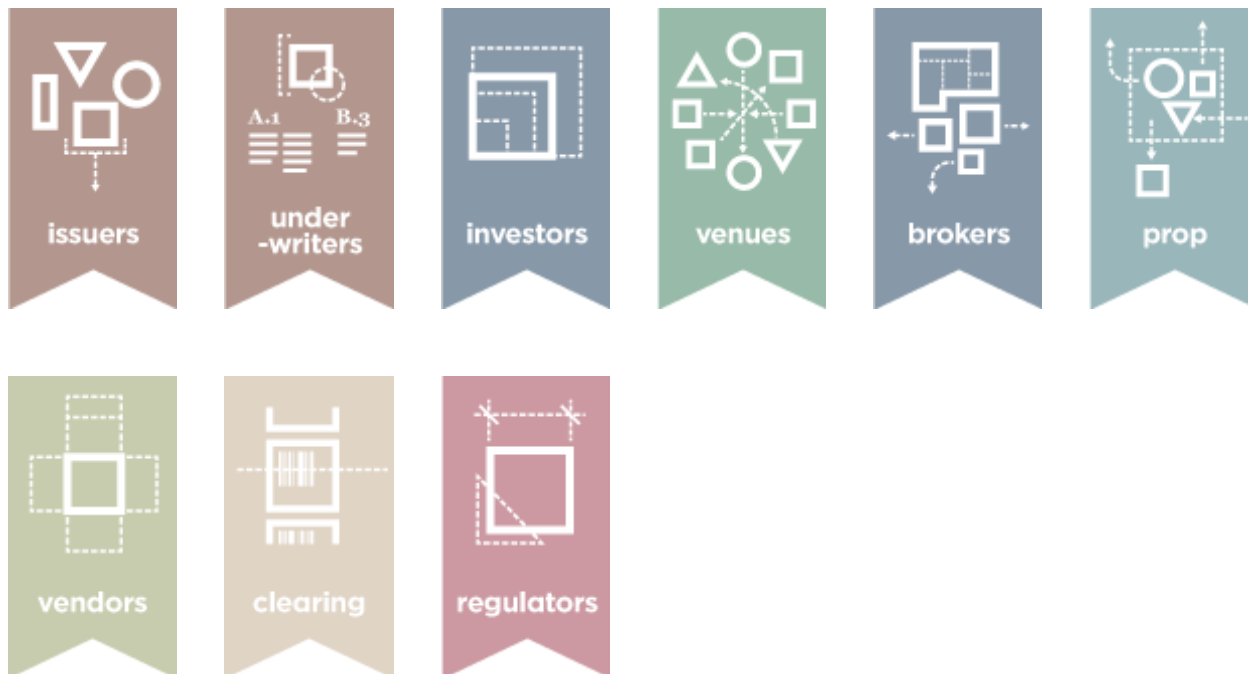


# Market Structure Primer

Get Started!

The purpose of this document is to provide an overview of the US equity trading landscape. It started as an onboarding document to help new hires who aren't as well versed in market structure. It can be read start to finish in order, or you can jump around. The visual Life Cycle of an Order also provides a handy view of the various events and entities involved in the process of a trade - from conception to completion. For those with little to no prior knowledge, the three core sections on market participants, mechanisms of communication between participants, and a birds-eye view of overall market activity should provide a working understanding of trading in the US equities market as it is today. Over time, we will be adding material that delves more deeply into further topics, especially into market structure history and the conflicts of interest that evolve along with market structure.

# Market Participants



## The Who and the Why

There are many different types of participants in the US equities market, each with distinct needs and objectives. Here we will focus on participants and trading mechanics involved in institutional trading. We will define our unit of a "participant" in terms of a single role, which does not always correspond smoothly to the often-used unit of a company. Within a large financial firm, there may be separate lines of business that fulfill separate roles, and treating the resulting mesh of sometimes conflicting incentives and functions as a "participant" can obscure the underlying mechanics driving behavior in the financial system. Conversely, considering only individual roles neglects the higher level constraints of company ties and relationships that can be needed to make sense of the lower level behaviors. To avoid both sources of potential confusion, we'll define and discuss individual roles as our base units first, and then periodically zoom out a bit to discuss the inter- and intra-company relationships between roles that comprise the overall financial ecosystem.



