The Quarter-Penny Tick

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Abstract

Stock exchange fee pricing schemes—maker-taker, inverted taker-maker, and flat pricing—have created convoluted markets in which an effective quarter-penny tick is primarily available only to sophisticated traders who switch between maker-taker, inverted, and flat markets as market conditions change. The system creates an agency problem between brokers and their clients, resulting in poor routing decisions as brokers try to maximize maker rebates. The quarter-penny tick also reduces the cost of certain parasitic trading strategies to the detriment of investors. This study identifies how sophisticated traders exploit the system and provides an empirical characterization of the problem.

Keywords: Maker-taker, taker-maker, inverted exchanges, trading tick, minimum price variation, exchange transaction fees

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1 Introduction

Securities and Exchange Commission Regulation NMS requires quoted prices in the National Market System to be a multiple of one penny in the United States.[1] Similar regulations also set the minimum price variation in other countries. The Commission adopted these regulations primarily to ensure that traders who want to trade ahead of other traders offering to trade at a given exchange must improve prices by a penny at that exchange.

Without this restriction, a trader who wants to trade ahead of all other traders could bid or offer prices that are only a tiny fraction of a penny better than the prevailing national best bid or offer. Because exchange trading systems enforce price priority, and because traders naturally seek the best available price, this tactic allows traders with insignificantly better prices to trade first when a marketable order arrives, regardless of how long other traders at slightly inferior prices have been waiting to trade.

The SEC set the minimum price variation at a penny following vociferous complaints by institutional buy-side traders about a parasitic trading strategy that practitioners call pennying and academics call quote-matching.[2] The buy-side traders were upset by electronic traders who would step in front of their standing limit orders by improving prices by a small fraction of a penny at alternative electronic trading systems (then mostly ECNs) that permitted subpenny pricing.[3] Since market order traders always seek the best price, these mostly proprietary traders would trade before the institutional traders. The institutional traders lost if prices subsequently moved away before their limit orders filled, as often happens.

The quote-matching strategy allows quick traders to extract option values from standing limit orders.[4] Standing limit buy and sell orders respectively provide put and call options to the first traders willing to sell or buy at the offered limit prices. For example, suppose that an institutional trader places a standing limit order to buy at $20.00. If a fast trader can buy first, perhaps at $20.000001, the fast trader will profit if prices subsequently rise. But if the fast trader subsequently suspects that prices will fall—perhaps because the trader is watching prices, volumes, and orders in correlated securities—the fast trader will sell to the institutional trader at $20.00 if the order is still standing. The institutional trader will fail to trade when she wished that she had, or she will trade when she wished that she had not. The fast trader using the quote-matcher strategy faces a potentially unbounded gain on the upside, and, if the institutional order remains on the book, a downside loss of only $0.000001 per share plus exchange fees and clearing costs. The quote-matching strategy is best executed by fast traders who can reverse

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[1] The national market system ("NMS") is the set of exchanges and order display systems that facilitate trade in exchange-listed stocks. All but the smallest stocks trade in the NMS. Regulation NMS only limits price quotations and thus the operation of exchange order precedence rules that depend on prices. Traders are permitted to negotiate sub-penny prices if they so desire.

[2] See Amihud and Mendelsohn (1990) for the first academic reference (of which I am aware) to the quote-matching strategy.

[3] ECNs (Electronic Communications Networks) are electronic trading systems that provide exchange matching services but which are not regulated as exchanges. The most important of these systems—Island, Archipelago, BATS, and DirectEdge—now operate as exchanges.

[4] See Harris (2002) *Trading and Exchanges* Chapter 11 (Order Anticipators) for a fuller description of the quote-matching strategy and how investors can defend against it.

their trades before any factors that break their confidence also cause the traders upon whose orders they are leaning on to cancel those orders. The quote-matchers also must trade before any other traders who also might want to trade with these standing orders.

The potential losses to the fast trader of exercising the quote-matching strategy decrease with the tick size because the tick size regulates the cost of using price priority to trade ahead. Accordingly, the SEC adopted the penny tick so that traders must improve prices by at least a penny to obtain order precedence. As a result, the penny tick discourages quote-matching, especially for low-priced stocks.

1.1 The quarter-penny tick

Recent developments in U.S. securities markets now ensure that the effective tick size is often one-quarter penny for sophisticated proprietary traders. Although Reg NMS regulates tick sizes at one penny, it only partly regulates the fees and rebates that exchanges charge and return to the traders and brokers who send orders to exchanges. Diversity in these fees and rebates has effectively created quarter-penny ticks for sophisticated traders.

Exchanges traditionally priced their services by charging a small fee to sellers, and depending on the exchange, sometimes also to buyers. These traditional exchange fees were like commissions that brokers charge for arranging trades. If exchanges still collected traditional exchange fees, they now would be about 0.05¢ per share.[5]

With the introduction of new electronic trading systems, collectedly called ECNs, a new exchange fee system called maker-taker pricing emerged.[6] Exchanges that use maker-taker pricing charge a high fee—called the taker fee or access fee—to the traders who initiate trades by taking standing bids or offers using a marketable order. They rebate a significant fraction of the taker fee to the makers whose standing orders made the market. The rebate is called the maker rebate or liquidity rebate. Although fees vary somewhat across maker-taker exchanges and substantially across clients based on their monthly trading volumes, the typical taker fee is 0.30¢ per share (the maximum permitted by Reg NMS[7]), and the typical maker rebate is 0.25¢ per share. The exchange thus earns the difference of 0.05¢ per traded share.

Almost all retail and many institutional brokers pay the taker fee and keep the maker rebate when trading on behalf of their clients. A few retail brokers, such as Interactive Brokers, pass these transaction fees and rebates through to their clients if they request unbundled pricing. Some institutional traders also obtain unbundled pricing from their brokers. High-frequency proprietary

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[5] Some smaller exchanges such as NSYE Chicago (the former Chicago Stock Exchange) still use the traditional pricing model. NSYE Chicago charges a flat fee of 0.10¢ per share to buyer and seller, with some exceptions. See https://www.nyse.com/publicdocs/nyse/NYSE_Chicago_Fee_Schedule.pdf. These high fees ensure that traders primarily use NYSE Chicago to report matched trades (crossed trades) for which it charges no fees, but for which it receives market data revenues from the trade reporting networks (Networks A and B and Nasdaq).
[6] Island ECN adopted the first maker-taker pricing scheme in 1997.
[7] See Reg NMS Rule 610, the "Access Rule" in https://www.sec.gov/rules/final/34-51808.pdf.

traders ("HFTs") pay and receive transaction fees whether they are registered dealers or trade through brokers.

