Clean Sweep:
Informed Trading through Intermarket Sweep Orders

Sugato Chakravarty
Purdue University

Pankaj Jain
University of Memphis

James Upson*
University of Texas, El Paso

Robert Wood
University of Memphis

Current Version: March, 2009

JEL classifications: G14, G18, G19

Key Words: Regulation NMS, Microstructure, Market Quality, Sweep Order

*Contract Author. Department of Economics and Finance, College of Business Administration, The University of Texas at El Paso, El Paso, TX 79968. Phone: 915 747 5147; Email: jeupson@utep.edu

Acknowledgments: We thank the seminar participants at the University of Memphis, Christine Jiang, Thomas McInish, Sandra Mortal, C.S. Pyun, Ronald Spahr, and Quentin Chu for helpful comments. Any mistakes remain our own.

Abstract:

We provide evidence supporting the concept that informed traders submit worked orders through a vehicle known as an Intermarket Sweep Order (ISO). Specifically, we investigate the use of ISO's in samples of large, medium, and small capitalization stocks, using the Daily Trade and Quote database. ISO orders are small size orders (average ISO order is about 179 shares) and represent 46% of trades and 41% of volume in our sample. While these orders have higher effective spreads, measured against the exchange calculated National Best Bid and Offer, ISO's also have statistically and economically significantly smaller realized spreads. Additionally, we find that small ISO orders dominate the information share of non-ISO orders, based on the method of Hasbrouck (1995), above and beyond their proportion of share volume, even though ISO orders are significantly smaller than non-ISO orders. In addition, the information share of ISO orders is increasing in idiosyncratic return volatility. These results are robust to market capitalization and the listing exchange of the sample securities. Overall, we find that ISO orders are the order of choice for informed traders in a post Reg. NMS market.

1.0 Introduction

Attempting to understand the robustness of our financial markets has never been more timely in the wake of the recent Wall Street meltdown and the continual gyration of the markets overall. In an earlier paper, Glosten (1994) showed that a market with an open limit-order book is robust to competition. More recently, Back and Baruch (2007) provide a theoretical analysis of comparing alternative market designs (floor exchange versus a limit order market). Their principle finding is that other market types may mimic an open limit-order book and hence have the same robustness as postulated by Glosten (1994).[1] An important contribution of the Back and Baruch model is to endogenize the option of allowing traders (informed as well as those who are purely liquidity seeking) the choice of submitting either a large order or a series of small orders (defined as a worked order). Recognizing that their stylized financial market is not likely to exactly match with any of the major asset markets[2], the authors provide a discussion of the characteristics of financial exchanges in which their results are likely to best apply. It is, however, clear that the usefulness of their model rests crucially on the validity of the assumption made by them regarding the concept that informed traders can and in fact do submit worked orders – a trading strategy that goes against the notion of informed trader behavior as espoused in the classical market microstructure literature (see, for example,

---

[1] In particular, assuming, as does Glosten (1994), perfect competition among risk neutral liquidity providers, a uniform-price auction has an equilibrium that is equivalent in all important respects to the equilibrium of an open limit-order book.

[2] Back and Baruch argue that their hypothetical model most closely resembles the CBOE.

Easley and O'Hara (1987), Seppi (1990), Kyle (1985), and Foster and Viswanathan (1990)).[3]

Accordingly, the goal of the current paper is to provide an actual real world illustration of the concept that informed traders submit worked orders through a vehicle known as an Intermarket Sweep Order (ISO hereafter) [discussed in detail in the next section] and thereby validate the usefulness of the underlying intuitions provided in Back and Baruch (2007). ISO orders are an exemption to the Order Protection Rule of Regulation NMS and differ from non-ISO orders in that they are designated for immediate execution on the indicated market center.[4] ISO orders are marketable limit orders that allow traders to process demand in parallel rather than the sequential processing of non-ISO orders. To highlight the differences in the ISO and non-ISO orders, consider a trader that wishes to purchase 10,000 shares and chooses to 'work' the order in the sense of Back and Baruch. The trader divides the total demand into many small marketable limit buy orders. If the orders are all designated as non-ISO orders and submitted to the market, then the orders will execute *sequentially*, being routed to the market center that posts the best execution price, which can change during the execution of the order set. Alternatively, the trader can choose to designate the orders as ISO orders and route these orders to several market centers *simultaneously*. As each order

[3] Running counter to the notion that informed traders will gravitate towards submitting large orders is an empirical stream of literature collectively known as "stealth trading". The underpinnings of this literature rest on the intuition that informed traders will fragment their orders into intermediate sized chunks – not too small so as to avoid excess costs and not too large to increase the likelihood of blending with the uninformed traders (see, for example, Barclay and Warner (1993), Chakravarty (2001), Chakravarty, Gulen and Mayhew (2004), Anand and Chakravarty (2007), and Alexander and Peterson(2007)).

[4] Regulation National Market System (Reg NMS) was adopted the the Securities and Exchange Commission in June of 2005 and consists of four main parts; Rule 610, the Access Rule, Rule 611, the Order Protection Rule, Rule 612, the Sub-Penny Rule, and the Market Data Rule. Implementation of all Reg NMS provisions was completed in October of 2007. As a group, these rules are designed to modernize and strengthen equity markets in the United States.

arrives at a market center it is immediately executed at the best price, up to the limit price of the ISO, offered by the selected market center. ISO orders are not redirected to other exchanges that may have a better posted price and can trade through the National Best Bid and Offer (NBBO) price. While, for a given market center, orders are processed sequentially, the fact that ISO orders from a single trader can be queued in many markets allow for parallel processing of total demand. This allows for a quicker execution of the total demand.[5]

We use the Daily Trade and Quote (DTAQ hereafter) database, which has time stamps to the millisecond and denotes ISO orders with condition code F thereby allowing us to conduct our analysis[6]. Our sample period is from August 20, 2007 through May 30, 2008, consisting of 197 trading days. Our sample of 120 firms, segmented into three equal groups of large, medium, and small companies, contains roughly 509 million trades.[7] We find that 46% of the trades are identified as ISO's, representing 41% of the 146 billion shares traded. It is clear that the new ISO order type is extensively used in the market.

We show that ISO initiators adopt a 'hide in plain sight' trading strategy that closely resembles the pooling equilibrium of Back and Baruch (2007). We find that the average trade size for ISO orders is only 178.8 shares, while that of non-ISO orders is 217.3 shares. It is worth noting that the average ISO order size corresponds to small size

[5] ISO initiators run the risk of liquidity depletion before the order is executed. If there is no liquidity available at the targeted market center with in the limit price of the order the order can be canceled or flipped to provide liquidity at the limit price. However, these decisions must be made prior to order submission.

[6] See the NYSE website for additional information on the DTAQ database.

[7] In terms of listing exchange, our sample consists of 72 NYSE listed securities and 48 NASDAQ listed securities.

orders in the classification scheme (small, medium and large size orders) used in the stealth trading literature cited earlier. In addition, roughly 89% of the ISO orders are under 500 shares compared to 86% of the non-ISO orders. The close distributional match between ISO and non-ISO orders indicates that the pooling equilibrium of the Back and Baruch (2007) model dominates in the NMS market. The order size distribution match is robust to market capitalization of firms considered in our sample. Informed traders appear to hide their total demand by matching the distribution of liquidity traders in the market, but use ISO orders to obtain quicker execution and larger counter-party depth to fill underlying demand. In addition, using the information shares method of Hasbrouck (1995) we find that ISO orders have a disproportionately high information share in the market, relative to their volume, even though the ISO orders are small sized orders as discussed before. We use regression analysis to show that the information share of ISO orders is increasing in idiosyncratic return volatility, even after controlling for market capitalization and listing exchange effects. We believe that ISO orders represent the order of choice for informed traders in a post Reg. NMS market place because they allow for faster order fill rates in today's fast markets.

A key aspect of the ISO order is that it allows the initiator of the order to designate the market that the order executes in. So, could ISO orders be a result of preferencing of order flow?[8] Not according to our findings. We find that ISO orders have significantly larger effective spreads per trade, but have significantly lower realized spreads 5 minutes after execution, when compared to non-ISO orders. The lower realized

[8] The preferencing of order flow remains controversial topic in the finance literature with some arguing that preferenced order flow has no negative impact on market quality while others find that preferenced flow adversely impacts trade execution. (see, for example, Battalio (1997), Hansch, Naik, and Viswanathan (1999), Peterson and Sirri (2003), Huang and Stoll (1996), and Chung, Chuwongannant, and McCormic (2004)).

spreads of ISO orders more than make up for the higher effective spreads paid by ISO initiators. He, Odders-White, and Ready (2006) define a Preferencing Measure (*PM*) as the ratio of realized spread to effective spread. This measure controls for information asymmetry that underlies order initiation. They show that the preferencing measure will be higher for preferenced order flow and lower in non-preferenced order flow. Uniformly we find this measure is smaller for ISO orders compared to non-ISO orders, indicating that ISO orders have better market execution quality. This finding is robust to market capitalization and listing exchange. While some portion of ISO orders are likely preferenced order flow, as a whole, the better execution quality of ISO orders and lower realized spreads compared to non-ISO orders indicates that ISO order flow is dominated by informed trading.

