



SIFMA Insights

Electronic Trading Market Structure Primer

October 2019



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SIFMA Insights Primers

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Executive Summary

Defining electronic trading is not black and white, with no single definition for a firm or strategy, and trading activities vary across markets (typically dependent upon level of liquidity and trading/post trade infrastructure). Firms of all types – including traditional market participants like broker dealers trading for clients, market makers and asset managers, not just proprietary trading firms or hedge funds – have adopted technologies to enable better trade execution over the years. Markets and market participants are intermingled in today’s environment – trading is a complicated and dynamic ecosystem, with competitive forces and structural and regulatory changes continually shaping the environment – and technology is now part of market DNA.

In this primer from SIFMA Insights, we attempt to define electronic trading by providing an overview of the types of platforms and strategies utilizing a form of electronic trading. Highlights from the primer include:

- **Why Market Structure Matters** – Given the need for market liquidity and minimized trading costs, market structure matters. Market structure can drive liquidity and costs to trade. Market participants, therefore, continually strive to create the most efficient markets. This includes adapting new technologies to achieve operational efficiencies, searching for new ways to transact and, generally, sculpting market structure to maximize efficiencies.
- **Answering the Unanswerable Question** – Electronic trading is not one thing, and defining it is, therefore, difficult. While the term covers a variety of systems and activities across the trade lifecycle (execution/trading – clearing – settlement), we focus on the execution side in this report. This section details the drivers of, benefits of and concerns around electronic trading.
- **Types of Electronic Trading** – This section walks through automated trading strategies, as well as describing common types of electronic trading platforms, activities and trading protocols.
- **The Electronification of Markets** – As technological advances and market structure evolved over time, markets and products began the electronification journey from over-the-counter (OTC) to exchange traded, predominantly in search of liquidity and efficiencies. This section diagrams differences between exchange traded and OTC markets and analyzes the percent of electronification across products/markets.
- **Financial Institution Infrastructure Feeds Electronification** – The role of the broker-dealer and in particular the markets and securities division has evolved significantly since the global financial crisis. This shift in business structure has enabled the growth of electronic trading.
- **Access to Information Enhances Electronic Trading Capabilities** – Access to information establishes the building blocks, along with technological innovations, to creating electronic markets.
- **Looking across Markets** – This section details the electronification journey across different markets (equities, futures & options, UST, corporates and rates).

Why Market Structure Matters

The Importance of Market Liquidity

Market liquidity can be defined as the ability to efficiently buy or sell securities, as measured by speed and ease of execution, without causing a substantial change in the price of the asset. Liquidity is a tradeoff between speed of execution and transaction costs. For example, a market participant may accept a less optimal price in order to execute the trade in a timely manner.

Markets need robust trading volumes to remain liquid, as liquidity is tied to price volatility. In a less liquid market, large transactions may lead to large price movements. Price volatility increases because there are not as many buyers and sellers in the market. Typically, asset prices represent the assessed fund value. When market participants see market prices move outside of their assessed price range, they step in to buy or sell the asset, adjusting the price back to fair value accordingly. In illiquid markets, without as many buyers and sellers to transact quickly and cost efficiently, market participants are not there to step in and adjust prices. Therefore, prices can experience wide swings.

As such, lower market liquidity can keep volumes depressed. Lower volumes lead to increased time to execute a trade and wider bid-ask spreads – the difference between the highest price that a buyer is willing to pay for an asset and the lowest price that a seller is willing to accept – which increases costs to trade. Spreads are often a measure of market liquidity. And in some fixed income markets, the dealers typically distribute transaction costs out across multiple transactions. In less liquid markets where there are lower volumes, the dealer is spreading transaction costs over less transactions, which increases the cost per transaction charged to an investor. Additionally, the risk premium charged on a transaction rises to cover the higher volatility attributed to less liquid markets. This further increases costs to trade.

Market liquidity, therefore, impacts returns to investors. Higher spreads lead to higher transaction costs which cut into an investor's return. Lower liquidity can also increase the cost of capital raising for corporations and governments. In many fixed income markets for example, asset price is calculated as:

Price = f (time value of money + credit risk premium + interest rate premium + liquidity premium + other)

- Time value of money = base return for giving up the use of these funds
- Credit risk premium = the risk of not getting repaid in full
- Interest rate premium = the potential decline in asset value if interest rates rise
- Liquidity premium = the degree of difficulty in buying or selling an asset
- Other = FX premium, etc.

The higher the rate, the lower the price of a bond (inverse correlation between prices and rate). This will increase the cost of a bond issuance.

The Cost of a Trade

The total cost of a trade can be broken out into explicit and implicit costs.

$$\text{Trade Cost} = f(\text{explicit costs} + \text{implicit costs})$$

Explicit costs can include:

- Broker or dealer commissions = cover trade execution expenses; provide reasonable profit for executing the trade; add a premium for the risk that they may lose money executing the transaction; cover costs to hold the inventory of securities to make markets (supply of securities; capital required to be held against these securities); costs of staff and technology; etc.
- Market access fees
- Market making¹ fees; add fees paid for subtracting liquidity, subtract rebates received for adding liquidity
- Clearing and settlement costs
- Taxes

Implicit costs can include:

- Bid-ask spreads
- Opportunity cost = time to fill an order; percent of an order filled; etc.
- Price impact of a trade = trade price deviates from current market price as a result of the trade; for example
 - Losses can occur from market prices moving when executing large volumes; block trades² are often performed outside open markets to lessen this price impact
 - Information leakage occurs when other market participants learn a player plans to execute a large block; they get ahead of that trade and move prices. Blocks are typically split in smaller amounts and executed over time to avoid a significant price impact; however, this makes the trade vulnerable to others anticipating its occurrence and trading ahead of it. Anonymity is key.
 - In some markets across the globe, brokers are required to seek the best execution price for clients (best ex includes an assessment of an opportunity to get a better price than what is currently quoted, the speed of execution, the likelihood that the trade will be executed, percent of fulfillment at current prices, etc.). To comply, brokers may evaluate orders from all customers, market makers, trading venues, etc. This takes time, during which markets may move and the broker must then execute at a less profitable price or not execute the clients' order.

¹ A market maker is a firm that stands ready to buy and sell a security on a regular and continuous basis, as they are often obligated to make two sided quotes in the market at all times (depending upon which market)

² A block trade = buy/sell large number of securities; 10,000+ equities, \$200,000+ value of bonds

Putting This Together

Putting together these pieces – achieving high levels of market liquidity and minimizing trading costs – shows that market structure matters. Market structure can drive liquidity and trade costs. Market participants, therefore, continually strive to create the most efficient markets. This includes adapting new technologies to achieve operational efficiencies, searching for new ways to transact and, generally, sculpting market structure to maximize efficiencies.

We do note that all markets or products are not created equal. For example, a financial institution may have only one stock, but it could have around 1,500 CUSIPs³ for its corporate bonds. Likewise, stocks are generally fungible in trading, settlement and clearing, yet this is not always the case in fixed income (albeit some common factors often exist).

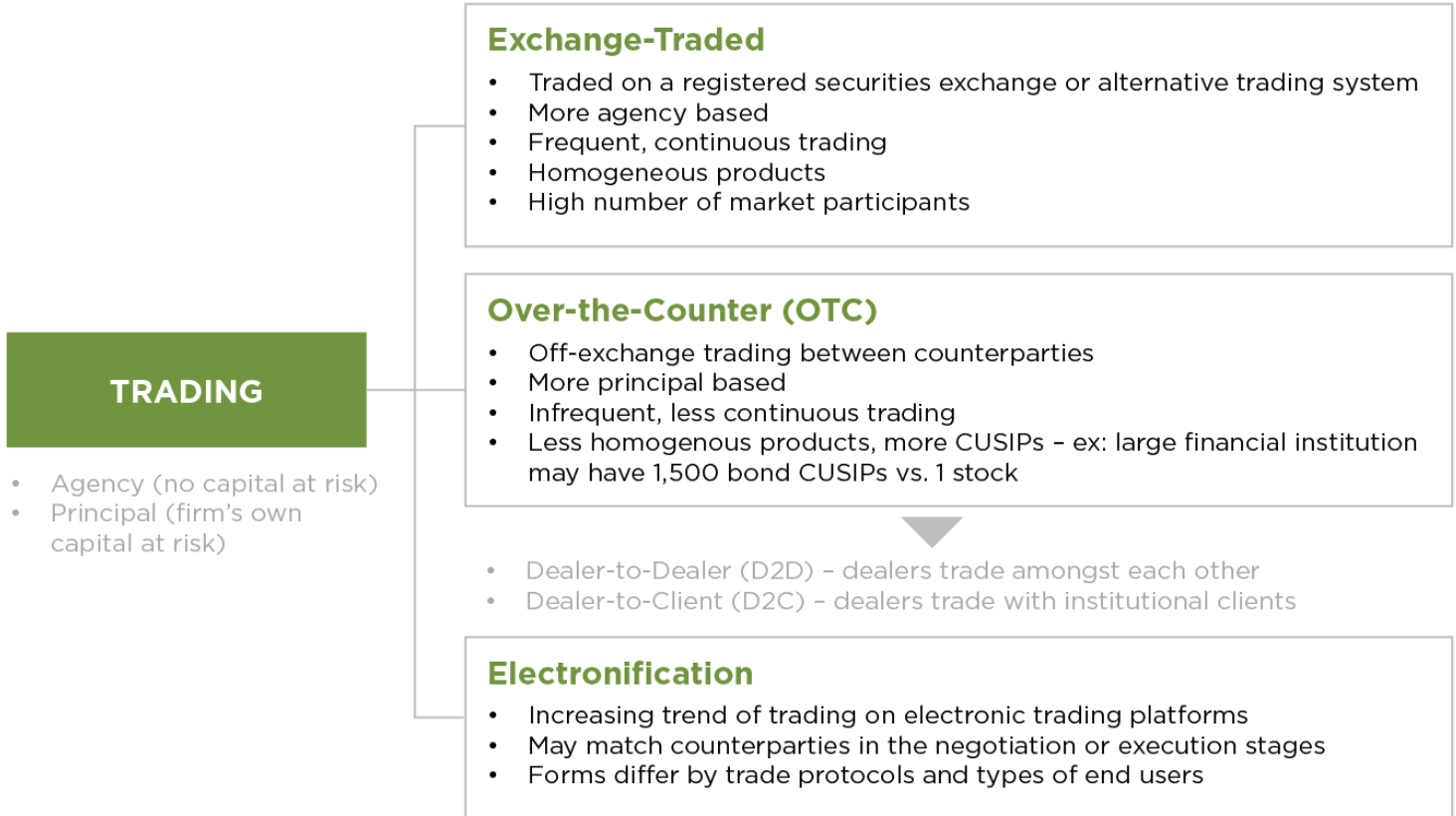
Products may trade on an exchange/trading venue or over-the-counter (OTC; please see the visual on the next page). On an exchange or registered trading venue, transactions are completed through a centralized source, where one intermediary connects buyers and sellers and guarantees trades/delivery. Products can be standardized, and the systems are highly regulated, leaving less chance for price manipulation. There are typically many participants, leading to generally higher liquidity.

In OTC markets, trades are done in a decentralized manner; there are multiple participants competing to link buyers to sellers. While this competition can keep prices down, there are limited regulated exchanges – although broker-dealers acting as intermediaries are regulated entities – operating in this market, which can decrease liquidity. (It should be noted that some products historically traded OTC because there was not enough volume to support exchange trading, a bit of a chicken and egg scenario.)

As market participants across different markets search for smart order routing paths to achieve the best trade for their client while minimizing market impact, they look to new technologies to address market fragmentation (which can decrease liquidity) and identify hidden liquidity. This is one of the main drivers of the electronification of markets.

³ CUSIP = Committee on Uniform Securities Identification Procedures; a nine character alphanumeric code identifying a security to facilitate clearing and settlement of trades

Trading Methods



Note: Characterizing trading as frequent or infrequent are generalizations for the groups; different products within each group may trade more or less frequently than others.

Please see SIFMA Insights Global Capital Markets & Financial Institutions Primer at: <https://www.sifma.org/wp-content/uploads/2018/09/SIFMA-Insights-Capital-Markets-Primer.pdf>.