ECNs introduced maker-taker pricing to create a financial incentive for brokers to route their customers' standing limit orders to them. [8] These limit orders provide liquidity (the ability to trade when you want to trade) to other traders and thus attract marketable orders that produce trades that generate ECN revenues.

The competition among ECNs to attract standing limit orders led to increasingly higher maker rebates and thus higher taker fees. It also caused all traditional exchanges to eventually adopt maker-taker pricing. When the taker fees charged by at least one ECN became greater than one cent per share, the SEC acted to limit taker fees to 0.3¢ per share.[9]

An effective half-penny tick is due to a second innovation in exchange pricing. Starting in 2009, some exchange holding companies created exchanges that differ from their original exchanges only in how they charge exchange fees.[10] These new exchanges, often called inverted exchanges, invert maker-taker pricing: They charge makers a fee for trading and provide rebates to the takers. The maker fee is typically about 0.25¢ per share, and the taker rebate is about 0.20¢ per share.[11] Like the maker-taker fees, the taker-maker fees vary somewhat by exchange and substantially across clients depending on their trading volumes.

The combination of maker-taker pricing and taker-maker pricing effectively creates a half-penny tick. For example, suppose that a proprietary trader places a limit order to buy at $20.00 at a maker-taker exchange and another at the same price at an inverted exchange. If the order at the maker-taker exchange executes, the trader will pay $20.00 per share but will receive the maker rebate of 0.25¢, yielding a net price of $19.9975. If the order at the inverted exchange executes, the trader will pay

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[8] ECNs originally called the taker fee and the maker rebate the "access fee" and the "liquidity rebate." Many exchanges now call them the liquidity-removing fee and the liquidity-providing fee.

[9] Attain ECN, among a few others, had been charging extremely high access fees. The high rebates associated with these access fees caused some dealers to quote very aggressive markets. Brokers who then routed to those ECNs because they were quoting the best prices were forced to pay extremely high fees. Some brokers refused to pay these fees, which led to some legal actions. The aggressive markets often locked or crossed other quotes, which caused some brokers' order handling systems to stop routing orders electronically. To avoid these problems, the SEC ultimately limited access fees to 0.30 cents per share in its Reg NMS Rule 610. See the Reg NMS Proposing Release No. 34-49325 Section IV.B.3.i, "How Access Fees Cause Distortion in the Markets", at https://www.sec.gov/rules/proposed/34-49325.htm.

[10] In 2009, Nasdaq Inc. converted the former Boston Stock Exchange, which it bought in 2007, into the first inverted exchange. Renamed Nasdaq BX, Nasdaq operates this inverted exchange in parallel with its maker-taker exchange, Nasdaq Stock Market.

[11] The Nasdaq fee schedule for the inverted exchange Nasdaq OMX BX appears at http://www.nasdaqtrader.com/trader.aspx?id=bx_pricing. Schedules for CBOE's two inverted exchanges, Bats EDGA and Bats BZX, appear at https://markets.cboe.com/us/equities/membership/fee_schedule/edga/ and https://markets.cboe.com/us/equities/membership/fee_schedule/byx/.

$20.00 plus the maker fee of 0.25¢, yielding a net price of $20.0025. The difference between the two prices is 0.0050, or half a penny per share.

Note that orders at inverted exchanges often trade before orders at the same price at maker-taker exchanges because takers prefer to receive rebates rather than pay taker fees. In the above example, the taking seller at the inverted exchange will receive a net price of $20.0020 = $20.00 + 0.20¢ when taking at the inverted exchange, and a lower net price of 19.9970 = $20.00 – 0.30¢ when taking at the maker-taker exchange. The difference in prices is $0.0050, or half a penny.[12]

The higher cost to makers at inverted exchanges ensures that makers always prefer to trade at maker-taker exchanges at any given price. But, if a maker-taker exchange already has substantial order volume waiting to trade at a price, a maker wanting to trade at that price must stand in line waiting until all previously submitted exposed orders at that price trade.[13] While waiting, the market might move away from the price so that the maker would fail to trade. At the cost of a half-penny, the maker can jump ahead of this line by placing the order at an inverted exchange, thereby increasing the probability of trading quickly.

A quarter-penny tick is now available to sophisticated traders due to an innovation in pricing that the Investor's Exchange ("IEX") adopted in March 2021. The IEX now uses a modified maker-taker pricing model—hereafter called "flat pricing"—that charges 0.06 cents per share for orders that remove liquidity (taking orders) and no fee for orders that provide liquidity (making orders).[14] It formerly used the traditional pricing model and charged equal amounts to buyers and sellers, with some exceptions.

With flat pricing, traders who want to trade ahead of orders at a maker-taker exchange can post at IEX. Then, if their orders execute, their net cost of jumping ahead is only 0.25 cents per share.

The availability of maker-taker, flat, and inverted exchanges provides three net price points surrounding every penny. Measured relative to a whole cent p, the price points are $p¢ – 0.25¢$, $p¢$, and $p¢ + 0.25¢$. The effective price grid thus has a resolution of one-quarter cent, except that net prices at $p¢ + 0.50¢$ are not available.

Widespread use of these different price points leads to net spreads that can be as small as 0.50 cents. For example, the net spread between a $20.00 bid at an inverted exchange ($20.0025 net price) and a 20.01 offer at a maker-taker exchange ($20.0075 net price) is $0.005, or 0.50 cents. In general, net spreads can be on any quarter of a cent above 0.50 cents. Reg NMS generally prohibits exchanges from quoting markets that would lock or cross another exchange quote. A lock occurs when one exchange's bid is equal to another exchange's ask. A cross occurs when a bid is above an ask. Accordingly, although net spreads of 0.25 cents are in principle possible (for example, when a maker-taker exchange has a bid at $20.00 and a flat exchange has an offer at the same price), they could occur only if one exchange

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[12] Variation in the fee schedules across exchanges and among traders due to volume discounts ensures that not all traders will see an exact half-penny tick, but the variation around one-half cent is significant for most traders, and the variation has almost no effect on order routing decisions (except those made to quality for volume discounts).
[13] At a given price, makers who expose their orders trade ahead of all traders who hide their orders.
[14] See https://www.sec.gov/rules/sro/iex/2021/34-91443.pdf.

locks the market with another exchange, which Reg NMS prohibits. Table 1 presents scenarios that give rise to different net spreads.