Chordia and Subrahmanyam (1995) show that preferenced order flow tends to concentrate on off-NYSE markets. We analyze the proportion of ISO orders executed on each exchange and find large differences in ISO use. For the NYSE, 20.9% of trades and 23.5% of volume is designated as ISO order flow, but Pacific/Arca has 52.8% and 53.5% of trades and volume, respectively, identified as sweep orders. On NASDAQ 62.7% of trades and 63.6% of volume is driven by ISO orders, while the Automated Display Facility (ADF) market center has a much lower 29.3% of trades and 21.9% of volume as designated ISO order flow. The remaining five market centers in our study range from a high of 70.0% proportion of ISO trades for the National Stock Exchange to a low of 42.1% for the Philadelphia Stock Exchange. These proportions are consistent across all market capitalizations included in our study.

Although there is significant variation in the use of ISO orders on different market centers, ISO orders represent a large proportion of trade volume on all market centers contained in the DTAQ database. The proportion of ISO activity tends to be increasing on exchanges with higher degrees of trader anonymity, such as NASDAQ, Arca, National, and the International Stock Exchange but lower where trader anonymity is decreased, such as the NYSE and ADF market centers. Garfinkel and Nimalendran (2003) show that insider traders prefer trading on the NASDAQ exchange because of higher trader anonymity compared with the floor exchange of the NYSE. While simple liquidity supply issues are likely to account for some proportion of the variation in sweep order use, we feel that exchange structure and rules are also likely to impact the venue choice of ISO initiators.

The rest of the paper is structured as follows. Section 2 gives background and regulatory motivation for the ISO exemption to the order protection rule. Section 3 describes the sample and gives a brief description of the DTAQ database used in the analysis. Section 4 presents the results of our analysis and we conclude in section 5.

2. The ISO mechanism.

The recent implementation of Regulation NMS, completed in October of 2007, represents one of the most significant changes in the structure of equity markets in recent memory. While the regulation consists for four main parts, perhaps the most controversial new rule is rule 611, the Order Protection Rule[9]. The essence of the Order Protection Rule requires that market orders be routed to the market center posting the best price with an accessible quote. There are several exemptions to the Order Protection Rule identified in section 611(b) of the regulation. This paper investigates the use of the Intermarket Sweep Order exemption to the Order Protection Rule[10]. The ISO exemption allows a trader to simultaneously access the display book of all market centers and was adopted to allow institutional investors to access liquidity at multiple price levels in multiple markets to fill large block trades. ISO orders allow for parallel processing of the total trade position, execution on many markets at the same time. Non-ISO orders are sequentially processed in the market, routed to the market(s) with the best execution price, which can change during the processing of the order.

In adopting the ISO exception to the order protection rule, the SEC states one of the main reasons as, "… the exception would allow institutional investors to continue to execute large-sized orders in an efficient manner."[11] Chiyachantana and Jain (2008) estimate that institutional investors incur roughly 8.87 billion in costs, based on their

---

[9] For example see Stoll (2006)

[10] The definition of an ISO can be found in rule 600(b)(30). An ISO is a marketable limit order that 1) is identified as an ISO when routed to a trading center and 2) simultaneously with the routing of the limit order, one or more additional limit orders are routed to execute against all better-priced protected quotations displayed by other trading centers up to their displayed size. All orders must be identified as ISO orders available for immediate execution.

[11] This quote is from page 105 of SEC release No. 34-51808 available on http://www.sec.gov/rules/final/finalarchive/finalarchive2005.shtml.

sample, due to the failure of trade execution. The use of ISO orders could help in mitigating this cost. Although the selection of ISO orders indicates a need for quick execution, the requirement for quick execution can be based either on information or simply a liquidity requirement due to order size. Table 1 outlines the properties of ISO trades and compares these properties with the properties of non-ISO trades.

There are a number of significant differences between the ISO and non-ISO trade execution mechanisms. The initiator of an ISO order designates the market center where the trade will be executed. When the ISO order arrives at the market center, it is available for immediate execution. Non-ISO orders however, can only be executed on a market center with price priority. In other words, the executing market for a non-ISO order must have a display price that is equal to the best available price in the market. For example, suppose a non-ISO order is submitted to the NASDAQ market for execution. If the NASDAQ market does not have price priority, the order must then be routed to a market center, which has price priority. If, when the re-routed order arrives at the new market, the targeted market no longer has price priority for the stock, the order must again be re-routed to the venue(s) posting the best price. In short, the execution venue for an ISO order is the same as the submission venue, while the execution venue for the non-ISO order can change based on the current price priority of the market.

Intermarket Sweep Orders are restricted to limit orders which include the maximum (minimum) execution price for buy (sell) orders. Non-ISO orders do not have this restriction. However, we find no other limitations for ISO orders in the SEC documentation. For example, ISO orders can be used for short sales, designated as

Immediate or cancel (IOC), or other types of secondary order designations can be combined with the ISO order type.

The ISO trade mechanism allows for the parallel processing of the total underlying demand of a trade position. To illustrate this point, consider a market condition where a single market center holds the price priority on a stock. However, the posted depth on this market is much smaller than the total size of the trade position to be executed. The ISO initiator can direct sweep orders to the price priority market that match the posted depth of the market, and at the same time submit sweep orders to markets with inferior prices. As these orders arrive at each market center, they are immediately executed based on the ISO exemption.

The sweep order mechanism requires the ISO initiator to attempt to 'take out' the posted depth of all better priced markets as she simultaneously accesses additional depth at inferior prices, however, there is no restriction on the order size used to 'take out' the price priority depth. Suppose, in our example, the price priority market posts a depth of 500 shares. The ISO initiator can submit a single ISO trade to the price priority market of 500 shares or submit five ISO trades of 100 shares each.[12] In short, while the ISO exemption requires the trade initiator to attempt to access the total posted depth on the price priority market, the regulation does not require a single large trade be used. In contrast, non-ISO orders, after depleting the posted depth of the price priority market, would then be re-routed, based on the order handling rules of the market center, to the next exchange(s) with price priority. The re-routing of orders extends the execution time require for a large trade position. Thus, the parallel processing ISO orders allows for a

[12] An additional example of the application of ISO orders can be found on page 153-155 of SEC release No. 34-51808 available on http://www.sec.gov/rules/final/finalarchive/finalarchive2005.shtml.

quicker execution and the ability to capture larger counterparty depth compared to non-ISO orders.

The parallel order processing advantage of ISO orders can also be used when ISO initiators do not intend to access posted depth at inferior prices.[13] Consider a market condition where three market centers are tied at the best bid of the market. The ISO initiator can submit sweep orders to all three markets simultaneously for execution. These orders will execute on the targeted markets, even if price priority changes during the order routing process. The sweep order exemption only requires that the selected market have price priority at the time of order initiation, not order execution. On the other hand, if the price priority market changes during the order submission process, the ISO order initiator will execute her trades at an inferior price, while a non-ISO order will be re-routed to the new price priority market and execute at a better price. In selecting an ISO order, the initiator gains execution speed at the cost of a possible trade at an inferior price. In this respect, the new ISO order represents the most aggressive order type available in the Reg. NMS market.

ISO orders also face some execution risk. While the ISO order is available for immediate execution on the designated exchange, it is quite possible that during order routing, the liquidity available on the targeted market evaporates. Non-ISO orders will simply be routed to the market center posting the best available price; however ISO orders are not available for re-routing. ISO orders can be specified as 'immediate-or-cancel' where any unfilled part of the order is canceled or they can be specified as 'fill-or-post', where any unfilled part of the order is posted as liquidity supply. Regardless of

[13] This interpretation of the ISO trade exemption can be found in the SEC response (4.04) at http://www.sec.gov/divisions/marketreg/nmsfaq610-11.htm#sec4

the order modifier used, it is likely that ISO orders require a greater degree of order management than its non-ISO counter part.

One of the key goals of the Regulation NMS initiative is to generate better market coordination facilitating 'best execution' of orders.[14] While the Order Protection Rule disallows trade throughs for non-ISO orders, ISO orders represent a sanctioned trade through of protected quotations.[15] In defining a trade through under Regulation NMS, the SEC included the 'flickering quotes' exemption. This exemption allows exchanges to trade at the least aggressive bid and ask price, over the previous second of NBBO quotes, with out violating the Order Protection Rule.[16] Therefore, the liquidity available to the ISO initiator for parallel order processing, with out triggering the 'take out' provision of the ISO exemption, is represented by all posted depth with a bid or ask price, at or better than the least aggressive NBBO bid and ask over the pervious second. It is only if the ISO initiator wishes to access liquidity that is out side of this price range that she must 'take out' all better protected orders while accessing the trade through depth. Rather than an instantaneous evaluation of the current market condition, the flickering quotes exemption creates a 'fuzzy' range of prices where orders, both ISO and

---

[14]Battalio, Hatch, and Jennings (2004) analyze the impact of market integration for exchange listed options and find that 'best execution' of options trades significantly improved after the SEC required option exchanges to be electronically linked. However, when Foucault and Menkveld (2008) evaluate the electronically linked Dutch stock market, they find that the advantages of market integration are constrained when there is little or no price protection of limit orders. With out the price priority protection, they find trade-through rates of between 73% and 77% in their study.

