than in years past. Continuing evolution of the implementation process and skilled, disguised execution on a day-to-day basis are required to minimize the impact high-frequency trading can have on these large orders.

In aggregate, HFT firms have grown from basically zero before 1997 to represent more than half of all current volume. HFT market share reached its highest point in 2009, when it was

reported to account for more than 60% of all trades in the U.S. market before relaxing closer to 50% in 2016. With such a large share of all volume traded, HFT firms undoubtedly present a systemic risk in today's market. This was most evident in the so-called "Flash Crash" on May 6, 2010, when the Dow Jones Industrial Average dropped as much as 9% in only five minutes. During the crash, it was believed that computer-driven algorithms operated in an uncontrolled manner and that simultaneously the liquidity that HFT typically provides withdrew, making it much more difficult for the market to find a bottom amidst a highly electronic and complicated market structure. A massive trade error experienced by Knight Capital after installation of new trading code in August of 2012 also highlighted the general risks associated with a highly automated, extremely rapid market structure.

Looking Forward

While there are no major changes to market structure slated for the immediate future, there will undoubtedly be continuing evolution and change. One thing is for certain, margins for all market makers, both on- and off-exchange, are likely to continue shrinking. Goldman Sachs recently announced that they would be closing down their dark pool in light of shrinking margins and increasing regulatory scrutiny. The SEC recently adopted Rule 613, which requires the creation of a consolidated audit trail to track and store all orders, quotes, and executions from inception to execution. This will help bring some light to the complex and sometimes opaque structure we face today.

Today's equity markets are faster, more efficient, and more automated than ever before. Given careful, diligent portfolio implementation and the adoption of appropriate measures to control the risks that this new structure presents, all market participants stand to benefit from the changes we've seen over the last 25 years.

Faced with ever-evolving market structure, how can investment managers effectively seek best execution for their clients? How should managers think about and measure trading costs? How can a manager tailor the implementation process to best fit their investment process while protecting clients' best interests? These questions and more will be addressed in Part 2 of our trading thought leadership series.

Trading Series Part 2: Trading Costs Are Very Real — Perspectives For Global Equity Investors



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As equity markets continue to be volatile and alpha more difficult to generate, active investment managers need to place greater emphasis on constraining those detractors from return that are within their control – the most notable being trading costs. Identifying, measuring and forecasting trading costs remain a challenge for all investment managers given the continued evolution of the markets and unique client constraints. In this paper we will discuss:

- some of the dominant measurement tools and best practices to help mitigate the potential negative effects of high-frequency trading (HFT);
- how investment managers may protect client interests with innovative trading techniques, without revealing too much intellectual property; and
- how INTECH has adapted its implementation process, given the structural changes in the market over the last two decades (see Trading Paper Series Part One: “The Evolution of Trading: From Quarters to Pennies and Beyond”).

For all investors, the ability of their investment managers to control trading costs is critical to achieving the highest returns and preserving alpha. Therefore, they should consider establishing a framework within which to successfully implement their investment process while protecting their clients' best interests.

To better understand the impact that trading costs have on safeguarding alpha, it is important to decompose equity transaction costs into explicit and implicit components. At a high level, explicit costs are typically comprised of brokerage commissions, clearing and settlement costs, taxes/stamp duties, and exchange/market fees, and are typically easily determined prior to executing trades. Investment managers have a much more challenging time ascertaining the implicit costs, which include: the bid-ask spread, market impact, and delay and opportunity costs. These costs cannot be known in advance, given that they are dependent upon the execution price, share quantity and market conditions. As a ship's captain navigating through icebergs is not concerned with the piece of the berg exposed above the water, but rather the piece underneath the surface that cannot be seen and may cause severe damage to the ship's hull, investors should be aware of the bigger chunk of the berg, implicit costs, which could potentially lead to lower investment portfolio returns.

Measuring Transaction Costs

Investment managers should closely monitor, estimate and report trading costs to their clients to ensure transparency, ultimately seeking to deliver best execution. There are various measurements that fundamental, quantitative and mathematical investment managers utilize to assist in best implementing their varying investment methodologies. Two of the most prevalent measurements for institutional trades include:

- implementation shortfall, and
- volume-weighted average price for the day.

