# Equity Trading in the 21st Century

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# 1. Introduction[1]

Trading in financial markets changed substantially with the growth of new information processing and communications technologies over the last 25 years. Electronic technologies profoundly altered how exchanges, brokers, and dealers arrange most trades. In some cases, innovative trading systems are so different from traditional ones that many political leaders and regulators do not fully appreciate how they work and the many benefits that they offer to investors and to the economy as a whole.

In the face of incomplete knowledge about this evolving environment, some policymakers now question whether these innovations are in the public interest. Technical jargon such as "dark liquidity pools," "hidden orders," "flickering quotes," and "flash orders" appear ominous to those not familiar with the objects being described. While professional traders measure system performance in milliseconds, others wonder what possible difference seconds—much less milliseconds—could have on capital formation within our economy. The ubiquitous role of computers in trading systems makes many people nervous, and especially those who remember the 1987 Stock Market Crash and how the failure of exchange trading systems exacerbated problems caused by traders following computer-generated trading strategies. Strikingly, the mechanics of the equity markets functioned very well during the financial crisis, despite the widespread use of computerized trading. Indeed, much of the focus of computerized trading during the financial crisis has been on offering liquidity ("market-making") and shifting liquidity ("arbitrage") rather than as in 1987 in consuming the market's liquidity ("portfolio insurance").

This paper discusses recent innovations in trading systems and their effects on the markets. Using non-technical language, we show that investor demands for better solutions to the trading problems that they have traditionally faced —and will always face—largely drove the innovations. The introduction of computerized trading systems and high-speed communications networks allowed exchanges, brokers, and dealers to better serve and attract clients. With these innovations, transaction costs dropped substantially over the years, and the market structure changed dramatically.

The winners first and foremost have been the investors who now obtain better service at a lower cost from financial intermediaries than previously. Secondary winners have been the exchanges, brokers, and dealers who embraced electronic trading technologies and whose skills allowed them to profitably implement them. The big losers have been those intermediaries who did not innovate as successfully, and, as a consequence, became less competitive, and ultimately less relevant.

Not all developments in financial market trading have been in the public interest. We identify several problems that regulators should consider addressing to ensure that our markets continue to serve well both investors and the corporations that use them for raising capital. For example, systemic risks can arise because poorly capitalized broker-dealers allow electronic traders to

[1] *To better inform parties interested in understanding innovations in market structures, Knight Capital Group, Inc. commissioned the authors to write a paper describing new market structures and the resulting effects on the markets. This article presents our analyses and opinions only and does not necessarily represent the opinions of the sponsor of this project. The authors retained full editorial control over the content and conclusions of this report.*

access the market in their name with insufficient real-time risk management controls on their trading. While exchanges and clearinghouses can alleviate this problem by better regulating their members, we support the recent SEC rule proposal on this issue. Front-running across markets also concerns us. To some extent, well-informed traders or their agents can control this problem through careful transaction cost analyses, but the SEC and CFTC should write and enforce new regulations that prevent agents from front-running client orders in correlated instruments. Finally, transparency and fairness problems arise when trading systems employing make-or-take pricing schemes compete against exchanges that charge traditional transaction fees and against dealers who cannot charge access fees. The SEC could solve this problem with a simple modification to Regulation NMS.

While the markets could potentially benefit from some specific regulatory changes, regulators must be sensitive to the "unintended consequences" of poorly considered responses to concerns now being raised about recent changes in the trading environment, many of which are not universally understood. Technological innovations have led to the emergence of electronic liquidity suppliers who have outcompeted— and thus supplanted—most traditional dealers by lowering the costs of trading to investors. If poorly conceived regulations were to handicap electronic liquidity providers, a significant degradation in market quality would be the likely unintended consequence.

An executive summary of our report appears in the next section. The following section provides empirical evidence of how markets have changed in recent years, and in particular, how they have become more liquid over time. We then discuss the main trading problems that traders must solve and how traders traditionally solved those problems. We next discuss several of the innovative systems that exchanges, brokers, and dealers have created to help investors address these problems, and we explain how they benefit the economy. We then offer brief comments about the market's performance during the financial crisis and contrast the equity markets with other market structures. We conclude by discussing concerns about specific aspects of electronic trading.

# 2. Executive Summary

The U.S. equity market changed dramatically in recent years. Automation gradually transformed the market from a human-intermediated market to a computer-intermediated market with little human interaction or real-time oversight. Regulation also changed. The 1997 order-handling rules and the 2001 decimalization led to dramatic reduction in transactions costs. Regulation NMS cleared regulatory impediments to electronic trading and thereby led to increased competition between market centers. Dozens of new trading platforms emerged, including some with very different models from the old exchanges. This study examines the impact of these changes on market quality. Our major findings follow.

## 2.1 Trading problems remain unchanged

- Traders still face the same challenges as before: Minimize total trading costs including commissions, bid/ask spreads, and market impact.
- Large traders remain very careful about exposing their trading interest.
- New technologies allow traders to implement traditional strategies more effectively.

Traders today face the same challenges they have always faced. All traders seek to minimize their transactions costs, which include commissions, bid-ask spreads, and market impact. Buyers and sellers must find each other and agree upon a price. They must avoid trading with better-informed traders to avoid losses from being on the wrong side of a transaction.

Large institutional traders cannot widely publicize their interest in trading large blocks. Indiscriminant dissemination of such information increases the costs of their trades by scaring away counterparties, by attracting front-runners and other traders who can trade to profit from this information at the expense of the large traders.

Traders used to solve these problems on exchange floors. New communications and computing technologies now allow them to solve these problems in electronic trading systems at substantially lower cost.

For example, large traders once used floor brokers to hide the full sizes of their orders. The brokers displayed size only to traders that they trusted would not unfairly exploit the information. Now large traders use the hidden order facilities of electronic exchanges and dark pools to control the exposure of their orders. These facilities generally are more reliable than floor brokers and much less costly to use. The traditional NYSE floor was the forerunner of today's electronic "dark pools" that only disseminate information to trusted traders.

## 2.2 The market changed

- Liquidity increased as volumes grew substantially.
- Average trade size fall as electronic systems allowed traders to easily divide orders to obtain better executions.
- Quote traffic increased substantially.
- Competition among exchanges intensified.

We document many changes that have occurred in recent years. U.S. average daily reported trading volume increased dramatically in recent years, from about 3 billion shares per day in 2003 to nearly 10 billion shares per day in 2009. Over this period, the share of trading reported by traditional exchanges fell substantially. The market share of the NYSE in its listed stocks fell from 80% of all volume in January 2003 to 25.8% in December 2009.

The nature of trading changed as "high frequency" and "algorithmic" trading grew to dominate trading volumes. Average trade size fell substantially as computers made slicing large blocks into small pieces a cost effective means of limiting adverse costs of trading large positions. Automated traders began providing liquidity, supplementing and displacing traditional liquidity suppliers. The number of quote updates per trade, as well as the number of orders cancelled per executed trade, increased dramatically as traders employed new electronic strategies for offering and searching for liquidity.

### 2.3 Market quality improved dramatically

- Execution speeds fell.
- Bid-ask spreads fell and remain low.
- Commissions fell.
- Market depth increased.
- Volatility continues to fluctuate.

These changes substantially improved market quality. Virtually every dimension of U.S. equity market quality is now better than ever. Execution speeds have fallen, which greatly facilitates monitoring execution quality by retail investors. Retail commissions have fallen substantially and continue to fall. Bid-ask spreads have fallen substantially and remain low, although they spiked upward during the financial crisis as volatility increased. Market depth has marched steadily upward. Studies of institutional transactions costs continue to find U.S. costs among the lowest in the world.

Volatility spiked in 2008 during the financial crisis. However, unlike during the Crash of 1987, the U.S. equity market mechanism handled the increase in trading volume and volatility without disruption. However, the selling ban increased trading costs by frustrating the implementation of liquidity providing and shifting strategies by active traders who often must sell short to offer liquidity or manage the risks of their trading.

The quality of the U.S. equity market is especially notable in comparison to markets in other instruments and countries. For example, U.S. retail customers pay much higher transactions costs when trading U.S. Treasuries in comparison to fixed income ETFs that contain the same Treasuries.

### 2.4 Some improvements can be made

- "Make or take" pricing causes problems.
- Direct access requires appropriate risk management supervision.
- Front running orders in correlated securities should be banned.

Electronic trading raises some concerns that should be addressed. In particular, the "make or take" model for pricing exchange services has led to perverse outcomes. In the make or take model, trading platforms charge access fees to traders who "take" liquidity with marketable orders and pay rebates to limit order traders that "make" liquidity by placing standing limit orders. Current best execution standards require brokers to take the "best" price without regard to the access fees. We recommend that the SEC require that all brokers pass through the fees and liquidity rebates to their clients. The SEC also should indicate clearly that the principles of best execution apply to net prices and not to quoted prices. Alternatively, the SEC simply could ban access fees.

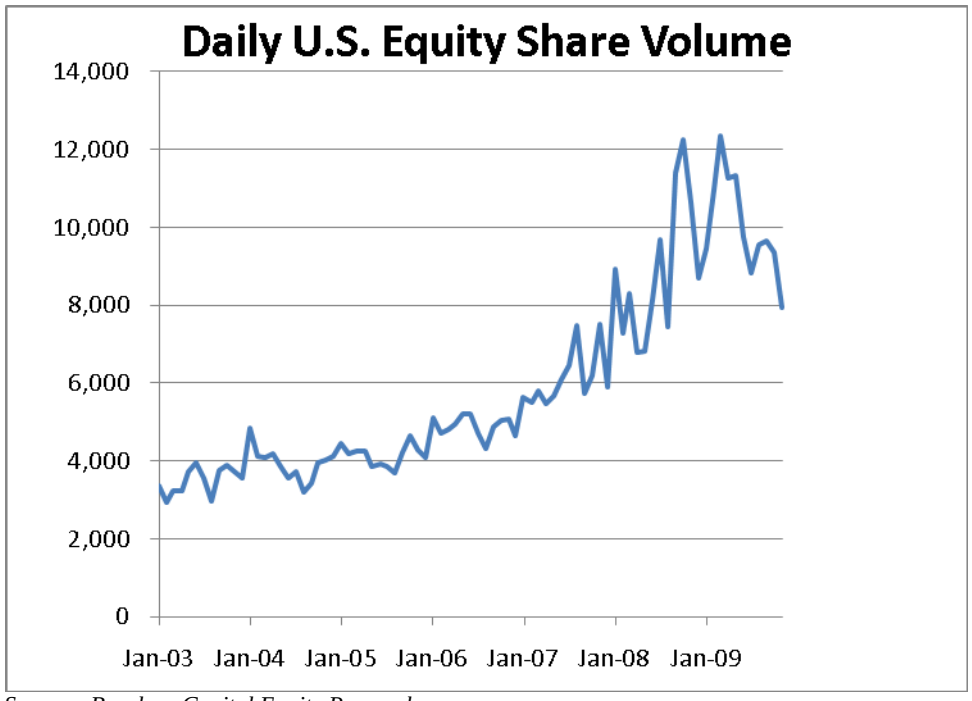
Concerns over the risk management practices of brokerage firms that provide "naked access" are legitimate. We support the proposed SEC rules that would require such firms to have appropriate risk management policies in place to prevent a catastrophic trading meltdown. At the same time, however, we note that no market-wide risk management systems are in place that would deal with a computer-generated meltdown in real-time. Regulators should give careful consideration to the question of what real-time controls could prevent a major computer malfunction from instantly throwing the market into chaos.

Although front-running a customer's order in the same instrument is illegal, we are concerned about front running in correlated instruments. For example, buying S&P 500 futures contracts while holding a large open customer buy order in an S&P 500 ETF (to profit from the expected price impact of the customer order) should be illegal since arbitrageurs will quickly shift the price impact of the broker's order in the futures market to the ETF market where it will increase the cost of filling the customer's order.

# 3. An Empirical Profile of Recent Changes in Markets

Innovations in electronic trading have produced new trading platforms and order types. Market participants now use better and faster tools, and the markets changed as a result. This section characterizes how various measures of market activity and liquidity changed in recent years.

## 3.1 Trading volumes increased



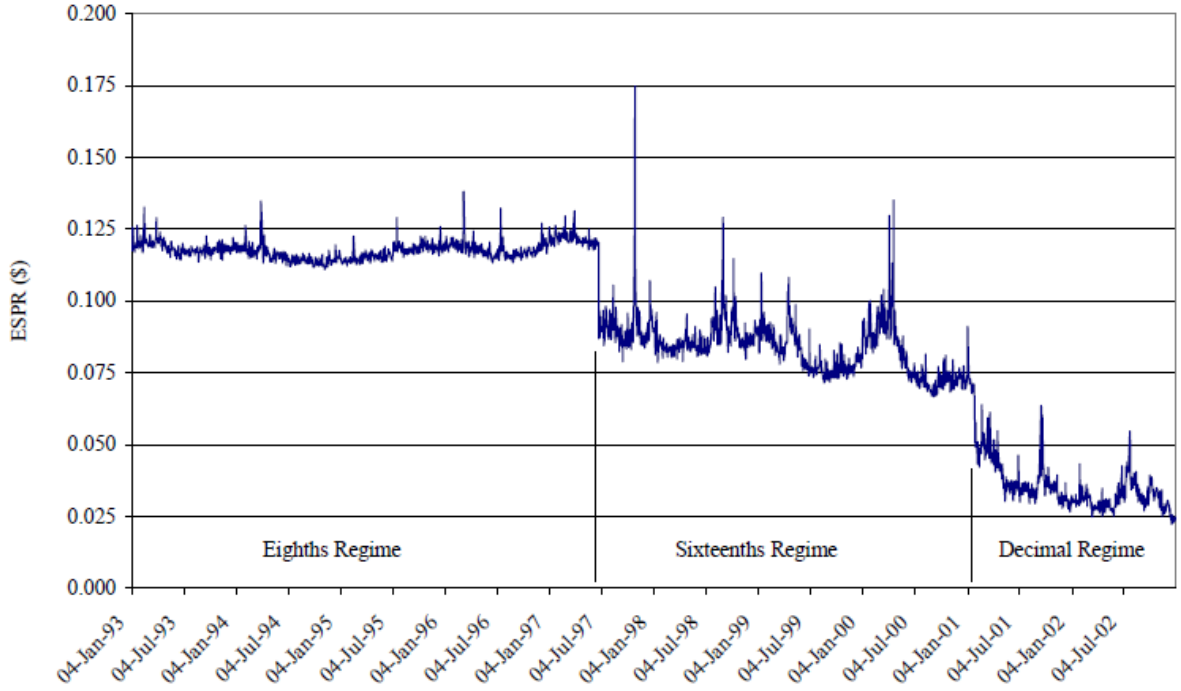

*Source: Barclays Capital Equity Research*

Reported equity trading volumes tripled in the last nine years. Several factors produced this outcome. The direct costs of trading fell substantially, making it economically feasible to implement strategies that would have been uneconomic at higher costs. The increase in derivative products also increased the amount of trading as arbitrage activity keeps derivatives prices linked with prices in the underlying cash markets. The growth in the number of exchange-traded funds (ETFs) also contributed to the increase in trading volume.