[15] Additional analysis of the impact of trades throughs in U.S. stock markets can be found in Bessembinder (2003) and Hendershott and Jones (2005)

[16] However, when the 'flickering quotes' exemption was proposed, one criticism was that it would allow exchanges to execute trades at the least advantageous price to the liquidity demander. This so called 'look back' option was investigated on the NASDAQ exchange by Stoll and Schemzier (2006). They show that NASDAQ market makers actively used the look back option to post trades at the least advantageous price.

non-ISO, can be executed without violating the trade through provisions, even though this range may be based on quotes that are no longer firm, or even exist.

Next, we continue with our analysis of the use and impact of sweep orders in the regulation NMS market. Our main contribution is to validate a key assumption in Back and Baruch (2007) by showing how informed traders balance the benefits and costs of using ISO orders given the market conditions of the regulation NMS environment.

3. Data and sample

3.1 Data

We obtain our trade and quote data from the DTAQ database. The DTAQ database is similar to the Monthly Trade and Quote (MTAQ) database used in microstructure research, however, the DTAQ database has more extensive condition codes that the MTAQ database, contains time stamps to the millisecond, and also includes the exchange calculated NBBO (posted-NBBO hereafter) for each stock that is traded[17]. ISO orders are identified in the DTAQ database with condition code F.

3.2 Sample

The implementation of the Order Protection Rule began on July 9, 2007 for a group of 250 pilot stocks. Full implementation for all NMS stocks began on August 20, 2007. We analyze the use of ISO orders between the period of August 20, 2007 and May 30, 2008. This represents 197 trading days. In selecting stocks we apply the following filters. The stock must exist at the intersection of the CRSP and DTAQ universes. Stocks are matched between the CRSP and DTAQ databases by CUSIP. We consider only common stocks in the study, CRSP stock code 10 and 11. Stocks must have a closing price on the last trading day of 2007, December 31st, greater than 10 dollars and less than 1,000 dollars.

We next group stocks into three sizes, large, medium, and small, based on the CRSP market capitalization on the last trading day of 2007. We then again rank stocks by market capitalization within each group and take the 40 largest stocks from each group resulting in a final sample of 120 stocks. Selected descriptive statistics are shown in

[17] We have been informed by the NYSE that the MTAQ database will have the extended condition codes, including the ISO code, and the exchange calculated NBBO in the near future.

Table 2. For the full sample the average market capitalization is 50.3 billion dollars. The sample includes 508.7 million trades producing a trading volume of 145.6 billion shares. Of this 46% of the trades and 41% of the volume are driven by ISO orders. We also break out the trade statistics based on firm size. While there is a wide range in the market capitalization and market intensity between the large, medium, and small firm size designations, we find no substantial difference in the use of ISO orders in either the percentage of trades or volume initiated by sweep orders. We also condition the descriptive statistics based on listing exchange of the sample stock. We have 72 NYSE listed stocks and 48 NASDAQ listed stocks in our sample. As one might expect, average market capitalization, the average number of trades, and the average share volume are significantly larger on NYSE listed securities. We also find that ISO orders are more prevalent on NASDAQ listed stocks. While 44% of trades in NYSE listed stocks are sweep orders, 52% of trades in NASDAQ stocks are ISOs. ISO volume, as a percentage of total volume, is also higher on NASDAQ listed stocks, 48% versus 38% on NYSE listed stocks. We will have more to say on the differential aspect of ISO usage across the NYSE and NASDAQ, in Section 4.2.

Overall we feel our sample represents a strong cross section of the market, at many levels. While we could extend our sample by including more stocks, at the expense of computer processing time, or randomize the sample selection within a give market capitalization grouping, we feel that this is unlikely to significantly change the main findings of our research. We next proceed to the results of our study.

4.0 Results

4.1 Trade size and distribution of ISO orders

The ISO exemption to the Order Protection Rule was adopted by the SEC to allow institutional traders the ability to efficiently process large block trades; however, the exemption places no restrictions or the order size of sweep trades. Order size is a key strategic decision for both informed and liquidity traders. These traders could choose medium sized orders to minimize the trade off between the price impact of the trade and order processing cost, consistent with the stealth trading literature. On the other hand, traders could choose to select a small order size and 'work' order volumes consistent with the Back and Baruch model. In Table 3 we show the average trade size of ISO orders and non-ISO orders for our sample. For the full sample, the average size of an ISO order is 178.8 shares, but for a non-ISO order the average size is 217.3 shares. The difference of 38.4 shares is very significant statistically with a means difference t-test statistic of -46.2. We consistently find that ISO orders, on average, are significantly smaller than non-ISO orders, regardless of the market capitalization of each sub-sample.

Table 3 also shows the median value of the time weighted average NBBO posted depth. In calculating this value, we first find the total depth posted on all markets that match the NBBO ask and bid prices. The time weighted average total depth (ask + bid) is then calculated for each stock day in the sample and the median of this distribution is reported. We interpret this value as the median posted reserve supply in the market.[18] For example, at any given instant in the market for large stocks, the median expected value of market depth is 63 round lots or 6300 shares. This measure is 'reserved supply'

[18] This value does not reflect any hidden depth in the market, only the top of the book depth in each market center.

in the sense that it represents the residual supply after demand is satisfied. The fact that there is significant liquidity supply remaining in the market means that trade size is not restricted due to supply considerations. For example, if the average trade size of both ISO and non-ISO orders increase by 100 shares, there would be ample reserve supply in the market to fill the change in distributional demand for all market capitalization groups. If we assume that traders strategically select order size to optimize the trade off between price impact and processing costs of trades, then the results of Table 3 suggest two basic findings. First, the smaller order size of ISO orders would indicate that these orders have higher price impact. Second, while there is ample liquidity supply to accommodate a large increase in average order size, the reduction in order processing cost would not offset the increase in price impact incurred.

In Table 4 we evaluate the distribution of ISO and non-ISO orders. We count the number of trades, conditioned on order size, for the sample period and then generate a cumulative distribution of the results. Panel A, of Table 4, shows that for ISO orders, 89.0% of the trades are less than 500 shares with only 0.1% of ISO trades being greater than 10,000 shares. When we compare the distribution of ISO and non-ISO orders, we find an extremely close match of trading intensity for each size grouping considered. The distributional match is consistent in each of the market capitalization groups. From a practical standpoint, the distributions are almost an exact match. These results closely follow the pooling equilibrium set forth in Back and Baruch (2007). They compare order size decisions of liquidity and informed traders in limit order and floor markets. Traders can issue large block orders or work their orders as a series of smaller orders to fill demand. By reducing order size, informed traders attempt to pool with small traders to gain better execution prices. They show that a pooling equilibrium, with all traders working their orders, dominates other potential equilibrium considered in their model. If we assume that the use of ISO orders follows the regulatory intent of the SEC, so that the use of ISO orders is dominated by institutional investors attempting to fill large orders, and non-ISO orders are dominated by liquidity traders, then the close distributional match between ISO and non-ISO orders supports the pooling equilibrium conclusion of Back and Baruch (2007)[19]. On the other hand, ISO orders are orders that are directed to execute on a selected exchange. In effect, ISO trades are de facto order preferencing. The small average order size of ISO orders is consistent with the preferencing use of ISO's. We investigate this issue next.

4.2 Are ISO orders preferenced order flow?

The focus of our research is to quantify the properties of ISO trades in the post regulation NMS market place. Since ISO orders limit the order execution to the specified market, sweep orders could simply represent preferencing agreements for order flow. Chordia and Subrahmanyam (1995) suggest that order preferencing tends to take place on off NYSE markets, implying that an evaluation of ISO trade and order volume conditioned on the executing market center maybe insightful. Table 5 shows the percentage of trades and trade volume that are designated as ISO orders as a function of executed volume in the market center. The market share column of Table 5 represents the percentage of volume executed at the market center for the full sample. The National (Cincinnati) stock exchange has the highest proportion of trades designated for execution as ISO orders. While 70.0% of the trades on National are ISO orders, the exchange has

[19] We will present evidence later in the paper that supports the conclusion that ISO orders are dominated by informed traders.

only 1.3% of the executed volume for our sample period. On the other had, the NYSE market has only 20.9% of trades as ISO orders, while maintaining a 44.4% volume market share. Interestingly, we find that the NASDAQ exchange executes 62.6% of their trades as ISO orders, representing 63.4% of volume. Chung, Chuwonganant, and McCormick (2004) find that 62.25% of volume on the NASDAQ market, after decimalization, is preferenced order flow. We also condition our results by market capitalization to check for competitive differences in the sense of Lipson (2004), however, we find that the proportion of sweep orders and volume remains relatively constant over the large, medium, and small market capitalization groups. We believe that our results are not being driven by any market center's competitive focus on specific classes of stock. While the exchange results for ISO executions potentially indicate order preferencing, the results might also reflect relative strengths in liquidity supply of each market center.

In addition, Garfinkel and Nimalendran (2003) show that insider traders tend to focus trading efforts on the NASDAQ exchange because of its grater trading anonymity compared to the NYSE floor exchange (arguably a more transparent market). The variation we identify in ISO use for each market center can also reflect the degree of trading anonymity for the various exchanges. We find that the predominately electronic exchanges like NASDAQ, National, the International Stock Exchange, and Pacific/Arca, have a higher percentage of order flow designated as ISO than the floor or dealer markets of the NYSE and ADF market centers. To the degree that the former exchanges provide increased trader anonymity relative to the latter, informed traders may prefer ISO orders on these exchanges.