# Issuers



Obviously, the stock market wouldn't exist if there were no public companies. It's common in the stock trading world to conflate the companies that issue stock (aka issuers) with the stock shares themselves - in fact, the lingo is built on it. It's normal to say "the price of Microsoft went up today" rather than "the price of a share of Microsoft went up today," even though this wordier version is more technically accurate. [Full disclosure: Allison used to work for Microsoft, so all hypothetical stock pricing examples tend to be about Microsoft.] But it is worthwhile to mentally preserve the distinction between issuers of stock and the stocks themselves, as the issuers are entities who have agency and goals of their own.

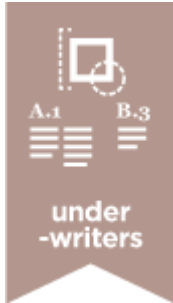
So what does an issuer of stock want? When a stock is first offered publicly in an IPO (Initial Public Offering), the issuer's goal might be to raise money and/or to allow early private investors to cash out. As a stock continues to trade publicly, an issuer's goal might be to increase or maintain its market capitalization, which is the total dollar value of its outstanding shares. Or its goal might be to increase or maintain its share price, which is subtly different. The market capitalization is equal to the number of outstanding shares times the price per share, so the two metrics are certainly related, but they are not quite the same thing. The market capitalization can change because the share price changes, or because the number of outstanding shares changes. The issuer might increase the number of outstanding shares by issuing new stock, or might decrease by the number of outstanding shares by buying back shares for itself that were previously in public circulation. This is called a stock buyback.

There are reasons why an issuer might not want the individual share price to be too high or too low, regardless of the market capitalization. Very low prices per share might violate rules

(like the listing standards of a given stock exchange - more on that later) or lead to an impression of low quality. High prices per share might have a dampening effect of trading, since the share is an indivisible unit and partial shares cannot be traded. An issuer may make it a goal for trading in its stock to be reasonably active, so that its investors don't get worried that trading will dry up and they will be stuck with shares they don't want in the future. Shares trade commonly in "round lots," which are typically multiples of 100 shares. To keep these typical units of a palatable size for active traders, the issuer might decide to do a stock split or reverse split to influence the price per share without necessarily changing the market capitalization. A stock split takes 1 share of stock and converts it to multiple shares (for a specified multiple), thereby lowering the price per share but raising the number of outstanding shares proportionately so that the market capitalization stays the same. A reverse split combines multiple outstanding shares into one, thereby increasing the price per share but lowering the number of outstanding share proportionately.

To sum up, an issuer is an entity whose stock is publicly traded. An issuer may want to control its market capitlization, its price per share, and/or the quality of trading activity in its stock. Some of the main tools it has at its disposal to accomplish these goals include issuing new stock, buying back existing stock, and stock splits and reverse splits.

# Underwriters



When an issuer plans an IPO, it typically hires underwriters to be responsible for selling the initially offered stock. Underwriters typically make some kind of commitment to sell a particular amount of stock at the IPO price. Often the total offering is split among several underwriters, who collectively form a syndicate. The immediate goal of an underwriter is to sell the initial stock and collect the corresponding fees. A more long-term goal is likely to position themselves for future underwriting business. Since underwriters are typically attached to firms that offer other financial services, they may have additional goals like pleasing the firm's other clients by offering them access to valuable IPOs.

# Investors



The term "investors" is a rather vague term, often used in different ways by different people. In the private equity world of companies whose stock is not publicly traded, the term "investors" typically refers to entities who purchase and hold shares in the company. But things are simpler in this context, where it is usually fine to conflate the entities who make the decision to purchase with the entities who then formally own the stock, because it is typical for these to be the same. In the public markets, this is much less true. If you as an individual person purchase 100 shares of Apple (a publicly traded company) in an individual brokerage account, you probably assume you count as an "investor" in Apple. But is your name actually on a stock certificate somewhere saying you own 100 Apple shares? Does Apple know who you are? Not necessarily. Some providers of brokerage accounts put their own names on the stock certificates and hold them "for you."

Things get even murkier if you pool your money with others in a retirement plan, say, and the plan manager decides to purchase shares in a mutual fund, and the mutual fund decides to buy some shares of Apple, a publicly traded company. In this case, who is the "investor"? You? The retirement plan manager? The mutual fund? All of the above? You don't have your name on an actual stock certificate for Apple, but a series of contractual links between financial entities approximately allows you to feel as if you do. And if things work as they should and Apple's share price goes up, you should get a proportional benefit from that.