What Is Electronic Trading

Answering an Unanswerable Question

Q: If the number 2 pencil is the most popular, why is it still number 2? **A:** Unknown

Q: Before they invented drawing boards, what did they go back to? **A:** Unknown

Q: If you try to fail and succeed, which have you done? **A:** Unknown

Q: What is the definition of electronic trading? **A:** That's complicated, and it's not a single answer...

Defining the Undefinable

Electronic trading is not one thing. The term covers a variety of systems and activities across the trade lifecycle: execution (trading); clearing; and settlement. However, we focus on the execution side in this report. On the execution side, it can mean transferring ownership of a security by matching two counterparties through an electronic platform. This is not just about the platform, as trades can be negotiated by voice yet settled electronically. Even the registered exchanges muddy the waters – they are not typically lumped into electronic trading, yet they utilize advanced technologies to run their markets.

The amount of electronic trading done in a product or market can be attributed to the type of marketplace. In general, markets can be defined as centralized or decentralized:

- **Centralized** – Most futures exchanges (and some other markets) use the central limit order book (CLOB) trading method – or matching engines in the equities world – an automated system which uses an algorithm to match customer orders on a price time priority basis (no negotiation). The highest bid and lowest ask orders establish the best market in a security, and low cost execution is achieved by crossing the bid/ask spread. Market depth is transparent, displaying bid/ask order sizes and prices. CLOBs/matching engines establish markets which are centralized, order driven (prices follow orders), transparent, real-time and anonymous. Interactions are multilateral and can be dealer-to-dealer (D2D), dealer-to-client (D2C) or client to client (C2C), albeit access is typically limited to dealers or members. Markets with CLOBs/matching engines have dealers or market makers quoting two-way prices, but market makers are not necessarily required in these already liquid markets. Ex: stock exchanges, futures exchanges
- **Decentralized** – OTC market interactions are bilateral, quote driven (orders follow prices) and segmented by D2D or D2C, and prices can be negotiated, particularly for large orders. Dealers quote indicative (estimate of current market price provided by the dealer to the investor, dealer is not obligated to honor it) or firm (price is guaranteed by the dealer) bids/asks up to a set trade size, and prices are finalized when a quote is hit by the other counterparty. Ex: fixed income, derivatives

Whether traditional or electronic, markets address several key features:

Feature	Description	Centralized (Exchange, CLOB)	Decentralized (OTC)
Access	Trading with each other or through intermediaries; D2D, D2C or C2C	No segmentation	Segmentation
Anonymity	Are counterparty identities disclosed	Anonymous	Not anonymous
Continuity	Continuous or periodic (orders are batched and cleared at set intervals)	Continuous or periodic	Generally continuous
Dealers	Is execution dependent on dealers or market makers, i.e. liquidity is too low without their involvement	Not necessary, but do exist	Necessary
Interaction	Bilateral allows price negotiation; multilateral pools interactions on a single trading platform	Multilateral	Bilateral
Pricing	Price discovery can be determined in or out of the system; prices can be order or quote driven; prices stem from quotes competing in a central location or fragmented price formation	Centralized, order driven	Fragmented, quote-driven
Protocols	Types of orders allowed (limit, stop, market, off-market), trading rules (tick size, trading halts, open/close hours)	Standardized	Not standardized
Transparency	Amount and extent information is disseminated; full = timely pre (bids, asks, depth) and post (last price, volume) trade details disseminated to all participants	High	Limited

Source: Bank for International Settlements, SIFMA estimates

As noted, electronic trading differs from traditional markets, whether on an exchange or OTC. While still about connecting buyers and sellers or dealers and their clients, technology automates part or all of the processes in the trade life cycle in order to generate efficiencies. These efficiencies seek to lower costs, increase speed of execution, enhance risk management or generally improve the market for trading a specific product.

- Integration** – Electronic trading enables straight-through-processing (STP), integrating the processes in the trade lifecycle. Systems can display pre-trade data (bid/ask quotes, depth of book), match buyers/sellers, execute the trade, clear/settle the trade, handle risk management and report post-trade data (price, volume). This eliminates the need to utilize multiple systems for different processes and creates efficiencies for both the front and the back offices, as well as for clients.
- Location** – Electronic trading is location neutral, allowing continuous multilateral interaction among participants; participants need only to connect to the system from any location, particularly enabling cross-border transactions.
- Scale** – Electronic trading can increase the amount of transactions handled by increasing the capacity of the system, enabling economies of scale to lower operational costs

Drivers of Electronic Trading

Drivers behind the greater adoption of electronic trading all relate to the search for efficiencies. This can come in the form of cost savings, increased speed of execution or sourcing liquidity. Or, in some fixed income markets, prudential regulatory requirements forced dealers to hold less inventory of securities and exit some businesses. This negatively impacted liquidity, driving market participants to search for alternative solutions (trading venues). Additionally, with new European regulations to prove best ex across multiple markets, firms need better systems to provide pre and post trade reporting.

And companies are always searching for cost savings, particularly in financial services where post-crisis regulations have driven up costs (increased capital requirements) and firms continue to increase budgets to bolster their cyber defenses, a double whammy on P&Ls. Additionally, as financial services is a relationship driven business, it is difficult for firms to walk away from costly businesses for fear of alienating clients. Therefore, moves to lower touch electronic trading in some markets allow firms to continue serving clients at a lower cost base.

Again, not all markets or products are created equal. The scalability of electronic trading platforms depends upon the capacity of the technology and the characteristics of the market/product. Economies of scale are more readily achieved for standardized products which are traded frequently or markets with a large, diverse set of participants. Therefore, the benefits of different electronic trading platforms and activities will vary.

Benefits of Electronic Trading

We breakout benefits of electronic trading into the following buckets:

- **Cost Savings** – Advances in technologies or utilization of technology (at sufficient scale) to automate processes frequently result in cost reductions. Electronic trading can increase speed of execution and lower both transaction and search costs. By increasing transparency via better (i.e. faster and accurate) dissemination of prices to a greater number of market participants, thereby limiting inherent information asymmetries, search costs come down. Price competition provides opportunities for price improvement and therefore can lower transaction costs. Additionally, the pooling of liquidity on electronic trading platforms reduces fragmentation and the costs associated with it, such as lowering spreads. As technological innovations advance, the fixed costs for building new trading systems decrease (albeit there are still costs to market participants to adopting new systems).
- **Operational Efficiencies** – Technological advances increase computational speed and therefore allow for the processing of large amounts of data simultaneously. This integrates processes across the trade lifecycle by enabling integration. Integration links execution, trade confirmation, clearing and settlement (as well as risk management), which lowers order processing costs and minimizes the risk of reporting errors. Electronic platforms enable direct market access to increase speed to markets. Electronic trading also automates the collection of pre- and post-trade information (prices, volumes), increasing the amount and speed of available

information. This reduces costs of searching for the best price. Further, electronic systems can help firms better monitor client trading behavior. Monitoring flow, and how it moves on news, enables firms to then internalize flow efficiently across trading desks, putting resources in the right areas to serve clients.

- **Price Formation** – Electronic trading systems, whether quote or order driven, enable price discovery, being more transparent than OTC markets. Additionally, prices produced in these systems may be used as proxies for less liquid or fragmented markets. For example, the continuously updated prices of highly liquid bond futures and on the run government bonds can be used in pricing engines to develop quotes for less liquid fixed income securities.
- **Transparency and Anonymity** – Electronic trading can increase pre (best bids/asks; depth of book; firm or indicative quote type; etc.) and post (price, volume, execution time, etc.) trade transparency. Technology can bundle information sources, explicitly drawing links across markets and products. Pooling information across joint platforms can also illuminate depth of market for participants. Further, electronic systems have access to all trade-related information, which can provide insights into clients' search and trading activities and dealers' reactions (price quality, speed, hits/misses, etc.). That said, electronic platforms are not created equal, rather are built for specific strategic reasons. In some platforms, anonymity is key and client-specific trade information is not shared. As electronic trading markets become more multilateral, it should become easier to unwind positions anonymously. Should these systems evolve into CLOBs/matching engine systems, trading can become completely anonymous.
- **Market Access** – Electronic trading enables the transition to a CLOB/matching engine system from OTC, which increases access to end users and allows users to interact directly with each other, altering the balance of power between dealers and clients but not necessarily eliminating the dealer role altogether. Electronic trading also allows non-intermediaries to directly access markets. Direct electronic access can come in the form of intermediated or non-intermediated. Intermediated direct access has clients accessing a market either via their dealers' infrastructure (automated order routing) or without utilizing the intermediary's systems (sponsored access). Either way, the intermediary retains responsibility for the order. Non-intermediated direct access (not allowed in all markets or jurisdictions) enables clients to connect directly to the market without an intermediary.
- **Compliance** – Electronic trading platforms can automate processes for risk management activities and regulatory reporting requirements across the trade lifecycle (real time or near real time reporting opportunities). Electronification enables efficient development of electronic audit trails. They can also improve processes for overall data management.

Concerns around Electronic Trading

Not every market participant views electronic trading as only a positive for markets. Several areas of concern have been expressed around the increased adoption of technology. For one, some market participants express concern that the continued adoption of various types of electronic trading changes market sentiment, with some participants discouraged from participating because they cannot match the technological advancements of some automated trading strategies. Additionally, regulators express concerns that today's more technology driven markets can contribute to the transmission of shocks across trading venues, whether trading the same products or across markets of different assets. Albeit, as we continue to put years, or decades, of electronic trading under our belts, regulators can get more comfortable with its benefits and their approaches to monitoring these markets.

2010 Flash Crash

What happened? On May 6, 2010 the prices of many US equity based products experienced an “extraordinarily rapid decline and recovery”. Major equity indices and futures markets dropped 5-6% (already down 4% from the prior day) in only a few minutes, and then rebounded almost as fast. Many stocks and ETFs suffered price declines of 5%, 10%, 15% or more (for some stocks) and reversed all within a short time, recovering most/all of the losses. 20,000+ trades on 300 securities executed at prices >60% off of their prices moments prior to trade. Major equities indices and futures recovered to close down 3% from the prior day.

Regulatory Assessment: A joint report was issued from the SEC and CFTC. Regulators were surprised by the interconnection between cash equities and futures markets. They noted that today's markets of fully-automated trading strategies and systems process a large volume of quotes, orders and trades each second. They also acknowledged that high trading volume is not necessarily a true indicator of market liquidity, particularly in markets with significant volatility. Essentially, the report acknowledged that market monitoring needs to evolve with evolving markets.

While electronification can lower barriers to entry and allow for more competition (which can lead to lower transaction costs), it can also lead to market fragmentation. There is a balance between concentrated and fragmented markets. Concentrated markets can provide greater depth of book and higher probability of order execution at the terms stated by the client. Yet, it can lead to monopolistic behavior in terms of pricing and limit innovation. On the other side, fragmented markets can be more competitive and geared toward innovation to win business. However, this can lead to lower probability of order execution and increased total trade costs, as brokers may search multiple trading venues to find the best price for their order (based on the order and client's objectives).

The U.S. equities markets are an example of fragmentation, with 13 exchanges (with three more announced) predominantly under three main parent groups, 31 equity ATS and 6 OTC venues. Conversely, some market participants believe there are too few trading venues in some fixed income markets, such as U.S. Treasuries. Again, markets need a balance.

Types & Subsets of Electronic Trading

As discussed above, defining electronic trading is not black and white. There is no single definition that would enable labeling one type of firm or trading strategy as simply electronic trading. Further, trading activities vary across markets, typically dependent upon the level of liquidity and trading/post trade infrastructure. Over the years, firms of all types – including traditional market participants like broker dealers trading for clients, market makers and asset managers, not just proprietary trading firms or hedge funds – have adopted technologies to enable better trading execution. Markets and market participants are intermingled in today's environment – trading is a complicated and dynamic ecosystem, with competitive forces and structural and regulatory changes continually shaping the environment – and technology enabling electronic trading is now part of market DNA.

Therefore, one cannot label one strategy or firm as good or bad. (And it is left to the regulators to determine whether a trader or trade is labeled bad, as manipulative trading activities like front running or spoofing are illegal.) Further, strategies may not be solo, with a firm switching between strategies over time.