To extend our analysis of ISO orders and extend the investigation of ISOs as order preferencing, we evaluate the transaction costs of ISO and non-ISO orders. To assess transaction costs we must infer the trade direction, buy or sell, of trades in the database. We adopt the trade inference method proposed by Ellis, Michaely, and O'Hara (2000). Inference is conducted against the posted NBBO, which is included with the DTAQ database. One benefit of the DTAQ database is that all time stamps are in milliseconds; this should improve the alignment between trades and quotes and presumably improve inference accuracy over the second time stamp of the MTAQ database.[20]

The results of our spread analysis are shown in Table 6. Effective half spreads are defined as $D_{it}(P_{it} - M_{it})$, where D_{it} is the trade direction indicator that equals 1 for buys and -1 for sells , P_{it} is the trade price, and M_{it} is the exchange posted-NBBO mid-point. The realized half spread is calculated as $D_{it}(P_{it} - M_{it+5})$, where M_{it+5} is the prevailing posted-NBBO quote mid-point 5 minutes after the trade. If there is less than 5 minutes before the market close (4:00 pm EST), the prevailing NBBO quote at the close of the market is used. The Preferencing Measure (*PM*) is defined at the ratio of realized spread to effective spread from He, Odders-White, and Ready (2006). The advantage of the *PM* measure, over effective and realized spreads, is that it controls for the information asymmetry that underlies the order initiation. This allows the *PM* measure to be used for comparisons between stocks and market centers; comparisons that are problematic with realized and effective spread. If ISO orders are dominated by preferenced order flow

[20] In defining a trade through, the SEC adopted the 'flickering quotes' rule. This allows any market center to post a trade at the least aggressive NBBO ask or bid price over the previous second. While the millisecond time stamp allows for better alignment between trades and quotes, the impact on trade inference remains indeterminate.

then these orders should have a higher preferencing measure compared to non-ISO orders. On the other hand, if ISO orders are dominated by informed traders than the preferencing measure should be lower than for non-ISO orders.

Panel A, of Table 6, shows the transaction cost results for the full sample of stocks. Spread and *PM* measures are calculated, based on an equally weighted average, for each day of the sample. We then test, for example, to see if the daily average of effective half spreads for ISO orders are statistically different from the effective half spreads of non-ISO orders. For the full sample, the effective half spread for ISO orders is 1.11 cents while for non-ISO orders it is 1.01 cents, for a difference of 0.10 cents per share. This difference is statistically significant with a t-value of 8.81. Although ISO trade initiators pay a higher effective spread at the time of the order, the realized half spread for ISO orders is only 0.06 cents, compared to 0.18 cents for non-ISO orders. Again, the difference is statistically different at better than the 1% level. The preferencing measure for ISO orders is also smaller than the preferencing measure for non-ISO orders, with a statistically significant difference of -0.11. While these results should not be interpreted as that no ISO orders are preferenced orders, we do find that ISO execution quality and information content are better than those of non-ISO orders.

In Panels B through D of Table 6 we show the conditional results of our spread analysis by market capitalization. For large market capitalization stocks ISO orders have an effective half spread that is 0.03 cents more than non-ISO orders. While 0.03 cents may seam like a trivial amount, some simple calculation may help add context. In our sample, large stocks traded 136.55 billion shares of volume, 41% of which was ISO orders. Thus, for the sample, the increase in effective spread paid by ISO order initiators, over non-ISO orders is 136.55 billion shares times 41% times 0.03 cents per share which equals 16.8 million dollars for only the 40 largest market capitalization stocks. On the other hand, the realized spread for ISO orders on large cap stocks is smaller than for non-ISO orders by 0.09 cents. Realized spreads measure the profitability of trades to liquidity suppliers. Based on the realized spread difference, ISO orders for large stocks are 50.4 million dollars less profitable for liquidity suppliers than non-ISO orders for the same transaction volume. Qualitatively similar results are shown, in Panels C and D, for medium and small cap stocks for our sample. However, as might be expected, the relative differences of values increase as market capitalization decreases. These results indicate that ISO trades are more informed than non-ISO trades.

For completeness, we also present spread results conditioned on the listing exchange of the security. In presenting these results we are not attempting to asses the relative quality of order execution between the NYSE and NASDAQ markets. Such an analysis, at a minimum, should have a sample matched on market capitalization between exchanges. Rather, we are comparing the order quality and information content of ISO and non-ISO orders. We turn first to the NASDAQ results. Recall that we find that 63.6% of volume executed on the NASDAQ exchange is ISO driven, while Chung et al. (2004) find that 62.3% of order volume is preferenced on the NASDAQ exchange. If ISO order flow represents preferencing on the NASDAQ market, then they have made a very bad arrangement. While effective spreads are larger for ISO orders, realized spreads are negative. Consistent with the rest of our findings, the Preferencing Measure for ISO orders is also smaller than the measure for non-ISO orders, indicating better quality of execution. The results are similar for NYSE listed stocks and support the same conclusion; ISO order flow is not dominated by preferencing.

4.3 Information share of ISO orders

While the lower realized spreads of ISO orders indicate that these orders are, *ex-ante*, more informed than non-ISO orders, a key affect of informed traders in the market is to improve the price discovery process of equities. Informed traders can equally select the use of ISO and non-ISO orders. Our question is whether or not informed traders prefer ISO orders over non-ISO orders and under what conditions this preference occurs. To address this question we turn to the Information Shares method developed in Hasbrouck (1995).

Operationally we create two price vectors for each stock day in our sample. One vector of non-ISO transaction prices and one vector of ISO transaction prices. While the DTAQ has time stamps to the millisecond, the added process challenges of using trades at the finest time increment of the database surpass the computational ability available. We use the last transaction price of ISO (non-ISO) trades for each second. The use of transaction prices follows the application in Hasbrouck (2003) and Anand and Chakravarty (2007) among others. Our transaction prices can vary 'across' markets as well as 'within' markets. However, the fact that transaction prices can come from any market center for each price vector is similar to Hasbrouck (1995) using the best price from all regional markets as one price channel in his analysis. Given the close distributional properties of the two order types, we feel that controlling for order size in our analysis is not required. Unless the resulting variance co-variance matrix is diagonal, the information share estimate for each order type is not uniquely identified. We therefore take the average of the upper and lower bounds as our point estimate of information share. Information shares are estimated for each stock day in our sample.

In Figure 1 we plot the time series of the equally weighted average information share of ISO (non-ISO) orders for each capitalization grouping of our study. In addition, we plot the equally weighted average proportion of ISO volume.[21] Panel A, of Figure 1, shows the information share results for large stocks in our sample. While there is clear variation as to which type of trade caries the larger information content on a given day, the information share of ISO orders is consistently larger than the volume traded in sweep orders. This result supports our argument that ISO orders are the preferred order type of informed traders.

Of particular interest is the increase in information share of ISO orders towards the end of the sample period. The end of our sample period corresponds with the start of the tremendous oil shock that impacted the market in June and July, as well as the crisis for financial stocks. The financial stock crisis resulted in the SEC issuing an emergency order on July 15, 2008, restricting short sales in 19 major financial stocks[22]. We find no statutory limitation in coupling short sales and ISO orders. In times of financial crisis, the ability of predatory traders, in the sense of Brunnermeier and Pedersen (2005), to couple short sales with ISO orders, allows these traders to decimate liquidity in all markets simultaneously. Our analysis focuses on the broader use of ISO orders in the market place, but the use of ISO orders in the recent financial crisis is a clear area for further research.

[21] ISO and non-ISO volume completely partition the sample. The proportion of non-ISO volume is simply one minus the proportion of ISO volume.

[22] See SEC release 58166 for details of the short sale restrictions

Panel B of Figure 1 shows the information share plot for medium sized firms in our sample. While the information share of ISO orders are, on average, larger than the volume share of ISO orders, information share and volume share of ISO orders have a stronger co-movement when compared to the large stocks shown in Panel A. Similar to the large stock plot, the results for medium stocks also show increased information share of ISO orders towards the end of the sample. Panel C shows the plot for small stocks. The results for small stock are much more like the results for large stocks, with ISO information share oscillating with the information share of non-ISO orders. There is a striking difference in the results for medium sized companies compared to those of small and large companies in our analysis of information shares. The implication of this result is that ISO orders have a different use in medium sized companies than for small or large companies. Our segmentation of stocks into three rough groups is too coarse of a clustering to effectively investigate this issue and we leave this question to further research.

We formally test the implications of Figure 1 in Table 7. In introducing the information share method, Hasbrouck (1995) finds that the price discovery process is under represented in the regional exchanges because their proportion of the information share is well below the percentage of transaction volume executed on these exchanges. We formalized this intuition by conducting a paired t-test comparing the proportion of ISO trade volume to the information share of ISO trades. Each sample point in the test represents one stock day of our sample. Results are presented, conditioned on the market capitalization grouping of the firms in our sample. The results are most striking for the large stocks. While ISO order represent over half of the information share of trades, with an equally weighted average information share average of 0.508, the equally weighted average proportion of ISO volume is only 0.402.[23] The difference of 0.106 is significant at well below the 1% level. Although our analysis does not specifically control for the trade size of ISO and non-ISO orders, to confirm that trade size is not driving our results we calculate the average trade size of each trade included in the information share analysis. For the large stocks, ISO trades included in the sample are, on average, 93.7 shares smaller than the non-ISO trades in the analysis. For each of the market capitalization groups considered in our analysis, trades sizes of ISO orders are consistently smaller than those of the non-ISO orders included in the information shares analysis. This finding differs markedly from previous findings that show that medium sized trades have the largest impact on the price discovery process. In our analysis, smaller ISO orders fill this roll. These results hold for each of the market capitalization groups in our study, although the differences are smaller for smaller firms.

