



# **Understanding Economic and Capacity Impacts of the Penny Pilot**

**Eric Stockland  
NYSE Arca Options  
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## ABSTRACT

NYSE Arca's analysis of the options penny pilot focused primarily on quote rates, data mitigation, effective spreads, quoted spreads, available liquidity, and volume changes.

NYSE Arca's Options Price Reporting Authority (OPRA) quote traffic in the pilot issues increased 203% during the pilot period or 2.1 million messages during the study period. The increase was offset more than 5 fold by the average daily mitigation savings of 12.1 million quotes per day in NYSE Arca OPRA output.

The daily mitigation savings were on average 13% of NYSE Arca's daily quote traffic sent to OPRA. Over 28 thousand series were mitigated every day, roughly 18% of all series listed on NYSE Arca Options. Including depth of book prices on NYSE Arca for all 13 issues volume weighted liquidity only decreased -1%. NYSE Arca's total top of book liquidity across all penny pilot issues and Minimum Price Variations (MPV) decreased -50% on a weighted average during the penny pilot.

On average across all exchanges effective spreads decreased for all issues trading in the penny MPV from at least -45% in CAT to as much as -61% in QQQQ. In the nickel MPV effective spread decreases for all issues ranged from at least -11% in FLEX to as much as -42% in WFMI. Exchanges with price improvement mechanisms still experienced double digit compression, suggesting that while price improvement mechanisms do offer the possibility of price improvement they are not as efficient at reducing spreads as published price competition.

Regardless if an issue was the most liquid ETF or illiquid equity option, all 13 experienced decreases in NBBO quoted spread widths. Within the penny MPV decreases ranged from at least -52% to as much as -64%. For the 12 pilot issues that also had a nickel MPV spreads were reduced at least -17% to as much as -37%.

Aggregating all 13 pilot issues there was a net increase in Average Daily Volume (ADV) pre-pilot to post-pilot of 23.9% or 283,562 contracts per day. This compares to an increase in ADV of 662,952 contracts or 8.0% growth for all equity options during that same period.

**Hopes For and Fears Of the Penny Pilot:** Glacial shifts in market structure tend to disrupt the status quo potentially creating new opportunities and new problems. Below is an analysis of those opportunities and potential problems.

**Market structure constraints often result in unintended consequences:** Outside of the penny pilot the current minimum price variation of five or ten cents, depending on an option's premium, has led to constrained price competition on the open and regulated exchange marketplace. In the absence of aggressive price competition exchanges often display the same price and consequently other forms of non-quote based competition have evolved such as payment for order flow and various exchange and broker dealer price improvement mechanisms.

The SEC has recognized that the marketplace wants to and does compete with prices inside of the publicly disseminated National Best Bid and Offer (NBBO) however this competition is neither transparent, comparable, or certain to yield price improvement. Allowing all participants, on a pilot basis, to enter quotes and orders in reduced MPVs that are disseminated in the NBBO is a solution as obvious as it is effective. A major concern of all market participants is what economic and capacity impacts reduced MPV trading will have on OPRA, exchanges and market participants.

For U.S. equity options traders, regulators and exchanges up until this point there has been limited quantitative analysis available on the penny pilot's economic impact and effect on capacity. This is partly due to the fact that unlike in the equities market there are often hundreds of options series tied to each underlying security, creating a multiplier effect on the amount of data to be analyzed and interpreted. Analysis over a length of time is further complicated by the expiration and creation of new series, volume concentration within a small subset of existing series and bifurcated minimum price increments within a single issue. The solution is selecting several key economic and capacity variables to conduct an analysis on at the series level, applying a weighting methodology that proportionally represents the more active series and by using this methodology, creating an aggregate issue level statistic that can be tracked over time. The purpose of this analysis is to track appropriately weighted economic and capacity variables at the issue level before and after the pilot, providing a simple and effective path to understanding the impact of the penny pilot on the U.S. equity options marketplace.

## **Quote Rates:**

*“We recognize that quoting in pennies will substantially increase message traffic and that the exchanges, vendors, and securities firms must have a plan to mitigate the voluminous quotes that could result from penny quoting.”* Commissioner Annette L. Nazareth<sup>1</sup>