## 3.2 Bid-ask spreads fell and remain small

### 3.2.1 NYSE bid-ask spreads since 1993

Figure 2. Value-Weighted Daily Average Effective Spread, NYSE, 1993-2002




*Source: Chordia, Tarun, Richard Roll and Avanidhar Subrahmanyam, 2008, Liquidity and Market Efficiency, Journal of Financial Economics 87:2, 256, as published.*

This chart tracks the fall in quoted bid-ask spreads on the NYSE following the reduction of the minimum price variation (tick size) from one-eighth to one-sixteenth and then to one cent.

### 3.2.2 NASDAQ bid-ask spreads since 1993

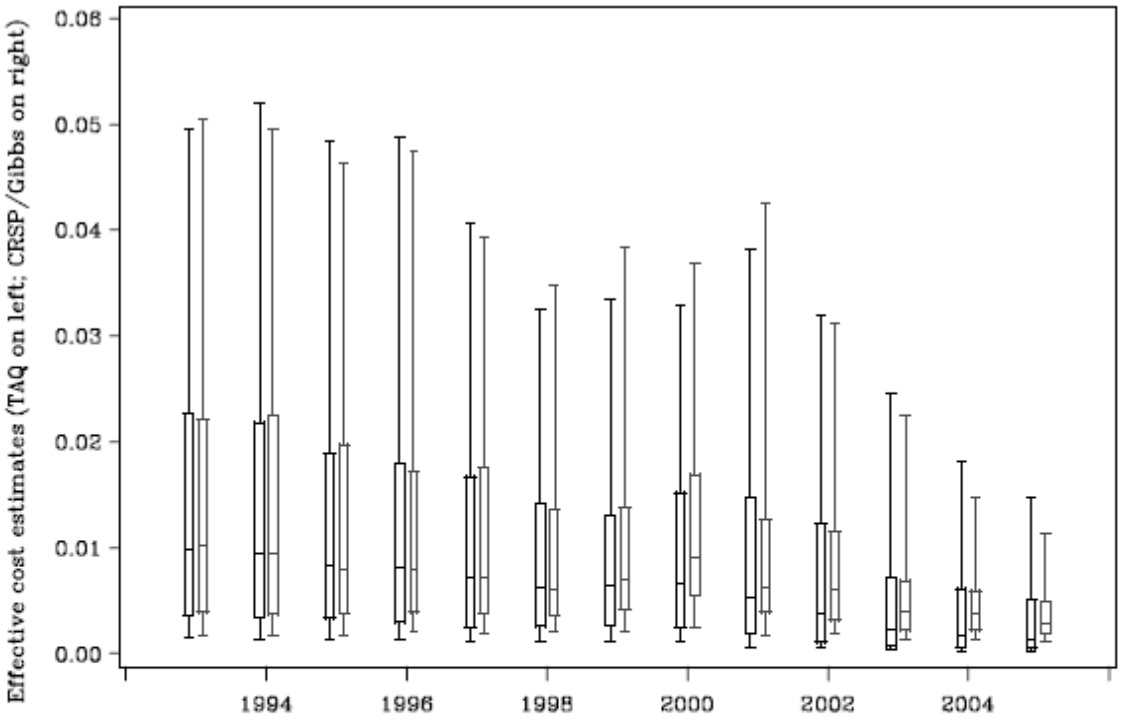
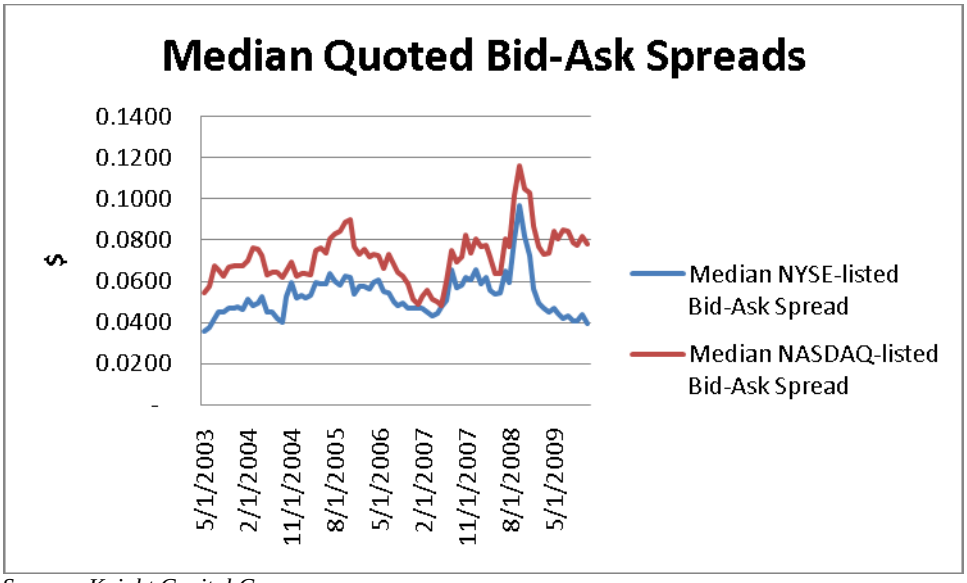



**Figure 2. TAQ and CRSP/Gibbs estimates of effective cost in the comparison sample.** The comparison sample consists of approximately 150 NASDAQ firms and 150 NYSE/Amex firms selected in a capitalization-stratified random draw in each of the years 1993 to 2005. For each firm in each year, the effective cost is estimated from TAQ data and from CRSP daily data using the Gibbs procedure. The figure depicts the cross-sectional distributions for these estimates year-by-year, with TAQ estimates on the left and Gibbs estimates on the right. The upper and lower ranges of the box-and-whisker figures demarcate the 5$^{th}$ and 95$^{th}$ percentiles; the upper and lower edges of the boxes correspond to the 25$^{th}$ and 75$^{th}$ percentiles; the line drawn across the box indicates the median.

*Source: Hasbrouck, Joel, 2009, Trading Costs and Returns for U.S. Equities: Estimating Effective Costs from Daily Data, Journal of Finance 64:3, 1457, as published*

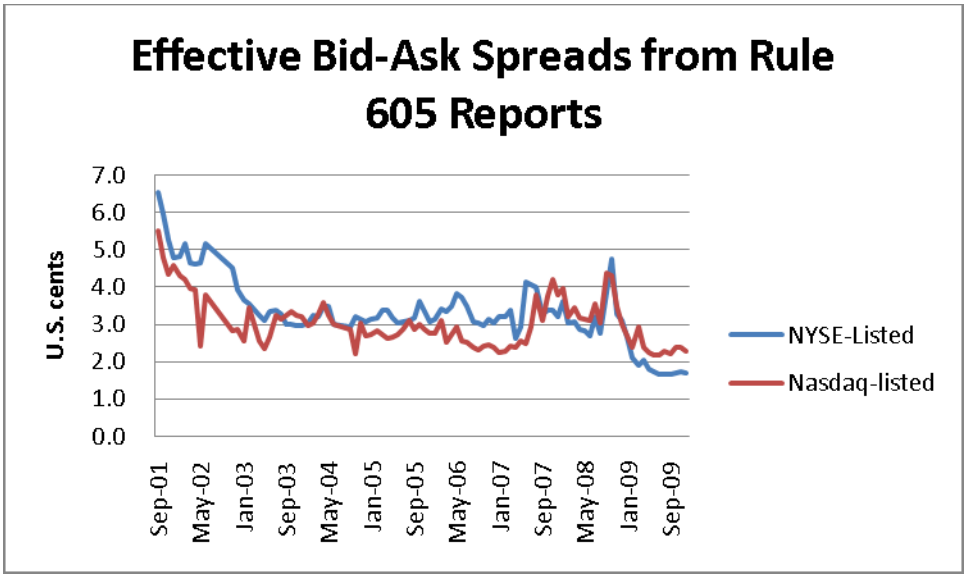
Decimalization, along with the SEC's order handling rules, led to a large decline in bid-ask spreads on NASDAQ as well as the NYSE.

### 3.2.3 Quoted and effective NYSE and NASDAQ bid-ask spreads since 2003




*Source: Knight Capital Group*

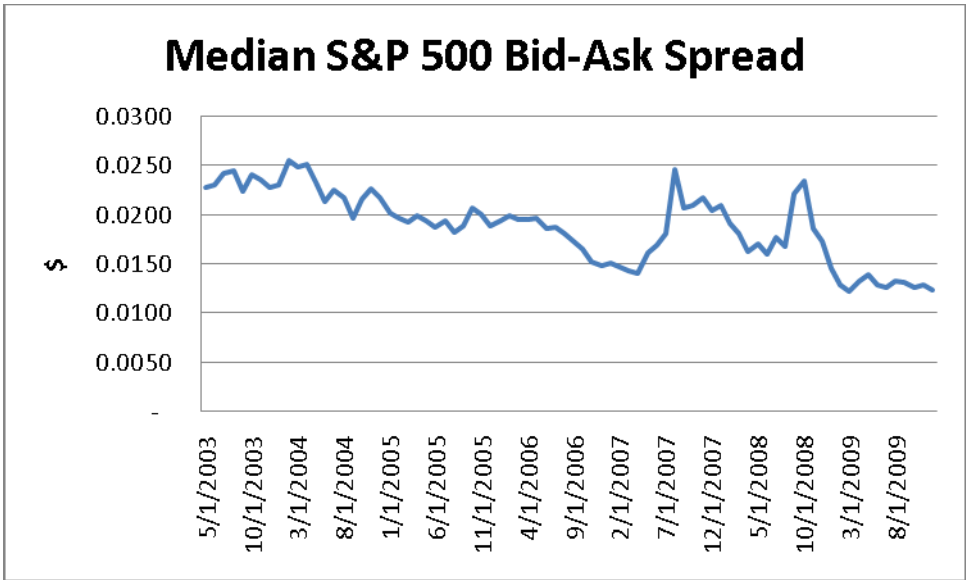
This chart displays the median quoted bid-ask spreads for NYSE- and NASDAQ-listed stocks.




*Source: Public Rule 605 Reports from Thomson, Market orders 100-9999 shares*

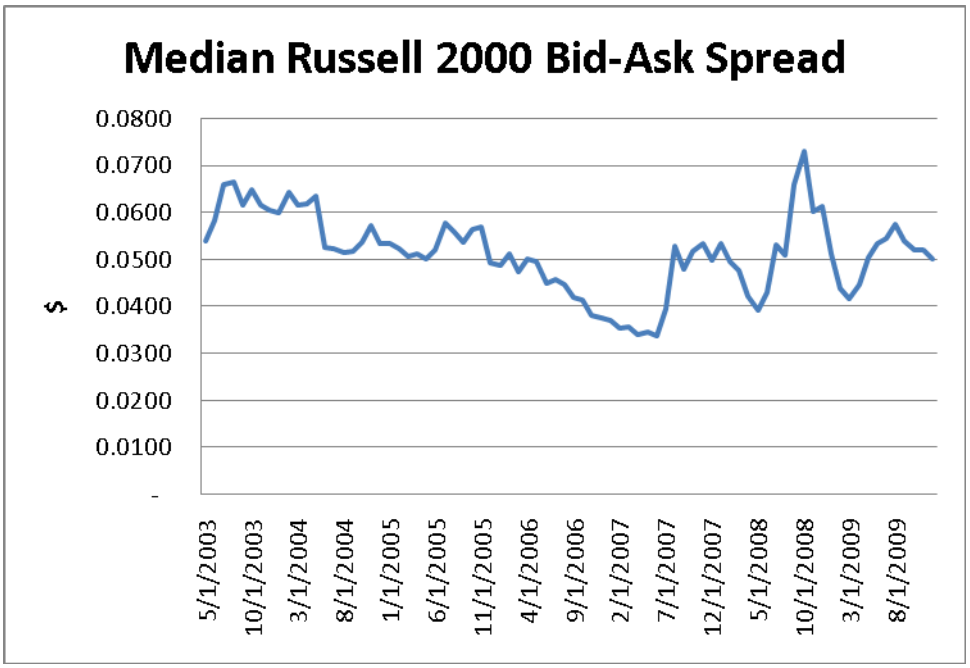
This chart displays the average effective bid-ask spreads obtained from the Rule 605 reports for eligible market orders. The effective bid-ask spread estimates spreads that investors actually pay. It is twice the difference between the actual trade price and the midpoint of the quoted NBBO at the time of order receipt. Once again, we see that the general trend on spreads has been downward, interrupted by an upward spike during the recent turbulence.

### 3.2.4 Quoted bid-ask spreads for index stocks since 2003




*Source: Knight Capital Group*

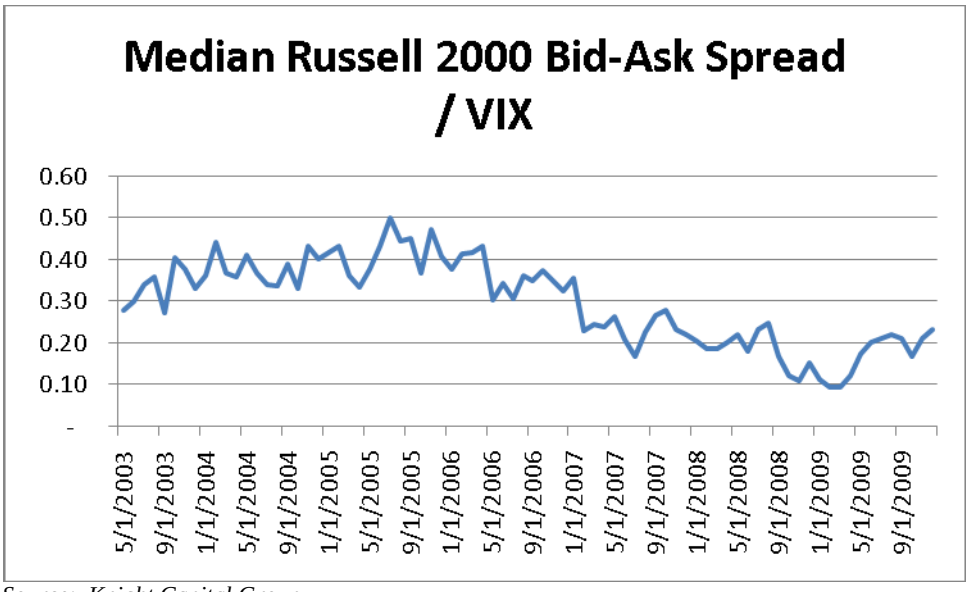
This chart presents the median bid-ask spread for S&P 500 stocks. The spread on many high volume stocks is now often only a penny or two.




*Source: Knight Capital Group*

This chart shows the median quoted bid-ask spreads for the Russell 2000 Index. The downward trend in spreads, which is so visible for the larger stocks, has not been as uniform for smaller stocks.