Sophisticated traders benefit from effective quarter-penny tick pricing by selectively routing their orders to maker-taker, flat, and inverted exchanges. For example, if the quoted best bid or offer is at a maker-taker exchange and they want to be first in line, i.e., improve the net price, they can route (or reroute) their order to a flat exchange where they quote the same price. If the quoted best bid or offer is at a flat exchange, they can route their order to an inverted exchange at the same price. And if the quoted best bid or offer is at an inverted exchange, they can route their order to a maker-taker exchange where they bid or offer a penny higher or lower to effectively be first in line at the cost of a half-penny.

The effective quarter-penny tick is available only to liquidity suppliers who can control their order routing and who pay and receive exchange transaction fees and rebates. Because most retail and institutional investors trade through brokers who absorb these fees, their brokers usually do not allow them to offer liquidity at inverted exchanges because the brokers would have to pay the maker fees. Instead, their brokers route their standing limit orders to maker-taker exchanges where the orders will trade only after orders at the same price and side trade at the inverted and flat exchanges.

The diversity in exchange fee pricing schemes thus creates an agency problem between brokers and their clients.[15] The brokers route to maker-taker exchanges to obtain transaction fee rebates even though their clients might prefer better representation of their standing orders. Investors who want better representation for their liquidity-supplying orders and are willing to pay for it must trade through brokers who pass through exchange transaction fees and rebates. Those brokers also must have routing systems and algorithmic trading systems that route orders based on net prices instead of quoted prices.

Finally, note that the agency problem does not affect the routing of marketable client orders. Brokers gladly route their customer's marketable orders to inverted exchanges where they receive taker rebates.[16] But the clients do not benefit because almost all brokers keep the inverted exchange maker rebates.

The quarter-penny tick cheapens the cost to proprietary traders of using the quote-matching strategy to extract option values from standing limit orders. If all exchanges used the same pricing model, the cost of stepping in front of an order would be a penny. Under the current market exchange fee system, the cost is a quarter-penny or a half-penny, depending on the exchange representing the standing order. Since brokers route most customer orders to maker-taker exchanges, the cost is a quarter-penny for stepping in front of most customer buy orders (by placing a same-priced buy order at a flat exchange) ,

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[15] This agency problem also existed when ECNs first used maker-taker pricing, but the traditional stock exchanges did not. It went away when all exchanges converted to maker-taker pricing with similar fee and rebate schedules. With the introduction of inverted exchanges, the agency problem returned.

[16] A regulatory problem would exist If, to avoid paying take fees, brokers refused to route marketable orders to maker-taker exchanges when those exchanges have the best price. But such behavior is not likely because the trade through prohibition in Reg NMS prevents orders routed to exchanges with inferior prices from trading at those prices, and because, unless explicitly permitted by a market-not-held instruction, brokers cannot retard the execution of a marketable order while waiting for an inverted exchange to offer the best price.

and a half-penny for stepping in front of most customer sell orders (by placing a sell order one-cent lower at an inverted exchange).

Being able to step in front of other traders also allows dealers and other proprietary traders to sell liquidity services more effectively, albeit at a lower spread, then can investors who cannot access inverted exchanges, or who do not know why and how they should do so. Traders who offer liquidity only at maker-taker exchanges will trade less often than those who will pay a half-penny or quarter-penny to get in front of them. Trading at inverted and flat exchanges by these sophisticated liquidity suppliers thus makes using standing limit orders less productive for investors who might want to lower the costs of their trades by using standing limit orders. Investors forced to compete on this unlevel playing field are more likely to use marketable orders than limit orders, which increases the revenues of the more capable traders.

The SEC has not publicly expressed much concern about this agency problem until recently. Its efforts to promote best execution historically have focused mainly on the execution of marketable orders and not on the best representation for standing limit orders.

In response to rising concerns about transaction fees, in December 2018, the SEC proposed a transaction fee pilot study of exchange fees.[17] However, a June 2020 District of Columbia Circuit Court ruling that the pilot study plan violated the Administrative Procedure Act stopped its implementation. As a result, the SEC has not yet mandated the study.

2   Evidence

To identify the use of net fractional pricing, using TAQ exchange quotations data, I computed the National Best Bid or Offer for each stock on several days based on net transaction-fee adjusted prices. I subtracted 0.25¢ from all bid prices for maker-taker exchanges and added 0.25¢ to all ask prices. I did the opposite for inverted exchange quotes. I left the flat exchange quoted prices unadjusted.

I analyzed three days: Friday, October 15, 2021; Friday, March 4, 2022; and Thursday, March 7, 2022. The first date was a typical trading day in October on which the open-to-close S&P 500 return was 0.5%, with an intraday range of 0.6%. Market volatility on March 4 was greater: The open-to-close S&P 500 return was -0.3%, with an intraday range of 1.3%. Finally, March 7 was still more volatile: The open-to-close S&P 500 return was -2.9%, with an intraday range of 2.9%.

Time-weighted frequency distributions showing which market type provided the transaction-fee adjusted National Best Bid or Offer appear in Figure 1. For each day, the maker-taker exchanges are most often at the best bid or offer, while the flat exchange (IEX) least often provides the best price.

If the fractional penny portion of actual security values were uniformly distributed between 0 and 1 penny, all traders were sophisticated, and traders rounded their orders to the nearest available net sub-penny price, then the expected frequencies would be 37.5% for maker-taker and inverted exchanges,

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[17] See "Transaction Fee Pilot for NMS Stocks," SEC Release No. 34-82873 at https://www.sec.gov/rules/proposed/2018/34-82873.pdf.

and 25% for flat exchanges. Flat exchanges have a lower share because their pricing is a quarter-penny from either of its neighbors, whereas the other two exchange types are a quarter-penny away on one side and a half-penny on the other.

At an average rate of approximately 18%, the flat exchange (IEX) market share of best prices is below the predicted 25% rate.[18] The difference may be due to IEX's 38 mile (61 kilometer) long fiber-optic coil ("the IEX speed bump") that slows quotes and trades by 0.350 milliseconds one-way and thus delays roundtrip order/response communications by 0.7 milliseconds. As a result, high-frequency traders may shun the exchange because they cannot cancel standing orders there as quickly as they can at other exchanges.

Comparisons of the distributions for bids and offers on each day show that the distributions appear nearly identical for bids and offers and also across days. The market shares of the three exchange types appear stable in both dimensions.

I separately tabulated absolute intraday quote changes in the transaction-fee adjusted National Best Bid and the National Best Offer for stocks in various price level bins for each day. The results (Figure 2) show that quote changes of less than one penny are much more common than changes of one penny or more for all price levels. Comparisons of Panels A with B (October 15, 2021), Panels C with D (March 3, 2022), and Panels E with F (March 4, 2022) show slight variation in these distributions between bids and offers. Comparisons of Panels A, C, and E (Offers) and of Panels B, D, and F (Bids) show that these distributions are quite similar across the three dates. Most notably, little variation appears between the distributions for March 4 and March 7, even though volatility on March 7 was much greater than on March 4.