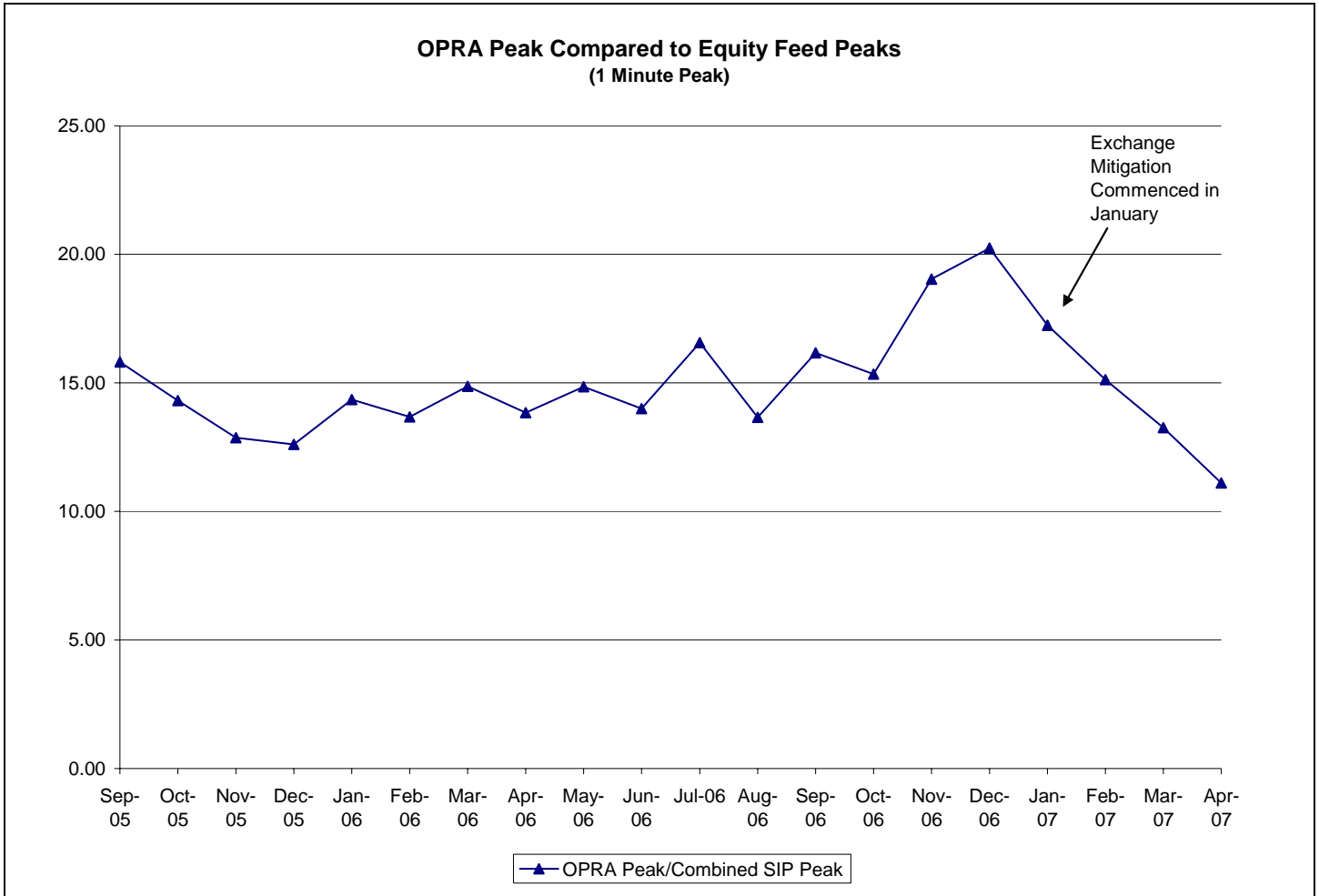
The drivers of increasing OPRA quote rates have been discussed over the years by industry pundits, and no factor is more feared than the trading of options in penny increments. However, one of the single most important drivers is often absent from the discussions, equity quote rates. The price of the underlying security is the key input to most options pricing algorithms; however, as it moves in one cent increments the options world cannot respond in kind.

If quote rates in the cash market are a key driver of quote rates in OPRA, the ratio of options quotes to equity quotes should remain relatively constant over time rather than reflect the explosive growth in OPRA traffic. The Financial Information Forum, or FIF, recently looked into this phenomenon and found that when comparing the combined OTC and Listed national market data feed peak rates to the options national market data feed peak rates the ratio remained relatively constant. The lack of growth in the ratio suggests that the market data rates of the equity and options markets move in lockstep.

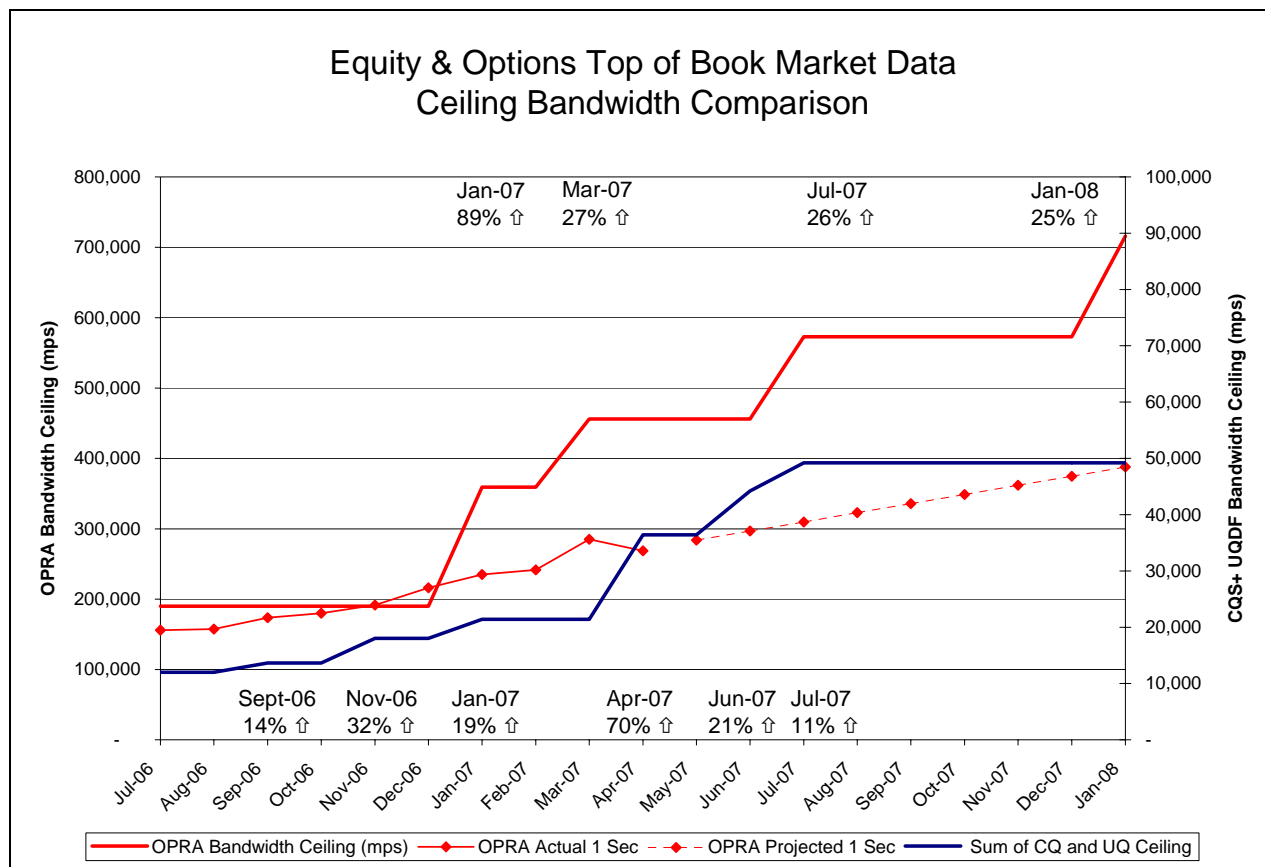
While OPRA quote traffic has more than doubled since 2005 the graph below illustrates that the ratio of options to equity quote traffic has remained relatively constant over that same period. A recent development also evident in the graph is the pronounced decrease in the ratio of OPRA to equity quote traffic. A portion of the decrease, which coincides with the start of the pilot and mitigation plans, is attributable to the quote mitigation efforts of the exchanges. For additional discussion on the effectiveness of quote mitigation please refer to the next section.