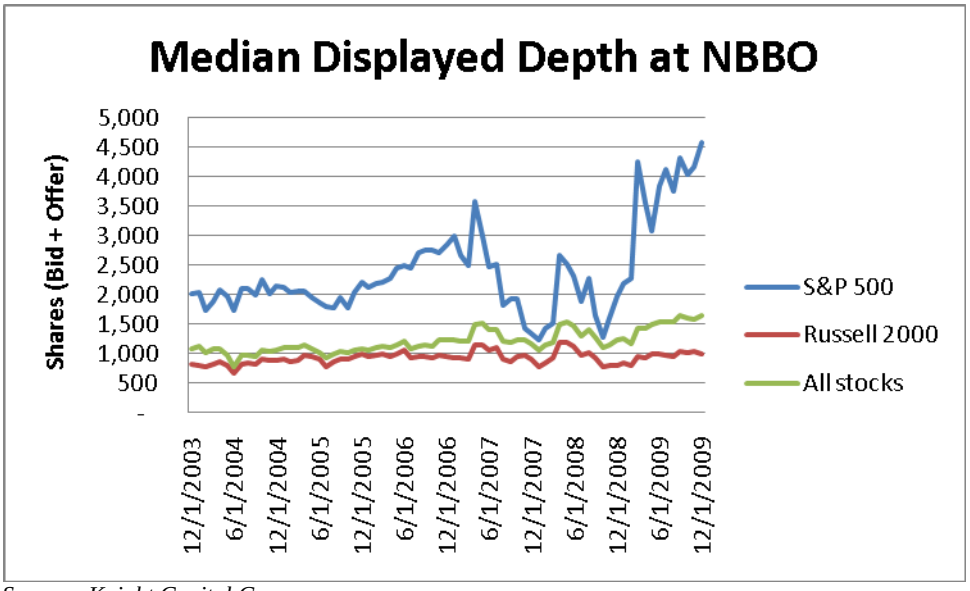
### 3.2.5 Quoted Russell 2000 bid-ask spreads relative to VIX since 2003




*Source: Knight Capital Group*

Most spreads spiked up during the financial crisis because high volatility increases risks for market makers. Dividing the reported spread by the VIX index of volatility shows that liquidity adjusted for volatility has been dropping. VIX measures the implied volatility of S&P500 options traded on the CBOE.

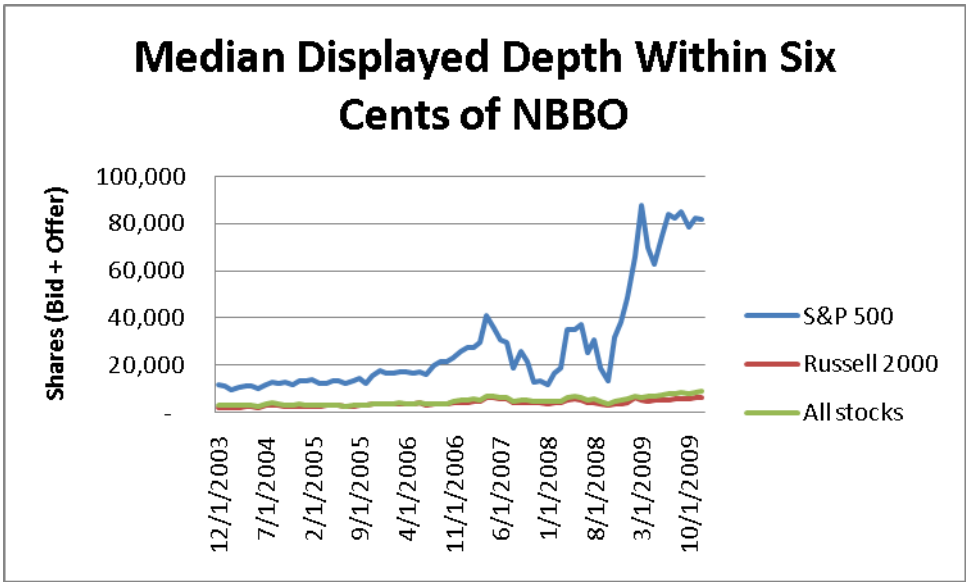
### 3.3 Market depth increased since 2003




*Source: Knight Capital Group*

Market depth is an indicator of liquidity. This chart shows the median number of shares (both bid and offer) displayed at the NBBO in the exchanges and ECNs. We see a steady upward trend over the last several years, an indicator of increased liquidity. Deeper markets imply lower price impacts for investors.

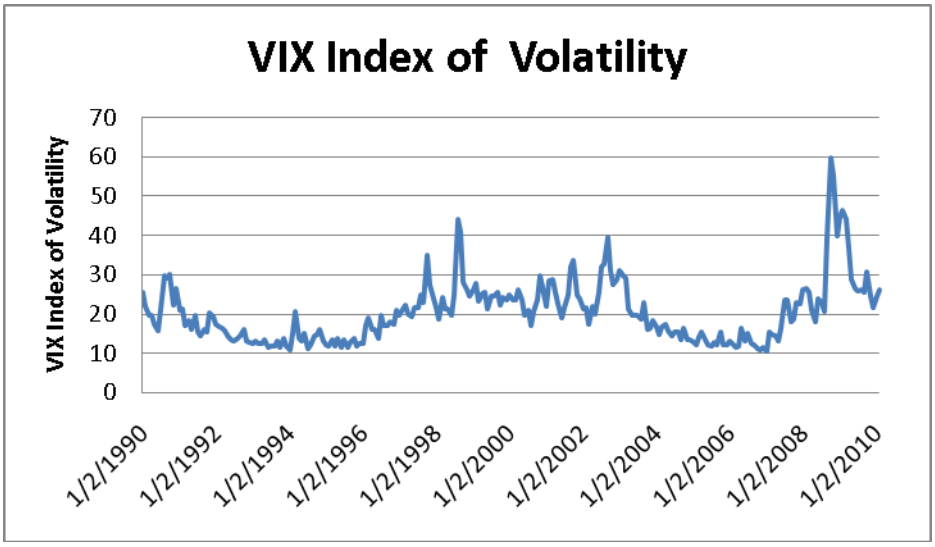
### 3.3.1 Displayed depth behind the NBBO since 2003




*Source: Knight Capital Group*

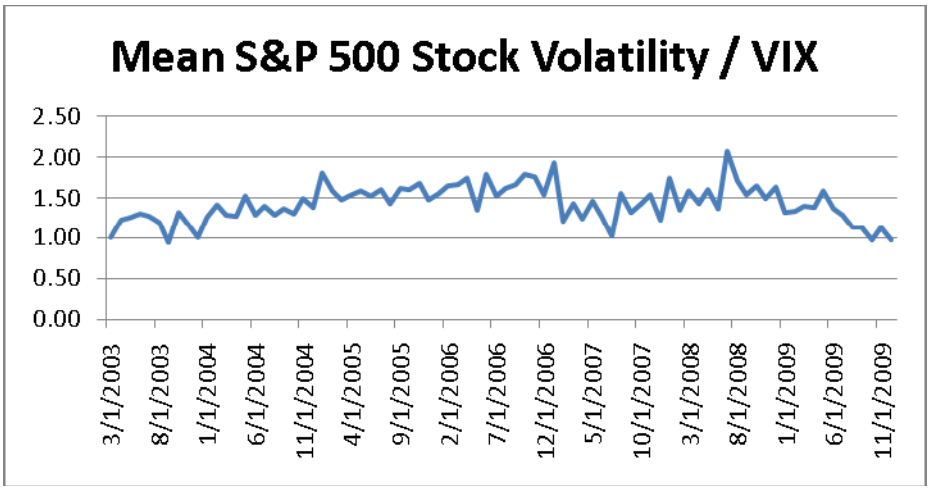
Depth increased substantially not just at the NBBO but also behind it. This chart shows the depth of book for various groups of stocks such as the S&P 500 and the Russell 2000 at the NBBO as well as within six cents of the NBBO.

### 3.4 Market volatility fluctuated




*Source: Knight Capital Group*

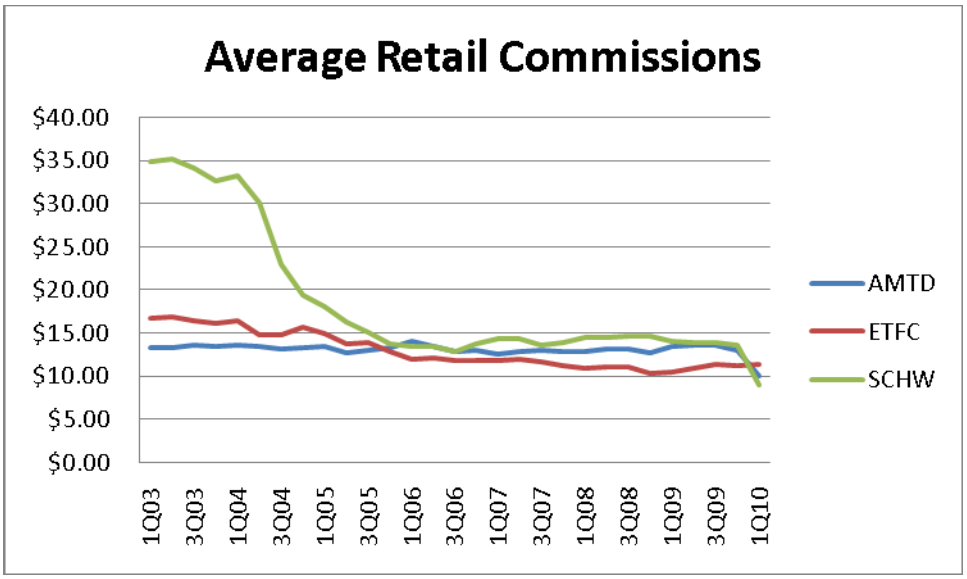
Volatility has always fluctuated in the U.S. equity markets, reflecting the changing levels of uncertainty in the overall economy. The 1930s and the early 1970s were periods of high volatility. Volatility also increased during the recent financial crisis. The VIX index, which is based on the implied volatility of S&P 500 options, was unusually low in 2006 but rose to record levels in the fall of 2008. It has since fallen to more normal levels. Volatility for the market as a whole is a poor measure for characterizing the impact of changes in market technology on the trading of individual stocks. We thus need to correct for overall market volatility.



*Source: Knight Capital Group*

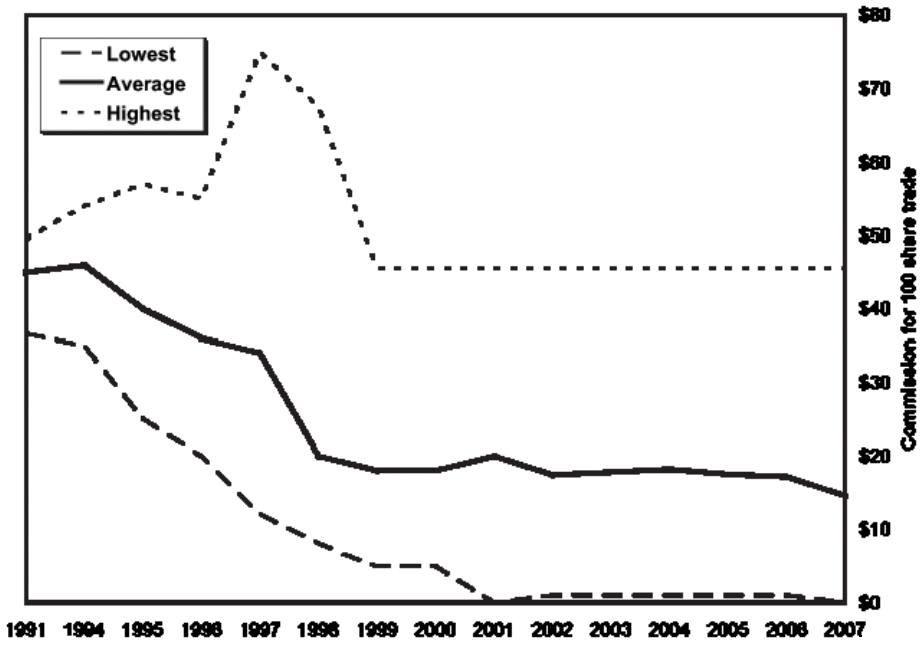
One simple way to correct for overall market volatility is to look that the total volatility of individual stocks relative to the VIX. This chart displays the average actual monthly intraday volatility of various groups of the stocks divided by the VIX. This measure has fluctuated in much the same range in recent years, indicating no overall increase in the volatility in excess of the VIX.

### 3.5 Retail commissions fell and remain low




*Source: Barclays Capital Equity Research*

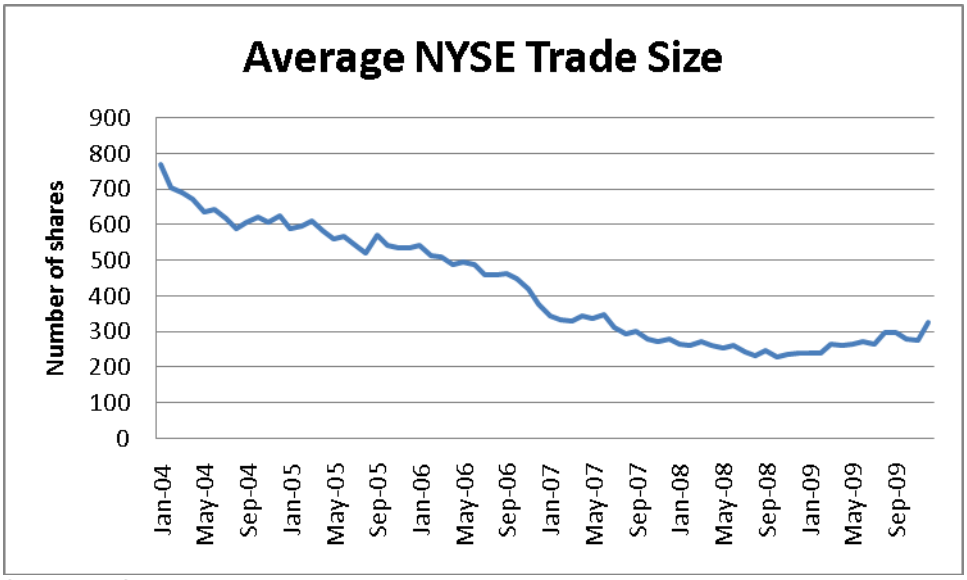
With small bid-ask spreads, commissions remain a significant component of total transactions costs paid by retail investors. This chart shows the average commissions charged by three of the largest online brokerage firms. Price competition intensified recently with prices dropping even further in last few months.




*Source: AAII Journal, Discount Broker Guide, February 2007 at http://www.aaii.com/journal/200702/guide.pdf, as published.*

This chart from the American Association of Individual Investors documents the steep drop in commissions among all the firms in its sample over the 27 years ending in 2007.