Figure 3 presents the distribution of time-weighted bid/ask spreads based on the transaction-fee adjusted National Best Bid and the National Best Offer. For each day, net spreads of less than one cent are common, especially for the lower-priced stocks. A comparison of Panels B (March 4, 2022) and C (March 7, 2022) shows slightly wider spreads in the more volatile March 7 trading session, as is commonly observed in all markets. The effect is small and most pronounced for the lower-priced stocks.

3   Summary

Exchange pricing schemes have created a convoluted system that produces a near-complete quarter-penny tick grid that sophisticated traders can use, but which most investors cannot access and do not even recognize. Agency problems arise when brokers do not pass transaction fees and rebates through to their customers. Instead, brokers route standing limit orders only to maker-taker exchanges, and proprietary traders often trade ahead, disadvantaging other traders.

Brokers, HFTs, and exchanges all benefit from the current exchange transaction fee schedules. The Brokers get fee rebates from their customers' trades. The HFTs obtain trading profits. And the

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[18] The IEX speed bump is described at https://exchange.iex.io/about/speed-bump/.

Exchanges collect market data revenues from selling low-latency data to HFTs who require these data to exploit the quarter-cent tick created by the exchanges' transaction fee schedules.

The problem can be best corrected by eliminating exchange pricing based on who is the maker or the taker in a transaction. Instead, exchanges would collect their exchange fees as they traditionally did—by charging fees to the buyer or seller.
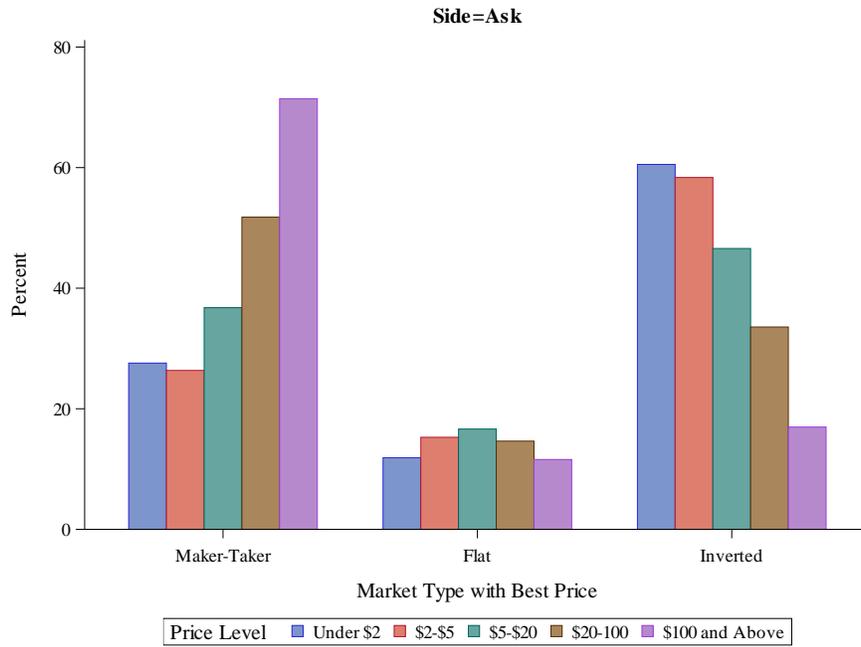
Figure 1: Time-weighted frequencies of the market type with the price setting the transaction-fee adjusted National Best Bid or Offer. The sample includes all stocks above $1 with 100 or more quotes during the day during normal trading hours.
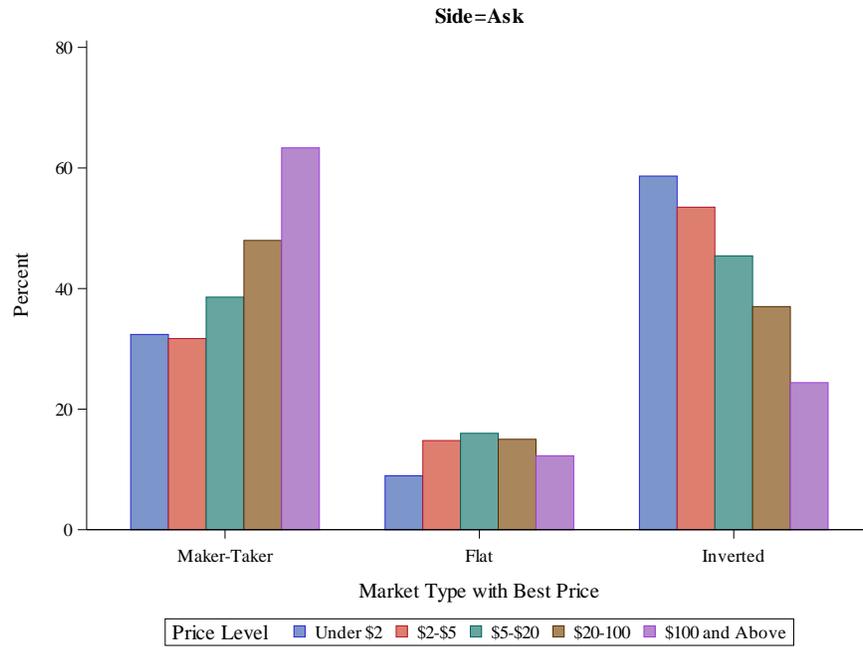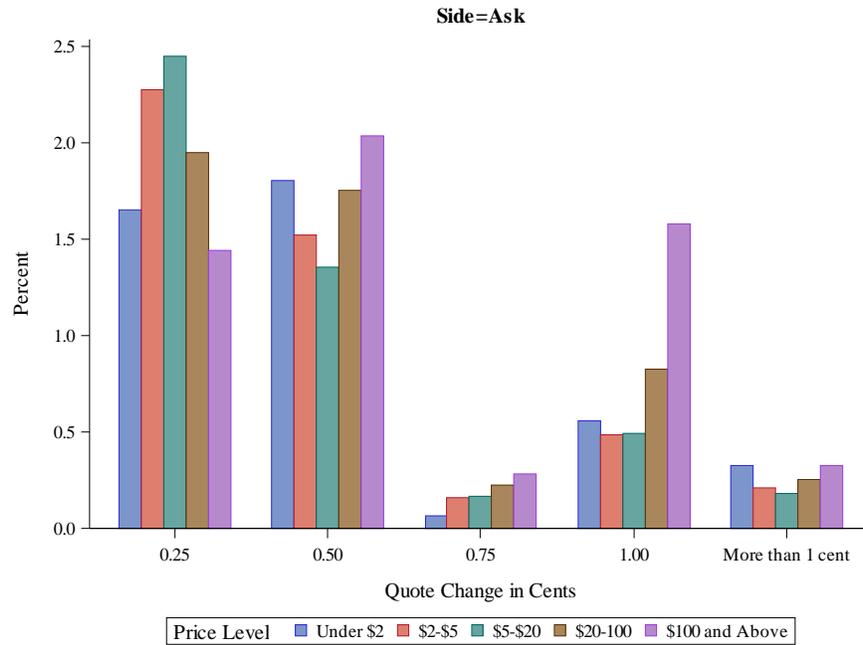