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<sup>1</sup> Speech by SEC Commissioner: Remarks Before the Securities Industry Association Options Market Structure Conference  
<http://sec.gov/news/speech/2006/spch102406aln.htm>



A final substantiation to the relationship of OPRA quote traffic to the equities market is the uncanny timing of bandwidth ceiling increases documented by FIF in the chart below. Considering that there is little crossover in market leadership between equity and option exchanges and that their processes for managing bandwidth are independent of each other the correlation in their bandwidth response to message rate growth is all the more stunning. The evidence suggests that the options quote rates have already been impacted by penny quoting in the equities marketplace.



To analyze quote traffic specifically in the penny pilot issues NYSE Arca collected the average daily quotes disseminated by the exchange to OPRA pre and post pilot. Unfortunately the exchange didn't have the functionality in place to count OPRA quote traffic changes for all exchanges in the 13 pilot issues. On an average daily basis NYSE Arca disseminated 157% more quotes in the nickel MPV series in the post pilot period and 222% in the penny MPV series. The total traffic increase across both price increments was 203% during the pilot period. In other terms, on an average daily basis NYSE Arca disseminated 468 thousand more quotes in nickel MPVs and 1.6 million more quotes per day in penny MPV series. Total quotes per day increased by 2.1 million during the pilot period. The increase of 2.1 million quotes per day was offset more than 5 fold by the average daily mitigation savings of 12.1 million quotes per day.

Several factors contributed to the increase, including a 50% increase in NYSE average daily volume in pilot issues and a 22% increase in registrations by remote market makers for pilot issues.

A complete table of quote traffic totals pre and post pilot can be found in Appendix A.

### **Quote Data Mitigation:**

*Data mitigation has been a topic widely discussed and debated for a number of years. While the debate has become more public since the introduction of the penny pilot, the core issues and concerns have not changed. Note the comments recorded in the minutes from the July 19, 2001 Division of Market Regulation Advisory Committee on Market Information which are still relevant today. Mr. Atkin highlighted the difficulties in providing a 'one size fits all' solution by contrasting different constituencies: [The 'screen traders' who are saying] "A lot of this data is useless. We don't want it. It's junk."... [and the algorithmic traders saying] "We want all the information we can get. We want everything."<sup>2</sup>*

NYSE Arca has studied quote mitigation techniques since 2005 and back tested several strategies of varying complexity seeking an optimal way to filter out quotes which are less valuable than others. The root problem with identifying a mitigation strategy that is efficient and minimally objectionable is that the value of quotes being mitigated is very subjective. One trader's trash is another's treasure.

The approach taken by NYSE Arca was to make a simple determination of value based on a trailing trade history and the presence of any orders on the book. The premise is that quotes for series which are not trading are less valuable than quotes for series that have traded recently. Series that have not traded in 14 calendar days and which did not meet one of the exceptions outlined in the rule filing were placed on a mitigated series list. All quotes for those series were not disseminated to OPRA unless a trigger event occurred, such as a trade on another market or receipt of an order on NYSE Arca Options.

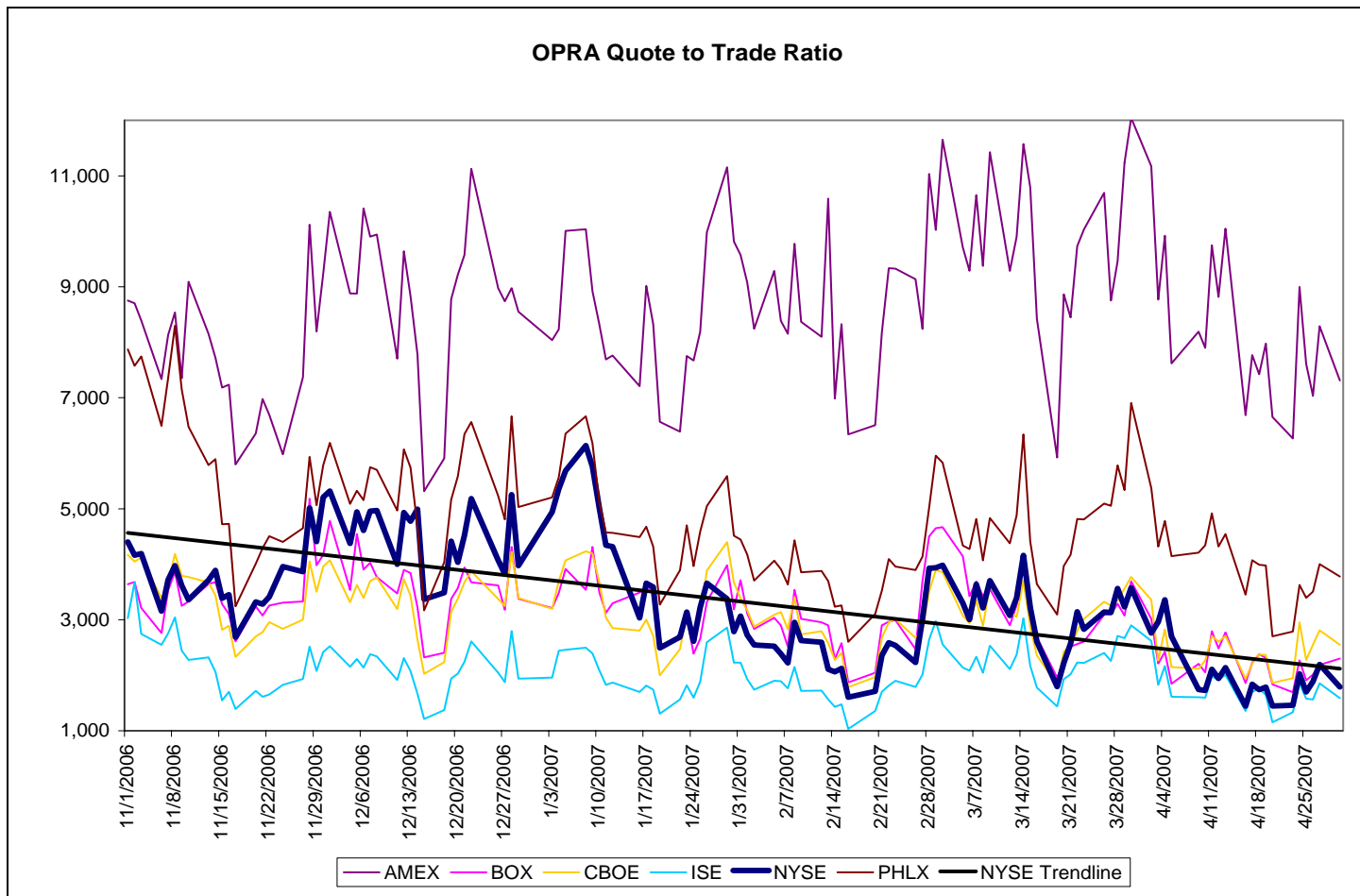
The mitigation savings varied day to day; however, the average savings were 12.1 million quotes per day, or 13% of NYSE Arca's daily quote traffic sent to OPRA. On average just over 28 thousand series were mitigated every day, roughly 18% of all series listed on NYSE Arca Options.