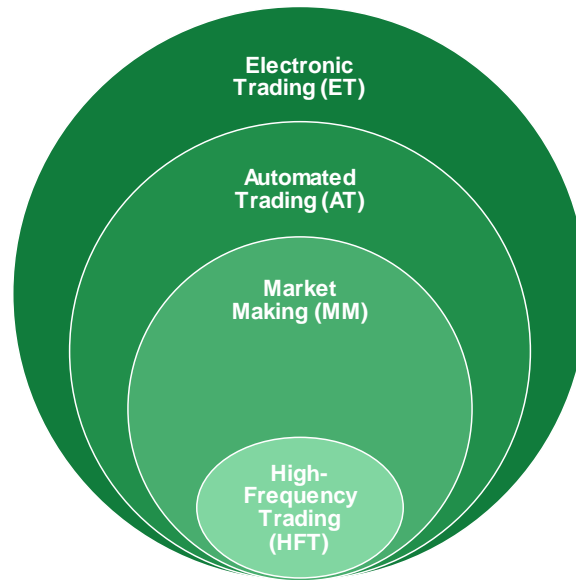
In explaining the world of electronic trading in this report, we draw from the Bank for International Settlements' (BIS; global standard setters⁴) guidance in this area, coupled with practical experience from market participants. As shown in the visual on the following page, electronic trading can be segmented in the following manner:

- **Electronic Trading (ET)** – The whole pie of electronic trading has many different subgroups
- **Automated Trading (AT)** – One main segment is automated trading
- **Market Making (MM)** – Within automated trading lies a trading strategy subgroup labeled market making, which can also be thought of as liquidity providing
- **High-Frequency Trading (HFT)** – A small subgroup of market making is the high frequency trading strategy

We note that our visual differs from BIS in one important area – we identify the differences between MM and proprietary HFT. In some overviews of the market, MM and HFT have been lumped together and generically all labeled HFT; and the firms have been given this label as a type of firm, even though it is more of a trading strategy than an entity. While any firm lumped into this category has received a lot of negative press over the last few years, it is important to note that this label has combined different functionalities, facilitating markets and proprietary trading. And not all firms or activities performing either function can be blanketly labeled as bad (the diversity of market participants is a key factor that contributes to the depth and liquidity of U.S. capital markets).

Further, this strategy is used by firms which have become significant providers of liquidity in today's capital markets. Perhaps instead of generically labelling all of these firms HFTs, it is time to rename them to technology enabled market makers or electronic liquidity providers.

⁴ BIS = established in 1930, owned by 60 central banks; represents countries from around the world that together account for about 95% of world GDP



Source: BIS, SIFMA estimates

The Automated Trading Subset of Electronic Trading

Before diving deeper into automated trading, it is important to note that the financial services industry is all about serving the client's needs. This is no different in electronic trading – the strategy or approach a firm uses to accomplish the provision of liquidity is in response to a client's request. Execution is driven by the customer base, and firms strive to provide the best execution for their clients, which can vary by the end goal of an order. Different types of investors, and therefore orders, may have different objectives (speed, size, price, etc.).

Electronic trading has enabled and increased the usage of automated trading as a means to improve efficiencies in trade execution. Automated trading employs complex statistical and econometric models on advanced technology and communication platforms to make order and trade decisions electronically and independently. These quantitative trading strategies interpret market signals and automatically implement trading strategies accordingly, with trades sometimes lasting only seconds or milliseconds. In short, electronic trading enables market makers to execute high volumes with narrow spreads and provide an opportunity for price improvement, on behalf of clients.

Automated trading can be split into algorithmic (algo) trading and market making, of which high-frequency trading is one smaller subset. None of these are single strategies, rather sets of technological activities and tools employed in a variety of strategies, each with different objectives and market impacts.

- **Algo** – Algorithmic trading strategies execute orders using automated pre-programmed trading instructions (time, price, volume, venue, etc.) to send small slices of an order into the market over time. Algo trading is used for a sell side firm's own trading, and these firms also offer their algos to clients to execute their trades.

Algos are used on the buy-side not only to minimize price impact on single trades but also with rebalancing large portfolios. Algo terminology dates back longer than HFT, which came into use in the early 2000s.

- **MM/HFT** – MM/HFT strategies submit orders and execute trades at very high speeds (microseconds), attempting to profit from very small changes in asset prices with small but frequently executed trades. Firms using this strategy maintain tight intraday inventories, i.e. they end the day flat. This strategy is about speed, or minimal latency. Minimal latency is important as providing liquidity can involve holding a risky inventory position; this risk is minimized by moving inventory or adjusting posted quotes to incorporate new information quickly. This can result in a high volume of messages to trading platforms, a large number of smaller sized trades which are held for short time periods (seconds or less), a high order to trade ratio and a high count of canceled orders. The strategy enables market makers to continuously provide two-sided quotes in the market, i.e. provide liquidity to facilitate trading.
- There are other automated trading strategies where speed is less critical, such as auto quoting by market makers.

Automated trading strategies perform best in markets with CLOBs/matching engines, which have solid market infrastructures (trading, communications) and demonstrate high liquidity even before automated trading is added. Conversely, automated trading strategies are limited in some OTC markets utilizing RFQ, as there is often not a continuous market. Many of these strategies attempt to capitalize on short-term patterns from price and order flow information in asset prices or markets. Rapid execution is therefore key to capturing these short-lived trends.

The main automated trading strategies include:

- **Market Making** – This strategy involves continuously posting orders on both sides of the trade, thereby providing liquidity to the market. Algos generate indicative or live screen quotes or reply to requests for quote, i.e. auto quoting. The objective is to profit on the bid-ask spread while maintaining minimal securities inventory. Of note, some firms register with exchanges and trading venues as official market makers. Yet, some trading firms instead act as informal liquidity providers and do not register as a market maker. All of these firms have become significant liquidity providers and contributors to price formation in many markets.
- **Execution** – Algos split a large trade into smaller trades and execute over time and across venues. The objective is to minimize the price impact of a transaction, attempting to build or exit a position at low cost. The strategy is used by broker-dealers and investors (asset managers).
- **Arbitrage** – This strategy attempts to capitalize on price discrepancies by purchasing a security in one market and simultaneously selling this asset in another market at a higher price. Examples include trading the same instrument: on an exchange and on an ATS or MTF; in an index and a basket of the underlying securities; or related instruments, i.e. a security and associated derivative. While often considered risk-free profit for a trader, arbitrage trading also ensures prices do not deviate substantially from fair value for long

periods of time. For example, arb traders look at historical deviations from trend (prices, correlations) and, assuming mean reversion, seek to eliminate inconsistencies between prices. Pair arb trading involves attempting to capitalize on price discrepancies between two closely related companies (Coca Cola vs. Pepsi, Lowes vs. Home Depot, Exxon vs. Chevron). These strategies adjust price discrepancies in markets to historical fundamental levels.

- **Directional** – The strategy to buy or sell is based on the investor’s view of the future direction of an asset price or the market. It involves carrying unhedged positions to trade across small but lasting intraday price changes. This can include trading around a stock mispricing which can occur around an event, such as corporate announcements (earnings, investor day), macroeconomic news, industry reports, etc. It can also include attempting to detect upcoming undisclosed liquidity changes caused by large institutional buying/selling (anticipation of upcoming block trades).
- **Relative Value** – This strategy trades securities in relation to each other. For example, an investor can simultaneously buy a stock and sell a stock index future at a spread.

Types of Electronic Trading Platforms & Activities

As discussed above, the generic term electronic trading covers a variety of systems and activities across the trade lifecycle. It cannot be defined by a single definition for a firm or strategy. For example, different types of electronic trading platforms can perform just the order transmission piece or up to full trade execution. Or different types of electronic activities can automate one piece or all aspects of the trading lifecycle.

Some common types of electronic trading platforms and activities include (among others):

- Systems handling quotation of prices or dissemination of trade requests
- Systems to disseminate pre- and post-trade information
- Clearing and settlement systems
- Reporting mechanisms
- Electronic order routing platforms
- Alternative Trading Systems (ATS)
- Electronic Communications Networks (ECNs)
- Dark Pools
- Dealer platforms (single or multiple dealer platforms)
- Exchanges
- Electronic trading platforms (ETPs)

Types of Electronic Trading Platform Protocols

ETPs all attempt to match buyers with sellers. Yet, they may use a variety of different trading protocols to align with the types of clients they are serving. Some common types of ETP trading protocols – which may differ in anonymity (quote receiver/requester identified), how many and what type of participants are involved, the type of quote (buy, sell; executable or indicative), etc. – include (among others):

- **Dealer-to-Dealer (D2D)** – System allows only dealers to negotiate and trade with other dealers
- **Dealer-to-Client (D2C)** – System allows dealers to negotiate and trade with clients
- **All-to-All (A2A)** – System allows any member, dealer or client, to negotiate and trade with any other member
- **Real Time Matching Session** – Orders matched throughout the trading session
- **End of Session Matching** – Orders matched at the end of the trading session
- **Central Limit Order Book (CLOB; matching engines in equities)** – System uses an algo to match customer orders on a price time priority basis (no negotiation); the highest bid and lowest ask orders establish the best market in a security, and low cost execution is achieved by crossing the bid/ask spread
- **Lit Order Book** – The order book is made public for all members, allowing all traders to see the amount of liquidity posted on the bid and offer side of the book
- **Hidden Order Book** – The order book is not fully made public for members, some pre-trade transparency (price, market depth) is deliberately hidden to entice liquidity suppliers to offer greater quantities for trade
- **Click to Trade (CTT)** – Systems allow immediate trading at aggregated prices streamed by a dealer or set of dealers
- **Request for Quote (RFQ)** – Platform members query dealers to request prices on an order at a set size
- **Request for Spread** – System enables members to trade on a spread rather than a cash price, uses RFQ protocol
- **Request for Stream** – Market makers provide continuous streams of firm quotes with available size; clients can click to trade
- **Auto Quoting** – Algos respond automatically to RFQs based on defined parameters (maturity, sector, security type, currency, etc.)
- **Internal Crossings** – System matches opposite trading interests of users based on internal pricing models or electronically determined mid prices

The Electronification of Markets

As described above, securities can trade on an exchange (or trading venue) or OTC. There are various differences among these types of trading environments, all of which generally lead to varying levels of liquidity in the market. Some of the main differences between exchange and OTC trading include:

Exchange*	OTC
<ul style="list-style-type: none"> • Centralized, 1 main intermediary • Standardization • Highly regulated • Many market participants • Order driven • Highly liquid 	<ul style="list-style-type: none"> • Decentralized, multiple intermediaries • No/less standardization • Not as regulated (but the dealers acting as intermediaries are regulated) • Fewer market participants • Quote driven • Less liquid

Source: SIFMA

Note: *Traded on an exchange or registered trading venue. FINRA has requirements for venues trading OTC U.S. cash equities