Panel A: Market Type at the Transaction-Fee Adjusted National Best Offer on October 15, 2021
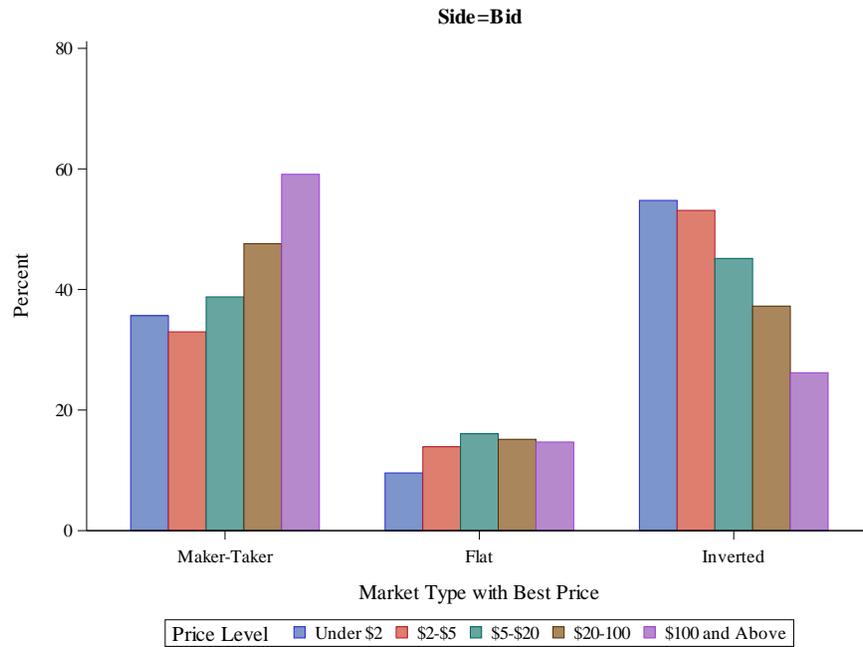
Panel B: Market Type at the Transaction-Fee Adjusted National Best Bid on October 15, 2021

Side=Ask

Panel C: Market Type at the Transaction-Fee Adjusted National Best Offer on March 4, 2021

Side=Bid
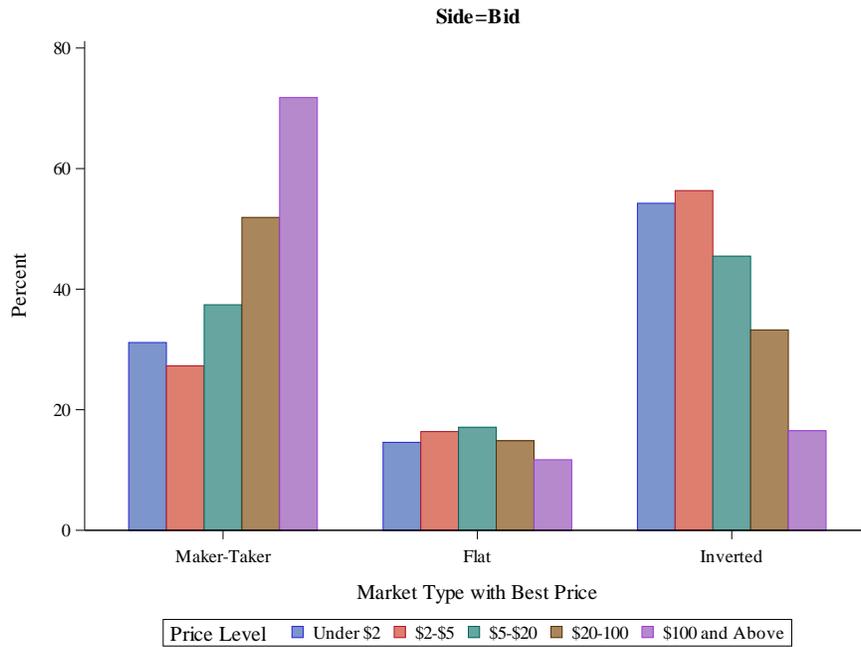
Panel D: Market Type at the Transaction-Fee Adjusted National Best Bid on March 4, 2021