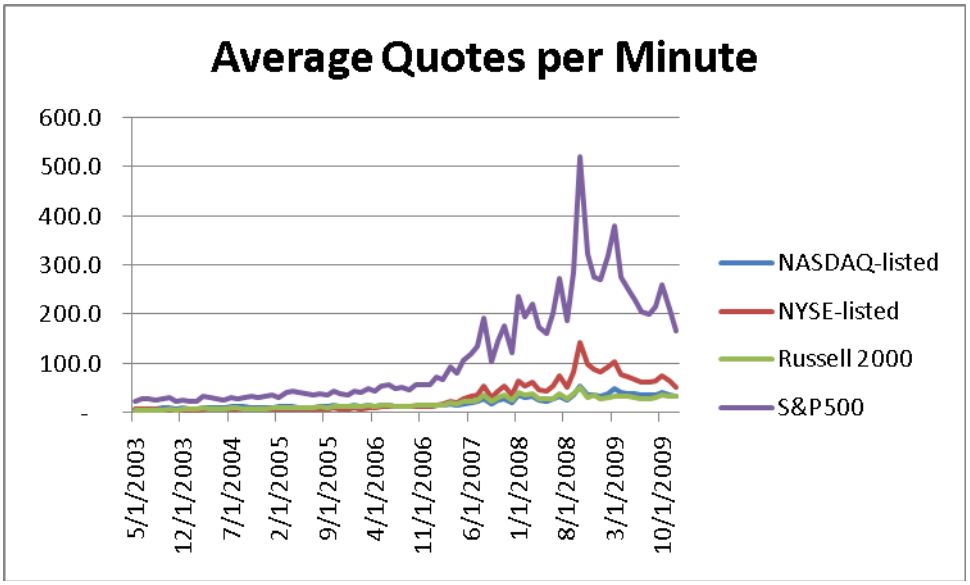
### 3.6 Average trade size fell




*Source: NYSE-Euronext, nyx.com*

The average size of reported trades has fallen significantly in the last decade. Average trade size on the NYSE by the end of 2009 was approximately 300 shares, half of what it was five years earlier. Traders have always chopped large orders into smaller ones to minimize market impact. Automation and lower trading costs now allow traders to economically slice orders into even smaller slices through what is known as “algorithmic” trading.

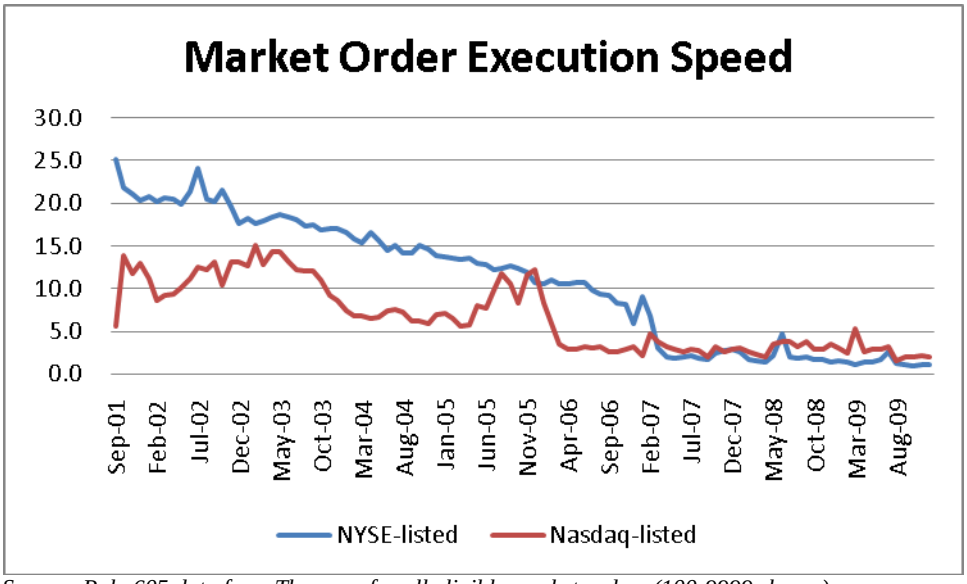
### 3.7 Quote frequency increased




*Source: Knight Capital Group*

This chart displays the average number of quote updates per minute for various groups of stocks. The frequency of quote updates increased dramatically in recent years, with a spike during the period of intense volatility and volume associated with the recent financial crisis. The increasing frequency of quote updates is consistent with higher trading volumes and the increased use of algorithmic trading strategies that break large orders into many smaller ones.

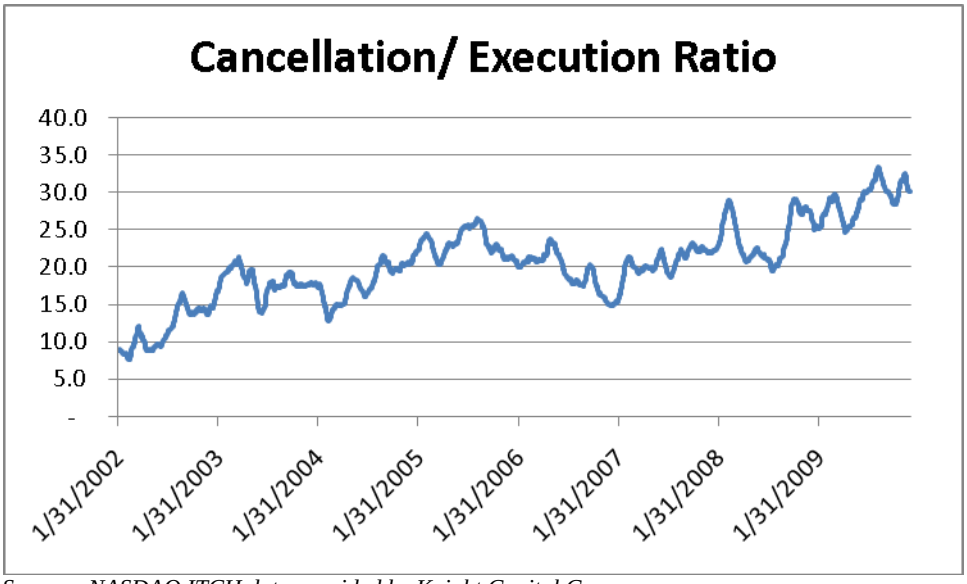
### 3.8 Execution times fell




*Source: Rule 605 data from Thomson for all eligible market orders (100-9999 shares)*

Increasing automation led to a market wide decrease in the speed of execution for small market orders.

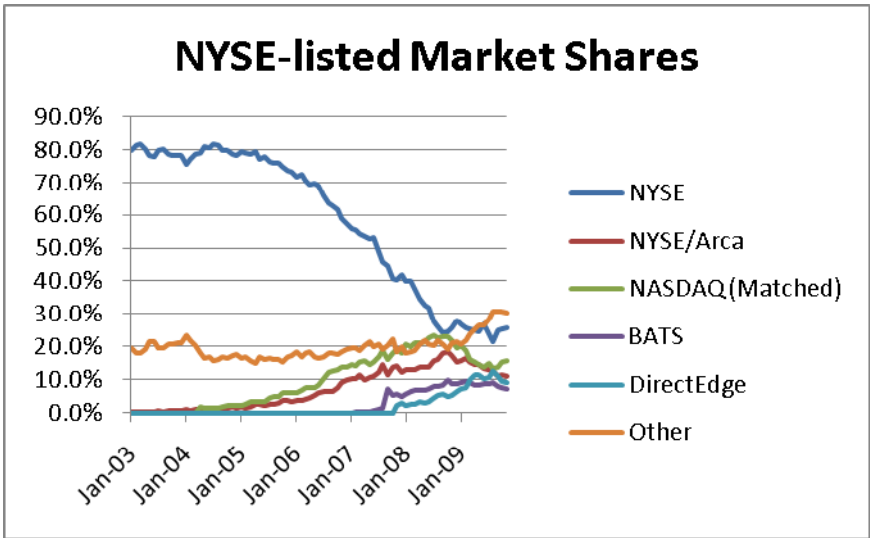
### 3.9 Order cancellations relative to executions increased




*Source: NASDAQ ITCH data provided by Knight Capital Group*

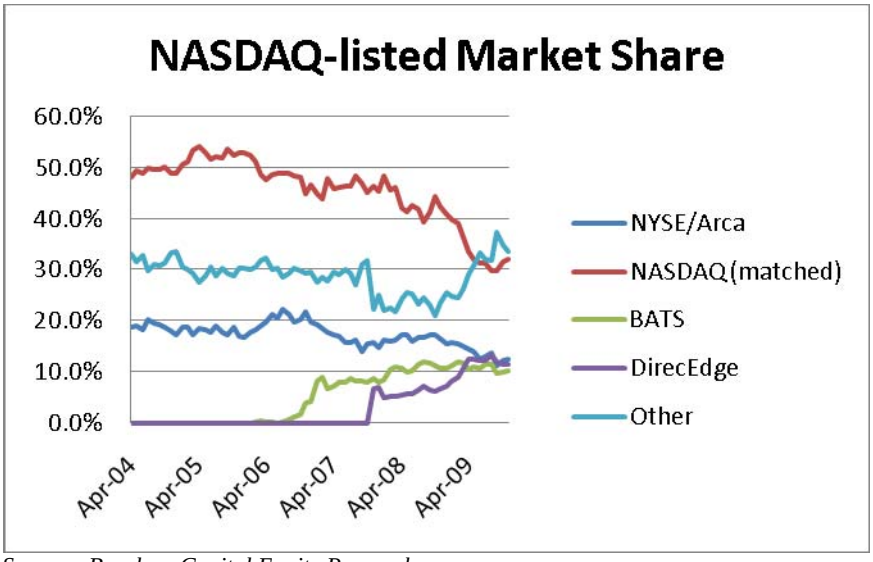
The ratio of orders cancelled to orders executed more than tripled in recent years, from under 10 at the beginning of 2002 to over 30 by the end of 2009. This graph presents the ratio of order cancellations per execution from NASDAQ ITCH data. Many trading strategies require the cancellation of an order. For example, an electronic market maker who wants to update a quote will first cancel the previous quote in the system. As trading volume increases and average trade size decreases, one expects many more quote updates.

### 3.10 Market shares at traditional markets fell




*Source: Barclays Capital Equity Research*

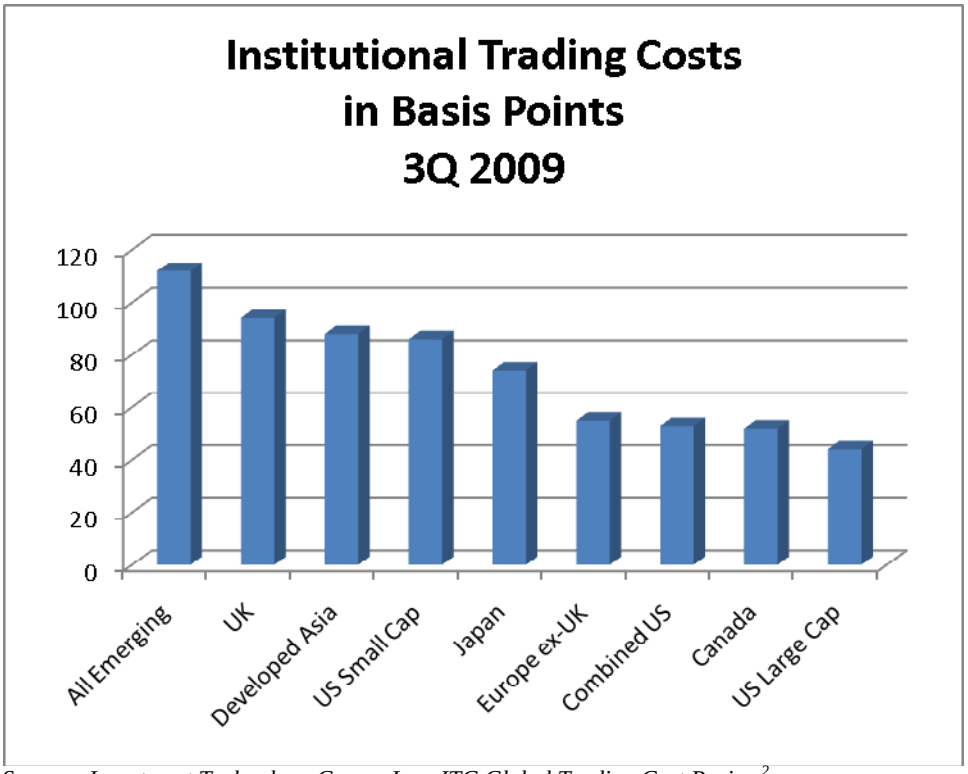
Regulation NMS (2005) freed electronic trading platforms to compete with the NYSE. Subsequently, new entrants gained significant market share. The NYSE market share of volume in its listed stocks fell from 80% at the beginning of 2003 to 25% by the end of 2009. NASDAQ matched share volume also increased, but it later fell as volume traded through new entrants such as BATS and DirectEdge increased. The "other" category, which includes both internalization by dealers as well as "dark pool" trading systems, also increased.




*Source: Barclays Capital Equity Research*

NASDAQ market share fell in recent years as other competitors gained ground. The old NASDAQ did not actually match trades, but relied on a dealer network for order execution. NASDAQ later added its own matching engine, SuperMontage, and acquired ECNs such as INET.

### 3.11 U.S. transactions costs are among the lowest in the world




*Source: Investment Technology Group, Inc., ITG Global Trading Cost Review*[2]

ITG, Inc. regularly reviews institutional trading costs around the world. The above chart shows that trading costs in the U.S. are among the lowest in the world. Care must be taken in using their data, as ITG does not correct for differences in the sizes of companies in different markets.

[2] *http://www.itg.com/news_events/papers/ITG_GlobalTradingCostReview_2009Q3.pdf*

# 4. Classical Trading Problems and Their Traditional Solutions

Three problems complicate trading. First, and most obviously, buyers must find sellers and sellers must find buyers. Second, traders are anxious not to trade with informed traders to avoid the losses typically associated with such trades. Finally, traders seeking to execute large orders must address several problems to ensure that they obtain the best prices for their trades. This section describes these problems and discusses the market structures that traders traditionally used to solve them. The following section discusses how recent advances in electronic communications and information processing technologies have substantially changed trading practices, and in particular, have provided innovative solutions to these problems.

## 4.1 The search for liquidity

Trades result only when willing buyers and sellers can meet and negotiate terms. Traditionally, traders came to exchanges where they or their brokers could locate one another and arrange trades. By providing a common meeting place and time, exchanges greatly decreased the cost of searching for liquidity.

Arranging trades at exchanges works well when buyers and sellers are both present. However, when securities are infrequently traded, or when traders seek to trade much more size than is typically available at an exchange, trading often moves away from traditional exchanges.

Finding a buyer or a seller in an infrequently traded security is often quite difficult. In such securities, investors will often trade with dealers. Dealers have an advantage in these markets as suppliers of liquidity because they often are more patient searchers than their clients. They also may have an advantage if traders widely recognize that they specialize in trading such securities, so that traders approach them when they want to trade. Since dealers generally are easy to find, they can conduct their businesses away from exchanges.

When traders seek to trade much more size than is typically available at an exchange, finding a willing counterparty often is particularly difficult. If the desired trade size is not too large, a block dealer might facilitate the transaction. But dealers often are not willing or able to arrange very large trades. To arrange such trades, traders seek the services of a block broker.

Block brokers specialize in knowing who would want to trade if presented with a suitable opportunity. Often such traders are not even aware of their interest since many traders who ultimately are willing to trade do not consider whether they would trade until asked. Economists call such traders latent liquidity suppliers. Block brokers identify such traders by keeping track of who owns large blocks of securities that they might sell and of who might be interested in purchasing large blocks of securities. Of course, the information that they collect and communicate rarely appears on exchange floors or in exchange trading systems. Many investment banks run large off-exchange block brokerage operations, as do some firms that have specialized in block brokerage, such as Jones Trading, whose operations were the original “dark pools.”