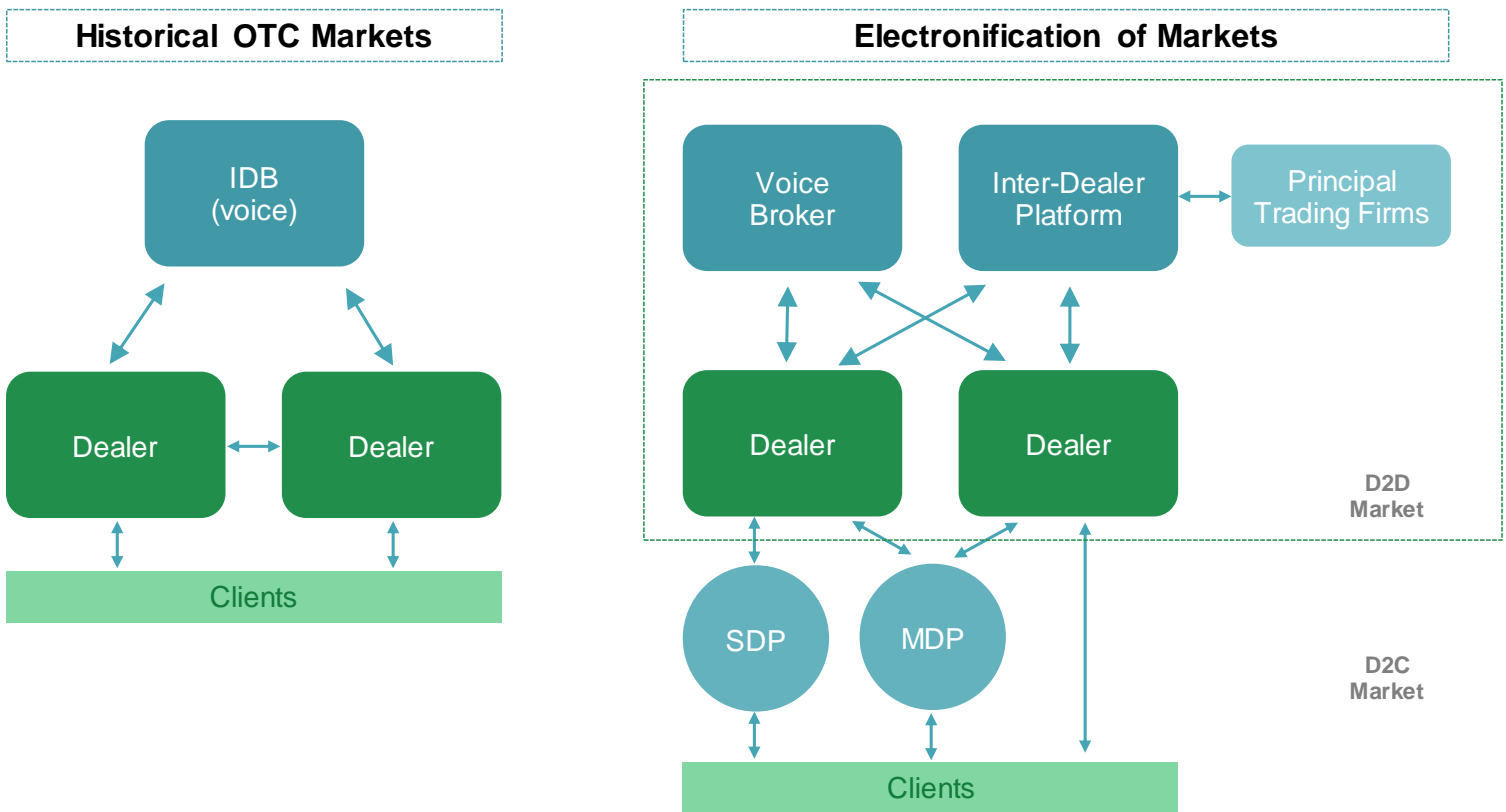
As technological advances and market structure evolved over time, markets and products began the electronification journey from OTC to exchange traded, predominantly in search of liquidity.



- **Voice** – Voice execution is OTC trading where dealers acted as intermediaries to match buyers/sellers in a quote driven marketplace; it is performed predominantly over the telephone (now instant messaging, email).
- **Electronic D2D** – In the late 1990s, electronic communication networks (ECN) emerged and took their place in more liquid markets, like equities, FX and government securities. ECNs are electronic systems acting as intermediaries to disseminate orders on a wide basis; orders can be executed in whole or part. This was a move to order driven markets, as ECNs often used CLOB/matching engine trading protocols. ECNs also offered integration to increase efficiencies in the trading process.

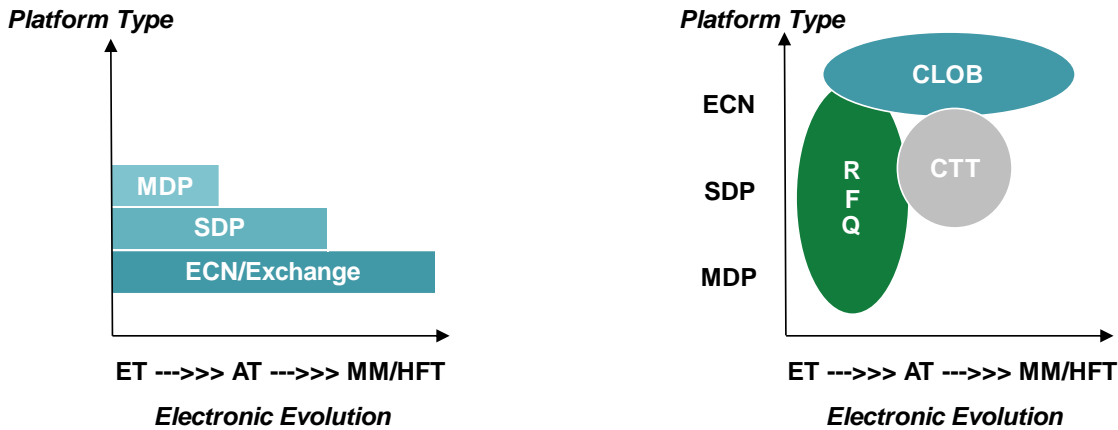
- **Electronic D2C** – Electronic D2C also began to grow in the late 1990s. D2C markets typically use RFQ trading protocols and are offered in two methods:
 - Single-dealer platforms (SDPs) – SDPs, or trading systems offered by a dealer to its clients, are electronic versions of bilateral OTC markets.
 - Multi-dealer platforms (MDPs) – MDPs enable clients to request quotes from multiple dealers simultaneously, thereby reducing search costs. MDPs also increase efficiencies in operations and compliance requirements by automating record keeping, helping with audit trails for regulators.

- **Automated Trading** – Electronic trading platforms enable markets/products to adopt automated trading. As described above, in automated trading order and trade decisions are made electronically and autonomously. Even traditional market participants have invested in automated trading platforms/strategies over the years.



Source: Bank for International Settlements [report](#) (January 2016), SIFMA estimates

Putting this all together, one can see the different types of platforms and trading protocols as they move across the electronic evolution scale:



Source: BIS, SIFMA estimates

Moving from OTC to Electronic

The electronification of markets indicates the increasing percentage of trading performed on ETPs. Today, market participants search for greater transparency across the trade lifecycle – pre trade, at trade and post trade. Additionally, European regulations are driving market participants’ demand for greater evidence around proving best ex. Therefore, many markets across financial services are already electronic, and the growth in other segments continues.

On the following pages, we assess the percent of electronification globally across different products. Markets that displayed good liquidity prior to electronification fall into the highly electronic camp, and the electronification scale rolls down in line with lower levels of liquidity. Additionally, the more fungible (essentially equivalent and therefore interchangeable) a security is, the higher potential for standardization and therefore electronification. The more bespoke the products or markets, the lower the probability of electronification.

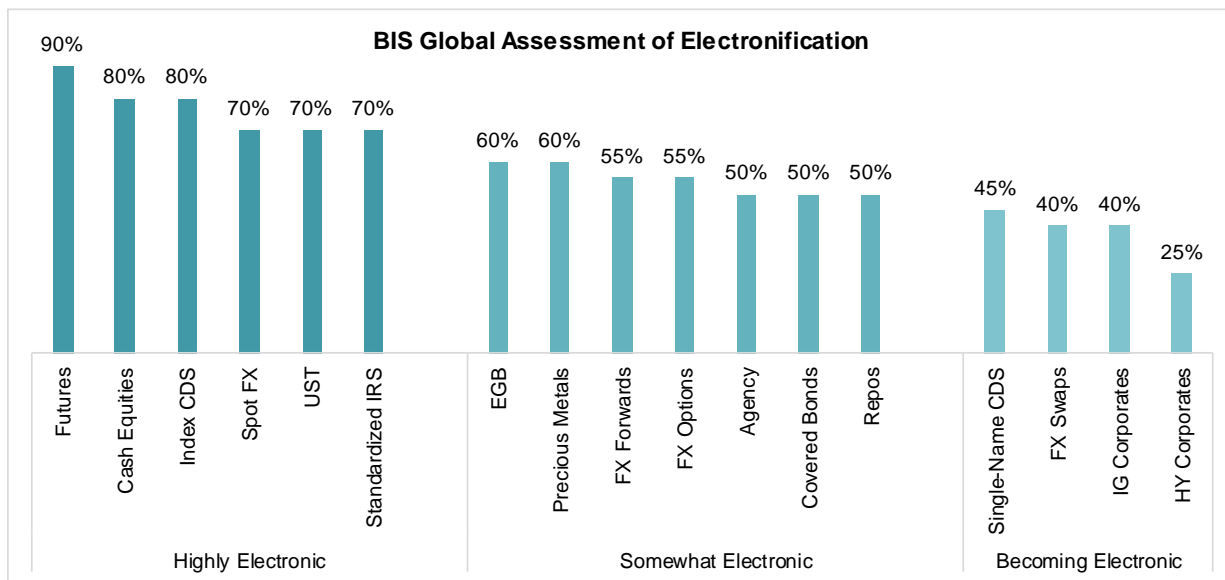
We note that the percent of electronification may not reach 100%. For example, block trades may use upstairs trading desks⁵ to break up the trade into smaller pieces that will not significantly shift market prices before the entire position is executed, i.e. working the order. Here anonymity is key and access to info is not considered a good thing, meaning this type of trading will continue as is.

⁵ Trading of high-touch blocks; a form of capital commitment trading which will print to the tape as off-exchange

When looking at the data sets on the following pages, please note that BIS measures global totals (buy and sell side) while Greenwich measures U.S. buy-side figures only. Therefore, electronic uptake does not always match across the two data sets, Greenwich and BIS. For example, cash equities is 80% in the survey of all global electronic trading volumes, yet 36% for U.S. buy side volumes only. This not only shows the differences across regions, but also nuances between buy and sell side trading preferences (such as the need for anonymity in executing large trade positions).

The BIS breaks out **total global electronic trading** (buy and sell side) of asset classes into highly (70%-100%), somewhat (50%-70%) and becoming (0%-50%) electronic.

- Highly standardizable and fungible products like futures, cash equities and index CDS show the highest degrees of electronification at 90%, 80% and 80% respectively
- FX swaps and corporate bonds are at the low end of the spectrum, as these are more bespoke products; FX swaps 40%, IG corporates 40% and HY corporates 25%

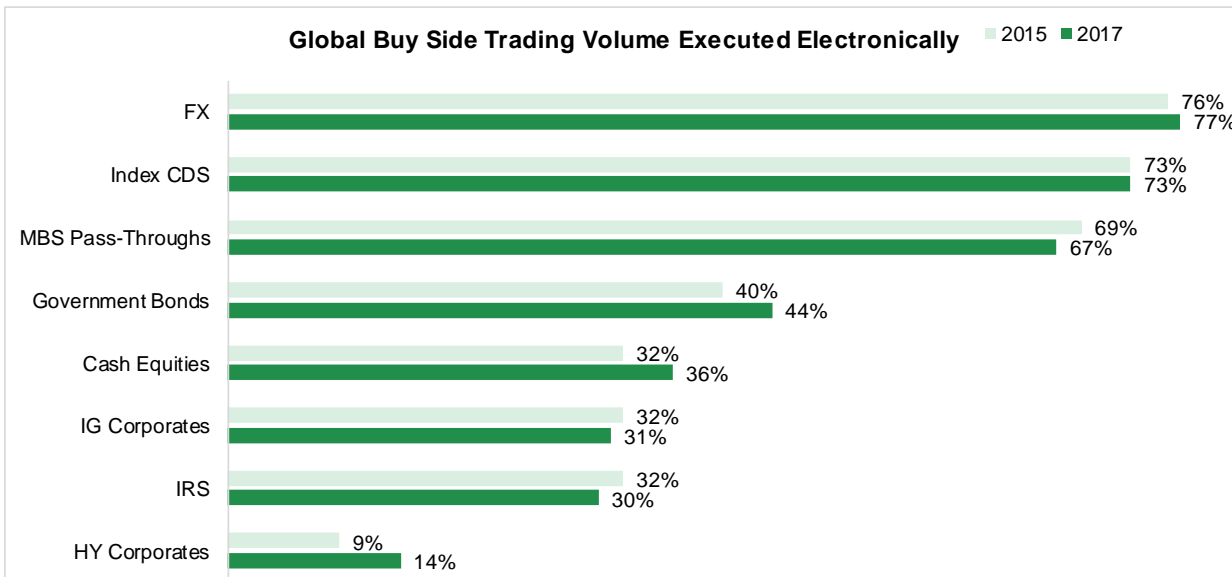


Source: (top) Bank for International Settlements [report](#) (January 2016, updated triennially; citing Greenwich Associates 2013/2014 & McKinsey & Co. 2013), SIFMA estimates

Note: CDS = credit default swap; FX = foreign exchange; IRS = interest rate swap; EGB = European government bond; IG = investment grade; HY = high-yield. Global totals may be greater than US-only figures in certain markets

Looking specifically at **global buy side usage** of electronic trading, we note the following trends across asset classes:

- FX the highest at 77%, HY corporates the lowest at 14%
- It is mixed for growth trends in % electronic from 2015-2017: increase = HY corporates, cash equities, government bonds and FX; decrease = IRS, IG corporates, MBS pass-throughs; same = Index CDS

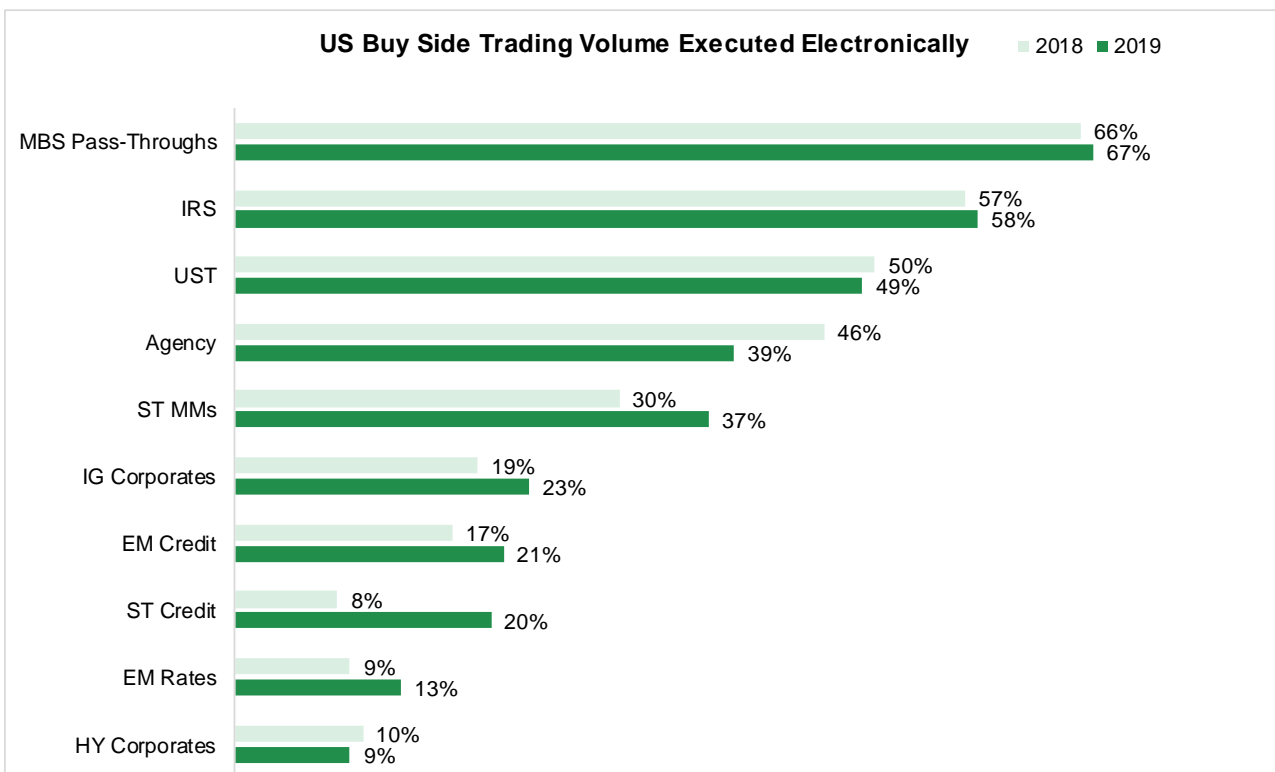


Source: Greenwich Associates

Note: CDS = credit default swap; FX = foreign exchange; IRS = interest rate swap; IG = investment grade; HY = high-yield; MBS = mortgage-backed security

Looking at the most recent data for **U.S. buy side usage** of electronic trading across fixed income segments, we note the following trends:

- MBS pass-throughs the highest at 67%, HY corporates the lowest at 9%
- More subcategories increased in % electronic than decreased in the fixed income space from 2018-2019: increase = MBS pass-throughs, IRS, ST MMs, IG corporates, EM credit, ST credit, EM rates; decrease = UST, agency, HY corporates



Source: Greenwich Associates

Note: IRS = interest rate swap; IG = investment grade; HY = high-yield; MBS = mortgage-backed security; UST = US Treasury; ST MM = short term money market; EM = emerging market.

The Shifting Financial Institution Infrastructure

Broker Dealers Adapt to Changing Market Environment and Clients' Needs

Financial institutions such as broker-dealers act as financial intermediaries, providing advice and connecting clients needing capital with those providing capital. Broker-dealers work on behalf of clients to understand clients' needs and connect them with the right products to fit their objectives. Roles include, among others: executing trades, making markets, managing risk, providing investment advice, and publishing investment recommendations.

The role of the broker-dealer and in particular the markets and securities division has evolved significantly since the global financial crisis. This has been driven not just by regulations, which have pressured cost structures for both sell and buy side firms, but also given financial technology innovations and shifting investor profiles. Broker-dealers had (and continue) to innovate to continue serving changing clients' needs.

This shift in business structure has enabled the growth of electronic trading.

From Sales & Trading to Markets & Securities

Historically, firms segmented groups and employees by:

- **Department** – Research; sales, trading and prime brokerage
- **Function** – Research, sales trader and trader
- **Product** – Cash equities, derivatives, credit, rates, commodities, structured products

One aspect that has not changed is firms are there to serve their clients' needs. Today, the divisions are setup to serve clients in one of two ways:

- **High Touch** – Interacting heavily with clients to provide tailored investment solutions
- **Low Touch** – Electronic trading for clients, emphasizing the provision of low cost, highly efficient execution

Broker dealers are now providing electronic trading across asset classes, and employees are trading for multiple products rather than focusing on one/two product specialties. Electronification frees up employees to spend more time maintaining and expanding client relationships.

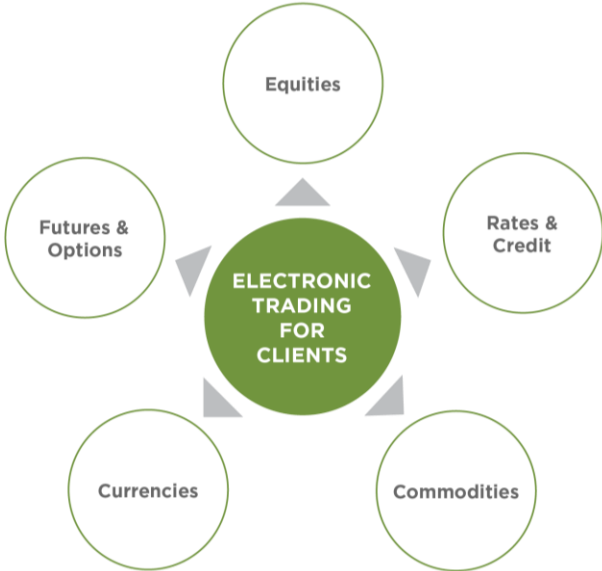
Firms are now competing on electronic trading platforms. There has been a strong momentum to provide global electronic trading capabilities that are integrated and cross asset: equities, fixed income, futures and FX. These platforms offer clients numerous e-trading solutions and innovations to provide deep liquidity pools and increased transparency, as well as often overlaying data science capabilities for trade analytics.

Today's Markets & Securities Division

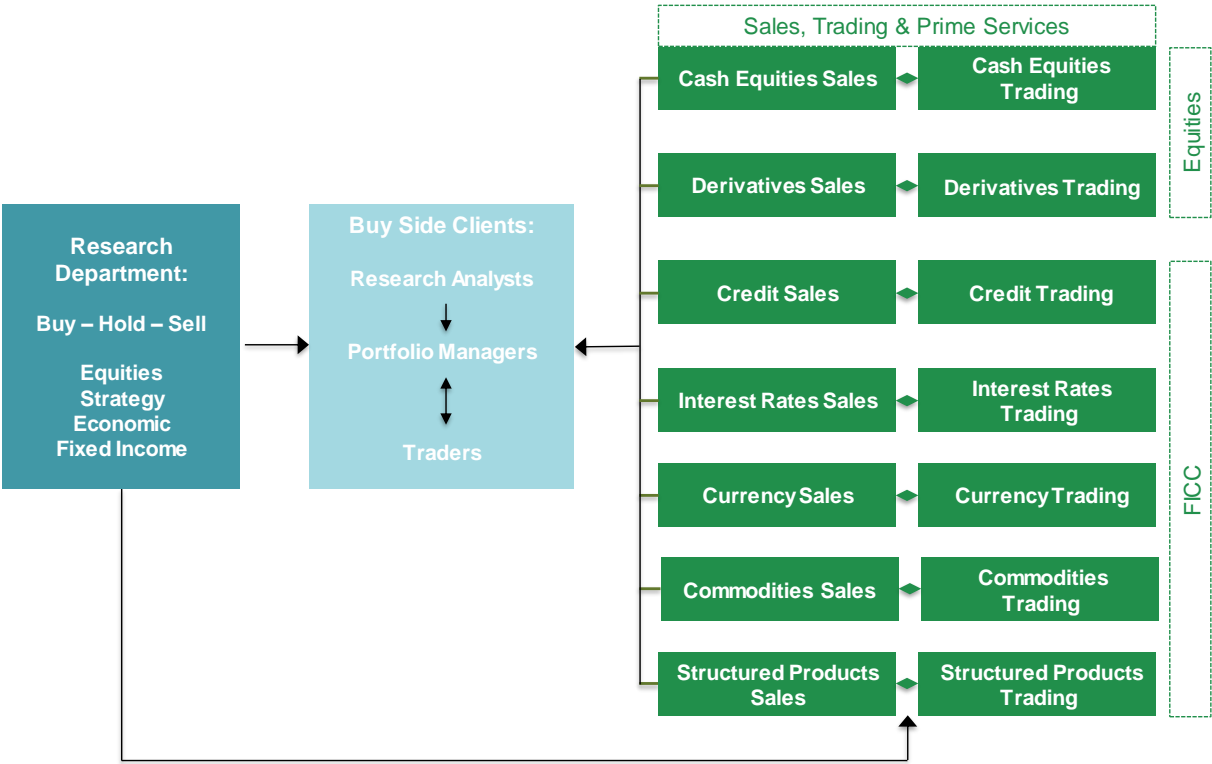
Focus: Tailored Investment Solutions



Focus: Low-Cost, High-Efficiency Execution



Formerly the Sales & Trading Division



Note: Firms may label items differently or provide additional services not mentioned here; the model will vary by firm, and not all firms have fully adopted this model.

Please see SIFMA Insights: Global Capital Markets & Financial Institutions [Primer](#) for more details on secondary markets.

It's All About Access to Information

Access to information is key in the trading world. An important part of the journey to electronification of trading is the capability for market participants to communicate with each other quickly, efficiently and across borders. As such, throughout the decades market participants continued to develop new ways to communicate fast and efficiently.

Decades ago, it was about location – futures markets had pits, while equities had specialist posts. Designated stocks, products or markets were traded in these locations. People knew where to go to get the most updated prices and execute trades efficiently. Market participants also developed electronic systems for reliable messaging (trade confirmation, settlement, etc.) and payments (interbank, with central banks, etc.). These were designed to gain operational efficiencies and decrease costs to trade. Eventually, market participants designed electronic communications systems.

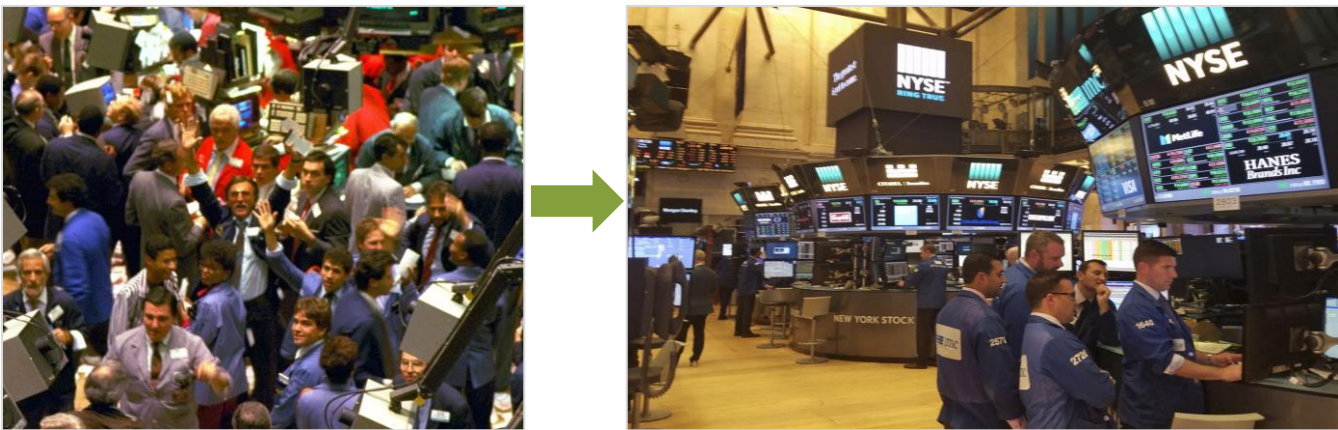
All of this established the building blocks – along with technological innovations – to creating electronic markets. Below we review a few pertinent communications and messaging methods and systems.