Side=Ask
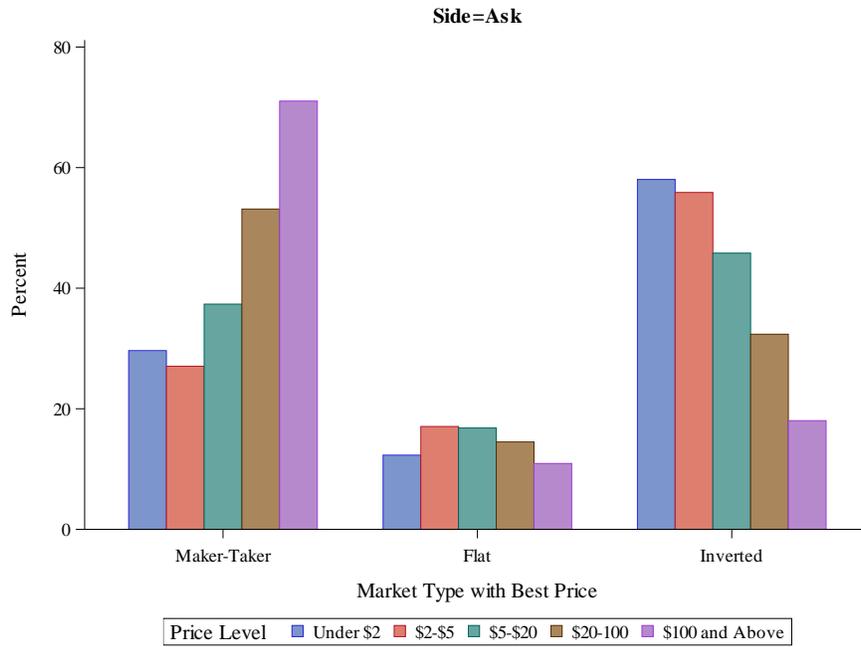
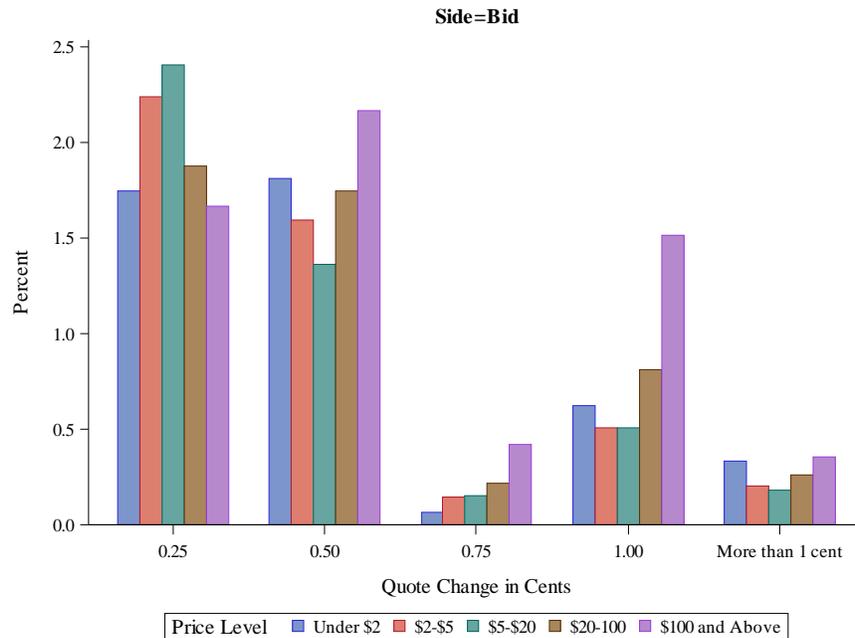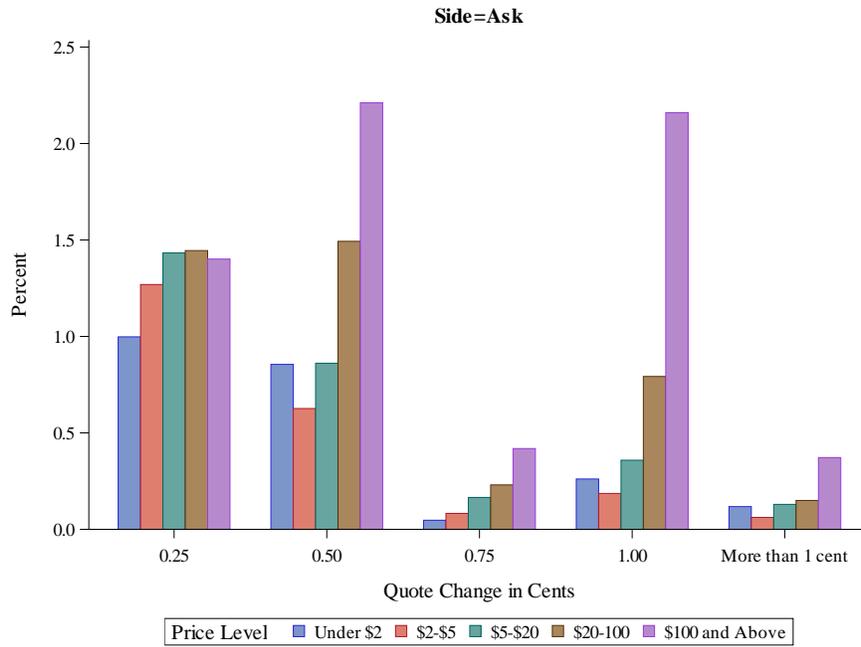**Panel E:** Market Type at the Transaction-Fee Adjusted National Best Offer on March 7, 2021

Side=Bid
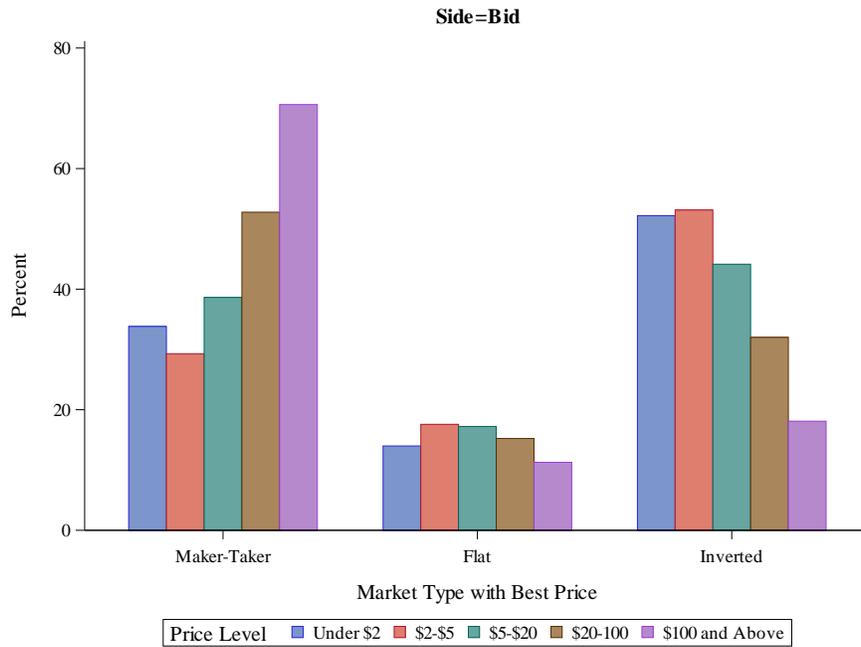
Panel F: Market Type at the Transaction-Fee Adjusted National Best Bid on March 7, 2021