A security's volume weighted average price (VWAP) is calculated by dividing the total dollar amount traded of a security on a given day (dollar volume) by the total number of shares traded during the same day (share volume). VWAP is not directly linked to an investment manager's strike price. Implementation shortfall is one of the most widely recognized cost measurements, in which the investment manager has the ability to capture the strike price prior to releasing the order to the marketplace. This strike price then serves as the

benchmark for the broker/dealer's ultimate execution of the trade. INTECH employs this measurement technique with its select list of broker/dealers, and goes one step further by awarding additional order flow to those brokers who demonstrate more favorable execution. Essentially, the closer to the strike price the broker executes the trade, the more order flow they receive. The result: helping to conserve the returns generated within the client's investment portfolio. This mitigates the delay and opportunity-cost components that may potentially hinder other investment managers' portfolio performance. The low-cost investment process, which focuses on incremental buying and selling of large-cap liquid stocks, in combination with this incentive system, has historically placed INTECH in the lowest quartile for trading costs among our peer group of large-cap global investment managers.

INTECH's research has led to a deeper understanding of the effects of two of the most important determinants on our trading costs:

- order size as a percentage of average daily volume (ADV), and
- the level of market volatility.

The dramatic increase in volatility in a short period of time during the Global Financial Crisis should have caused investment managers to re-assess their trading strategies to better adapt to this changing market landscape. Of importance is if those changes have led to improved investment performance. We have learned from past experiences that by improving our ability to identify spikes in volatility, our investment process is better able to adapt and potentially capture the true premium that results from rebalancing portfolios back to optimal target weights. The exhibit below highlights the relationship between INTECH's trading costs and order size as a percentage of ADV in 2016.

Exhibit 1: INTECH's 2016 Trading Costs by % of ADV*

% of ADV	% Traded	Cost
>8%	10%	44 bps
4-8%	15%	33 bps
2-4%	20%	25 bps
1-2%	20%	21 bps
<1%	35%	13 bps
Total	100%	23 bps

* Source: INTECH. Represents rebalancing trading costs for INTECH strategies. Trading costs measured as the difference between the decision and execution price of the stock, plus commission costs. Data reflects past performance, which is no guarantee of future results.

High-Frequency Trading

Over the last decade, as high-frequency trading has become a prominent share of trading volume, INTECH has continued to implement trading mechanisms designed to prevent information leakage to the marketplace. Some of these advancements include:

- randomizing windows of no trading in a way to disguise our hand to sophisticated traders;
- applying intelligent trading techniques that are adaptive to changing market conditions; and
- measuring broker performance beyond implementation shortfall to minimize impact to our strategies.

These advancements have helped to combat the rapid dissemination of information today, as highlighted in Part One of this paper series. To operate against this backdrop, we maintain a concentrated list of institutional program-trading broker/dealers, with the goal of leveraging their critical understanding of the continuous evolution of the markets. Our portfolio rebalancing is performed using a secure proprietary

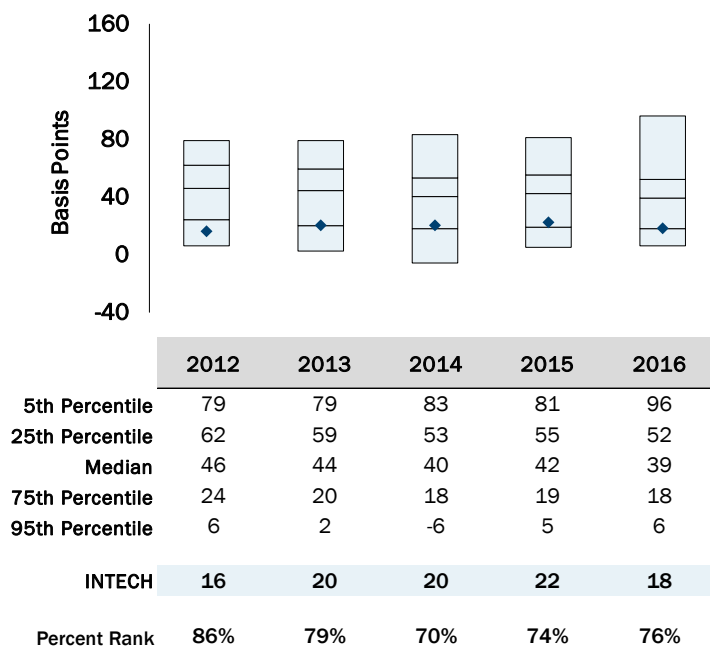
platform that automates the entire investment process, producing a straight-through processing application.