The mitigation savings of 13% were roughly half of what the exchange had expected based on previous back testing which used data from the PCX+ trading platform (subsequently retired in fall of 2006 and replaced with NYSE Arca's electronic platform). Unlike PCX+ the new NYSE platform uses proprietary technology to discard quotes that would otherwise override each other, sending only the most current update. This technology is not akin to a holdback timer as no intentional delays are introduced into the system; rather it takes advantage of naturally occurring patterns in quote traffic. The proprietary mitigation technology was the reason actual savings were not equal to forecasted. The impact of NYSE Arca's proprietary mitigation technology is evident in the exchange's quote to trade ratio which was among the lowest in the industry even before the penny pilot began.

NYSE Arca's formal mitigation plan continued to drive down the exchange's quote to trade ratio 37% during the pilot period, as depicted in the graph below. The graph also reflects decreasing quote to trade ratios for five of the six options exchanges, reflective in part of the impact of their mitigation plans.

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<sup>2</sup> <http://sec.gov/divisions/marketreg/marketinfo/071901mtg.htm>



NYSE Arca’s mitigation technology has built-in flexibility, whereby the window for number of days a series has not traded can be contracted or expanded to make the mitigation plan more or less aggressive in mitigating quotes.

It’s worth noting that the highly competitive market data industry has been responding to the needs of the market data consumers with an array of products designed to meet the needs of varying constituencies. For example, opportunistic firms have been launching heavily mitigated products since 2005 trying to capitalize on the subset of consumers who are willing to trade bandwidth and expense for a mitigated subset of market data<sup>3</sup>. Conversely a number of firms offer software and hardware installed directly at client sites with the goal of continuously minimizing latency and maximizing throughput for firms who want to consume all the data in optimal fashion. The market data business is a buffer that frees exchanges from having to productize data feeds to meet the spectrum of market data consumer needs with their varying sensitivity to latency and bandwidth.

<sup>3</sup> ComStock has introduced a new mitigated options service that provides best bid and offer data and is aimed at clients that don’t require the full options data service. <http://www.finextra.com/fullstory.asp?id=13277>

## **Liquidity Evaluation:**

“Some in the industry have expressed hesitation with the pilot. They cite the possibility of a lack of liquidity at the top of the book, similar to what occurred in the equity market. Others express concern that without depth of book transparency, trading options in pennies will be more difficult.” Commissioner Annette L. Nazareth

Aside from capacity fears, concerns about liquidity are a key source of trepidation surrounding the penny pilot. What will be the impact to size at the inside and where will all the liquidity go? There are several approaches to measuring liquidity, the most obvious of which is to measure the liquidity displayed on the OPRA top of book feed before and after the pilot period. However the obvious analysis doesn’t take into account the liquidity available for execution within the price band of the previous MPV.

To capture and represent liquidity that is available for execution but not at the inside price the exchange included the ArcaBook Options depth of book feed in the analysis. ArcaBook Options is a proprietary market data feed, available to members and nonmembers alike. The depth of book feed displays NYSE Arca’s top five price levels per side and aggregates volumes at each price. Liquidity in the depth of book feed post pilot that was within \$.05 of the inside for penny MPVs and within \$.10 for nickel MPVs was compared to the pre pilot top of book liquidity on NYSE Arca. Liquidity in the top of book and depth of book was aggregated daily using two separate methods.<sup>4</sup>

When liquidity resident in the depth of book within a legacy MPV price band was compared to pre pilot top of book liquidity the net impact was close to neutral. Across all 13 issues volume weighted liquidity only decreased 1%; and on a simple average basis liquidity actually increased 9%.

Some significant percentage change deviation did exist within the 13 names and within the MPV ranges. Full details for each issue, MPV, and calculation methodology can be found in the table below. A total liquidity change irrespective of the MPV was calculated and can be found in the last two columns of the table below under the heading ‘Issue Total’.