Specialist Traders/Designated Market Makers

The specialists system for trading stocks on the NYSE had been in place for almost 150 years; NYSE had specialists operating on the floor since 1872. A specialist was a member of a stock exchange acting as a market maker⁶ to facilitate trading of stock. They traded 5-10 stocks at a time, with one specialist per stock standing ready to step in and buy/sell as needed to ensure a fair and orderly market. A specialist stood on a particular spot on the floor of the exchange (his trading post), and floor traders acting on behalf of clients would come to the post for price discovery and to execute orders. (This is an open outcry auction system, just under a different name.)

Due to electrification of equities markets, the number of specialists declined significantly. In the mid-1980s, there were ~420 floor brokers selling ~250 million stocks each day. Today, the NYSE floor is almost vacant during intraday trading, with the majority of equity trading executed electronically. In fact, the specialist system is gone, with NYSE now using the Designated Market Maker (DMM) model, which still requires the maintaining of fair and orderly markets for assigned securities. Today, DMMs operate manually and electronically to facilitate price discovery during market opens, closes and periods of trading imbalances or instability.

The Transformation from the Mid-1980s to The Modern Era



Source: (left) Quartz, October 2017; (right) William & Mary, May 2017

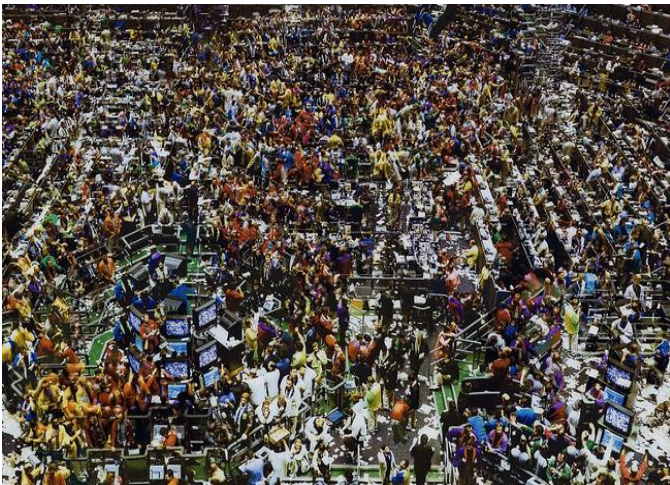
⁶ Market makers stand ready to buy and sell stocks on a continuous basis, as they are obligated to make two sided quotes in the market at all times

Open Outcry Pits

In open outcry trading, verbal and hand signals convey trading information (volume, price, intentions, acceptance) in the trading pits, or a set area on the trading floor designated to trade a certain product or market. To the untrained eye, it looked like a mosh pit. For those of us who love the movie *Trading Places*, we remember the mayhem that ensued in the frozen concentrated orange juice futures pit once the real orange crop report was broadcast. In reality, open outcry was an organized auction process where participants had a chance to compete for orders. Once traders agreed on terms, they settled a contract for that trade. The format enabled price discovery and other efficiencies (for their time!).

It was used in futures and listed options markets for many years. While some commodity and option exchanges continued to use open outcry, they simultaneously offered electronic alternatives until the time they fully closed the pits. The London Metal Exchange is the largest exchange still using open outcry.

The Closing of CME's Trading Pits



Source: (left) MarketWatch, June 2015; (right) Crain's, June 2015

Messaging Systems

SWIFT Messaging System

The Society for Worldwide Interbank Financial Telecommunication (SWIFT) is a member owned cooperative founded in 1973 to create a global financial common language and messaging service. It was developed to validate and route messages in a standardized manner for financial institutions across the globe.

It went live in 1977, replacing the Telex technology then used by firms to communicate cross-border transfers, with 518 institutions in 22 countries connected to its services. It processed 10 million messages within its first 12 months of operations. In 1983, it connected central banks for the first time, officially establishing itself as the common link between all parties in financial services. By 1989, it served 2,814 customers in 79 countries, with 296 million messages processed in 1989. Technology advancements (UNIX interface systems, straight-through processing capabilities) in the 1990s enable it to serve 6,797 customers in 189 countries, with over 1 billion messages in 1999. Today SWIFT is used by 11,000+ institutions in 200+ countries, having processed 7.8+ billion messages.

SWIFT remains a primary channel for institutions – banks, broker-dealers, custodians, investment managers, central banks, market infrastructures and corporations – to ensure a secure and cost effective way to transmit standardized messages relating to: payments (interbank transactions, corporate services, cash management, compliance), securities (trade confirmations, clearing, settlement) and FX/Treasury.

SWIFT's services address operational challenges and increases efficiencies for financial institutions, including: automating manual and time consuming processes; back office processes; communications; etc. Over the last 15 years, SWIFT reduced the average message price by >90%, from over 30 EUR cents per kilocharacters to ~2.5.

FIX Messaging System

The Financial Information eXchange (FIX) protocol is an electronic communications protocol established in 1992. It enables electronic communication of global, real time securities transactions and market information, replacing phone communications between broker-dealers and institutional clients. Its objectives are to provide standardization, operational efficiencies, transparency and cost reductions to market participants.

The FIX protocol language is comprised of a series of messaging specifications used in trade communications, originally used in equities markets for pre trade and trade communications. It expanded into post trade transactions, supporting straight-through processing, and it gained acceptance in fixed income, FX and listed derivative markets.

The FIX messaging standard is owned, developed and maintained by the FIX Trading Community. Its membership includes 290+ financial institutions across the globe (35% EMEA, 29% Americas, 26% Asia Pacific and Japan, 10% other). These firms work to ensure the standard continues to meet emerging trading requirements and to promote its increased adoption.

Looking Across Markets

As we have been detailing in this report, there are many benefits from the electronification of markets – faster execution, operational efficiencies, lower error rates and lower costs to recap a few. Electronification also enables 24-hour trading capabilities, which not only expands the trading day but also increases access to traders to other regions whose time zones may have limited trading during only U.S. hours.

Additionally, liquidity levels, messaging systems and fungibility of products come into play in determining the electronification journey of various products and markets. For example, equities are fungible, and most futures markets exhibited high levels of liquidity prior to electronification. Conversely, most of the fixed income, currencies and commodities (FICC) markets started (and remain) as RFQ markets, where dealers act as intermediaries and communicate over phones (now through instant messaging, email).

We have seen a transformation in fixed income markets since the crisis, historically bilateral and performed by dealers. Post-crisis regulatory constraints on balance sheets, such as the Volcker Rule, have resulted in many dealers dramatically reducing inventory and market making capabilities, as they exited businesses with high capital charges. This was to the detriment of some fixed income activities, i.e. decreasing liquidity. To continue servicing clients' needs, markets had to be innovative and leverage product innovation and technology. This enabled the development and adoption of electronic market makers (and the growth in ETFs and other passive investments as well), albeit gradual and varying by type of security. In other words, the FICC electronic transformation is driven by the search for liquidity.

Below we detail the electronification journey across different markets.

Equities, Futures & Options

In more liquid markets, such as equities, futures and options, the adaption of electronic trading over the years has enabled market makers to provide execution of high volumes at narrow spreads, with the opportunity for price improvement. This provides investors with not only with low cost execution but also the chance to execute the trade at a price better than they had required, essentially a chance to overachieve on the best execution front.

Equities

- 1968 Paper Crisis
- 1969 Instinet founded
- 1971 Nasdaq debuts as an electronic market
- Electronic conversions:
 - 1986 London Stock Exchange
 - 1994 Borsa Italiana*
 - 1995 NYSE moved toward automation via the use of wireless hand held computers
 - 1997 Toronto Stock Exchange
 - 1999 Tokyo Stock Exchange
- 1996 Archipelago created as one of the first ECNs
- 2001 Archipelago (ArcaEx*) becomes an exchange
- 2006 NYSE acquires ArcaEx, now NYSE Arca
- 2008 Virtu Financial* founded as an electronic market maker

Futures & Options

- F&O
 - 1992 CME's Globex launched as the first electronic trading system for F&O
 - 1998 Eurex* debuted as an all electronic exchange
- Multi-Listed Options
 - 2000 International Securities Exchange (ISE*) founded as fully electronic options exchange

Source: Company websites

Note: *Eurex now owned by Deutsche Börse; Borsa Italiana owned by London Stock Exchange; Arca owned by NYSE, a subsidiary of Intercontinental exchange (ICE); ISE owned by Nasdaq; in addition to equities, Virtu trades FICC and options products

The Paper Crisis

By 1968, equity average daily trading volume (ADV) reached over 12 million shares per day. With no computerized trading or electronic centralized stock delivery system, financial institution's back offices were overrun with paper – they actually delivered paper stock certificates by hand! – and they could not handle the volume of clearing and settlement processes. The Paper Crisis forced the NYSE to restrict trading to four days a week, as the exchange shut down on Wednesdays (and often closed early other days) to work through the backlog of paper. Despite this, the surge of fails (failure to receive or deliver securities within five days of a trade) continued, and firms lost control of records in the confusion.

Enter The Depository Trust Company (DTC) in 1973 to alleviate the paper crisis. (The use of computers also helped ease the paper crisis and drove down transaction costs.) DTC is the sole U.S. (and a large global) central securities depository (CSD), handling settlement, and asset & wealth management services (ex: book-entry changes to ownership of the securities) across equities and corporate and municipal debt. In 1976, as another solution to the paper crisis, the National Securities Clearing Corporation (NSCC) was formed to clear U.S. equities using multilateral netting. These are all under the Depository Trust & Clearing Corporation (DTCC) umbrella, officially established in 1999 as a holding company providing post trade market infrastructure to advance automation, centralization, standardization and streamlining of processes. Its mission is to increase transparency and efficiencies, as well as decrease transaction costs.

Instinet

In 1967, Instinet offered the first major electronic trading alternative. Institutional clients could use the platform to bypass the trading floors and interact directly with each other on a confidential basis, bringing efficiencies to financial markets.

Today, Instinet (owned by the Nomura Group) continues to innovate its technology to serve up institutional clients a portfolio of services, including: research and insights (U.S. equity research, expert commentary); trading services (high touch, algo and low latency trading); liquidity venues (a suite of alternative crossing venues); and workflow solutions (pre trade strategy, real time trade performance data, post trade analysis).

National Association of Securities Dealers Automated Quotations (Nasdaq)

In 1971, Nasdaq was founded as the first electronic stock market. In the beginning it provided an automated quotation system – as stated in its name – which enabled brokers to see prices offered by other firms, as trades were handled over the phone at this time. It added additional automated trading features, eventually launching its Small Order Execution System in the late 1980s. This was a response to market makers not picking up their phones after the 1987 crash. Automation was offered as a means of reliability and operational certainty.

Electronic Communications Systems (ECN)

An electronic communication network (ECN) is an electronic system that automates the process to match buyers/sellers in markets, essentially a digital pool of orders. It connects brokers and traders, enabling them to trade directly and efficiently (without an intermediary). ECNs display the best available bid/ask quotes from multiple market participants, automatically matching and executing orders. They typically process limit orders, allowing full or partial execution. Over the years, some ECNs merged with registered securities exchanges or became an exchange themselves, such as BATS and Direct Edge (BATS bought Direct Edge in 2013; now owned by Cboe Global Markets).