The brokers INTECH selects to execute its orders utilize a wide range of complex algorithmic trading tools to help make complicated decisions about how to best access liquidity in the markets. Our brokers are connecting to as many as 40 trading venues and are providing an infrastructure of systems, traders and technology for best execution of large block trades. Investors' Exchange (IEX), as noted in the book, "Flash Boys" by Michael Lewis, is a trading exchange designed to eliminate HFT predatory behavior. Our brokers have used IEX, at times, for best execution for our clients. In the end, we believe, this structure has allowed INTECH to stay ahead of the curve, developing trading techniques that help protect our clients' interests.

Other Hidden Costs

Soft dollars, directed brokerage and commission recapture are other hidden costs that could ultimately negatively impact investment performance. The most common use of soft dollars is the exchange of free research and services from the broker, which are used to help identify securities to be bought and sold for a client's portfolio, for higher brokerage commissions on client trades. Directed brokerage is a client instruction to an investment manager to execute orders with a specific broker. Commission recapture is a provision that may allow a client to regain some of the transaction costs or commissions for various investment activities from individual brokers. INTECH does not participate in soft dollars, directed brokerage or commission recapture arrangements. This policy has allowed us to allocate brokerage based on an objective and quantifiable benchmark, focusing solely on seeking best execution. Exhibit 2 shows INTECH's total developed-market trading costs are consistently in the lowest quartile among its peers.

Exhibit 2: Total Trading Costs vs. Peer Group: Global Developed Markets*



AUM and Trading Costs – A Careful Balance

As assets under management (AUM) increase, position sizes also increase and could result in portfolio returns suffering. Unless a manager's investment process is scalable in overcoming the relationship between market impact and order size, their ability to grow could be impeded. Larger orders (>15% of ADV) are typically more challenging to execute than smaller orders. These larger trades tend to increase the levels of market impact (the bottom of the iceberg), which ultimately

* Source: ITG. Results based on trading cost analysis vs. an all developed markets peer group for the periods shown as of the last quarter in each year. For the fourth quarter of 2016, the peer group consisted of 35 managers encompassing a trade value of USD 838 billion. Number of managers and trade values for other periods are available upon request. Additional information about ITG can be obtained from its website at www.itg.com. Data reflects past performance, which is no guarantee of future results.

leads to performance deterioration. Additionally, capacity is not only based on the level of assets, it is based on the timing of inflows as well. For example, a strategy can temporarily reach capacity at lower asset levels – if the timing of inflows occurs over a short period of time. Conversely, a strategy can reach capacity at higher asset levels – if the timing of inflows happens over longer periods of time. As part of portfolio construction, our strategies invest in a broad number of stocks, with the intent of building portfolios that are potentially more efficient than the market, and have moderate portfolio turnover for any given rebalance. We trade incrementally in stocks to capture small but persistent price volatility through regular rebalancing. As a result, our average order size by percentage of ADV in 2016 was roughly 3% for all developed markets, placing INTECH in the 1st percentile in its peer group.*

Conclusion

Trading costs are very real and may impact an investment manager's ability to generate alpha. This paper has touched upon the explicit and implicit costs, with the understanding that the breakdown of implicit costs for a fundamental or quantitative manager continues to be a gray area depending on the preferred measurement of assessment. Within this context, INTECH continues to monitor the trade execution quality for our clients, aligning our unique mathematical investment approach with our proprietary trading methodology. Since the emergence of HFT more than 15 years ago, we have been tracking developments through a combination of discussions with and inspections of our brokers, participation in academic and practitioner conferences, and internal trading research. We estimate the overall impact of the market changes and the emergence of HFT to be a net positive, based on the decline of trading costs for INTECH's U.S. equity strategies over the last ten years.**

As markets have evolved, INTECH's proprietary trading process has also evolved, helping to mitigate market impact. INTECH's trading methodology:

- provides a transparent and objective way of seeking best execution for our clients by allocating brokerage with the goal of providing transparency and objectivity; as well as
- creates a competitive environment whereby brokers earn their order flow.

Attempting to generate an excess return above the benchmark is critical to our clients being able to meet their funding obligations. Managing trading costs is a vital component of INTECH's unique investment process. In light of the significant market structure evolution over the last two decades, INTECH has implemented enhancements to its trading methodology with the goal of adapting to and potentially benefitting from these changes in the market. Over the long term, we believe these enhancements strengthen our ability to generate alpha and should be beneficial to our clients.