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<sup>4</sup> Liquidity in the top of book and depth of book was aggregated daily using two separate methods. The first method calculates the average liquidity for a series and then a simple average across series to arrive at average liquidity for an issue. The other method took the average liquidity for a series and volume weighted each series within an issue based on the contracts traded nationally. Both methods produced a daily measure of liquidity available for execution at the issue level. The daily liquidity figures for an issue were then averaged for the three months preceding and immediately following the pilot start date. The simple average and weighted average calculations were run for each issue and MPV combination. No sampling was done; every change in the market data that impacted inside price or depth prices within a legacy MPV band were included in the analysis.

| <b>Change in Liquidity on NYSE, Including Depth of Book</b> |                |                  |                |                  |                |                  |
|---|----------------|------------------|----------------|------------------|----------------|------------------|
| Issue   | Penny MPV      |                  | Nickel MPV     |                  | Issue Total    |                  |
|   | Simple Average | Weighted Average | Simple Average | Weighted Average | Simple Average | Weighted Average |
| A   | 91%            | 93%              | 105%           | 99%              | 97%            | 95%              |
| AMD   | 21%            | 2%               | -1%            | -19%             | 11%            | -6%              |
| CAT   | -8%            | -5%              | -13%           | -3%              | -10%           | -4%              |
| FLEX  | 28%            | 19%              | 8%             | 8%               | 20%            | 15%              |
| GE  | 25%            | 9%               | 36%            | 34%              | 29%            | 17%              |
| INTC  | -1%            | -16%             | 43%            | 49%              | 14%            | 2%               |
| IWM   | 68%            | 50%              | 81%            | 95%              | 74%            | 69%              |
| MSFT  | 21%            | -4%              | 54%            | 52%              | 34%            | 14%              |
| QQQQ  | -25%           | -27%             | -              | -                | -25%           | -27%             |
| SMH   | -5%            | -20%             | 5%             | 17%              | -1%            | -8%              |
| SUNW  | -11%           | -7%              | 4%             | -4%              | -6%            | -6%              |
| TXN   | 16%            | 12%              | 24%            | 38%              | 20%            | 23%              |
| WFMI  | 6%             | 11%              | 8%             | 19%              | 7%             | 15%              |
| <b>Total</b>  | <b>-1%</b>     | <b>-12%</b>      | <b>33%</b>     | <b>36%</b>       | <b>9%</b>      | <b>-1%</b>       |

Comparing NYSE Arca's post pilot top of book liquidity to the pre pilot data showed the expected drop off. The weighted average change in top of book liquidity across all issues in the penny MPV was a decrease of -63%. Using only simple averages liquidity in the penny MPV decreased -42%.

Weighted average top of book liquidity in the Nickel MPV for all pilot issues decreased by -9%. Using the simple average liquidity across all thirteen issues decreased -10% during the pilot period.

Total top of book liquidity across all issues and MPVs decreased -50% on a weighted average during the penny pilot.

| Change in Top of Book Liquidity on NYSE |                |                  |                |                  |                |                  |
|---|----------------|------------------|----------------|------------------|----------------|------------------|
| Issue                                   | Penny MPV      |                  | Nickel MPV     |                  | Issue Total    |                  |
|   | Simple Average | Weighted Average | Simple Average | Weighted Average | Simple Average | Weighted Average |
| A                                       | -4%            | -4%              | 46%            | 46%              | 18%            | 17%              |
| AMD                                     | -24%           | -37%             | -6%            | -25%             | -16%           | -32%             |
| CAT                                     | -43%           | -46%             | -26%           | -18%             | -35%           | -33%             |
| FLEX                                    | -35%           | -39%             | -8%            | -9%              | -24%           | -28%             |
| GE                                      | -37%           | -47%             | -7%            | -12%             | -25%           | -35%             |
| INTC                                    | -57%           | -62%             | -9%            | -3%              | -41%           | -46%             |
| IWM                                     | -20%           | -32%             | 35%            | 43%              | 5%             | 0%               |
| MSFT                                    | -41%           | -53%             | 1%             | -2%              | -24%           | -36%             |
| QQQQ                                    | -70%           | -74%             | -              | -                | -70%           | -74%             |
| SMH                                     | -72%           | -77%             | -47%           | -44%             | -63%           | -66%             |
| SUNW                                    | -53%           | -51%             | -28%           | -33%             | -44%           | -45%             |
| TXN                                     | -43%           | -46%             | -16%           | -6%              | -31%           | -30%             |
| WFMI                                    | -46%           | -45%             | -26%           | -19%             | -37%           | -33%             |
| Total                                   | -56%           | -63%             | -10%           | -9%              | -42%           | -50%             |

### Effective Spread Changes:

For the 13 pilot issues and the two minimum price increments, NYSE Arca measured the effective spread using the following generally accepted formula:  $ABS(2 * (Execution Price - NBBO Midpoint))^5$ . All exchanges logged dramatic decreases in effective spreads for all penny MPV issues; no exchange experienced an increase in an effective spread in the penny MPV. On average across all exchanges effective spread decreases ranged from at least -45% in CAT to as much as -61% in QQQQ. The decreases occurred regardless of whether the issue was an ETF or common stock derivative, liquid or illiquid, or traded by a manual or automated exchange.

The table below lists the change in effective spread by exchange and issue with a simple average of effective spread reduction across exchanges appearing in the last column. In addition to the percent change tables below the pre and post pilot effective spreads expressed in dollar value can be found in Appendix B.

<sup>5</sup> An Effective spread was calculated for each trade printed by each exchange. Trades were also categorized based on the execution price, if the price was  $\leq \$3.00$  the effective spread was considered in the penny MPV category. Conversely if the trade price was  $\geq \$3.05$  the effective spread was considered in nickel MPV category, except for QQQQ's which were always counted in the penny category.

The effective spread observations within a series were volume weighted based on individual trade sizes to arrive at a single effective spread for each series. To arrive at the issue level effective spread the series effective spreads were volume weighted based total national volume for each series. The issue level effective spread was then averaged over time to arrive pre-pilot and post-pilot figures.