Some information providers such as Autex offer systems that allow traders to post indications of interest (IOI) designed to help other large traders find them. An IOI is a message that effectively

says, “I’m interested in buying XYZ—give me a call.” These messages are similar to those that appear on Craigslist in the sense that they help direct people to potential matches. Like those on Craigslist, they also can be potentially dangerous. Many brokers post IOIs with the hope of obtaining clients, many traders call upon IOIs with the hope of identifying trading interest that they can exploit, and many traders can post false IOIs with the hope of influencing the markets. These problems ensure that the flow of IOIs may not be particularly informative.

### 4.2 Informed trading

All traders would prefer to avoid trading with well-informed traders, who have superior information about future price levels. They buy when they expect prices to rise and sell when they expect prices to decline. Since well-informed traders are correct more often than not, they tend to profit. Those traders who trade against them tend to lose when they buy, or lose the opportunity to profit if they sell. Either way, they often will regret that they had traded. Accordingly, traders try to avoid trading with well-informed traders or on the side opposite from which well-informed traders are trading.

Concerns about informed trading make trading large blocks difficult. Most traders presume that large traders are well informed because well-informed traders tend to trade large orders and because large traders generally can afford the research necessary to become well informed. Indeed, empirical findings show that large trades tend to reflect more information than small trades. The risk of trading with a well-informed trader makes dealers and other traders wary of filling the orders of large traders. Large traders thus must convince other traders that they are not well informed to fill their orders at the best possible prices.

Dealers who know their clients well generally know who are well informed and who trade for other reasons. The dealers tend to provide better prices to those traders whom they believe trade for other reasons and try to avoid trading much, if at all, with well-informed traders.

When dealers do not know whether they are trading with informed traders, for example when they trade with anonymous traders, they widen their spreads to recover from uninformed traders what they lose on average to well-informed traders. Since traders transact anonymously at exchanges, exchange bid-ask spreads depend on the degree to which informed traders participate in the exchange markets.

Brokers who know their clients well also can help them obtain better prices by telling potential counterparties that their clients are trading for reasons other than information. They stake their reputations on the quality of this representation. If other traders suspect that the brokers have been disingenuous, they will avoid trading with them in the future.

Although exchange floor brokers generally cannot tell other traders that their clients are well informed, they can tell them they are not well informed. Those who honestly represent the nature of their clients’ motives can obtain better prices for their uninformed clients.
Many dealers specialize in filling retail orders. Since retail traders are not as informed on average as are institutional traders, dealers can offer better prices to them. To capture the benefits associated with largely uninformed order flow, brokers preference (route) their retail orders to correspondent dealers. Best execution standards require that the dealers execute the orders at the National Best Bid or Offer (NBBO) or at better prices, and the brokers demand certain levels of price improvement. Dealers receiving preferenced orders often pay the brokers for the order

flow. Since brokers cannot obtain these payments if they do not have retail orders, competition forces the brokers to return much, if not all, of these payments to their clients in the form of lower commissions or better services, both of which attract retail clients and their orders.

Many broker-dealers internalize their retail orders for the same reasons that brokers may preference the orders to certain dealers. Acting as dealers, these broker-dealers often provide price improvement to their customers. Trading this informed order flow can produce excess dealing profits, especially if the NBBO reflects the costs of dealing to many well-informed traders. However, since internalizing broker-dealers cannot obtain these payments if they do not have retail orders, competition forces them to offer lower commissions or better services to attract retail clients and their largely uninformed orders. In recent years, retail commissions of some electronic brokers became very small.

The ability of dealers to price discriminate based upon their perception of how well informed their clients are allows them to offer better execution to investors who they believe are not well informed. When dealing was strictly face-to-face or phone-to-phone, dealers would quote different prices based on their perception of the risks of trading with each client.

Dealers now trade over electronic systems. Many dealers continue to discriminate by offer better prices and large quantities to those traders who they trust will not cause them losses. In many cases, they do this by sending out actionable indications of interest. Lately, the SEC has become concerned about IOIs because they are not available to all traders.

If regulations required dealers to disclose firm quotes to all traders, uninformed investors would be harmed. Dealers would widen their spreads and withdraw liquidity to take into account the greater access to their quote by informed investors. Although the dealers could still discriminate in favor of their less informed (mostly retail) clients by offering them improved prices, dealers would not be able to attract their order flow by bidding aggressively with IOIs directed only to them (or their brokers). A prohibition on IOIs in this context thus would have the unintended consequence of reducing the relevant quote information available to less informed traders, and thereby reduce price competition for their order flow.

### 4.3 Problems Associated with Large Traders

Large traders face—and cause—special trading problems. Other traders may front-run their marketable orders or employ quote-matching strategies to extract option values from their standing orders. Both strategies increase their transaction costs. In contrast, large traders try to price discriminate among liquidity suppliers to reduce the costs of filling their orders. This behavior causes liquidity suppliers to withdraw from the market.

Attempts to solve these problems account for much of the innovation in market structure. This section introduces these problems and explains how traders traditionally solved them.

#### 4.3.1 Front-running

Traders generally like to expose their orders to help traders on the other side locate them. However, exposing orders produces undesirable consequences, especially for large traders.

Traders who fill large orders often must move prices substantially to encourage other traders to trade with them. These price concessions are especially large when other traders believe that the

large traders are well informed, but they may still be quite significant even when the large traders are not informed.

Expectations of these price changes make filling large orders problematic. If other traders become aware of a large buy order, some may immediately buy in front of the order in an effort to profit from the expected price change. They likewise may sell in front of large sell orders. Such trades increase the ultimate costs of filling large orders.

Also, traders who have posted limit orders or quotes will try to cancel their orders and quotes if they become aware that they could trade with large traders. They replace their orders and quotes with new orders and quotes placed further from the market so that they do not lose as the large traders put pressure on prices. If these trades can fade from the market, the large traders will pay more to fill their orders.

Both problems—front-running by traders on the same side and fading by traders on the opposite side make large traders very reluctant to disclose the sizes of their orders. Traders traditionally address this problem by giving their orders to floor brokers and upstairs brokers who expose the orders only to traders that the brokers trust will not front-run the large orders. However, information leakage often occurs because brokers cannot effectively conceal their orders, even assuming that they do not favor others.

Many buy-side traders believe that floor brokers are unable or unwilling to effectively conceal the information in the orders entrusted to them. At best, the brokers simply cannot keep a straight face. At worst, the brokers may tip off others to gain other advantages. The clients try to identify these problems by measuring their transaction costs to identify the quality of the service that they obtain from their brokers. However, transaction costs are notoriously difficult to measure, and measurement is not useful if all brokers suffer the same failings. Accordingly, many buy-side traders have enthusiastically supported innovative hidden order and dark pool trading systems that address this problem.

### 4.3.2 Quote-matching

Large traders who expose their limit orders risk that other traders will employ a strategy called quote-matching against them. The quote-matching strategy increases transaction costs for large traders. An example can help introduce the quote-matching strategy. Suppose that a large trader places a limit order to buy at 30. A clever trader who sees this order could immediately try to buy ahead of it, perhaps by placing an order at 30 at another exchange, or by placing an order at a tick better at the same exchange. If the clever trader's order fills, the clever trader will have a valuable position in the market. If prices subsequently rise, the trader will profit to the extent of the rise. But if values appear to be falling, perhaps because the prices of correlated stocks or indices are falling, the clever trader will try to sell to the large trader at 30. If the clever trader can trade faster than the large trader can revise or cancel his order, and faster than can other traders competing to fill the large trader's order, the clever trader can limit his losses. The clever trader thus profits if prices rise, but loses little otherwise. The large trader has the opposite position: If prices rise, he may fail to trade and wish that he had. If prices fall, he may trade and wish that he had not. The profits that the clever trader makes are lost profit opportunities to the large trader.

The quote-matching strategy is profitable when very fast traders can extract option values from limit orders. Orders have option values because they give other traders rights to trade at fixed prices. For example, a standing limit sell order represents a call option struck at the limit price granted to the market as whole. The first trader who wants to buy at the limit price exercises this option.

Large traders traditionally have avoided quote-matching losses by limiting the exposure of their orders. On floor-based exchanges, large traders trust their orders to floor brokers with the understanding that the brokers will only display the orders to traders whom the brokers expect will fill the orders and who the brokers trust will not front-run the orders. Off-floor brokers likewise carefully manage the exposure of the orders entrusted to them.

Large traders who do not trust their brokers may break their orders into small pieces so that they do not expose the whole order all at once. However, by breaking up their orders, they increase the number of trades taking place on the same side of the market. Dealers and other traders who see such trading patterns often conclude that well-informed traders are in the market, which makes it difficult for the large traders to fill their orders at a low cost.
Concerns about the quote-matching problem have caused many buy-side traders to enthusiastically support innovative trading systems that help them solve this problem.

### 4.3.3 Price discrimination

Large traders often try to break their large orders into smaller pieces so that can fill the first pieces at the best available prices and then only fill the remaining sizes at inferior prices. Since traders who offer liquidity are aware of this problem, they tend not to post much size at the best quoted prices. Those who do post significant size too often fail to earn the price concessions that large traders typically pay to fill an order.

Large traders may avoid this problem to some extent by using the services of block dealers or brokers. These traders try to determine the full size of their large clients' orders so that they can properly price them. They keep their clients honest by paying close attention to their clients' subsequent trades and by refusing to arrange trades again for clients who prove to be dishonest. Those traders who can credibly convince others that they will not price discriminate often obtain better average prices for their orders than they would if they tried to price discriminate.

# 5. Innovative Solutions to the Classical Trading Problems

New communications and computing technologies have allowed exchanges, brokers, dealers, and alternative trading systems to create innovative solutions to the traditional trading problems described above.

## 5.1 Order routing to exchanges

Perhaps most notably, innovations in electronic communications and computing technologies have greatly reduced the costs of searching for liquidity at exchanges and in other trading systems.

The first benefit that new technologies provided was remote access. Traders who were far from an exchange could quickly send their orders to the exchange over telegraphs, then telephones, and now over computer linkages. These communications technologies have allowed investors off the floor of an exchange to easily participate in the search for liquidity and quickly learn about executions of their orders.

The introduction of ticker tapes, and later quotation feeds, allowed remote traders to determine whether brokers and dealers were handling their orders fairly on the floors of the exchanges to which they routed their orders. With this information, traders could send orders to distant exchanges without worrying too much about being cheated.

These advances in telecommunications technologies substantially decreased the number of exchanges as investors increasingly sent their orders to larger markets where the probability of finding contra-side interest was greatest. Transaction costs decreased and trading volumes increased as buyers and sellers could more easily find each other by sending orders to brokers and dealers on exchange floors. Order flows consolidated substantially to the point that exchanges such as the New York Stock Exchange and the American Stock Exchange obtained market shares of 90 percent or more in their listed securities. Regional exchanges merged to form larger exchanges, but never competed very successfully. Many small exchanges failed.

As information technologies continued to improve, consolidated quote feeds mandated by the SEC and sold by various data venders allowed remote traders to know almost instantly the quotes posted by exchange specialists, and later, all order sizes at the best bid and offer. With these feeds, traders could easily determine which markets posted the best current trading opportunities.

At first glance, the availability of these quote feeds should have promoted competition from secondary exchanges because traders could easily route their orders to the best trading opportunities. However, these feeds did not adequately represent all relevant information about trading opportunities at an exchange, and in particular, at the dominant exchanges. Quote information was incomplete in two respects. First, only the best bid and offer were reported whereas traders on the floor of an exchange often could see trading interest behind the best prices. Second, many traders did not post orders that the exchange could disseminate. Instead, for reasons discussed in the previous section, larger traders typically gave their orders to floor brokers who revealed them to other traders on the floor of the exchange on a selective basis. As a result, for most traders searching for liquidity, the primary exchanges remained the destinations

of choice as those exchanges continued to be the most productive places to search for counter-parties.

The SEC designed the ITS order routing systems to connect exchanges in the National Market System (NMS) to each other. In conjunction with a rule prohibiting trading through the quotes of a NMS exchange, the ITS system was supposed to facilitate the search for best price while promoting competition among exchanges. In practice, the system did not meet its objectives because it operated too slowly (operators entered orders manually) and because specialist dealers receiving orders did not have to respond immediately. These problems with the ITS system ensured that most traders continued to route their orders to the primary listing markets.

In the OTC markets where unlisted securities traded, dealers would contact each other over the phone when they wanted to trade with each other. The NASD created NASDAQ as an automated quotation system to help the dealers identify who was offering the best price. Over time this system eventually evolved to become an exchange system that maintained order books and automatically executed trades.

### 5.2 ECNs

Innovative brokerage systems such as Instinet and Island created alternative trading systems called Electronic Communication Networks ("ECNs") to collect and match their client orders automatically. The ECNs initially did not take much trade from the primary listed markets because too much order information in these floor-based markets remained on the floor. Traders were unwilling to trade in the electronic systems because more trading opportunities were available on the floor. Without traders posting orders in these systems, the systems never became liquid and therefore never posed any significant challenges to the traditional listing exchanges until Regulation NMS became effective.

Best execution standards that prevented brokers from arranging or accepting trades at prices inferior to those quoted in the National Market System also limited the ECN growth in listed securities. These restrictions prevented them from trading through quoted prices at the floor-based exchanges.

As a purely electronic system, NASDAQ was always a fast system, and latency (the amount of time needed to respond to a message) decreased substantially with technological innovations in communications networks and in processing systems. The low latency allowed traders to submit marketable orders and quickly receive confirmation that their orders executed. Low latency also allowed the traders to submit order cancellation instructions and quickly receive confirmation that their orders were cancelled or already had been filled.

The low latency in NASDAQ allowed the ECNs to compete very successfully in NASDAQ-listed stocks. The ECNs solicited order flow for their systems by making the following proposition to their brokerage clients: If you post an order with us, we will post a copy of that order in the NASDAQ quote montage. If the order executes at NASDAQ, you will obtain the execution. While the order is sitting at NASDAQ, if an incoming marketable order arrives in our system, we will hold the marketable order, cancel the standing NASDAQ order, and then fill your order. If we arrange the trade for you, we will charge you less than other NASDAQ dealers.

This proposition ensured that brokers would obtain the benefit of any liquidity offered in the NASDAQ system, while still posting orders in the ECN. The ECN could offer this proposition only because it could cancel and confirm cancelation of its NASDAQ quote very quickly. Without that facility, the ECN could not hold up the execution of the incoming marketable order. With this facility in place, trading in the ECNs grew very substantially in NASDAQ-listed stocks.

Likewise, the low latency of the NASDAQ system allowed ECNs to accept orders that were not marketable in their systems, but which were marketable against other NASDAQ dealer's quotes. They submitted these orders through NASDAQ, received quick confirmations of their executions, and then continued to process any remaining size in their systems if possible. The ECNs thus were able to avoid trading through the NASDAQ quotes, while conducting their operations.

The ECNs could not offer these facilities for listed stocks because they could not quickly obtain confirmed executions and order cancellations from the floor-based exchanges where latency was often greater than 15 seconds. Their slow floor markets of the primary listing exchanges thus protected them from ECN competition. To obey the trade through rules, the ECNs would have had to halt their system while waiting for the NYSE floor to respond to their orders.