In Panel B, of Table 7, we also show the information test results conditioned on the listing exchange of the stocks in our sample. Our analysis of market center execution of ISO orders, show in Table 5, indicates a wide range of ISO use in the different market centers included in our study. In particular, the use of ISO orders was roughly three times greater on the NASDAQ exchanges than on the NYSE exchange. We test to see if exchange affects are driving the results conditioned on market capitalization. Again, we find that ISO orders have a disproportionate impact on the price discovery process when compared to the execution volume of ISO trades, although the difference is higher for NASDAQ listed securities than for NYSE listed securities. We also find that ISO orders

[23] This volume proportion differs slightly from the value in Table 2 because the ISO volume proportion is first calculated by each stock and then average, while in Table 2 all trade volumes are summed to create a market level proportion of ISO volume.

have a higher information share, compared to ISO volume, than non-ISO orders, even with a smaller average trade size. This finding is unique in that small trades have the larger proportion of the price discovery process. Previous research in the Stealth Trading literature finds that medium size trades dominate the price discovery process.

Interpretation of our information share results needs to be considered carefully. The information share result represents the proportion of the random walk component of the efficient price that is attributed to ISO and non-ISO trades. The magnitude of the random walk component also needs to be considered. In other words, it is possible that ISO orders dominate non-ISO orders on days when there is little information being developed in the market. On days with a high information affect, informed traders may chose non-ISO orders over ISO orders to execute trades. To investigate this issue we use regression analysis.

We wish to investigate if ISO orders are used by informed traders when there is information in the market. If the information share of ISO orders is higher on days with high information then our interpretation of ISO orders as the preferred order of informed traders is supported. As a proxy for the idiosyncratic level of information in the market we use the daily residual from a Fama and French 3 factor regression, based on daily CRSP returns.[24] We then run the following cross sectional regression

$$ISOinfo_{it} = \alpha + RtrnStd_{it} + LnCap_i + List_i + \varepsilon_{it} \qquad (1)$$

where $ISOinfo_{it}$ is the information share of ISO orders for stock i on day t, $RtrnStd_{it}$ is the absolute value from the residual Fama and French 3-factor model regression, $LnCap_i$ is

[24] In a recent paper, Spiegel and Wang (2005) compare idiosyncratic risk estimates based on the 3-factor model and the EGARCH method based on monthly returns. While they find that the EGARCH method produces better out of sample predictions, we feel that the 3-factor model is adequate for our application and consistent with prior literature.

the log of market capitalization, and $List_i$ is a dummy variable that is 1 if the listing exchange is NASDAQ and 0 otherwise. If the coefficient of $RtrnStd_{it}$ is positive and significant than we have support that informed traders prefer ISO orders on high information days.

Table 8 shows the results of this regression. There is one observation for each stock day in the sample, for a total of 23,622 stock days. There are 18 stock days where stocks do not trade or there is no trade and quote data in the DTAQ database. The coefficient of $RtrnStd_{it}$ is in fact positive and significant. We interpret this result to show that ISO trades have a higher information share on days when the price discovery process is more active. The information share of ISO orders is also positively related to market capitalization and stronger for NASDAQ listed securities. These results are consistent with our overall findings that ISO orders are dominated by informed traders, trading on time sensitive information.

We realize that our sample has large jumps in the properties of each subgroup. As a robustness check to these results, we rerun the regression for each market capitalization group in our sample. The coefficient for $RtrnStd_{it}$ is both positive and significant for each of the three regressions. This indicates a consistent use of the ISO trade type across market capitalization groupings. In these sub group regressions, the listing exchange dummy is also consistently positive and significant; however, the market capitalization control variable is only significant in the large stock group. One would think that higher market capitalization stocks would have the least information asymmetry in the market, since larger stocks typically have higher analyst following. Lower information asymmetry would imply a lower likelihood of informed trading. It would be an interesting extension to this research to evaluate informed trading measures such as *PIN* and the use of ISO trading. On the other hand, information asymmetries for larger stocks might have very short time durations, leading to the use of ISO orders for quick execution to fill orders. With smaller stocks, the information asymmetry duration might be relatively longer, leading to the use of both ISO and non-ISO orders. However, the consistent results for each regression indicate that the information share of ISO trades is increasing with the information flux of the market.

5.0 Conclusion:

In this paper we investigate the properties of the new Intermarket Sweep Order (ISO), created as an exemption to the Order Protection Rule of Regulation NMS, Rule 611. ISO orders are allowed to trade through the best price without violating the price priority defined in Rule 611. Specifically, an ISO is a limit order that 1) is identified as an ISO when routed to a trading center and 2) simultaneously with the routing of the limit order, one or more additional limit orders are routed to execute against all better-priced protected quotations displayed by other trading centers up to their displayed size. The ISO exemption was adopted to allow institutional traders to forgo the best price requirement, in order to fill large orders.

Using a sample of 120 firms, equally grouped from large, medium, and small market capitalization companies, we find that ISO orders are a major proportion of the trading that occurs on the market. For the full sample, ISO orders represent 46% of the 509 million trades and 41% of the 146 billion shares traded in our sample. These proportions remain consistent for all capitalization segments as well as conditioning on the listing exchange of the traded security. However, while ISO orders are significantly smaller than the non-ISO counter part, we find that the frequency distribution, based on trade size, of ISO and non-ISO order differ marginally. This supports the pooling equilibrium proposed by Back and Baruch (2007) in which informed traders split large orders to pool with liquidity and small traders.

One of the important aspects of an ISO order is that the order initiator designates which market center the trade will execute on. In this sense, ISO orders are de facto order preferencing. We find that the percentage of ISO trades and trade volume differs significantly by market center. In particular, 62.6% of trades and 63.4% of volume on the NASDAQ exchange are ISO initiated orders, while on the NYSE only 20.9% of trades and 23.6% of volume are ISO trades. However, if ISO trades are dominated by preferenced order flow one would expect lower realized spreads and a higher value of the preferencing measure developed by He, Odders-White, and Ready (2006). We find that ISO orders have both statistically and economically significantly lower realized spreads when compared to non-ISO orders, even while the effective spreads of ISO orders are larger than non-ISO trades. Collectively, these results indicate that ISO orders are not dominated by order preferencing.

While eliminating order preferencing as the dominate driver of ISO order flow, we do show that ISO orders are chosen by informed traders. ISO orders dominate the information share component of the efficient price as estimated by the method established in Hasbrouck (1995), even though ISO orders are significantly smaller than non-ISO orders. We find that it is the small ISO order that drives the price discovery process. In addition, we use regression analysis to show that the information share of ISO orders is increasing in idiosyncratic return volatility, even when controlling for firm size and listing exchange effects. In short we find that the new ISO order type is the dominate order type for informed traders in the regulation NMS market. Our finding related to the price discovery role of small sized ISO trades contributes to the stealth trading literature which has previously documented the information role played by medium sized trades in the price discovery process.

References

Anand, A., and Chakravarty, S., 2007, Stealth trading in options markets, *Journal of Financial and Quantitative Analysis* 42, 167 – 188.

Alexander, G., and Peterson, M., 2007, An analysis of trade-size clustering and its relation to stealth trading, *Journal of Financial Economics* 84, 435 – 471.

Back, K., and Baruch, S., 2007, Working orders in limit order markets and floor exchanges, *Journal of Finance* 62, 1589 – 1621.

Barclay, M.J., and Warner, J.B., 1993, Stealth and volatility: Which trades move prices?, *Journal of Financial Economics* 34, 281 – 306.

Battalio, R., 1997, Third market broker-dealers: Cost competitors or cream skimmers?, *Journal of Finance* 52, 341 – 352.

Battalio, R., Hatch, B., and Jennings, R., 2004, Toward a national market system for U.S. exchange – listed equity options, *Journal of Finance* 59, 933 – 962.

Bennett, P., and Wei, L., 2006, Market structure, fragmentation, and market quality, *Journal of Financial Market*s 9, 49 – 78.

Bessembinder, H., 2003, Quote-based competition and trade execution costs in NYSE-listed stocks, *Journal of Financial Economics* 70, 385 – 422.

Brunnermeier, M., and Pendersen, L., 2005, Predatory trading, *Journal of Finance* 60, 1825 – 1863.

Chakravarty, S., 2001, Stealth-trading: Which traders' trades move stock prices?, *Journal of Financial Economics* 61, 289 – 307.

Chakravarty, S., Gulen, H., Mayhew, S., 2004, Informed trading in stock and option markets, *Journal of Finance* 59, 1235 – 1257.

Chiyachantana, C., and Jain, P., 2008, Institutional trading frictions, Working paper, The University of Memphis.

Chordia, T., and Subrahmanyam, A., 1995, Market making, the tick size, and payment-for-order flow: theory and evidence, *Journal of Business* 68, 543 – 575.

Chung, K., Chuwonganant, C., and McCormick, T., 2004, Order preferencing and market quality on NASDAQ before and after decimalization, *Journal of Financial Economics* 71, 581 – 612.