More generally, in the public markets there are many flavors of separations between those who technically own stock, those that make the decisions of which stocks to buy and sell, and those who have contractual rights to reap the benefits or absorb the losses of stocks that

others buy and sell "on their behalf." This makes it challenging to formulate a clear cut definition of the term "investor" that feels right in all situations. Some people make a technical definition of an "investor" that would isolate the mutual fund in the example as the true investor: they reserve "investor" for someone who is making the final decision of what stocks to buy/sell, and doing the buying/selling with someone else's money. For our purposes, it makes more sense to categorize participants by goals rather than by mechanics, so the distinction of whose money is it is less important than what is the goal. A better definition for our purposes might be: an "investor" is an entity who makes a decision to buy or sell a stock in order to express an opinion on the medium or long-term health of an individual company, a set of companies (e.g. a sector of the economy), or the stock market holistically (e.g. through an index like the S&P 500). The opinion might be positive or negative: a short-seller, for example, expresses a negative opinion about the outlook for a particular stock by selling stock they have borrowed rather than own. If the stock price goes down, they will be able to buy the stock at a low price and return it to the lender, making a profit off the negative trend.

The shrewd reader will note the wishy-washy-ness of the phrase "medium or long-term" - let's say this covers anything from multiple days to months to years to decades. Which is not to say that investors seeking long-term returns won't occasionally buy and sell the same stock within a single day - but we'll make a distinction between investment strategies that are intended (or at least very willing) to hold risk over multiple days and longer time scales and those that are designed to get in and out of positions intra-day (or even in a matter of milliseconds). The short-term strategies we will discuss later below.

## **Institutional Investors**

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Institutional investors are entities like mutual funds, pension funds, and hedge funds that take positions in the stock market with money that is pooled from many individuals. Those individuals trust the institution to make decisions about which stocks to buy and sell, when to trade, etc., and they also trust the institution to allow them to put money in and out of the pool under agreed upon terms. If the institution does well, the individuals share in its prosperity, and if it does poorly, they share in its paucity. The goals of the institution are typically stated publicly and known to the individuals contributing, and are typically a mix of growing capital, and controlling and/or hedging risk. To achieve this goal, the institutional investor may do



research and formulate opinions about the overall worth of a certain security, sector of securities, or the stock market as a whole, and choose a mix of financial instruments to express those opinions (in the sense that they will benefit if the opinions turn out to be true), and to hedge the risk of the opinions being wrong (e.g. use counterbalancing financial instruments to lower the probability of significant loss). Institutional investors are often colloquially referred to as the "buy-side" within the US equities market.

## Quant Funds

There is a growing segment of hedge funds whose strategies are driven primarily or entirely by quantitative models. Some of the most well-known quant funds are Renaissance Technologies, D.E. Shaw, and AQR. These types of firms are not to be confused with high frequency traders who also enact computer-driven strategies, but often make trading decisions on a much shorter (e.g. sub-millisecond) timescale, although it is worth noting that some firms employ both high frequency and less speed dependent strategies under the same roof.

## Retail Investors

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Retail investors are individuals who make their own decisions about what stocks to buy and sell, and when to place orders. Essentially, retail investors directly reap the rewards or losses of the trading they direct. There is one technical caveat though, since retail investors send their orders to trading venues through brokers, who we will discuss in detail below. As we mentioned above, a broker might put its own company name on the stock certificates as it trades on behalf of a retail investor, and internally keep track of which customers "own" which stocks. This can create issues if a broker declares bankruptcy, and can't make good on everything on its books. There is insurance that mitigates this issue, provided by the SIPC, similar to how the FDIC ensures savings accounts at banks.

The goal of a retail investor may be similar to an institutional investor, e.g. achieving a particular balance of risk and potential growth of capital. A retail investor may also be seeking to express an opinion about a particular security, sector, or the economy more generally.



# Trading Venues



Trading venues are the entities who match orders to buy and sell stock, and execute the resulting trades. A more common phrasing for that would be: "trading venues are where buyers and sellers find each other, and trades take place." We have deliberately eschewed this common phrasing, as it obscures the active role of the trading venue as an entity with its own goals. Despite the name of "venue," it can be misleading to think of a trading venue as a "place." A trading venue is still a "who."