In the U.S., ECNs must register with the SEC as broker-dealers and adhere to Regulation ATS, as an ECN is a type of alternative trading system (ATS). An ATS is a trading venue to match buy/sell orders, but it is not a registered securities exchange. They are known as multilateral trading facilities (MTF) in Europe. ATS are significant contributors to liquidity across global markets.

Fixed Income, Currencies & Commodities (FICC)

On the FICC side of trading, the story is more about the search for liquidity. Post financial crisis regulations (liquidity requirements, capital charges, etc.) forced broker dealers to decrease the amount of balance sheet committed to holding positions to facilitate execution, preventing them from making markets in the broadest sense possible. Now there are fewer bonds with active intraday markets than 10 years ago, i.e. lower liquidity.

Electronic trading platforms have attempted to step in and fill these holes, at varying rates of speed and degrees of success across different FICC segments. For those instruments that can fit well into electronic trading – higher level of standardization, more fungible, etc. – clients in these markets have and will continue to benefit.

FX	UST	Corporates
<ul style="list-style-type: none"> •FXall (Refinitiv) •FX Connect/Currenex (StateStreet) •360T (Deutsche Börse) •Bloomberg FXGO •EBS Direct (CME) •FastMatch (Euronext) •FlexTrade •FXSpotStream •HotSpotFXi (Cboe Global Markets) •Integral - FX Inside •Gain GTX (Deutsche Börse) •LMAX •LiquidityFX (smartTrade Technologies) 	<ul style="list-style-type: none"> •D2D --BrokerTec (CME) --eSpeed (Nasdaq) --SDPs (each owned by a dealer) --Dealerweb (Tradeweb) --LiquidityEdge (now MarketAxess) --FENICS (BGC Partners) •D2C --Bloomberg --Tradeweb --MarketAxess --MTS BondVision (LSE) 	<ul style="list-style-type: none"> •MarketAxess •Tradeweb •Bloomberg •Trumid •Liquidnet •BondCliq •BondPoint (ICE) •MTS Bonds (LSE) •TMC Bonds (ICE)

Note: FlexTrade = no matching engine, an execution management system (EMS); LSE = London Stock Exchange; ICE = Intercontinental Exchange; LSE announced its intention to acquire Refinitiv in August 2019, pending shareholder and regulatory approvals

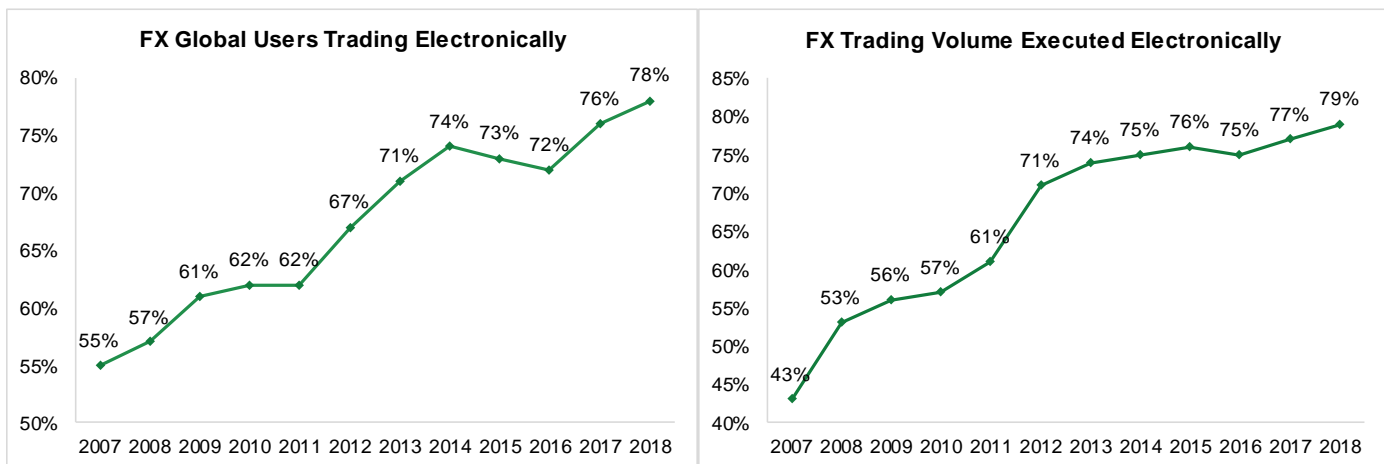
FX

As noted earlier in this report, electronic uptake does not always match across data sets, nor do all data sets account for nuances across subcategories within an asset class. Different users (buy versus sell side), may have adopted electronic trading at different rates. Different products within an asset class may also have moved across their electronic journey at different rates. Depending upon which subgroup holds the higher percentage of total volumes, this may skew the top level average. And different data sets present the results in dissimilar manners.

FX is a great case study in this. 2016 BIS data shows global total FX (sell and buy side) at 70% for spot, which is more standardizable, versus 40% for swaps, which are more bespoke. According to a 2018 Greenwich Associates survey analyzing responses from global top tier users of foreign exchange, 79% of total FX volume is now executed electronically. These differences could be based on the heavier weight to spot trading (more easily traded electronically) in the pure buy side volume data set, whereas the data with both buy and sell side volumes covers a more diverse product set traded (ex: swaps are less easily traded electronically).

Looking at electronic volumes, we note the following trends:

- 78% of respondents performed some level of electronic execution; up from 55% in 2007, +23 percentage points (pps) in 11 years (Greenwich 2018)
- 79% of total FX volumes of those surveyed were executed electronically in 2018; up from 43% in 2007, +36 pps in 11 years (Greenwich 2018)
- 74% replied the reason to execute via an algo was urgency of execution, followed by volatility 63% and both size by currency pair and currency group at 53% (Greenwich 2017)
- Over 1/3 of market share is held by FXall, followed by FX Connect 19% and 360T 10% (Euromoney 2018)



Source: Greenwich Associates

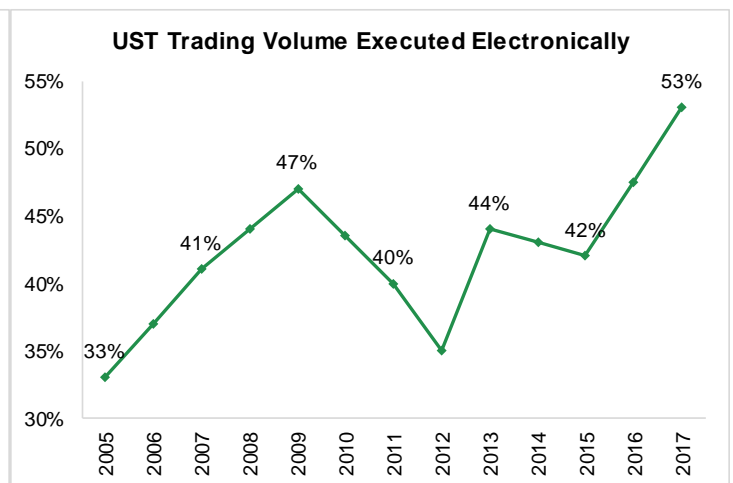
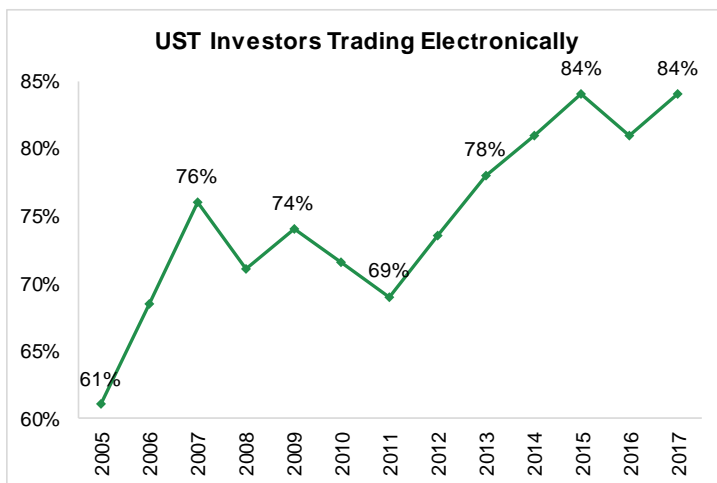
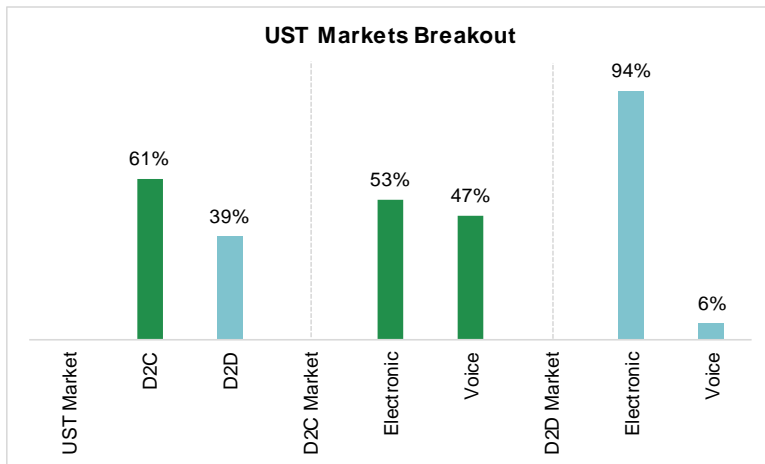
Note: Responses from global top tier FX users listed in order of year = 1,780; 1,437; 1,497; 1,562; 1,632; 1,622; 1,584; 1,682; 1,633; 1,530; 1,421; 1,451

UST

Almost 70% of the UST market is executed electronically. Yet, the percent of electronic trading versus voice varies across subsegments. D2D (61% of the total UST market) is much farther along at 94% electronic than D2C at 53% (top chart).

Looking at investor take-up of electronic trading of UST, we note the following trends: (bottom charts)

- 84% of 2017 respondents performed a level of electronic execution; up from 61% in 2005, +23 pps in 12 years
- 53% of volumes of those surveyed were executed electronically; up from 33% in 2005, +20 pps in 12 years

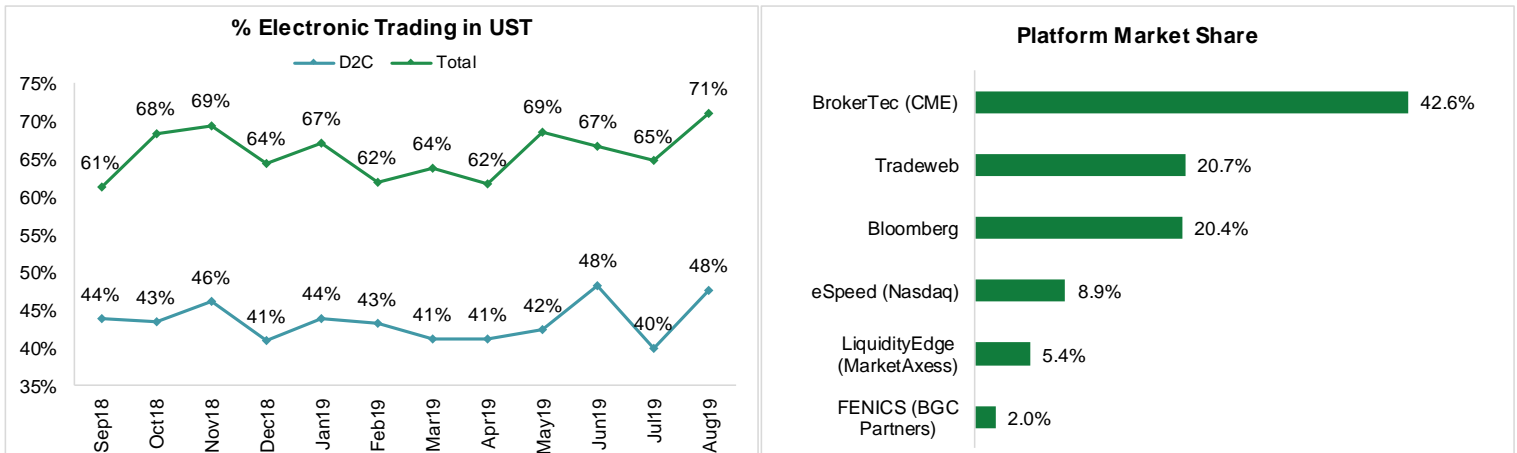


Source: Greenwich Associates, SIFMA estimates

Note: (top) As of 2017. (bottom) Respondents by year = 129, 114, 130, 130, 85, 90, 115, 111, 101, 93, 100, 90, 92