Easley, D., and O'Hara, M., 1987, Price, trade size, and information in securities markets, *Journal of Financial Economics* 19, 69 – 90.

Ellis, K., Michaely, R., and O'Hara, M., 2000, The accuracy of trade classification rules: Evidence from Nasdaq, *Journal of Financial and Quantitative Analysis* 35, 529 – 551.

Foster, F., and Viswanathan, S., 1993, A theory of the intraday variations in volume, variance and trading costs in securities markets, *Review of Financial Studies* 3, 583 – 624.

Foucault, T., and Menkveld, A., 2008, Competition for order flow and smart order routing systems, *Journal of Finance* 63, 119 – 158.

Garfinkel, J., and Nimalendran, M., 2003, Market structure and trader anonymity: An analysis of insider trading, *Journal of Financial and Quantitative Analysis* 38, 591 – 610.

Glosten, L., 1994, Is the electronic limit order book inevitable?, *Journal of Finance* 49, 1127 – 1161.

Hansch, O., Naik, N., Viswanathan, S., 1999, Preferencing, internalization, best execution, and dealer profits, *Journal of Finance* 54, 1799 – 1829.

Hasbrouck, J., 1995, One security, many markets: Determining the contributions to price discovery, *Journal of Finance* 50, 1175 – 1199.

Hasbrouck, J., 2003, Intraday price formation in U.S. equity index markets, *Journal of Finance* 58, 2375 – 2399.

He. C., Odders-White, E., and Ready, M., 2006, The impact of preferencing on execution quality, *Journal of Financial Markets* 9, 246 – 273.

Hendershott, T., and Jones, C., 2005, Trade-through prohibitions and market quality, *Journal of Financial Markets* 8, 1 – 23.

Huang, R., and Stoll, H., 1996, Dealer versus auction markets: A paired comparison of execution costs on NASDAQ and the NYSE, *Journal of Financial Economics* 41, 313 – 357.

Kyle, A.S., 1985, Continuous auctions and insider trading, *Econometrica*, 53, 1315 – 1336.

Lipson, M., 2004, Competition Among Market Centers, Working paper, The University of George.

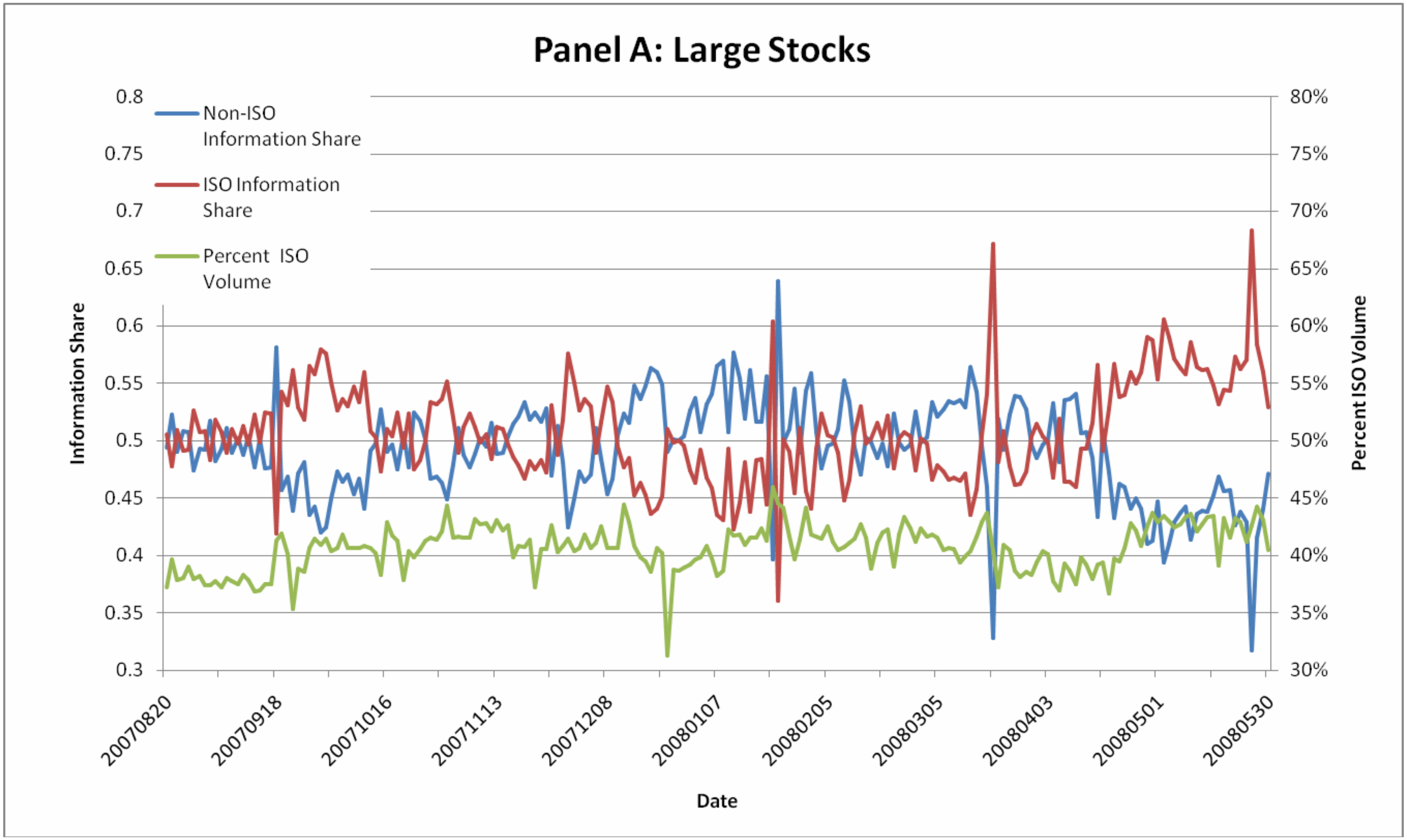
Peterson, M., and Sirri, E., 2003, Order preferencing and market quality on U.S. equity exchanges, *Review of Financial Studies*, 16, 385 – 415.

Seppi, D., 1990, Equilibrium block trading and asymmetric information, *Journal of Finance*, 45, 73 – 94.

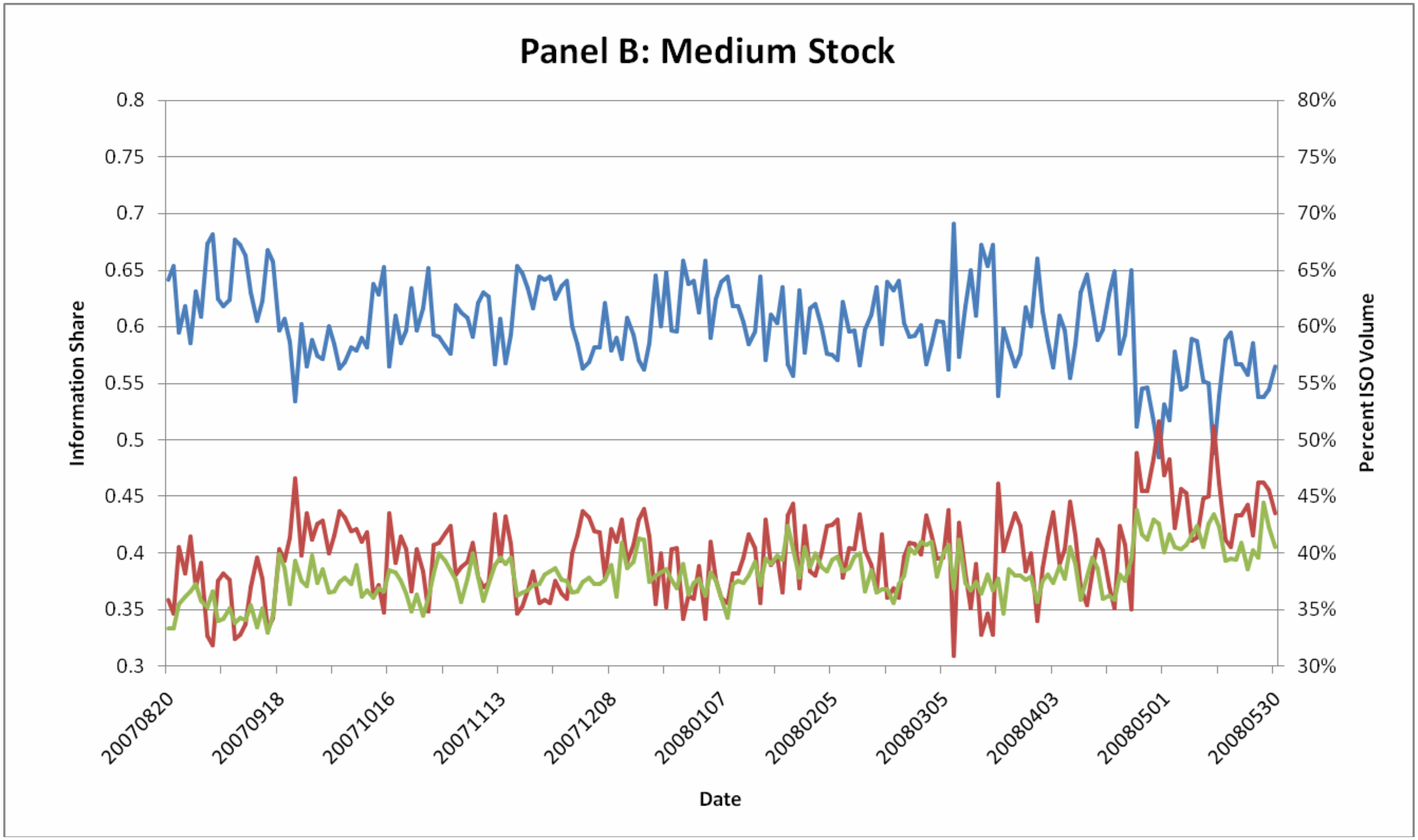
Spiegel, M., and Wang, X., 2005, Cross-sectional variation in stock returns: Liquidity and idiosyncratic risk, Working paper, Yale School of Management.