### 5.3 Hidden order size

To help protect order flow information, many exchanges and ECNs created hidden order facilities. These facilities allow traders to submit orders to their execution systems that limit the exposure of their sizes. Depending on the order type, traders may completely hide size (hidden orders), partially reveal size (reserve orders), or reveal size in whole or part at prices away from the market (discretionary orders). Traders use these orders to offer liquidity without revealing information about the full sizes of their orders. They thereby hope to avoid front-running and quote-matching problems.

Traders who seek liquidity discover hidden order sizes at a given price by submitting orders to trade at that price. If hidden size is present, a larger trade will result than displayed quantities would indicate. The price of discovering the hidden size is a binding commitment to trade with it.

Although these systems only reveal hidden size to the extent of the size of the marketable orders, some proprietary traders "ping" the market repeatedly with small orders to discover whether hidden sizes are present. They can only be sure about the size that they discover, but they often infer additional size when their orders repeatedly fill. At some exchanges and dark pools, large traders who want to prevent such discoveries of their orders can place minimum fill quantities restrictions on their orders. The availability of such restrictions obviates regulations that might prevent pinging.

Large traders who seek liquidity generally are as unwilling to display their searches, as are the large traders whose hidden orders they seek. To prevent discovery of the remaining sizes of their orders, large traders submit immediate or cancel orders (IOC) when seeking hidden liquidity.

IOC orders are by far the most commonly submitted orders. Brokers use them to sweep across trading venues at progressively more aggressive prices to discover hidden liquidity. Most do not execute, but those that do provide executions at improved prices and augmented sizes. These tactics are feasible because latency at many exchange trading systems is now under a millisecond.

### 5.4 Alternative trading systems for large block traders (dark pools)

Brokers and others have developed many alternative trading systems to help large traders arrange trades and enhance liquidity provision, while protecting these traders from front-running and quote-matching problems that arise when information about their orders is widely known. Large traders are anxious to protect the intellectual property and privacy of their trading plans. In a trading floor context, these traders previously used floor brokers who worked their orders based on their experience. Now many large traders use dark pools instead. Space constraints prohibit description of all of these systems, or even all of the most significant of these systems. Here we discuss two of the most innovative systems.

#### 5.4.1 POSIT

Brokers created alternative trading systems specifically designed to solve search problems for large traders. The first such system that enjoyed wide popularity was POSIT. POSIT conducts a call market that appeals to large traders who do not wish to expose their orders to the market. Traders submit orders to POSIT, which does not display the orders to anyone. At the time of the call, POSIT matches the buy orders to the sell orders. Generally, all orders on the side with the smaller total size are filled. The orders on the other side are filled on a pro-rata basis. Once so matched, the trades take place at the midpoint of the bid and ask quotes at the primary listing market for the security.

Since many POSIT orders are extremely large, very large order imbalances are common when one side is present, but the other is not. Since the POSIT order imbalance is not displayed, imbalances in POSIT cannot attract balancing size. Accordingly, most POSIT calls trade only a small fraction of the total order size submitted.

Despite the low fill probability, buy-side traders use POSIT because the prices for the trades that they do obtain are very favorable. When large traders meet on opposite sides in POSIT, they both obtain executions with no price impact that are much better than they would otherwise expect to obtain if they traded in the market. By calling traders to a single point in time, the POSIT market increases the probability that both sides will be present. Moreover, they obtain this service without revealing information about their orders to the market. In particular, their orders are not revealed when they fail to trade.

The POSIT system is not perfect, however. Traders whose orders fill partially can estimate the total size submitted on their side of the market from knowing the total POSIT fill, which is public information, and the portion of their order that filled, which only they and other participants on their side know. Buy-side traders are aware of the leakage of this information and many use other alternative trading systems, at least in part, due to concerns about this issue.

#### 5.4.2 Liquidnet

Liquidnet is another innovative alternative trading system that large buy-side traders use widely. Subscribers allow Liquidnet's computers to see the orders in their order management systems. These are the orders that the portfolio managers give to their buy-side traders to fill. The buy-side traders then try to fill these orders by negotiating with dealers or by submitting orders to block brokers, to exchanges, or to alternative trading systems. When Liquidnet sees that a buyer and a seller are both interested in the same security, it sends a message to the two buy-side traders that indicates that they may be able to arrange a trade. The message does not reveal trader

identities. The traders then negotiate with each other to arrive at a price and size for their trade. The resulting trades are often very large.

To help guard the order information, Liquidnet rates traders by their propensity to conclude deals suggested to them. To avoid front-running and quote-matching problems, traders can indicate that they do not want information about their orders to be shared with traders who have low completion rates. Liquidnet thus ensures that only traders who have a high probability of arranging trades obtain information about future trades.

Liquidnet also allows clients to indicate traders and classes of traders with whom they do not to want to trade. For example, clients generally do not want to trade with traders that they perceive to be better informed than themselves.

### 5.4.3 Dark pools and retail orders

Many brokers have arranged to pass marketable order flow through dark pools with the hope of obtaining better executions than they would if they were sent to other venues. Institutional traders generally welcome the opportunity to trade with retail order flow because retail traders are largely uninformed. If they trade, the retail traders obtain better executions and the institutional traders obtain more size. Using dark pools benefits both sides, but not informed traders who these pools try to exclude.

## 5.5 Indications of interest and actionable indications of interest

Dark pools only work when traders are willing to express their interests in trading as orders and then make those orders available to the alternative trading system. If only one side to a potential trade expresses its interest as an order, no trades can be arranged or proposed.

Traders sometimes can attract contra-side interest by showing that a trading opportunity is available. Traders thus have an interest in displaying their orders because such displays may attract other orders. However, as noted above, order display can often lead to front-running and quote-matching problems.

An IOI represents a middle strategy in the search for liquidity between displaying an order and hiding an order. Since IOIs are not firm, traders who might try to exploit the information in them may find that the order is not available to them.

IOIs are most valuable when they are displayed by traders widely recognized to be reliable, and when they are received only by traders who will not engage in exploitive trading strategies. When an IOI truly represents a real opportunity to trade, and when the recipient can be trusted not to exploit the information, both traders have an interest in ensuring that they can act upon the IOI at minimum cost to produce a trade.

To this end, many dark pools have systems for disseminating actionable IOIs to trustworthy entities. These actionable IOIs inform the entity that a trade is possible. For example, a retail broker may receive an IOI from a dark pool. If the broker has an order that would help fill the interest, the broker then could route to the dark pool and obtain a better execution at lower cost for its client.

Without actionable IOIs, the broker would have to use an IOC order to probe the dark pool for liquidity when looking to fill an order. Since such probes usually produce fruitless results and thereby waste time while in flight, brokers may choose not to probe the dark pool when trying to fill their orders. Alternatively, they may only probe the pool late in their sweep sequences so that they can probe first other trading venues that generally produce better results.

The actionable IOI differs from a firm quote because dark pools offer them only to certain market participants based on the degree to which they trust them not to exploit the information that they convey. Firm quotes that are displayed to all traders are much riskier.

Dealers also publish actionable IOIs to brokers for whom they are willing to fill their clients' orders. These brokers typically represent traders whose orders the dealers do not fear, either because the traders are uninformed, or because the dealers are confident that they can layoff their positions before the information in an informed traders order moves the market. The actionable IOI allows the dealer to advise the broker that liquidity is available so that the broker can quickly route to it if it represents the best available trading opportunity.

As noted above, the actionable IOI allows the dealer to offer better prices and more size to certain clients. While this discrimination against well-informed traders might seem to be unfair, allowing it lowers transaction costs for retail clients and many institutional investors. If regulations prevented the use of actionable IOIs, dealers would offer less liquidity as they faced greater losses from being picked off by informed traders. Banning the use of actionable IOIs by dealers would much more likely discourage liquidity provision than dramatically increase their use of firm quotes.

A continuum of investors trade in our marketplace, ranging from well informed to uninformed. The use of a range of order types by those prepared to commit capital to liquidity provision enhances the liquidity process by allowing them to risk their capital when they want to and avoid doing so otherwise.

The use of actionable IOIs reflects the evolving nature of trading technology. They allow dealers to efficiently communicate with potential customers and for the customers to respond. Although other traders do not share the same opportunities, post-trade reporting requirements ensure that all traders share in the information produced in trades arising from actionable IOIs.

### 5.6 Algorithms

To avoid displaying information about the full sizes of their orders, large traders often break their trades into smaller pieces to fill them over time. This trading strategy also allows markets to recover over time from the effects of order imbalances so that the price impacts of large orders may be reduced. Practitioners call strategies for breaking up orders and for submitting them to markets algorithms.

Algorithms differ according to whether they offer liquidity or take it. Many do both. For example, some algorithms immediately take liquidity upon starting up. They then post limit orders to obtain better fill prices. While posting liquidity, they may often cancel their orders to obfuscate their presence and thereby frustrate traders who would try to exploit information in their orders. As a trader-imposed deadline approaches, the algorithm may then take liquidity, if necessary, to finish filling the order.

Computerized trading systems implement algorithms based on information available to them from trade and quotation feeds. Many algorithmic strategies are based on substantial statistical analyses into how orders execute on average and in specific situations.

Algorithmic trading has substantially reduced workloads for buy-side traders and for the brokers who serve them. Although the costs of developing and maintaining algorithms are high, the cost savings from using them often greatly cheapen the overall costs of trading, especially for routine trades.

### 5.7 Proprietary trading

By providing very fast and inexpensive systems, today's electronic markets allow nontraditional dealers to offer liquidity using electronic proprietary trading systems. These traders use various high frequency trading strategies to provide liquidity. They could act as dealers who commit capital to connect buyers to sellers who arrive at different times, or they could act as arbitrageurs who connect buyers in one market to sellers in another correlated market.

These electronic proprietary traders have substantial advantages over traditional dealers who cannot see as much information, process as much information, or react as quickly to new information as can computers. As they competed with traditional dealers and with each other, they substantially decreased bid-ask spreads while making prices more informative and more resilient to transitory displacements caused by unexpected demands for liquidity.

### 5.8 Co-location

When many traders seek to take advantage of the same trading opportunities, the fastest traders are the most successful. Accordingly, algorithmic traders and proprietary traders seek every speed advantage that they can obtain. They try to employ the fastest computers, write the fastest software, and obtain market data before others, often through direct links to exchanges. Communications latencies are due to time lost as messages travel at the speed of light and to delays caused by passing messages through routers. To speed their communications, high frequency traders co-locate their servers as close as possible to the exchange servers that produce market information and collect orders.

Co-location is no different than the traditional practice of locating brokerage firms close to the stock exchange to reduce the time and expense of filling an order. If the practice of co-location were banned, traders would merely seek to locate their servers in the closest piece of real estate to the exchange data centers, with far less oversight than is possible within the exchange data centers.

### 5.9 Effects on listed exchanges

Combined efficiencies from high frequency proprietary trading and from the operation of the low-cost electronic ECNs substantially decreased the costs of trading NASDAQ stocks. Practitioners and regulators observed similar decreases in transaction costs in Canada, Europe, and Asia, where different regulatory environments allowed electronic exchanges to flourish earlier than in the United States.

In response to these observations, regulators at the SEC adopted Regulation NMS in 2005. That regulation removed the ITS trade-through rule and substituted a rule that prohibited trade-throughs of electronically accessible quotes. As a result, floor-based trading systems lost their

primacy to electronic systems. The listed exchanges (NYSE and AMEX) started to offer electronic trading, but their systems were too slow and too expensive, and they quickly loss market share to faster electronic competitors. At the same time, floor brokerage at the listed exchanges has become less important as buy-side traders increasingly use dark pools to arrange their trades with less information leakage. As illustrated earlier, the New York Stock Exchange now only trades 25% of the volume in its listed stocks.

## 6. Market Performance during the Panic of 2008

The financial markets experienced a severe financial crisis in 2008. During this period, equity trading systems handled the extreme volatility and volumes without system problems. Their performance stands in sharp contrast to the system problems experienced during the Crash of 1987, which led to serious delays in executing orders. The trading systems then used could not, or would not, handle the trading volume. For example, the printers that generated order tickets on the NYSE floor could not print out the orders fast enough, and NASDAQ market makers would not pick up the phone. These glitches in the trading system added to confusion and uncertainty, as investors could not be certain of the status of their orders or of current market conditions.[3]

Some commentators would like to blame the recent drop in stock prices on short selling or other practices in the equity market such as computerized trading. We believe that stock prices fell for fundamental reasons as investors began to recognize the extent of valuation and risk management problems on various balance sheets. Indeed, the approximately 50% drop in equity prices is comparable to the experience of other recessions such as in 1974 and 2001, at which times no significant concerns were expressed about short selling or computerized trading.
We note that short sellers and computerized traders did not induce lenders to make loans to millions of borrowers who could not pay them back. Short sellers did not package those loans into securities that were then sold to investors, nor did short sellers get the rating agencies to stamp AAA on securities that should not have been rated AAA. Neither did computerized traders force entities such as Fannie Mae, Freddie Mac, or Lehman Brothers to purchase tens of billions of dollars worth of what were later called "toxic" securities.

Concerns over short selling led to various restrictions on the practice in the U.S. and other markets during the panic in 2008. Beber and Pagano, among others, have analyzed these restrictions and found that they were detrimental to market liquidity and failed to support market prices.[4] These findings are reasonable because much, if not the majority, of short selling does not consist of directional bets on the value of a security. Instead, short selling helps markets operate more smoothly in areas such as market making, arbitrage, and statistical arbitrage. Categorical restrictions on short selling do more to reduce such beneficial short selling than to prevent any alleged abusive short selling.

Restrictions on short selling also frustrate the trading of well-informed traders who recognize that companies are overvalued. Overvaluation generally is a more serious problem in public markets than is undervaluation. When securities are overvalued, capital gets wasted as companies sell securities to fund poor projects, and investors lose money when prices fall. When securities are undervalued, companies often find capital from other sources, and long-term investors do not experience losses if they hold until prices regain their true values.

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[3] *For more information on the Crash of 1987, see Presidential Task Force on Market Mechanisms, 1988, Report of the Presidential Task Force on Market Mechanisms, Nicholas Brady (Chairman), U.S. Government Printing Office.*

[4] *See Beber, Alessandro and Pagano, Marco, Short-Selling Bans Around the World: Evidence from the 2007-09 Crisis (November 2009). CEPR Discussion Paper No. DP7557. Available at SSRN: http://ssrn.com/abstract=1533163. See also Kolasinski, Adam C. Reed, Adam V. and Thornock, Jacob R., Prohibitions versus Constraints: The 2008 Short Sales Regulations (October 5, 2009). AFA 2010 Atlanta Meetings Paper. Available at SSRN: http://ssrn.com/abstract=1365037.*

# 7. Comparison with Other Markets

No examination of the U.S. equity market would be complete without a comparison with markets in other financial instruments and with other equity markets around the world.

## 7.1 Other equity markets

The U.S. equity market is characterized by its open architecture, which makes it easy for those with innovative ideas to enter the market. This intense competition has led to a dramatic fall in execution costs. Many other countries are behind the United States; especially those that accepted exchange monopolies. Europe has moved quickly toward a competitive exchange structure, and many of the same trends of declining legacy exchange market share seen in the U.S. are visible there as well. However, trade reporting in Europe generally lags behind the United States, and no equivalent official NBBO exists there. We note once more the ITG results that show U.S. transactions costs are among the lowest in the world.