A trading venue's goal might be to increase its revenue from trading fees or other fees that it charges to those who use its services. A related goal may be to attract as many buyers and sellers as it can in order to execute more trades. Another goal may be for the trading it executes to exhibit certain desirable features. To try to accomplish these goals, a trading venue has many tools at its disposal. It can design/modify its rules for how buyers and sellers express their interest to buy and sell semantically. It can design/modify its infrastructure for how buyers and sellers communicate with it mechanically. It can design/modify its rules for how compatible interests are ultimately matched into trades. It can also design/modify its rules for who can use its services, and what information about active interest and completed trades is provided to whom, up to some regulatory constraints. The constraints differ based on the type of venue, and from a regulatory perspective there are two types of venues:

## Exchanges

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Exchanges are heavily regulated by the SEC and are also self-regulatory organizations (SROs) themselves - this means that the exchanges have certain regulatory authority over their customers. Exchanges generally publish firm quotes describing at what prices market participants are currently willing to buy or sell a given stock in real-time. In addition, exchanges publish messages describing the price and quantity of transactions after they're consummated. These trade and quote messages are known as market data.

In some markets around the world, certain securities trade exclusively on a single exchange, but in the US, pretty much all public companies are traded on all venues.

There are currently 3 major exchange families: ICE (NYSE) which operates 5 exchanges, Nasdaq which operates 3, and Cboe (BATS) which operates 4. IEX is the only other current exchange operator, though there are three other companies with exchange plans in the works: MEMX, MIAX, and LTSE.

## ATS's

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Alternative Trading Systems (aka ATS's) are much more loosely regulated than exchanges and hence have lower barriers to entry. They typically don't disseminate quotes. ATS's come in two flavors:

### Dark Pools

Dark pools are designed to allow many would-be buyers to interact with many would-be sellers. They function pretty much like exchanges, but with a few major differences. Since they are scrutinized in a more lenient regulatory framework, dark pool operators can pick and choose which participants they allow to use their service. (Exchanges in contrast must provide fair access to any entity that follows the rules.) Dark pools also tend to tightly control information, not revealing who their subscribers are or any details about the trading in their pools that is not required for them to reveal. They do report trades after they happen - something we will discuss in more detail later after we have defined the mechanics of communication among the various players.

The typical explanation for why dark pools exist is that "investors with big orders to buy/sell want to trade quietly in a semi-private pool with other investors, away from the revealing

lights of exchanges which publish more information for all the sharks to see." But it is important to separate the goals of the investors and traders who might use a dark pool from the goals of the dark pool itself. The dark pool operator may have similar goals to an exchange operator: maximizing revenue from trading and other fees, maximizing trading activity, obtaining certain features of trading, etc.

Dark pools must be operated by broker-dealers, and they are typically run by large banks. The largest dark pools are run by UBS, CS, JPM, GS, Barclays, MS, and Level (owned by a consortium of banks). This introduces other possible goals a dark pool operator might have that don't necessarily make sense for the dark pool in isolation, but do make sense in the context of the operator's larger business.

## **Internalizers**

Internalizers are designed to allow many would-be buyers/sellers to interact with a single possible counterparty. These are crossing engines operated by proprietary trading firms and banks, where the operator trades against the client. Most retail trading occurs in this fashion, and a portion of institutional trading executes through these channels as well. The largest internalizers are Citadel and Virtu.

The operator of an internalizer might have it as a goal to execute more of their own trading internally so that they minimize their fees to exchanges and other venues.

# Brokers



A broker is a firm that facilitates trading on behalf of an investor. The brokers are collectively referred to as the "sell-side." In the US equities market, only broker-dealers are allowed to participate directly on an exchange. One goal of a broker is presumably to provide a service to the investor that meets the investor's needs, at a cost which is profitable to the broker.

The mechanics of the relationship between a broker and an investor can take on many different forms, but a good rule of thumb to keep in mind is that an investor decides what to trade and when to trade at a coarse level, while a broker decides when to trade at a more granular level, as well as where to trade and how to trade. For example, an investor may convey to a broker that they want to buy 10,000 shares of Microsoft sometime over the next few hours. The broker will decide if/how to break this amount into smaller orders and how to put these orders into trading venues, potentially spreading them out over venues and over time. The investor will naturally want the broker's decisions to result in purchasing the target amount of stock within the target time frame at the lowest possible cumulative price. Competition among brokers is supposed to drive brokers to achieve this goal while charging competitive fees for their services.