Stoll, H., 2006, Electronic trading in stock markets, *Journal of Economic Perspectives*, 20, 153 – 174.

Stoll, H., and Schenzler, C., 2006, Trades outside the quotes: Reporting delay trading option, or trade size?, *Journal of Financial Economics*, 79, 615 – 653.



Panel A: Large Stocks
Non-ISO Information Share
ISO Information Share
Percent ISO Volume
Information Share
Percent ISO Volume
0.8
0.75
0.7
0.65
0.6
0.55
0.5
0.45
0.4
0.35
0.3
80%
75%
70%
65%
60%
55%
50%
45%
40%
35%
30%
20070820
20070918
20071016
20071113
20071208
20080107
20080205
20080305
20080403
20080501
20080530
Date



Panel B: Medium Stock
Information Share
Percent ISO Volume
Date
0.8
0.75
0.7
0.65
0.6
0.55
0.5
0.45
0.4
0.35
0.3
80%
75%
70%
65%
60%
55%
50%
45%
40%
35%
30%
20070820
20070918
20071016
20071113
20071208
20080107
20080205
20080305
20080403
20080501
20080530

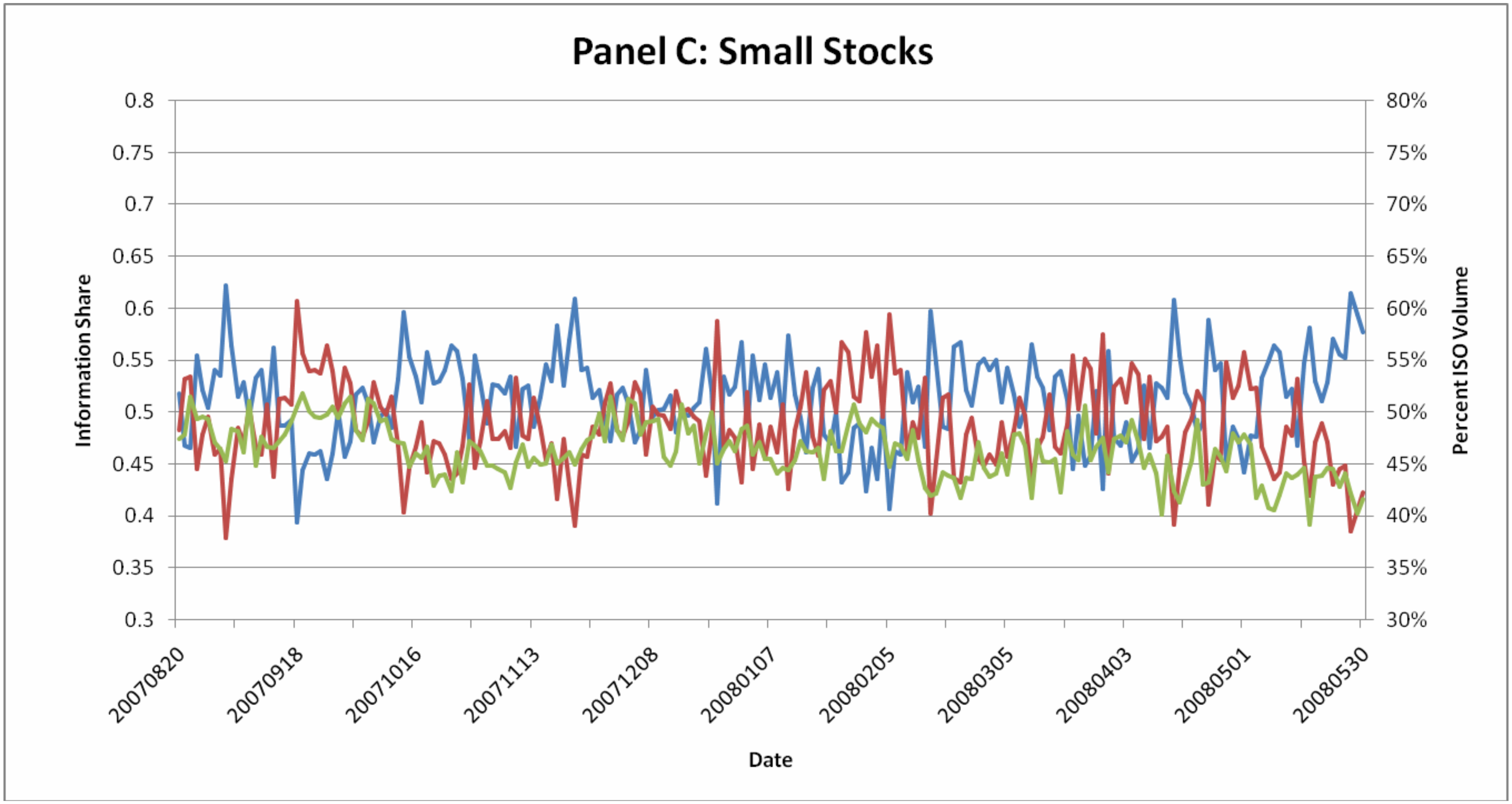


Figure 1: Time series plot of the information share of ISO and Non-ISO orders using the Hasbrouck (1995) method. Panel A is for large market capitalization stocks, Panel B for medium market capitalization stocks, and Panel C for small market capitalization stocks.

Table 1
ISO orders versus non-ISO orders
We compare the properties of ISO and non-ISO orders based on the sweep order exemption of the Order Protection Rule.

		ISO Order	non-ISO Order
1	Submission venue	Important: Specific instruction to execute at the market center where submitted	Always searches for the price priority market irrespective of submission venue
2	Execution Venue	Executes at submission venue	Reroutes to market center with price priority, if necessary
3	Order Type	Has to be a limit order	Can be market, limit, or any other type of order
4	Execution method	Allows parallel processing across multiple markets	Sequential processing and price priority market is established before and after every partial trade
5	Execution Speed	Faster	Slower
6	Execution Quantity	Helps capture bigger counterparty depth	Some order quantity can remain unexecuted or execute at changed prices
7	Execution price	Executes at the current quote within each market center	Can only execute at best prices within the previous one second or get rerouted to the center with price priority
8	Trade Through	Allowed with concurrent execution of all better posted prices	Not allowed

Table 2

Sample descriptive statistics

Our sample period consists of 197 trading days starting August 20, 2007 and ending May 30, 2008. Market capitalization values are based on the last trading day of 2007. Sample stocks are selected based on the following criteria. First, the stocks must exist at the intersection of the DTAQ and CRSP databases. The stock must have a closing price greater than ten dollars and less than 1,000 dollars on the last trading day of 2007 and must be a common stock (CRSP share code 10 or 11). Stocks are then grouped as large, medium, or small based on market capitalization. The top 40 stocks, based on market capitalization, from each grouping form the sample of 120 stocks considered in this study. ISO orders are identified in the DTAQ database as condition code F.

	Number of firms	Average market capitalization (billions)	Number of trades (millions)	Percent ISO trades	Share volume (billions)	Percent ISO volume
Full Sample	120	50.30	508.70	46%	145.60	41%
by firm size						
Large	40	148.55	460.39	47%	136.55	41%
Medium	40	1.89	39.07	44%	7.45	40%
Small	40	0.45	9.24	50%	1.61	45%
by listing exchange						
NYSE	72	67.13	363.64	44%	96.38	38%
NASDAQ	48	25.05	145.06	52%	49.23	48%

Table 3

Comparison of order size for sweep and non-sweep trades

A comparison of average trade size of ISO and Non-ISO orders. T-values are based on a means difference t-test. The median NBBO quoted depth represents the total (top of the book) quoted depth, ask plus bid, from all market centers matching the NBBO ask or bid price in shares.

Sample	ISO	Non-ISO	Difference	t-value	p-value	Median NBBO Quoted Depth
Full Sample	178.8	217.3	-38.4	-46.2	0.0000	1,300
Large Stocks	235.5	291.8	-56.9	-32.3	0.0000	6,300
Medium Stocks	157.4	187.3	-29.9	-39.1	0.0000	1,200
Small Stocks	143.5	172.7	-29.2	-30.6	0.0000	700

Table 4

Trade size distribution for ISO and Non-ISO orders

Comparison of trade size for ISO and Non-ISO orders. ISO Trades represents the count of trades that occur in the indicated trade size grouping. Our sample period consists of 197 trading days starting August 20, 2007 and ending May 30, 2008. Market capitalization values are based on the last trading day of 2007. Sample stocks are selected based on the following criteria. First, the stocks must exist at the intersection of the DTAQ and CRSP databases. The stock must have a closing price greater than ten dollars and less than 1,000 dollars on the last trading day of 2007 and must be a common stock (CRSP share code 10 or 11). Stocks are then grouped as large, medium, or small based on market capitalization. The top 40 stocks, based on market capitalization, from each grouping form the sample of 120 stocks considered in this study.