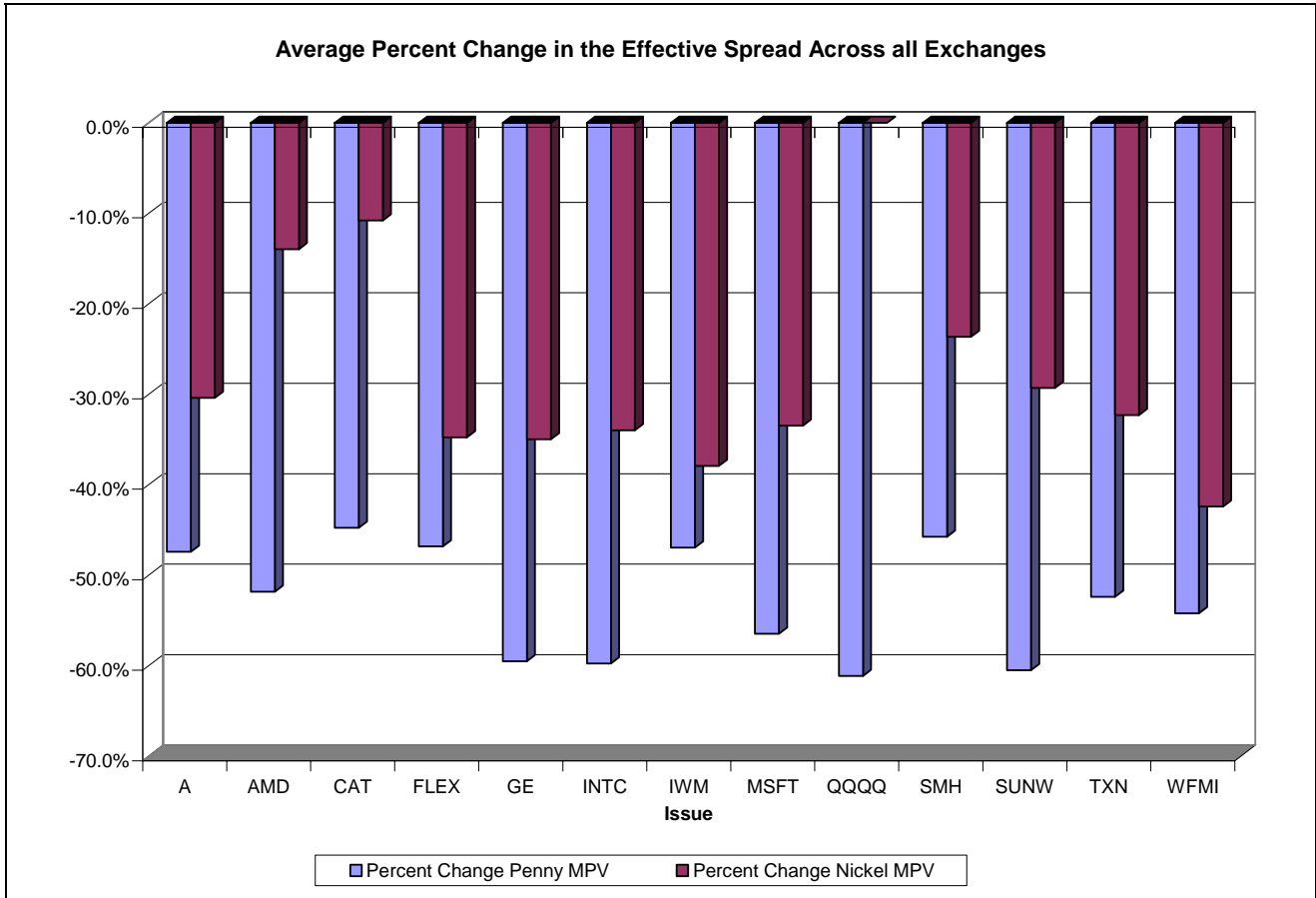
Due to missing sequence numbers on the trade data available to NYSE Arca, original trades associated with a bust were not filtered out of the data set. Only in circumstances where highly unusual effective spreads were found would busts be removed from the data manually. Of the trade conditions provided by OPRA only the following which are associated with 'regular transactions' were kept for analysis: (blank), I, J, K, L, M, P and Q. Additionally NYSE Arca's inbound OPRA quote and trade logging software omitted certain trade and quote conditions from the data log files between November 13<sup>th</sup> 2006 and December 29<sup>th</sup> 2006 in the pre pilot period. The issue was corrected effective for business on January 3 2007; consequently only data from November 1 to November 13 and January 3 to February 8 was included in the pre pilot figures.

| <b>Percent Change in Effective Spreads for Penny MPV Trades</b> |          |          |          |          |          |          |                |
|---|----------|----------|----------|----------|----------|----------|----------------|
| <b>Issue</b>  | <b>A</b> | <b>B</b> | <b>C</b> | <b>I</b> | <b>P</b> | <b>X</b> | <b>Average</b> |
| A   | -53%     | -34%     | -50%     | -52%     | -48%     | -47%     | -47%           |
| AMD   | -51%     | -47%     | -52%     | -51%     | -62%     | -48%     | -52%           |
| CAT   | -49%     | -38%     | -45%     | -46%     | -50%     | -41%     | -45%           |
| FLEX  | -26%     | -45%     | -53%     | -49%     | -55%     | -53%     | -47%           |
| GE  | -55%     | -62%     | -61%     | -56%     | -62%     | -61%     | -60%           |
| INTC  | -61%     | -57%     | -63%     | -57%     | -66%     | -56%     | -60%           |
| IWM   | -45%     | -57%     | -23%     | -50%     | -48%     | -59%     | -47%           |
| MSFT  | -56%     | -54%     | -59%     | -52%     | -60%     | -58%     | -56%           |
| QQQQ  | -70%     | -54%     | -57%     | -60%     | -64%     | -63%     | -61%           |
| SMH   | -49%     | -40%     | -45%     | -42%     | -52%     | -47%     | -46%           |
| SUNW  | -62%     | -51%     | -62%     | -59%     | -69%     | -61%     | -61%           |
| TXN   | -45%     | -48%     | -53%     | -56%     | -60%     | -54%     | -52%           |
| WFMI  | -59%     | -43%     | -55%     | -54%     | -66%     | -49%     | -54%           |

Effective spreads for trades in the nickel MPV also experienced substantial compression, although there was some additional deviation in the data depending on the issue and or executing exchange. Some of the deviation in AMD, INTC and especially SUNW is due to the low underlying security price which results in fewer option premiums greater than \$3.00. On average in the nickel MPV across all exchanges effective spread decreases ranged from at least -11% in FLEX to as much as -42% in WFMI.