## 7.2 Other financial markets: U.S. fixed Income

In the U.S. fixed income world, no definitive source for price information exists that is comparable to the National Best Bid and Offer (NBBO) and last sale for equities. Brokerage firms typically trade as principals against their retail customers, and retail customers often cannot easily determine the quality of their executions.

For example, U.S. Treasury bonds are considered to be among the safest and most liquid securities in the world. Treasury bonds have characteristics that should make their transactions cost among the lowest in the world: huge trading volumes, large supply, and virtually no traders who possess better information than the dealers. Published quotations in the Wall Street Journal's online edition typically show institutional spreads of about 1/32nd of 1%, about 3 basis points. Yet retail investors typically face much wider spreads, on top of which they pay commissions as well. For example, a recent online retail quote for the November 2039 4.375% long bond from one of the largest brokerage firms was 97.30 bid and 98.75 offered, or a bid-ask spread of 145 basis points (1.45%) of the bond's par value. In contrast, the bid-ask spread on a Treasury ETF such as the iShares Barclays 20+ Year Treasury Bond (TLT) is typically only one or two cents on a $92 stock, or around one or two basis points. It is clear that the present U.S. equity markets deliver far lower trading costs to retail investors than do the fixed-income markets.

# 8. Recommendations for SEC Rulemaking

## 8.1 Make-or-take pricing

Make-or-take pricing has significantly distorted trading in the National Market System in which best execution standards and mandated order routing determine execution venues and execution prices. The distortions arise because orders are priced on different bases in different markets. The problem is large and growing larger as bid-ask spreads and commissions decrease. It has distorted order routing decisions, aggravated agency problems among brokers and their clients, unleveled the playing field among dealers and exchange trading systems, produced fraudulent trades, and produced quoted spreads that do not represent actual trading costs.

In the make-or-take pricing model, exchanges (and some alternative trading systems) charge an access fee for executing marketable orders that fill against (take) standing orders and provides a liquidity rebate for executed standing orders that make markets. The difference between the access fee and the liquidity rebate is the net fee that the make-or-take exchanges earn for arranging trades. In contrast, exchanges that charge a transaction fee for arranging trades simply charge the buyer, the seller, or the member trader a fee for executed trades. The transaction fee and the net fee earned by make-or-take exchanges are of similar magnitudes so that access fees are generally greater than transaction fees. (On rare occasions, the relationship has been inverted when an exchange runs a promotion.)

At first glance, the make-or-take pricing model appears attractive because it seems to reward makers for good behavior—offering liquidity. To earn the liquidity rebate, makers tend to compete to offer better prices, which reduces bid-ask spreads on average. However, in competitive markets, the access fee offsets the narrower average quoted spreads so that takers are no better or worse off on average. Likewise, the liquidity rebate offsets the narrower quoted spreads so that makers also are no better or worse off on average. The actual economic bid-ask spread at these exchanges is the quoted bid-ask spread plus twice the access fee. (This sum is the total cost of simultaneously buying and selling using marketable orders.) In competitive markets, the actual spread will not depend on how high the access fees and liquidity rebates are, so long as the difference between them is constant. Traders simply adjust their quoted prices so that the net prices that they pay or receive are the same on average. The make-or-take pricing model thus would appear to accomplish nothing besides reducing quoted spreads and thereby obfuscating true economic spreads, which are the net spreads inclusive of the access fees and liquidity rebates.[5] The obfuscation makes it more difficult for traders to recognize the true costs of their trading.

The obfuscation problem may be best understood by considering its analog in retail commerce conducted over the Internet. Some retailers quote low prices for their products so that search engines rank their offers high. They then charge high shipping and handling fees so that their net prices are as high as or higher than their competitors. Variation in shipping and handling fees that is unrelated to actual costs creates substantial price confusion and can lead to poor decisions by

[5] *In some markets, the minimum price variation—the tick size—sets a binding floor on the bid-ask spread. In those markets, makers offer more size at make-or-take exchanges than they would at traditional transaction fee exchanges to increase the probability that an order will be routed to them. The additional size will expose them to greater losses to information traders, and the greater losses offset the liquidity rebates that they obtain.*

uninformed shoppers. Some Internet search engines attempt to solve this problem by ranking offers by net price rather than quoted price.

Unfortunately, make-or-take pricing has effects on order routing decisions that are substantially more significant than simple obfuscation of true spreads. Brokers make most order routing decisions based on the quoted prices that their clients will receive, and not the true net prices of the trades. They typically route customer limit orders that they cannot immediately execute to make-or-take exchanges where the broker will receive a rebate—which usually is not passed on to the customer—for the order execution. They route marketable orders to exchanges, and alternative trading systems if they have the same prices, but do not charge access fees. They also may route marketable orders to internalizing dealers who promise to fill orders at the National Best Bid or Offer (NBBO).

These routing decisions ensure that makers at make-or-take exchanges receive later executions than they otherwise would receive. At a given price, the standing orders of such makers execute only after no size remains at that price at venues that do not charge access fees. Since brokers route marketable retail orders to internalizing dealers to avoid access fees, the traders who pay the access fees at make-or-take exchanges typically are proprietary and institutional traders whose orders internalizing dealers will not accept. These traders tend to be well-informed traders. The retail orders routed to make-or-take exchanges thus always execute when prices move against them, but they may not execute as often as they would otherwise execute when prices move in their favor. The problem results because retail customers usually do not receive the liquidity rebates, and because standards for best representation of limit orders are primitive in comparison to standards for best execution of marketable orders.

Make-or-take pricing also affects the competition between internalizing dealers and exchanges. Best execution principles require that dealers who internalize retail order flow match the National Best Bid or Offer (NBBO) when trading. The artificially decreased quoted bid-ask spreads that result when make-or-take pricing hurt internalizing dealers because they must trade at tighter spreads on average, but they cannot charge access fees to their customers, and they do not receive liquidity rebates when they trade. As a result, this pricing model ensures that internalizing dealers compete at a disadvantage with make-or-take exchanges. The problem is exacerbated by the fact that make-or-take pricing distorts brokerage order routing decisions so that internalizing dealers fill most retail orders.

The make-or-take pricing model forces dealers into organized markets where they can receive liquidity rebates. Unfortunately, they cannot provide better prices on a selective basis to largely uninformed retail traders in such markets as they can and do when filling retail order flows.

Make-or-take pricing also affects the competition between the make-or-take exchanges and the transaction fee exchanges. Regulation NMS trade-through rules require that exchanges must route marketable orders to other exchanges that provide better prices. When the other exchanges are make-or-take exchanges, the routing exchange must pay the destination exchange the access fee. Some exchanges absorb the loss while others pass the access fee along to their customers. Those that accept the loss clearly are hurt. Moreover, they are exposed to customers who strategically route orders through them to avoid the take fee. Those exchanges that pass the fee along to their customers force their customers to pay fees that they generally do not expect and could only avoid by adding immediate-or-cancel instructions to their orders.

To avoid these problems, many exchanges have created flash trading facilities. These facilities help them find traders who are willing to match or improve the prices at the make-or-take exchanges, so that the transaction fee exchange can retain the execution and thereby avoid the access fee. In this sense, flash trading can be viewed as a way to limit the "unintended consequences" of the "make-or-take" pricing framework under the current regulatory system.

The distortions induced by make-or-take pricing perhaps are illustrated best with an explanation of how proprietary traders can exploit — and we understand are exploiting — the current market structure. Suppose a proprietary trader can post orders at a make-or-take exchange and receive a liquidity rebate of 0.3 cents/share when their standing orders execute. Suppose further that they can trade through one of several Internet brokers that allow their customers to trade unlimited size at a commission of $9.99 per trade. To exploit the make-or-take problem, the proprietary trader will post an aggressively priced buy (or sell) order at the make-or-take exchange in a low price stock for which the bid-ask spread is wider than the minimum price variation, and thereby improve the NBBO in that stock. The trader then immediately will submit a marketable sell (or buy) order at the same price to the Internet broker. If the Internet broker routes the order to the make-or-take exchange, the liquidity rebate will be greater than the $9.99 if the trade is for more the 3330 shares. If the order is sufficiently large, the proprietary trader will profit and the broker will lose the take fee. Alternatively, if the Internet broker routes the order to an internalizing dealer, the internalizing dealer will fill the order at the NBBO and then very likely immediately cover his position by taking the order at the make-or-take exchange for his own account. Again, the proprietary trader will profit (if the order is sufficiently large) and the dealer will lose the take fee. Brokers tell us that they believe this abuse is already taking place. Although trading this strategy is potentially illegal, clever traders certainly would be able to accomplish its objective through the coordinated use of seemingly unrelated accounts. Alternatively, Incorporation of a slight modification of this strategy into an otherwise profitable proprietary dealing strategy substantially increases the profits that could be made.

The make-or-take pricing problem is growing larger as bid-ask spreads and commissions decrease. When Regulation NMS limited access fees to 0.3 cents per share, spreads, commission, and dealer trading profits per share were much larger than they are presently. The growth of electronic trading, better order routing systems, and proprietary trading has substantially decreased spreads commissions and per share dealer profits, while substantially increasing trading volumes. The constant access fee consequently has become a relatively larger determinant of routing decisions, and ultimately of transaction costs.

The SEC could solve these make-or-take problems by requiring that all brokers pass through access fees and liquidity rebates to their clients. Presently, some brokers do this voluntarily or upon request by their clients. However, the practice is complex and therefore confusing to most customers. Most retail brokers provide single fee commissions because this single fee pricing appeals most to their customers.

We recommend that the SEC require that all brokers pass through the fees and liquidity rebates to their clients. Doing so would ensure that the customers receive and pay the actual net prices associated with filling their orders. The SEC also should clearly indicate that the principles of best execution apply to net prices and not to quoted prices. These changes would ensure that brokers route all orders to best serve their clients, rather than to enrich themselves. With these

changes, we expect that make-or-take exchanges would quickly change to transaction fee exchanges so that little confusion would actually result.

Alternatively, we recommend that the SEC eliminate access fees. This change would offer a common pricing standard for exchange services and thereby ensure that price quotes are comparable across exchanges.

The elimination of access fees would also cause securities markets to conform to common agency law. Common law generally prevents agents from collecting fees from people seeking to do business with their clients. Such fees are prohibited because they inevitably reduce the value of the business that the clients receive. Oddly, these fees have been accepted in securities markets where exchanges act as agents for the traders that post orders on their books and where brokers act as agents for their clients. Exchanges should not be allowed to require that traders pay them to trade with their clients; neither should brokers be allowed to receive liquidity rebates for routing client limit orders to make-or-take exchanges. In other contexts, these payments would be recognized as illegal kickbacks.

### 8.2 Naked sponsored access

Proprietary high frequency trading can expose markets to systemic risks if an electronic trader's trading system submits orders that lead to trades that the trader cannot settle. Such settlement failures may arise when a programming error or an unanticipated response to erroneous data causes a trading system to go out of control and issue unintended orders. Settlement failures may also arise when traders who know that they are bankrupt continue to trade with the hope that subsequent events may reverse their fortunes before anyone becomes aware of their financial problems.

The trades that result in either of these events can be very costly to other traders when they fail to settle. The failures may result because the exchange breaks (nullifies) the trades, or because the initiating trader is financially unable to settle the trades. Both processes are disruptive at best, and often quite costly to other traders.

Exchanges generally break trades if the trades obviously were mistakenly ordered. The contra-side traders whose trades occurred at unreasonably high or low prices are disappointed, but they can hardly be surprised when they learn their trades turned out to be too good to be true. The costs of broken orders are incurred by traders who rationally believed that their trades were good and relied upon their confirmations. For example, brokers representing customers to whom they have already reported the trades must either break the trades with their customers or make the trades good on their own accounts. In either event, the brokers lose through degradation in their client relationships or through trading losses that they must place in their error accounts.

Other losses from broken trades arise when traders arrange related trades before learning that the broken trades will be broken. For example, following the sale of one stock, proprietary traders commonly buy a correlated stock to responsibly manage their portfolio risks. When the first trade is broken, they are still left with the second trade, which will become un-hedged. If prices in the second security have changed to their disadvantage, they will lose. Since the second security is correlated with the first security, any reversal in the price of the first security will likely also appear in the second security so that the proprietary trader will far more likely realize a loss rather than a gain in the second position. When exchanges break trades to reverse errors, they make

good on trading losses in related securities. The risk of such events thus is systemic. These considerations make exchanges and other regulators very reluctant to break trades.

Similar problems arise when trader are financially unable to settle their trades. In that case, the trader's broker must settle the trades. Any losses that the broker suffers are due to the broker's failure to adequately monitor and regulate the client's trading. If the broker lacks the capital to settle the trades, the trades must be settled by the clearing member through whom the broker clears trades. Any losses that the clearing member suffers are due to the clearing member's failure to adequately monitor and regulate the introducing broker's business practices and customer's trading. If the cleaning member lacks the capital to settle the trades, the clearinghouse must settle the trade, which imposes a cost upon all other clearing members. Aside from creating substantial disruption, the failure of brokers, clearing members, and potentially clearinghouse may cause many other problems as these entities are all bound together through various contractual relationships that may fail in the event of a bankruptcy.

To avoid these problems, governmental regulators, clearinghouses, clearing members, and brokers impose capital requirements designed to ensure that those responsible for settling trades can do so. They also oversee and regulate the trades of those traders whose trades they guarantee. To this end, most brokers examine and approve customer orders before they permit them to interact with the market.

Proprietary electronic trading is most profitable when traders can route their orders for execution as quickly as possible. To avoid the time spent confirming that a trader's orders are acceptable, some brokers have been allowing their clients to submit orders for which the brokers will guarantee execution without first examining and approving those orders. This arrangement is called "naked sponsored access." For the reasons discussed above, this practice introduces systemic risk into the markets if the broker lacks sufficient capital to make good on the clients trades, should the client be unable to settle those trades.

The SEC recently proposed to prohibit naked access. In principle, the clearinghouse and clearing members introducing trades for brokers who provide sponsored access to their customers should regulate associated risks themselves. However, we believe that the right to interact directly with the markets comes with certain responsibilities, and that these rights and responsibilities should be bound together in a common regulatory framework. According, all traders who seek direct access to the markets should be registered as broker-dealers. We thus support the proposed rule.

In its rule proposal, the SEC expressed concern about the problem of identifying the origins of proprietary order flow directly routed to the markets in naked sponsored access arrangements. These concerns can involve only issues about which real-time decisions must be made since all order flows ultimately are adequately identified in audit trails. The concern arises if a sponsoring broker permits many traders to route orders in its name. If the order flow proves to be problematic, exchanges or regulators may want to shut if off without shutting off all other order flows routed through that broker and without relying upon the sponsoring broker. We believe that the concerns expressed above provide sufficient basis for restricting naked access. Brokers who fail to manage their clients' trades should risk losing the privilege to introduce orders from all sources. We believe that this risk undoubtedly will encourage brokers to be more effective regulators than they would be if they knew that regulators could shut off access only to identified sources of their order flow.