Trade Size	ISO Trades (millions)	Percent	Non-ISO Trades (millions)	Percent
Panel A: Full Sample				
<500	210.26	89.0%	234.68	86.0%
501-1,000	16.92	7.2%	23.92	8.8%
1,001-5,000	8.68	3.7%	13.34	4.9%
5,001-10,000	0.35	0.1%	0.64	0.2%
10,000+	0.13	0.1%	0.26	0.1%
Total	236.33	100.0%	272.83	100.0%
Panel B: Large Stocks				
<500	189.32	88.3%	209.81	85.2%
501-1,000	16.23	7.6%	22.84	9.3%
1,001-5,000	8.45	3.9%	12.89	5.2%
5,001-10,000	0.34	0.2%	0.61	0.2%
10,000+	0.12	0.1%	0.25	0.1%
Total	214.46	100.0%	246.40	100.0%
Panel C : Medium Stocks				
<500	16.49	95.5%	20.47	93.9%
501-1,000	0.58	3.3%	0.92	4.2%
1,001-5,000	0.19	1.1%	0.38	1.7%
5,001-10,000	0.01	0.0%	0.02	0.1%
10,000+	0.00	0.0%	0.01	0.1%
Total	17.27	100.0%	21.80	100.0%
Panel D: Small Stocks				
<500	4.45	96.7%	4.39	94.7%
501-1,000	0.11	2.4%	0.16	3.4%
1,001-5,000	0.04	0.9%	0.08	1.7%
5,001-10,000	0.00	0.0%	0.00	0.1%
10,000+	0.00	0.0%	0.00	0.1%
Total	4.60	100.0%	4.64	100.0%

Table 5

Exchange distribution of intermarket sweep orders

Trade represents the percentage of trades identified as ISO orders, condition code F in the DTAQ database, and volume represents of percentage of ISO volume executed on the indicated exchange. Our sample period consists of 197 trading days starting August 20, 2007 and ending May 30, 2008. Market capitalization values are based on the last trading day of 2007. Sample stocks are selected based on the fallowing criteria. First, the stocks must exist at the intersection of the DTAQ and CRSP databases. The stock must have a closing price greater than ten dollars and less than 1,000 dollars on the last trading day of 2007 and must be a common stock (CRSP share code 10 or 11). Stocks are then grouped as large, medium, or small based on market capitalization. The top 40 stocks, based on market capitalization, from each grouping form the sample of 120 stocks considered in this study.

	Market	Full Sample		Large Stocks		Medium Stocks		Small Stocks	
Exchange	Share	Trades	Vol	Trades	Vol	Trades	Vol	Trades	Vol
National	1.3%	70.0%	71.4%	66.5%	68.4%	67.3%	68.5%	76.8%	77.8%
ADF	22.7%	29.3%	21.9%	29.2%	21.9%	27.3%	20.1%	31.4%	23.6%
International	1.3%	52.4%	52.0%	55.8%	55.6%	53.5%	52.8%	43.4%	43.1%
Chicago	0.3%	63.7%	58.1%	62.2%	54.5%	64.1%	62.1%	72.9%	72.7%
NYSE	44.4%	20.9%	23.6%	20.8%	24.1%	20.6%	22.6%	22.5%	25.2%
Pacific/Arca	14.8%	52.8%	53.5%	57.3%	57.9%	55.8%	56.3%	45.2%	46.3%
NASDAQ	33.5%	62.6%	63.4%	61.3%	62.6%	62.9%	63.7%	63.6%	64.0%
Phil	0.2%	42.1%	52.1%	43.9%	54.6%	24.4%	27.5%	14.3%	14.3%
CBOE	0.2%	43.3%	42.5%	44.3%	43.2%	47.1%	46.7%	32.4%	32.3%

Table 6

Comparison of transaction costs for Sweep and Non-Sweep orders

All spread calculation are based on the exchange posted NBBO contained in the DTAQ database. Trade direction inference is based on Ellis, Michaely, and O'Hara (2000). Effective half spreads are defined as $D_{it}(P_{it} - M_{it})$, where D_{it} is the trade direction indicator, P_{it} is the trade price, and M_{it} is the exchange posted NBBO mid-point. The realized half spread is calculated as $D_{it}(P_{it} - M_{it+5})$, where M_{it+5} is the prevailing NBBO quote mid-point 5 minutes after the trade. If there is less than 5 minutes before the market close (4:00 pm EST), the prevailing NBBO quote at the close of the market is used. The Preferencing Measure is defined at the ratio of realized spread to effective spread from He, Odders-White, and Ready (2006). The t-value represents the results of a means difference t-test. Spreads are displaced in cents.

Spread	Sweep	Non-Sweep	Difference	t-value	p-value
Panel A: Full sample					
Effective Spread	1.11	1.01	0.10	8.81	0.0000
Realized Spread	0.06	0.18	-0.12	-8.64	0.0000
Preferencing Measure	0.14	0.24	-0.11	-7.06	0.0000
Panel B: Large market capitalization stocks					
Effective Spread	0.71	0.68	0.03	3.03	0.0026
Realized Spread	0.24	0.33	-0.09	-5.31	0.0000
Preferencing Measure	0.39	0.49	-0.10	-3.78	0.0002
Panel C: Medium market capitalization stocks					
Effective Spread	1.01	0.91	0.10	11.69	0.0000
Realized Spread	0.13	0.22	-0.08	-4.81	0.0000
Preferencing Measure	0.12	0.23	-0.11	-6.50	0.0000
Panel D: Small market capitalization stocks					
Effective Spread	1.60	1.44	0.17	6.46	0.0000
Realized Spread	-0.18	-0.01	-0.17	-7.15	0.0000
Preferencing Measure	-0.10	0.00	-0.11	-6.83	0.0000
Panel E: Listing Exchange					
NYSE					
Effective Spread	0.86	0.79	0.07	8.23	0.0000
Realized Spread	0.24	0.29	-0.05	-2.85	0.0046
Preferencing Measure	0.33	0.41	-0.08	-3.39	0.0008
NASDAQ					
Effective Spread	1.48	1.33	0.15	6.04	0.0000
Realized Spread	-0.20	0.02	-0.21	-10.13	0.0000
Preferencing Measure	-0.15	0.00	-0.15	-10.18	0.0000

Table 7

Information share evaluation

The table contains the evaluation of the impact of ISO trades on the price discovery process. We conduct a paired t-test comparing the proportion of information share to the proportion of ISO trade volume. Each sample point in the test represents one of the 23,622 stock days in the sample. In conducting the information share analysis, we use the last ISO (non-ISO) trade price for each second containing one or more trades. Information shares are estimated for each stock day in the sample. We present the mean trade size for ISO (non-ISO) trades used in the information share analysis. We also conduct a paired t-test comparing the trade size of ISO and non-ISO trades included in the information share analysis. We first calculate the average trade size for each trade type on each stock day in the sample. The paired t-test is then conducted on the resulting time series.

	Mean Information Share	Mean ISO Volume Proportion	Paired Difference (Info Shr)	Mean ISO Trade Size	Mean non-ISO Trade Size	Paired Difference (Trd Size)
Panel A: Market Capitalization						
Large Stocks	0.508	0.402	0.106*	261.7	355.4	-93.7*
Medium Stocks	0.399	0.380	0.020*	157.6	199.7	-42.0*
Small Stocks	0.487	0.461	0.026*	141.6	182.4	-40.8*
Panel B: Listing Exchange						
NYSE Listed	0.399	0.360	0.039*	196.4	252.0	-55.5*
NASDAQ Listed	0.564	0.496	0.068*	172.8	236.6	-63.8*

*Difference is statistically significant at the 1% level

Table 8

Regression Results

We estimate the following cross sectional regression:

$$ISOinfo_{it} = \alpha + RtrnStd_{it} + LnCap_{i} + List_{i} + \varepsilon_{it}$$

Where $ISOinfo_{it}$ is the information share of ISO orders for stock *i* on day *t*, $RtrnStd_{it}$ is the absolute value of the residual from a daily Fama-French 3-factor regression for stock *i* on day *t*, $LnCap_{i}$ is the natural log of firm market capitalization, and $List_{i}$ is a dummy variable that is 1 if the stock is NASDAQ listed and 0 otherwise. T statistics are based on heteroskedasticity-consistent standard errors and are located in prentices below the parameter estimate. N represents the number of stock days included in the regression.

Parameter	Full Sample Estimate	Large Stocks	Medium Stocks	Small Stocks
Intercept	-0.0798	0.1859	-1.7610	-0.5072
	(-10.29)	(4.07)	(-1.46)	(-0.30)
RtrnStd	0.0108	0.0126	0.0105	0.0104
	(17.04)	(9.95)	(11.35)	(10.62)
LnMcap	0.0287	0.0153	0.1433	0.0624
	(65.28)	(6.31)	(1.72)	(0.49)
List	0.2184	0.1294	0.2854	0.2106
	(89.45)	(43.47)	(68.91)	(39.85)
Adj R2	0.277	0.184	0.404	0.158
F-Statistic	3,017	592	1,781	493
N	23,622	7,876	7,874	7,872