There can be complicating tensions, however, between the goals of the investor and the goals of the broker that arise from the ways that brokers charge for their services, which may holistically encompass more than just trading. To achieve goals like attracting business and maintaining/increasing profitability, brokers can do more than just tinker with their trading algorithms. They can also design and change their billing practices, as well as their full offering of services.

## Commissions

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Unlike many other businesses, brokers often charge different commission rates to their customers, even for the same type of execution. In US equities, broker commissions are usually charged on a flat per-share basis, or on a simple scale based on the securities price (for example, 1 cent per share on stocks below \$5; 3 cents per share on stocks above \$5). Common equities commissions range from free to 5 cents per share (an enormous range), with a typical rate in the ballpark of 0.5 cents per share.

## Cost Plus

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Many brokers offer their clients the option of cost plus pricing, which means charging a relatively small commission and passing through their actual explicit transaction costs. For example, if a broker charged "cost plus 10 mils," this would mean they tally up the exchange and dark pool fees (and rebates) that they incurred while executing this order, and then add a flat 10 mils per share on top of this. (A "mil" is a one-hundredth of a penny, for some cruel reason, despite the usual rule that "milli" as a measurement prefix corresponds to a one-thousandth, e.g. there are 1000 milliseconds in a second. But I digress.) Cost plus pricing has the wonderful benefit of removing the incentive for a broker to route (potentially to the client's detriment) based on its own economic outcome, but it complicates the billing process and many investment firms are unable to process cost plus billing. Without cost plus pricing, brokers are incentivized to route to venues that charge lower fees or give them rebates, which may be in conflict with getting the best trade price for clients.

## Researchers and Corporate Access

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Full service brokers also provide services like research and corporate access. Researchers produce detailed research reports on companies and sectors. This role exists at companies called "full service brokers," which provide a wide array of services to institutional investors beyond trade execution. Full service brokers also coordinate direct access to corporate executives for interview.

In the US, brokers generally don't charge fees for these additional services, and instead they expect to receive indirect compensation via their trading commissions. Those payments are

thus considered part of the transaction costs as opposed to operational costs for their investment firm clients, an arrangement which many buy-side firms prefer. This means the typical goal of providing these additional services is to acquire or at least maintain trading business. This leads to some trading behaviors that seem weird in isolation but can be explained in the larger context. For example, an institutional firm may receive comparatively worse trading services for higher commissions, and still be unwilling to move too much of their business to another broker, because they value the research and other services provided by their full service broker.

## Prime brokerage

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There are other services that can be bundled together in the offerings a broker makes to clients like hedge funds. For example, a hedge fund who uses multiple brokers may not want to track and manage all of their trading relationships and collateral requirements individually. A prime broker can serve as a centralized manager of their activity to reduce the overhead for the client.

## Stock loan

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Brokers can also facilitate stock lending and borrowing for their clients. This can allow clients to sell a stock "short," meaning that they don't own the stock they are selling, but rather have borrowed it, with an obligation to return it at a later point in time. Short sellers are often expecting the price of a stock to go down, and can profit if it does, since they can buy the stock to return at the later time in the market for a lower price than what they previously sold. Brokers may manage the lending and borrowing of stocks for their clients, and may set collateral requirements for securing the loans, etc.

*Further reading*

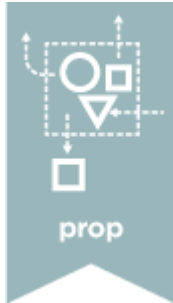
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# Proprietary Traders



A large segment of the trading ecosystem is proprietary trading firms - companies that use their own capital to buy and sell securities directly in the market. By most estimates, these firms comprise roughly 50% of all trading volume in the US. Some of the largest firms in this segment are Citadel, Virtu, HRT, Tower Research, IMC, TwoSigma, and Quantlab.

In terms of goals, it's not clear why someone trading with their own money should behave any differently than someone trading on behalf of others. Growing capital and managing risk etc., are reasonable goals for either case. However, there is a general differentiation in terms of time horizons. At least most (if not all) of the large proprietary trading firms focus on time horizons within a day or even shorter time intervals, and do not seek to hold positions overnight.