| <b>Percent Change in Effective Spreads for Nickel MPV Trades</b> |          |          |          |          |          |          |                |
|--|----------|----------|----------|----------|----------|----------|----------------|
| <b>Issue</b>   | <b>A</b> | <b>B</b> | <b>C</b> | <b>I</b> | <b>P</b> | <b>X</b> | <b>Average</b> |
| A  | -34%     | 7%       | -35%     | -36%     | -50%     | -35%     | -30%           |
| AMD  | -6%      | -10%     | -33%     | -14%     | -29%     | -26%     | -19%           |
| CAT  | -26%     | -2%      | -18%     | -12%     | -1%      | -5%      | -11%           |
| FLEX   | -63%     | -18%     | -55%     | -24%     | -32%     | -18%     | -35%           |
| GE   | -26%     | -20%     | -36%     | -35%     | -62%     | -31%     | -35%           |
| INTC   | -30%     | -24%     | -38%     | -36%     | -44%     | -32%     | -34%           |
| IWM  | -49%     | -35%     | -22%     | -47%     | -35%     | -39%     | -38%           |
| MSFT   | -25%     | -28%     | -37%     | -28%     | -45%     | -39%     | -33%           |
| SMH  | -36%     | -22%     | -1%      | -20%     | -36%     | -27%     | -24%           |
| SUNW   | -34%     | -12%     | -35%     | -14%     | -47%     | -34%     | -29%           |
| TXN  | -38%     | -40%     | -21%     | -38%     | -27%     | -30%     | -32%           |
| WFMI   | -39%     | -42%     | -41%     | -47%     | -45%     | -40%     | -42%           |

The absence of a Price Improvement Mechanism (PIM) prior to the penny pilot might explain why some of the exchanges experienced a larger decrease in effective spreads. However it's also worth noting that exchanges with price improvement mechanisms still experienced double digit compression, suggesting that while PIMs do offer the possibility of price improvement they are not as efficient at reducing spreads as published price competition



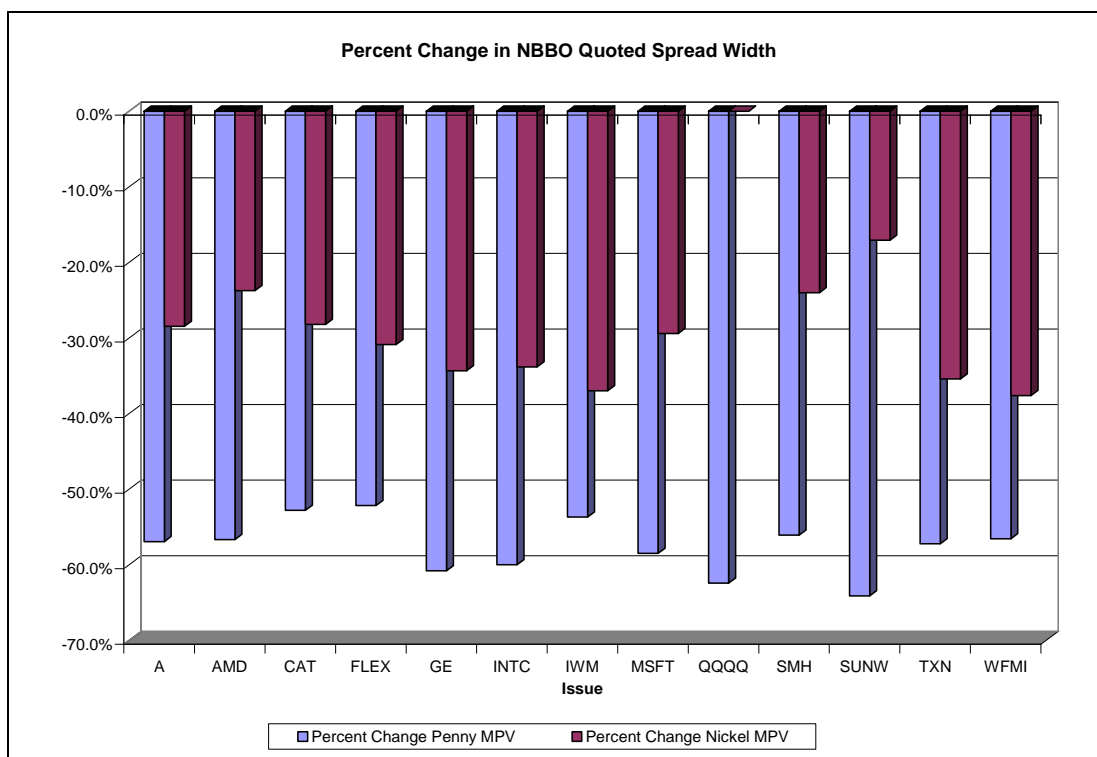
**Quoted Spread Reduction:**

One economic impact of the options penny pilot is the reduction of the quoted spread width. To quantify the change in spread width from the perspective of a market participant the analysis is based on the spread of the NBBO as published by OPRA, not the spreads of individual exchanges. Due to the bifurcated MPVs within 12 of the 13 issues the spread width was calculated twice for each issue, one calculation per MPV.<sup>6</sup>

Decreases in quoted spread widths in the penny MPV ranged from at least -52% up to as much as -64%. In dollar value the spreads during the pilot period ranged from \$0.041 in A to \$0.024 in QQQQ. Regardless of whether a pilot issue was the most liquid ETF or illiquid equity option, all thirteen issues in the pilot experienced substantial spread reduction from their pre-pilot baselines.

For the 12 pilot issues that also had a nickel MPV spreads were reduced at least -17% in SUNW and as much as -37% in WFMI. In dollar value the spreads during the pilot period ranged from \$0.137 in A to \$0.075 in SUNW. Similar to the results for the penny MPV all issues trading in the new nickel MPV experienced spread reduction.

It's important to note that within the new penny MPV there were 4 new price points created compared to the legacy nickel MPV (.01, .02, .03, and .04), whereas in the nickel MPV only one new price point was created compared to the legacy dime MPV (.05). The 4 new price points in the penny MPV were a primary contributor to the difference in spread reduction between the penny and nickel MPVs. In addition to the graph of quoted spread with reductions below a full table of pre pilot and post pilot spreads can be found in Appendix C.