Looking Forward

The first two parts of this trading paper series focused on the evolution of trading and best practices in managing trading costs (to provide best execution for clients). As investment managers think about how to provide their clients with best execution, some of the questions they will need to answer to help provide the best outcome for their clients include:

- What are some of the benefits of outsourcing trade execution?
- If a manager elects to outsource trading, does it make sense to then outsource the middle- and back-office operations?

Given the fragmentation of market venues across the world, complex trading infrastructure, ever-changing technology advancements, and heightened awareness of reducing implementation costs, we will explore the concept of outsourcing trade execution in Part Three of our trading paper series.

* Source: INTECH. Represents rebalancing trading costs for Global/Non-U.S. strategies only. Trading costs measured as the difference between the decision and execution price of the stock, plus commission costs.

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Trading Series Part 3: Choosing an Implementation Strategy – When and How to Outsource Trading



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Implementation costs are a critical, and often overlooked, component of an investment process. If not properly managed, implementation drag from market impact, commissions, taxes and fees, and clearing and settlement costs can reduce or altogether eliminate excess returns from even the most effective investment process. Consequently, careful consideration on how to best minimize these costs is paramount to providing value for clients.

Every equity manager must decide, from an operational perspective, exactly how it is going to implement the trading of client portfolios. The options for equity trading are:

- outsource trading to a third-party brokerage firm;
- establish an in-house trading function, or
- adopt a combination of both.

Today's equity markets are fast paced and constantly evolving, and therefore require access to a complex trading infrastructure to achieve best execution.

This paper will explore the opportunities and challenges of each of the approaches above, and the factors that determine which approach is best for a particular manager.

Implementation Must Fit the Investment Process

No approach to implementation is ideal for all managers. Each must undergo a thorough evaluation of its own investment process to consider how its specific characteristics may affect trading costs in various ways.

Managers should consider the impact of the following characteristics of their investment process:

- 1) **Portfolio concentration:** Highly concentrated portfolios, or portfolios that hold fewer stocks, tend to result in above-average participation in a stock's average daily volume (ADV), particularly for portfolios holding relatively illiquid mid- and small-capitalization stocks. Even with relatively modest assets and turnover, a manager risks higher implementation costs both from simple demand price pressure as well as information leakage to other market participants. At the other end of the spectrum are portfolios that strictly track major cap-weighted indexes such as the S&P 500 or Russell 1000. These portfolios typically experience much lower transaction costs due to the highly liquid nature of the large-cap stocks that make up those indexes, and the relatively low turnover required to track the benchmark index.
- 2) **Turnover:** Turnover acts as a direct multiplier on the real costs of implementation in a given investment strategy. All things being equal, higher turnover increases the total drag on investment returns from trading. Investment processes that necessitate higher turnover must be even more mindful of market impact, since it is more likely to make up a greater portion of their overall trading costs.
- 3) **Market capitalization (size) and regional exposure:** The market capitalization, or size, and geographical location of the securities being traded can have a meaningful impact on the level of transaction costs in a portfolio. The liquidity, transparency, complexity, and regulatory characteristics of the stocks and market will all impact the degree to which it makes sense to trade in house versus outsourcing. For example, trade execution in emerging markets possesses inherent challenges, such as rapidly changing regulations, prohibitive restrictions on foreign investors, larger ticket and custody fees, and other market idiosyncrasies. Acquiring direct market access to these venues may be operationally difficult and costly.
- 4) **Assets under management (AUM):** The total AUM of an investment manager will have a significant impact on the

decision of whether to trade in house. A smaller manager, with less operational resources, will have a more difficult time justifying a build out of in-house trading capabilities than will its larger counterparts. In addition, an investment process that is not readily scalable may suffer disproportionately higher trading costs as AUM increases. Because trading costs tend to increase with order size (as a percentage of ADV), managers that aren't able to effectively mitigate this as they gain assets are at risk for prohibitive implementation drag that limits their ability to grow. Effectively using all of the market's liquidity can help reduce capacity constraints.

- 5) **Price sensitivity and order urgency:** A manager must decide the relative importance of time and price impact in its investment process. For example, momentum-driven investors rely on a relatively small delay between their decision to make a trade and execution and have less sensitivity to short-term price impact. Conversely, deep-value managers may care much more about price level than time of order execution.