Looking further at growth rates in UST electronic trading and platform market shares, we note the following trends:

- D2C electronic trading is at 48% in August 2019; up from 44% roughly a year ago, settling in the low 40s for most of 2018
- This lags total UST market electronic trading, now at 71%; this total also settled lower for much of 2018, around the low 60s
- Of the total electronically traded UST market, BrokerTec holds a 43% share, followed by Tradeweb at 21% and Bloomberg at 20% (September 2018)
- In the D2D market, BrokerTec dominates at a ~80% market share, followed by eSpeed 11% and SDPs <4%



Source: Greenwich Associates (2017)

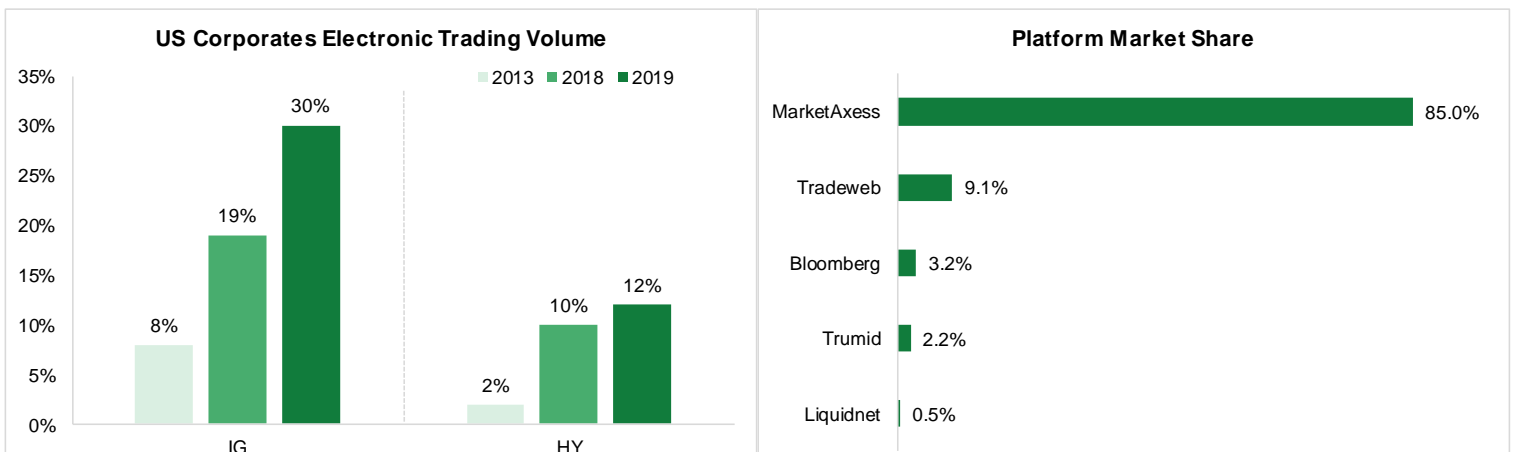
Note: (left) As of 2017. (right) As of September 2018; based on non voice portion of \$517B ADV reported by the NY Fed

Corporates

Corporate bond electronic trading lags other fixed income markets. This is due to a lack of fungibility – a large financial institution may have 1 stock but 1,500 CUSIPs for corporate bonds – and the bespoke nature of the role of corporate bonds, i.e. debt is issued for a specific project or purpose with different terms (maturity, coupon, etc.) each time. Yet, it is an area that continues to search for ways to increase electronic trading, as investors seek liquidity due to dealers holding less inventory than pre crisis levels.

We note the following trends in electronic trading of corporates:

- Electronic trading varies dramatically by region, with total (IG + HY) volumes traded electronically 60% for Europe versus 15% in the U.S.⁷
- U.S. electronic trading now 30% in IG and 12% in HY, up from 8% and 2% in 2013; growth in IG continues to outpace, as it has increased 11 pps Y/Y versus 2 pps for HY (left chart)
- 90% of IG cash bond investors report they trade online, versus 83% in HY
- Global total (IG + HY) corporate bond market share led by Bloomberg at 51%, followed by 38% MarketAxess and 9% Tradeweb⁸
- D2C (U.S. institutions, IG + HY) market share dominated by MarketAxess at 85%, followed by Tradeweb 9% and Bloomberg 3% (right chart); MarketAxess total (D2D + D2C) IG market share estimated at 19%⁹



Source: Greenwich Associates (left = June 2019; right = 2018)
 Note: IG = investment grade, HY = high yield

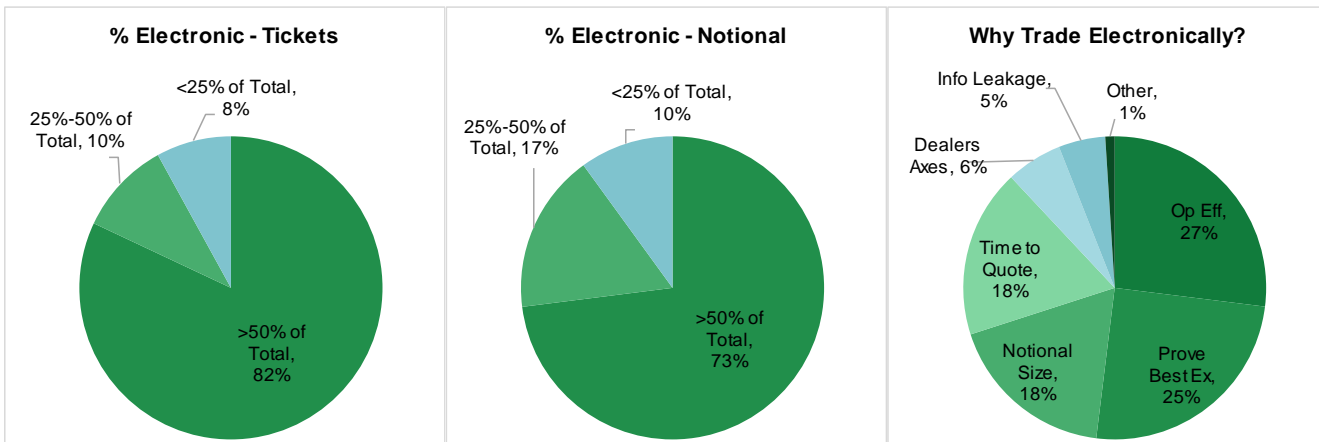
⁷ Greenwich Associates survey based on 296 responses for 2016
⁸ Greenwich Associates survey based on 407 responses for 2016
⁹ MarketAxess website, current investor presentation as of September 2019

Rates

A Barclays' client survey in April 2019 polled sentiment across a variety of electronic rates trading topics, such as best execution (best ex), broker selection and transaction cost analysis (TCA). The results include responses from various institutional clients (asset managers, hedge funds, banks, broker-dealers, insurance companies, etc.) to analyze how technology is transforming rates trading.

The survey showed:

- 82% of clients execute the majority (>50% of total) of their rates transactions electronically, based on # tickets
- 73% of clients execute the majority (>50% of total) of their rates transactions electronically, based on notional value
- Seeking operational efficiencies is the leading driver behind transacting electronically, at 27%, followed by proving best ex at 25%



Source: Barclays (April 2019)

Note: Op eff = operating efficiencies; info = information

Appendix: Terms to Know

BIS	Bank for International Settlements
CFTC	Commodity Futures Trading Commission
FINRA	Financial Industry Regulatory Authority
SEC	Securities and Exchange Commission
FX	Foreign Exchange
ADV	Average Daily Trading Volume
Algo	Algorithm (algorithmic trading)
ATS	Alternative Trading System
Best Ex	Best Execution
BPS	Basis Points
CLOB	Central Limit Order Book
D2C	Dealer-to-Client
D2D	Dealer-to-Dealer
Dark Pool	Private trading venues, not accessible by the public
ECN	Electronic Communication Network
ETP	Electronic Trading Platforms
HFT	High-Frequency Trading
IDB	Inter-Dealer Broker
IOI	Indication of Interest
MM	Market Maker
OTC	Over-the-Counter
SI	Systematic Internaliser
Bid	An offer made to buy a security
Ask, Offer	The price a seller is willing to accept for a security
Spread	The difference between the bid and ask price prices for a security, an indicator of supply (ask) and demand (bid)
NBBO	National Best Bid and Offer
Locked Market	A market is locked if the bid price equals the ask price
Crossed Market	A bid is entered higher than the offer or an offer is entered lower than the bid
Opening Cross	To determine the opening price of a stock, accumulating all buy and sell interest a few minutes before the market open
Closing Cross	To determine the closing price of a stock, accumulating all buy and sell interest a few minutes before the market close
Order Types	
AON	All or none; an order to buy or sell a stock that must be executed in its entirety, or not executed at all
Block	Trades with at least 10,000 shares in the order
Day	Order is good only for that trading day, else cancelled
FOK	Fill or kill; must be filled immediately and in its entirety or not at all
Limit	An order to buy or sell a security at a specific price or better
Market	An order to buy or sell a security immediately; guarantees execution but not the execution price
Stop	(or stop-loss) An order to buy or sell a stock once the price of the stock reaches the specified price, known as the stop price
Investors	
Institutional	Asset managers, endowments, pension plans, foundations, mutual funds, hedge funds, family offices, insurance companies, banks, etc.; fewer protective regulations as assumed to be more knowledgeable and better able to protect themselves
Individual	Self-directed or advised investing; some considered accredited investors: income > \$200K (\$300K with spouse) in each of the prior 2 years or net worth >\$1M, excluding primary residence

FICC	Fixed Income, Currencies and Commodities
CUSIP	Committee on Uniform Securities Identification Procedures
UST	U.S. Treasury Securities
Corporates	Corporate Bonds
HY	High Yield Bond
IG	Investment Grade Bond
EMS	Equity Market Structure
NMS	National Market System
Reg NMS	Regulation National Market System
SIP	Security Information Processor; aggregates all exchange's best quotes, sent back out to the market in one data stream
PFOF	Payment For Order Flow
Tick Size	Minimum price movement of a trading instrument
CAT	Consolidated Audit Trail
SRO	Self Regulatory Organization
AP	Authorized Participant
PCF	Portfolio Composition File
NAV	Net Asset Value
IIV	Intraday Indicative Value
ETF	Exchange-Traded Fund
ETP	Exchange-Traded Product
MF	Mutual Fund
OEF	Open-End Fund
CEF	Closed-End Fund
UIT	Unit Investment Trust
Call	The right to buy the underlying security, on or before expiration
Put	The right to sell the underlying security, on or before expiration
Holder	The buyer of the contract
Writer	The seller of the contract
American	Option may be exercised on any trading day on or before expiration
European	Option may only be exercised on expiration
Exercise	To put into effect the right specified in a contract
Underlying	The instrument on which the options contract is based; the asset/security being bought or sold upon exercise notification
Expiration	The set date at which the options contract ends, or ceases to exist, or the last day it can be traded
Stock Price	The price at which the underlying stock is trading, fluctuates continuously
Strike Price	The set price at which the options contract is exercised, or acted upon
Premium	The price the option contract trades at, or the purchase price, which fluctuates constantly
Time Decay	The time value portion of an option's premium decreases as time passes; the longer the option's life, the greater the probability the option will move in the money
Intrinsic Value	The in-the-money portion of an option's premium
Time Value	(Extrinsic value) The option premium (price) of the option minus intrinsic value; assigned by external factors (passage of time, volatility, interest rates, dividends, etc.)
In-the-Money	For a call option, when the stock price is greater than the strike price; reversed for put options
At-the Money	Stock price is identical to the strike price; the option has no intrinsic value
Out-of-the-Money	For a call option, when the stock price is less than the strike price; reversed for put options

Appendix: SIFMA Insights Research Reports

- SIFMA Insights: <https://www.sifma.org/resources/archive/research/insights/>
- SIFMA Insights Market Structure Primers: <https://www.sifma.org/resources/news/primers-by-sifma-insights/>
 - Global Capital Markets & Financial Institutions
 - Fixed Income
 - Equity
 - Multi-Listed Options
 - ETF
 - Capital Formation & Listings Exchanges
 - SOFR: The Transition from LIBOR
 - Electronic Trading

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