Figure 2: All non-zero absolute transaction-fee adjusted net changes in the National Best Bid or Offer. The sample includes all stocks above $1 with 100 or more quotes during the day during normal trading hours. The low percentages reflect high frequencies of zero-change records when sizes changed but prices did not, or when one side of the market changed, but the other side did not.
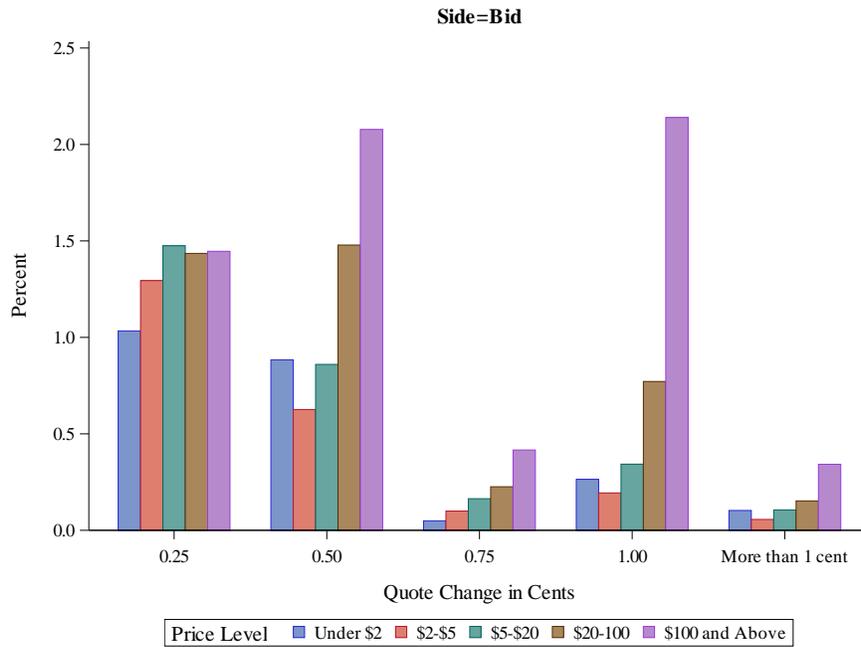

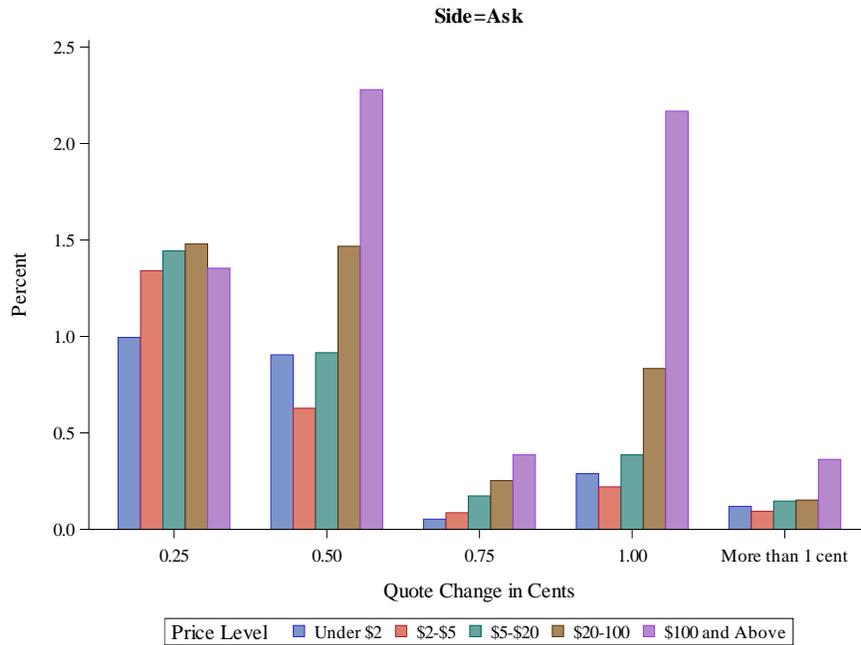**Panel A:** Absolute Changes in the Transaction-Fee Adjusted National Best Offer on October 15, 2021

Panel B: Absolute Changes in the Transaction-Fee Adjusted National Best Bid on October 15, 2021
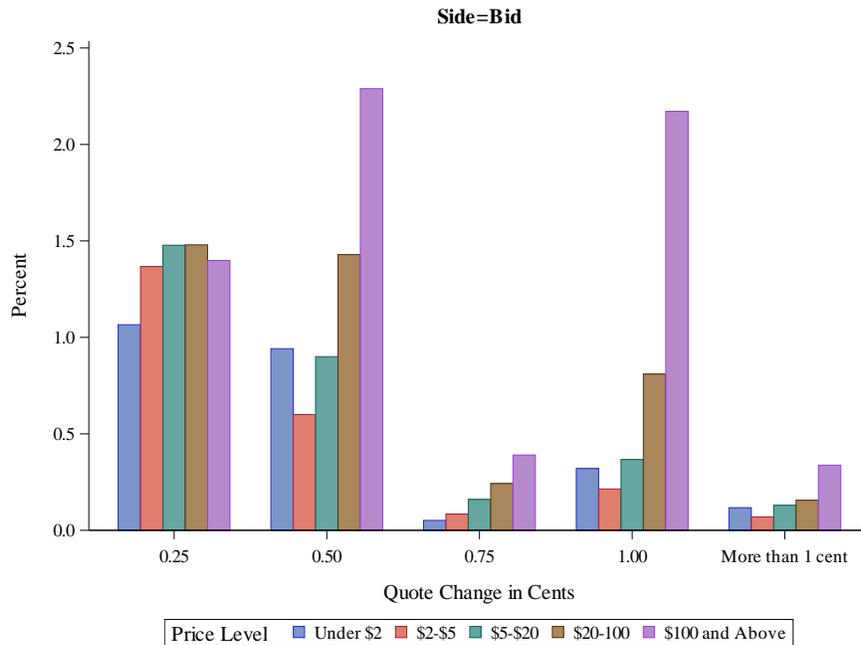
Side=Ask

Panel C: Absolute Changes in the Transaction-Fee Adjusted National Best Offer on March 4, 2021

Side=Bid

Panel D: Absolute Changes in the Transaction-Fee Adjusted National Best Bid on March 4, 2021