No approach to implementation is ideal for all managers. Each must undergo a thorough evaluation of its own investment process to consider how its specific characteristics may affect trading costs in various ways.

In-House Trading: Overcoming Obstacles

The primary goals in taking the trading function in house are: decrease client commission costs, increase control over execution, and reduce information leakage. However, establishing an effective in-house trading team is a challenging and timely undertaking in today's complex and rapidly evolving market structure. The U.S. equity markets have changed dramatically over the last 20 years as a result of regulatory changes and technological advances. As discussed in Part One of our Trading Paper Series, equities are now traded much faster, and at much lower spreads, than they were even ten years ago. An additional consequence of these changes is that the markets are also much more fragmented than at any point in history. In the late 1990s, the New York Stock Exchange and NASDAQ controlled the overwhelming majority of U.S. equity trading volume. Today, that number is close to 40%. Dark pools and other off-exchange venues make up an additional 40%, with the remainder occurring on newer, electronic exchanges such as BATS. The net result for the investment manager is that the market is continually changing, and stock liquidity

must be intelligently sourced from dozens of venues. Keeping pace with market changes from this perspective alone presents a significant undertaking.

Foreign markets, both developed, and, in particular, emerging, are evolving at an even quicker pace. For example, the Securities and Exchange Board of India only recently lifted restrictions on direct market access in 2012, and other emerging-market countries are even further behind. Most large brokerage firms have regional offices around the world that access the various global exchanges or contract trading out to local firms who execute orders on their behalf.

Beyond the cost of obtaining access to all of these venues, firms that prefer to trade in house need to consider the resources involved in building out an in-house trading desk. These include hiring and retaining all the relevant talent – analysts, developers, researchers, and traders – as well as maintaining the systems and technology required to transact in those venues.

The last key consideration in considering in-house trading are the risks associated with taking on the trading function. Trading errors present significant financial and business risk to the firm. With the legal and regulatory environment changing so rapidly, constantly staying up to date involves significant investment in people, systems, and technology. By trading in house, a manager must assume all risks associated with trading errors. Conversely, firms that outsource trade execution also outsource at least some portion of these risks.

Today's equity markets are fast paced and constantly evolving, and therefore require access to a complex trading infrastructure to achieve best execution.

Outsourcing Trading; Evaluating Efficacy

An investment manager that decides against trading in house must establish a comprehensive and effective process by which to select brokerage partners, measure those brokers' performance, and allocate order flow.

In determining the ideal number of brokerage relationships, it is important to find a balance between having too many and too few. With too many, order flow can be unprofitable or immaterial to any individual firm, resulting in poorer execution quality, operational and settlement issues, and difficulty in managing relationships. With too few, the manager risks having insufficient coverage and diversification in execution.

Also crucial is the selection of a performance benchmark by which to measure the brokers' execution that is appropriate for the investment process. Volume-weighted average price (VWAP), implementation shortfall, or some other metric should be selected to align the specific goals of the process with how brokers are evaluated. Performance can be measured in house, but a manager may find it beneficial to also hire a third-party trading-cost consultant to verify results and help put its costs in perspective as measured against its peers of similar size and investment style.

Brokers should also be continually monitored to ensure they are making the proper investments to keep pace with the evolution of market structure from a trading, settlement, and regulatory perspective.

Once broker performance has been effectively quantified, a manager should institute a system of trade allocation that aligns the interests of all parties: client, manager, and broker. Orders should be distributed in such a way as to control information leakage both to the broker and to the marketplace at large. In addition, order flow should be allocated in such a way as to incentivize best execution: directing more trades to the brokers with the best performance according to the chosen metric.

A Hybrid Approach: Best of Both Worlds?

It is possible to utilize a combination of in house as well as outsourced trading. For example, a manager could choose to execute its more liquid transactions, such as smaller orders of well-known large-cap stocks, through its own direct market access, but outsource larger or more difficult orders to brokerage firms that have the expertise and systems already in place to effectively execute these trades.

There are two important items to consider when evaluating this approach. First, a hybrid approach could adversely affect trading costs primarily in two ways:

- the potential introduction of competition on trades of the same stock or related stocks through internal execution, and
- the withholding of information and flexibility by not releasing an entire group of trades as a single order. For example, less-liquid names that are more difficult to execute individually can be balanced with more liquid trades to potentially reduce the overall cost of trading.

Any institution utilizing a combination of internal and external execution needs to be acutely sensitive to the manner in which those trades are allocated so as to minimize overlap in activity.