### 8.3 Misfiring algorithms

In a related area, we are also concerned that, even without naked access, the risk control procedures at a brokerage firm may fail to react in a timely manner when a trading system malfunctions. In the worst case scenario, a computerized trading system at a large brokerage firm sends a large number of erroneous sell orders in a large number of stocks, creating a positive feedback loop through the triggering of stop orders, option replication strategies, and margin liquidations. In the minutes it takes humans at the exchanges to react to the situation, billions of dollars of damage may be done.

Currently our exchanges have no automatic systems that would halt trading in a particular stock or for the entire market during extraordinary events.[6] It is our understanding that the circuit breakers instituted after the Crash of 1987 would be manually implemented, which could take several minutes.[7] These circuit breakers are triggered only by changes in the Dow Jones Industrial average, so severe damage could be done to other groups of stocks, and the circuit breakers would not kick in. Also, a misfiring algorithm could also create a "melt-up" as well. We recommend that the exchanges and clearinghouses examine the risk and take appropriate actions. Perhaps the issue most simply could be addressed by requiring that all computer systems that submit orders pass their orders through an independent box that quickly counts them and their sizes to ensure that they do not collectively violate preset activity parameters.

### 8.4 Flash Orders

The SEC should ensure the use of flash trading facilities remains voluntary. Whether the flash order instruction is an opt-in instruction or an opt-out instruction is not important. If traders or their brokers regularly measure and act to control their transaction costs, they will determine whether flash orders are in their interest and act accordingly.

With two exceptions, the SEC should make it illegal for flash order participants to take liquidity on the same side at a price equal or better than the price of a flash order that they have seen within one second of seeing that order. Flash participants should be exempt from this restriction if they filled the flash order or when they are trading to fill another flash order.
The SEC should encourage exchanges to conduct a sealed-bid auction among the flash participants during the flash period to allocate the flash order to the participant offering the best price, rather than to the participant who is first to respond. Since the bids will be sealed, they should not be subject to any minimum price variation.

### 8.5 Front-running orders in correlated markets

Common law, regulation, and basic fiduciary principles prohibit broker-dealers from trading ahead of their clients. In particular, the Manning decision restricts brokers-dealers buying or

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[6] *The exchanges do have some pre-trade filters designed to catch bad orders based on criteria such as size and frequency of submission. The NYSE has a procedure to slow down trading when Liquidity Replenishment Points (LRP) are hit, but this procedure only applies to the traditional NYSE system. We understand that this LRP mechanism does not apply to NYSEArca or to other exchanges, which would continue with their normal automated trading.*

[7] *The circuit breakers are activated at various levels of decline in the Dow Jones Industrial Average, and vary with the time of day when they are activated. If a 10% drop occurs before 2:00 pm, then trading is halted for one hour, but would have no effect after 2:30pm. A 30% drop at any time would halt trading for the remainder of the day. See http://www.sec.gov/answers/circuit.htm and http://www.nyse.com/press/1254305776282.html for more details on the circuit breakers.*

selling a security when they hold an open order for that security. Broker-dealers cannot buy (or sell) for their house accounts before filling their customer buy (or sell) market orders, and they can only buy (or sell) for their house accounts at prices one penny or higher (or lower) than the prices of their customers' open limit buy (or sell) orders. These restrictions prevent brokers-dealers from profiting by front-running the price effects of their customers' orders, and from taking for themselves liquidity that should go their clients.

We are concerned that with the growth in proprietary high frequency trading by brokers and dealers who also have access to information about open client orders, some brokers-dealers may engage in a proprietary trading strategy that uses information in customer orders to profit by trading securities and contracts whose prices are correlated with the prices of the securities and contracts for which their customers have submitted orders. In particular, we believe that broker-dealers could profit from the following strategy at the expense of their customers:

1. Based on information in the client order flows that the broker-dealer sees, extract predictions for future price changes.
2. Trade on these predictions in securities for which you are not presently holding open client orders.

We are not aware of any broker-dealers who presently are engaged in such trading, but we know that the expertise, infrastructure, and data necessary to profitably conduct such proprietary trading are widely available. Indeed, given the very small bid-ask spreads that characterize most markets, dealing is only profitable to the extent that dealers can anticipate future price changes. We know that electronic proprietary traders employ models that predict future price changes from publicly available information. Imagining that broker-dealers might try to predict future prices using information about their customers' orders is not farfetched.

Although broker-dealers conducting such trades would not trade in the same securities in which they hold orders, the effect of their trading could hurt their clients. For example suppose that a broker-dealer holds a large order to buy the homebuilder Pulte Homes that will certainly require that the stock price rise to completely fill the order. The broker-dealer could profit by buying other homebuilders such as D R Horton or Lennar since the prices of their stocks are highly correlated with the price of Pulte's stock. When the execution of the Pulte purchase causes the Pulte stock price to rise, the price of other homebuilder will rise as arbitrageurs buy the other homebuilders and sell Pulte, and as dealers and other traders in the other homebuilders adjust their quotes and orders to reflect the information that they may infer from the Pulte price rise. The harm to the broker-dealer's client come from the reverse effect: As the broker-dealer buys other homebuilders and pushes up their stock price up, or simply lifts liquidity so that traders become aware that their prices are more likely to rise than fall in the near future, the price of Pulte stock will also rise, which will harm the client. We are not aware of specific rules that prohibit these activities.

FINRA released a rule proposal in December 2008 on a related topic.[8] FINRA proposes to prohibit brokers from front-running a client block order in a security, security future on that

[8] *FINRA Release 08-83 at http://www.finra.org/web/groups/industry/@ip/@reg/@notice/documents/notices/p117629.pdf. The comment period ended Feb 27, 2009 with only three comments submitted. No action appears to have been taken.*

security, or option on that security in any of the other two instruments ("all related financial instruments"). The proposed rule is limited to block orders and clearly limited to "related financial instruments," where the relation is legal/contractual and not based on correlation. The fact that FINRA is considering this rule indicates to us that the correlated security front-running issue is an open legal issue. However, in the request for comment FINRA notes, "… FINRA believes that this type of trading would generally violate existing FINRA rules, such as FINRA Rule 2010 (Standards of Commercial Honor and Principles of Trade) ..." It appears to us that FINRA believes the rule is necessary because it cannot effectively enforce Rule 2010 without the proposed rule.

We are concerned about the potential abuses that would result if broker-dealers could employ the front-running strategy we outline. Those broker-dealers that use this strategy would have a significant advantage over those who do not: Competition among broker-dealers who exploit their order flow this way would tighten spreads and lower commissions as they compete to fill their orders and compete to obtain the order flows necessary to make their inferences. Moreover, since the value of exploiting order flow information increases with the total order flow processed, permitting broker-dealers to pursue such proprietary trading would be anticompetitive because greatest advantage would go to the largest firms, which then would grow larger.

We recommend that the SEC specifically prohibit the use of information gleaned from open client orders in proprietary trading strategies. Definitive evidence of any rule violations would be found by examining computer codes.

### 8.6 Sub-penny pricing

The minimum price variation was a full eighth of a dollar at the start of the 1990s. It decreased to a sixteenth and finally to a penny when markets completed decimalization in 2001. With each of these decreases, bid-ask spreads dropped, but so too did displayed order sizes.
The decrease in spreads was due to competition among traders to provide better prices, much of which had been frustrated by the binding constraint that a formerly large minimum price variation placed on bid-ask spreads. These smaller spreads benefit retail traders who submit small marketable orders that typically execute without price impact.

The decrease in displayed order sizes occurred because traders will not quote for significant size when they are exposed to trading losses that they incur when trading with informed traders or with large uninformed traders whose orders move prices significantly. Displayed sizes also decreased because smaller tick sizes reduced the incentives to place orders early and because small tick sizes facilitate parasitic quote-matching trading strategies designed to extract option values from standing orders.

Bid-ask spreads for many actively traded stocks are now often just one cent for the reasons described above and also due to the recent drop in stock prices of many actively traded stocks. For stocks trading above one dollar, Regulation NMS's prohibition on sub-penny quotes sets a binding lower bound of one cent on their spreads. However, trades can be—and often are—executed on smaller increments.

Some market participants recently have called for a further decrease in the minimum price variation, perhaps to a mil. This decrease would further lower bid-ask spreads for stocks where spreads are commonly one penny, and it would further lower displayed sizes in those stocks.

A decrease in tick size would have the beneficial effect of reducing the minimum price variation to the same order of magnitude as the access fees and liquidity rebates that make-or-take trading systems charge and pay their customers. Regulation NMS currently caps access fees at three mils per share. With a one-mil price increment, the SEC could easily require that quoted prices reflect access fees.[9] We believe that this change would quickly eliminate the make-or-take pricing model and the problems associated with it.

Despite these benefits, we do not recommend that the minimum price variation be decreased further. We are particularly concerned about the effect of a small minimum price variation on order display and on transaction costs of large traders, most of whom represent pensions, endowments, and mutual funds. Dark pools and hidden order exist because large traders are reluctant to reveal their orders. Their reluctance in large part is due the losses they suffer from traders who step in front of their orders to extract their option values—the so-called "pennying strategy" that we identified above as quote-matching. The decrease in tick sizes over the last two decades is responsible for much of the growth in dark venues.

As discussed above, the SEC can solve make-or-take problem by simply requiring that access fees and liquidity rebates be passed along to clients. Alternatively, the SEC could establish a single pricing standard for exchange fee pricing by further reducing the maximum permitted access fee.

Sub-penny pricing also would be burdensome to the market information systems that deliver information to trader's screens. The primary burden would not be transmission capacity, but rather screen real estate. An additional digit would further clutter screen displays. The data vendors would have to substantially modify their systems to present sub-penny prices, and users would see more data but less information.

Sub-penny pricing also would further exacerbate the Manning penny problem that dealers face. When dealers hold a client buy order at priced at 20.00, if they buy from another client at any price below 20.01, they must give the fill to their customer at 20.00. The dealers lose the difference while providing price improvement to their clients—an untenable proposition in the long run. A change in the tick size thus would require some change in the Manning rule. However, that rule sensibly protects clients from strategies that dealer might deliberately take to disadvantage their clients without their knowledge. The rule probably should be modified to exempt trades that dealers make when compelled to by reasonable business models.

Finally, we note that issuers concerned about the one cent binding constraint upon bid-ask spreads in their low priced stocks can reverse split their stocks. Companies do not like to engage in such transactions because they are costly and disruptive, and because they draw attention to their poor financial performance. The SEC might remove some of the stigma by suggesting that all companies interested in conducting reverse splits do their splits on the same day.

### 8.7 Rules 605 and 606 and consumer disclosures of broker quality

SEC Rule 605 requires market centers to reveal information about the quality of their executions. Rule 606 requires brokerage firms to disclose information about order routing and payment for

[9] *Quantity discounts in access fees would complicate such a rule.*

order flow practices. The intent of these rules was to focus attention on execution quality. The rules should be updated with the intent of providing information usable to consumers about the execution quality delivered by the brokerage firms. For example, a brokerage firm could provide statistics giving execution times along with the percentages of orders filled at the quote, better than the quote, and worse than the quote, for different size buckets including odd lots.

# 9. Conclusion

Equity markets have evolved quickly over the last decade. The U.S. equity market is now an open architecture market in which entrants with innovative technology can compete effectively. This freedom has led to a decline in market shares for previously dominant exchanges. The character of trading has also changed. We have moved from a market in which humans manually traded to one in which computers execute the bulk of trades without human intermediation. Volume is higher. Trade size has become smaller as it is now cheaper for institutions to divide orders up into smaller slices to reduce their market impact.

Many innovations in market structure help investors do what they have always done, only in more advanced ways. For example, so-called dark pools permit investors to trade while limiting the dissemination of their trading information. Traders have always limited the display of their orders by using the upstairs block market or through instructions given to floor brokers on NYSE and AMEX trading floors.

Transactions costs have fallen to very low levels, and trading volumes have increased, as basic economics predicts. The increased liquidity reduces corporate costs of capital because investors will pay more for investments that are not costly to enter and exit.

Lower transactions costs also allow computerized investors to provide cost effective market improving services. For example, arbitrageurs ensure that the prices of related instruments, such as a stock and its derivatives, are in the proper alignment. Thus, when retail investors purchase S&P500 ETFs, they depend on the arbitrageurs ensure that the ETF price reflects the prices of the constituent stocks in the ETF.

The ability to trade at low cost allows high-speed traders to provide great liquidity to the markets. Their willingness to devote capital to buy when others desire to sell and vice versa smoothes out the price effects of order imbalances and further reduces transactions costs for end investors.

Although U.S. equity market structures are operating very efficiently, some changes can produce further improvement. The requirement that brokers ignore exchange access fees when seeking "best execution" defies economic rationalization and leads to market distortions. Front running orders through trades in correlated instruments can harm brokerage customers and should be banned. Markets and clearinghouses also should consider how to best protect our high-speed markets from a high-speed meltdown caused by programming mistakes.

Electronic traders now provide most liquidity in U.S. equity markets. Their greater efficiencies allowed them to largely displace traditional dealers. Although the resulting markets are more liquid than they have ever been, the unintended consequences of new regulations could easily damage them. For example, even a small transactions tax on trading would seriously reduce liquidity because the margins on which electronic traders operate are so small. Accordingly, regulators must carefully consider all implications of proposed regulations lest they accidently harm our markets and thereby retard or reverse the economic recovery we presently are experiencing.

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Professor Harris's research, teaching, and consulting address regulatory and practitioner issues in trading and investment management. Chairman Harvey Pitt appointed Dr. Harris to serve as Chief Economist of the U.S. Securities and Exchange Commission in July 2002 where he continued to serve under Chairman William Donaldson through June 2004. As Chief Economist, Harris was the primary advisor to the Commission on all economic issues. He contributed extensively to the development of regulations implementing Sarbanes-Oxley, the resolution of the mutual fund timing crisis, the specification of Regulation NMS (National Market System), the promotion of bond price transparency, and numerous legal cases. Professor Harris currently serves on the boards of Interactive Brokers, Inc., the Clipper Fund, Inc., and CFALA, the Los Angeles Society of Financial Analysts. Other professional service has included year-long assignments to the U.S. Securities and Exchange Commission and to the New York Stock Exchange immediately following the Stock Market Crash of 1987. Dr. Harris received his Ph.D. in Economics from the University of Chicago in 1982.

**CHESTER S. SPATT**
*Professor of Finance, Tepper School of Business, Carnegie Mellon University*

Professor Spatt is a well-known scholar studying financial economics with broad interests in financial markets. He has extensively analyzed market structure, pricing and valuation, and the impact of information in the marketplace. His co-authored 2004 paper in the Journal of Finance on asset location won TIAA-CREF's Paul Samuelson Award for the Best Publication on Lifelong Financial Security. In the past, he served as Chief Economist of the U.S. Securities and Exchange Commission and Director of its Office of Economic Analysis from July 2004 through July 2007. Additionally, he has served as Executive Editor and one of the founding editors of the Review of Financial Studies, President and a member of the Founding Committee of the Society for Financial Studies, President of the Western Finance Association, and is currently an Associate Editor of several finance journals. He earned his Ph.D. in economics from the University of Pennsylvania and received his undergraduate degree from Princeton University.