Side=Ask

Panel E: Absolute Changes in the Transaction-Fee Adjusted National Best Offer on March 4, 2021
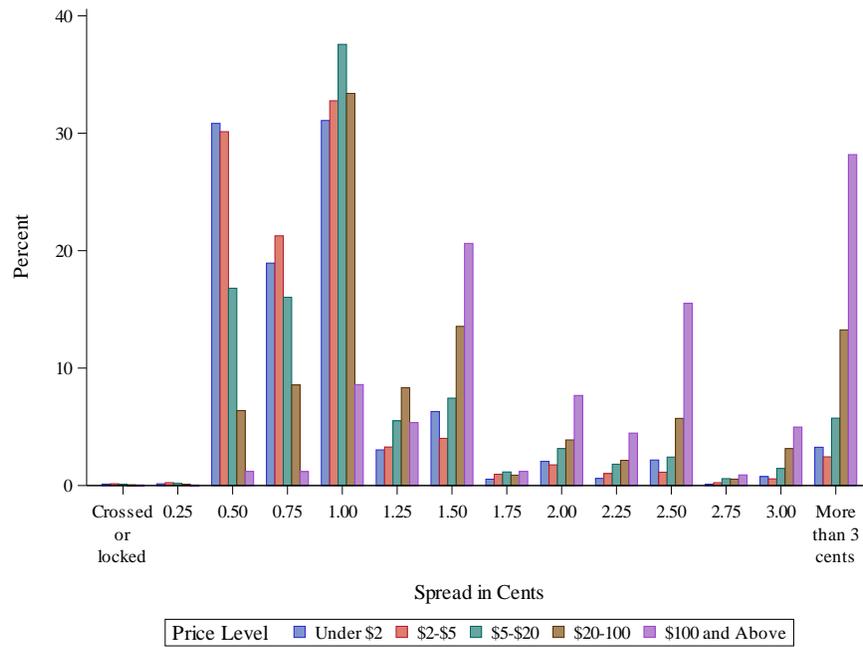

Side=Bid

Panel F: Absolute Changes in the Transaction-Fee Adjusted National Best Bid on March 4, 2021
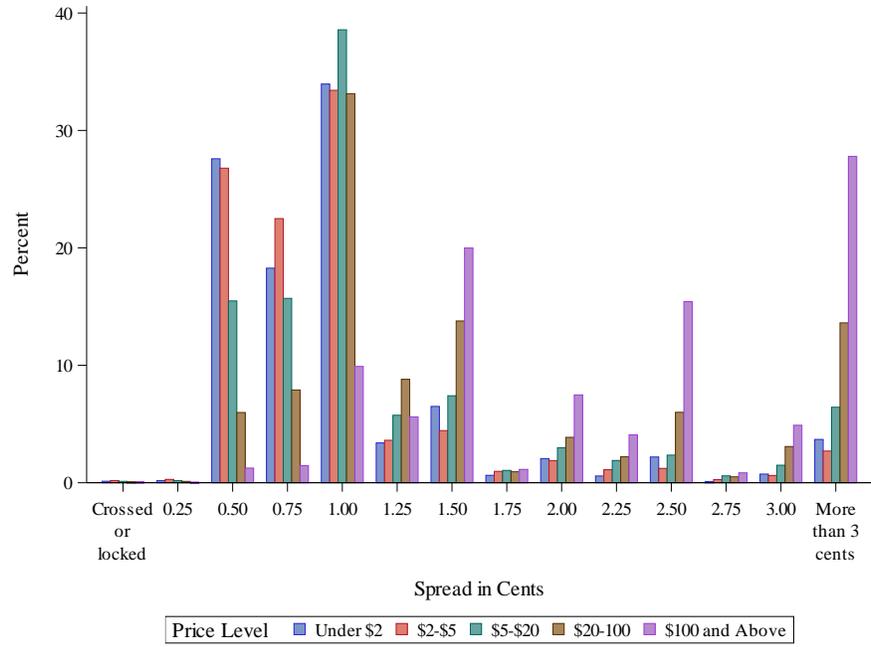
Figure 3: Time-weighted transaction-fee adjusted National Best Bid or Offer spreads. The sample includes all stocks above $1 with 100 or more quotes during the day during normal trading hours.
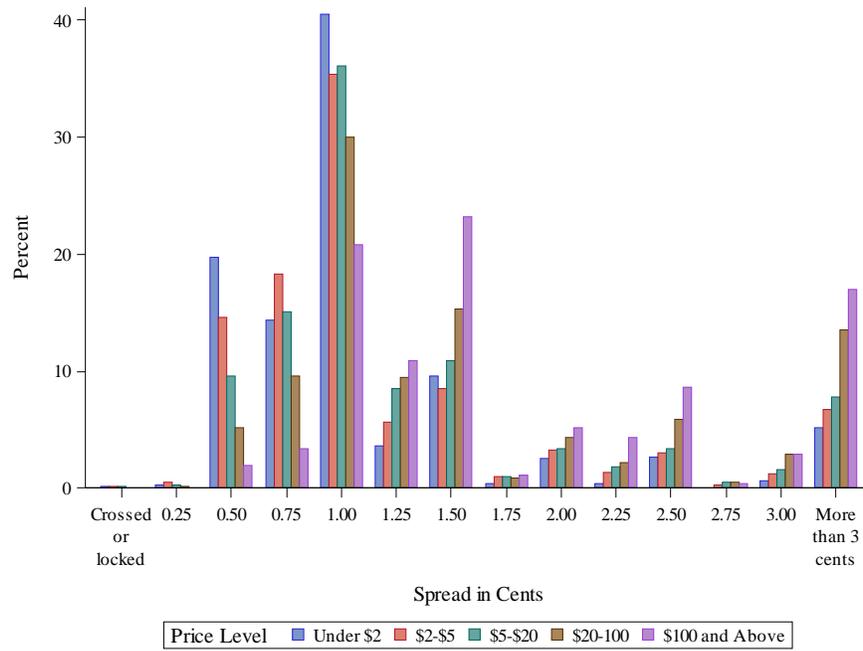
Panel A: Transaction-fee adjusted NBBO spreads for October 15, 2021

Panel B: Transaction-fee adjusted NBBO spreads for March 4, 2022

Panel C: Transaction-fee adjusted NBBO spreads for March 7, 2022

Table 1: Scenarios that give rise to some different net spreads. The maker fee is -0.25 cents/share at maker-taker exchanges, 0 cents at flat exchanges, and 0.25 cents at inverted exchanges.

Net Spreads (cents)			Ask Prices (cent part only)					
			20 at flat exchange	20 at inverted exchange	21 at maker-taker exchange	21 at flat exchange	21 at inverted exchange	22 at maker-taker exchange
		Net price	20.00	20.25	20.75	21.00	21.25	21.75
Bid Prices (cent part only)	20 at maker-taker exchange	19.75	Locked	Locked	1.00	1.25	1.50	2.00
	20 at flat exchange	20.00	Locked	Locked	0.75	1.00	1.25	1.75
	20 at inverted exchange	20.25	Crossed	Locked	0.50	0.75	1.00	1.50
	21 at maker-taker exchange	20.75	Crossed	Crossed	Locked	Locked	Locked	1.00
	21 at flat exchange	21.00	Crossed	Crossed	Crossed	Locked	Locked	0.75
	21 at inverted exchange	21.25	Crossed	Crossed	Crossed	Crossed	Locked	0.50

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