Second, taking some portion of the trading function in house can result in less material business to the brokerage relationships, which may have a detrimental impact on execution quality and operational efficiency.

A manager's primary consideration, when deciding how best to trade its client portfolios, should be realizing best execution to meet client objectives.

INTECH's Implementation Strategy

INTECH's investment process begins by taking a given benchmark index as an investment universe. Using estimates of stock-return volatility and correlation, portfolio weights are mathematically optimized within a given set of objectives and risk controls, seeking to construct a more efficient (higher return – less risk) portfolio. The process generally seeks to overweight more volatile, less correlated stocks, to create rebalancing opportunities for excess return while maintaining a desired level of absolute or relative risk. As the individual stocks within the portfolio exhibit natural price movements, the positions are systematically and efficiently traded back to the optimal target weights. This process captures a rebalancing premium, or "trading profit," from buying low and selling high. Because the nature of the process relies on periodic trading to generate alpha, we consider managing implementation costs to be a high priority. Our rebalancing tends to be inherently low cost, which is critical to our ability to deliver value for our clients, due to two primary factors:

- The portfolios are constructed from a diversified universe of large, highly liquid stocks; and
- The optimal target portfolio weights move relatively slowly throughout time, resulting in generally small, incremental moves in any individual stock in a single rebalancing trade.

INTECH's average order size represented only 3% of the stock's average daily volume on global developed market trades in 2016, compared with a peer group median of 65%. Although INTECH traded more than 67% of its peer group in 2016, our average order size as a percent of the ADV ranked smaller than 99% of those peers. Consequently, total trading costs in 2016

came in at 18 bps, ranking INTECH better than 76% of its peer group.*

Rebalancing orders typically contain a large number of individual stocks and an equal dollar value of orders to buy and sell, creating trade baskets that are largely shielded from intraday market movement (e.g., a rising market would tend to increase the cost of all buy orders but also the value recovered from all sell orders). Although no individual order in a typical INTECH rebalancing trade is particularly difficult to execute, an entire day's worth of orders may contain several hundred stocks, requiring complex tools to manage and complete the entirety of the trading activity throughout the day.

After considering how all of the factors discussed herein relate to both our investment process and the firm, INTECH made the decision to outsource trading to allow us to focus our efforts on executing the investment process and maximizing client returns. INTECH has recognized that the resources required to build the teams, systems, and processes for in-house trading are more effectively allocated toward serving our core function as investment managers.

Because execution is outsourced, INTECH has put in place a transparent and objective system to measure broker performance and allocate orders. INTECH measures market impact as the difference between the decision and execution price of the order, in the base currency of the account. We utilize this metric because our model is focused on executing transactions near a recorded real-time price, and market impact accurately assesses how close we are to achieving that target price. INTECH does not participate in soft dollar or directed commission arrangements, nor do we consume or utilize any external investment research. All brokerage commissions paid are strictly for execution-only services. We are able to record the "all-in" cost of execution as market impact plus commission, or implementation shortfall, and use this metric as the sole determinant when allocating future order flow. This process is designed to reward the best-performing brokers with more order flow using objective, quantifiable metrics. INTECH's implementation philosophy is to align the interests of all parties involved – INTECH, its clients and its brokers – to focus on the best result for its clients.

Trading externally does not excuse a firm from having to keep up with market-structure evolution, although it does afford the manager access to valuable research and commentary on the subject from leading experts. Using external brokerage firms,

* Source: ITG. Results based on one year ending December 31, 2016. Most recent results based on analysis versus an all developed markets peer group of 35 investment management firms, encompassing a total trade value of USD 838 billion. Number of managers and trade values for other periods are available upon request. Additional information about ITG can be obtained from its website at www.itg.com. Data reflects past performance, which is no guarantee of future results.

closely with our executing brokerage firms to collect feedback on market conditions and utilize this information to improve our proprietary implementation management platform.

Conclusion

A manager's primary consideration, when deciding how best to trade client portfolios, should be realizing best execution to meet client objectives. A host of factors should be taken into consideration, including the characteristics of the investment process, the size of the investment manager, and the capacity of a manager to acquire and retain both the talent and systems required to take on the trading function in house. INTECH's decision to outsource trading has been supported by its experience: establishing, monitoring, and properly incentivizing external brokerage relationships continues to enable us to provide the most value to our clients.

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