At short time horizons, one common goal is market making, which means connecting buyers and sellers who are separated by time and/or venues, and charging a fee for the service. Market makers may stand ready to buy or sell a stock at any moment, with the price they are willing to buy at being slightly lower than the price they are willing to sell at. The difference between these prices is called the "spread," and it is the compensation that market makers get for providing immediate transactions to buyers and sellers who might otherwise have to wait seconds, minutes, or hours to find each other in the larger market, if at all.

A proprietary trader might also have a goal of expressing a very short-term opinion about the price of a security. The time horizon here might be as short as 1 millisecond or less. Such opinions can be formed on the basis of very fast data feeds and recognition of common

patterns in how price changes tend to travel throughout the fragmented landscape of venues. Some high frequency trading strategies seek to leverage predictive analytics acting on top of expensive high-speed data access at various venues and high-performance architecture to make a profit off of patterns of trading at a millisecond or microsecond time scale. Market makers may also employ such technologies to try to adjust their buying and selling prices ahead of detectable trends at this time scale.

# Technology Vendors



Technology vendors provide services that are useful (sometimes arguably required) for other participants. Technology vendors may provide physical and/or logical connectivity to trading venues, software that is used to communicate and/or track orders and trades, processed data feeds that contain various kinds of quote and trade information, access to microwave towers or fiber optic cables that carry messages quickly between market participants, cloud computing resources, database and analytics tools, etc.

The goal of a technology vendor is typically to maximize its revenue in the long-term, but this may be consistent with low pricing in the short-term to encourage broad adoption and entrench dependency on their services. Especially for technology that connects participants, like execution management systems (EMS) that connect investors to brokers, it can be hard for participants to switch providers, as this has to be coordinated by both sides of the connection. These kind of effects dampen the power of competition among technology providers to drive prices lower and service quality higher.

A technology provider might be in a strongly unique position to offer a particular service if it sits inside a company such as an exchange. For example, NYSE is clearly in the best position to offer optimally fast connection services into a NYSE exchange. Similarly, it is in the best position to offer up-to-date data feeds about what is going on at a NYSE exchange. These natural monopolies of latency-sensitive products and services that originate at a trading venue are another phenomenon that heavily limits the power of competition to control pricing of services in the securities trading ecosystem.



# Clearing / Back Office



After a buyer and a seller are matched on a trading venue, there are back office processes that need to be done. The buyer needs to pay the seller, and the seller needs to produce the security. The security's title needs to be formally changed so that it now demonstrably belongs to the buyer. The entity who performs these back office processes is called a clearing broker. The clearing broker charges a fee for the services it provides, and manages regulatory compliance with this part of the trade. The goal of a entity performing a clearing service may be to maximize revenue from this service, or it might be to attract customers that it can then pitch on other services offered by the same firm.

# Regulators



Regulators are charged with making sure that the stock market functions in an orderly fashion, and serves its intended purposes. Regulators create and update rules intended to protect the health of the market, and are charged with enforcing these rules. Regulators also must scrutinize and approve or disapprove changes that exchanges propose to their existing policies. The goal of regulators is to ensure that the rules are designed to serve the interests of investors and the market as a whole, and that the day-to-day activities in the market follow the rules.

## SEC

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The primary regulator of the US equities market is the SEC, which is a government agency. The SEC's mission is two-fold: investor protection and the facilitation of capital formation. The SEC is tasked with, among other things, policing investment firms, brokers, exchanges, and corporate issuers. The SEC is empowered to make policy that affects the operations of market participants. Sometimes the SEC will test the impacts of new policies before making them widespread or permanent in the form of "pilots." Pilots are policy changes that are applied in a way that is limited in time or in scope, typically designed to yield a meaningful comparison with market behavior happening in parallel that is not subject to the contained changes.

The SEC is also empowered to review and to potentially reject changes to operations that trading venues like exchanges would like to make. The goal here is to ensure that proposed

changes are not counter to the interests of investors or the facilitation of capital formation. This can be a difficult job, as there is often little or no quantitative basis to understand what impact the proposed changes might have until they are implemented.

## FINRA

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FINRA (the Financial Industry Regulatory Authority) is a private not-for-profit organization that oversees the broker-dealer industry. Like the exchanges, it is a self regulatory organization and thus has power to create and enforce rules and impose fines on its members.

As per their [website](#) , FINRA does five things:

1. Deter misconduct by enforcing the rules
2. Discipline those who break the rules
3. Detect and prevent wrongdoing in the US markets
4. Educate and inform investors
5. Resolve securities disputes