<sup>6</sup> The NBBO spreads for every series in the pilot were calculated and time weighted for all quotes disseminated, no sampling was done. The resulting time weighted spreads for every series were then volume weighted, based on national series volume relative to total issue volume, to arrive at an issue level quoted spread width for every day in the analysis period. The daily spreads were then averaged to arrive at a pre pilot and post pilot average spread for each issue and MPV.

### **Volume Weighted Methodology:**

One of the unique challenges in options data analysis relative to the equity markets is the one to many relationship of the underlying asset to options series. This challenge is compounded by the fluid number of series listed and the shifting trading patterns within those series as they approach expiration and or the underlying price changes.

An aggregation method was sought that allowed the roughly 2,500 series to be tracked at an issue level while keeping the process relatively simple and preventing the dilution of data and impact for series that are actively traded. Dilution is a risk in options analysis because activity within an issue is typically concentrated in a smaller number of series relative to the larger population of listed series for an issue. For example LEAPs, deep in the money, and far out of the money series tend to be less active than near the money and front month series. Data points within a series were volume weighed or time weighted, depending on the nature of the data, to arrive at a daily series level data point. A simple average of that data point, such as an effective spread, would give equal weighting to a series which traded one contract or one hundred thousand contracts when the economic impact is a function of the volume traded. Therefore it is appropriate when calculating economic impacts at the issue level to volume weight series level data points preserving their proportional impact.

The daily issue level data points were averaged over time, generally in the pre and post pilot time frames. Adjustments in the averages were to accommodate for the staggered rollout schedule. For example, in issue WFMI, the pre pilot period ended on 1/25/2007, where as for MSFT and GE, the pre pilot period ended on 2/1, and for all other issues the pre pilot period ended on 2/8/07. The post pilot data period for the three rollouts began on 1/26/07, 2/2/07, and 2/9/07 respectively.

### **Payment for Order Flow:**

“Pricing inefficiencies caused by nickel and dime minimum increments correspond to a proliferation of payment for order flow practices and internalization arrangements.” Commissioner Annette L. Nazareth

Prior to the penny pilot only one options exchange did not facilitate a Payment-For-Order-Flow (PFOF) program. At the onset of the pilot period, NYSE Arca eliminated the marketing fee in all pilot issues. Subsequently, CBOE first restructured its program by reducing the rate to \$0.25 for most of the pilot classes, and sidelined it in the two most active issues<sup>7</sup>. ISE and PHLX similarly reduced the rate from \$0.65 to \$0.25 per contract for issues in the pilot, while AMEX reset their rate from \$0.75 to \$0.35 for pilot classes.

The payment for order flow practices of the retail order flow consolidators are less transparent and therefore no concrete data on how the practice and rates were impacted by the penny pilot is available.

### **Linkage/Routing:**

NYSE Arca primarily uses a private router to reach away markets when the exchange does not have the best price. Linkage is only used for backup routing and therefore the options linkage authority statistics don't reflect the exchanges routing activity. No changes were made to the routing algorithm for the penny pilot, routing of marketable orders is done without delay.

Over the course of the study period, NYSE Arca received 17 satisfaction orders from other exchanges. Upon review of each order, no further action was required.

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<sup>7</sup> Subsequent to the study period, CBOE further reduced its PFOF Program in most Pilot issues to \$0.10.

### **Locked Crossed Trade Through:**

Our internal surveillance reports did not show a noticeable increase in the frequency of locked or crossed market alerts for the 13 pilot issues. Both the NYSE Arca Options surveillance group as well as the trade support desk did not receive trade through complaints for the 13 pilot issues.

### **Volume Changes:**

Will the new penny and nickel price increments reduce costs resulting in new trading opportunities and increased volumes? Or will it fragment liquidity making increasingly difficult to trade larger size orders pushing them into the over the counter market?

Volume was tabulated on a daily average basis for the three months preceding the pilot and the three months immediately after the pilot began. To provide context for the countless variables that impact volume in the marketplace, a control group of national Average Daily Volume (ADV) for all equity options was calculated.

Out of the 13 pilot issues, 8 experienced a decrease in ADV where as 5 experienced an increase in ADV. The largest percentage decrease occurred in the issue FLEX at 28% or 822 contracts a day. The largest decrease in ADV occurred in issue INTC dropping 11,077 contracts per day or 11.3%. The largest percentage increase occurred in the issue IWM at 58.9% or 169,241 contracts per day. IWM also had the largest increase in ADV, followed by QQQQ, which had an increased ADV of 120,234.

Aggregating all 13 pilot classes, there was a net increase in ADV pre-pilot to post-pilot of 23.9%, or 283,562 contracts per day. This compares to an increase in ADV of 662,952 contracts, or 8.0% growth for all equity options during that same period.

Considering volume changes at the exchange level, 5 of the 6 options exchanges experienced a net increase in ADV in the pilot classes. Only one exchange experienced a net decrease, -3,936 contracts per day.

For a complete list of volume changes by issue and by exchange see Appendix D.

### **System Capacity:**

NYSE Arca did not experience any capacity related problems during the penny pilot.

### Appendix A

| Percent Change in NYSE Arca Quotes sent to OPRA |                                 |                                |              |
|---|---------------------------------|--------------------------------|--------------|
| <b>Symbol</b>                                   | <b>Average Daily Nickel MPI</b> | <b>Average Daily Penny MPI</b> | <b>Total</b> |
| A   | 150%                            | 534%                           | 429%         |
| AMD   | -18%                            | 162%                           | 96%          |
| CAT   | 195%                            | 306%                           | 245%         |
| FLEX  | -19%                            | 173%                           | 146%         |
| GE  | 136%                            | 142%                           | 141%         |
| INTC  | 43%                             | 82%                            | 71%          |
| IWM   | 294%                            | 414%                           | 361%         |
| MSFT  | 139%                            | 195%                           | 175%         |
| QQQQ  | -                               | 193%                           | 193%         |
| SMH   | 43%                             | 69%                            | 64%          |
| SUNW  | -7%                             | 163%                           | 152%         |
| TXN   | 174%                            | 288%                           | 252%         |
| WFMI  | 77%                             | 240%                           | 130%         |
| <b>Total</b>                                    | <b>157%</b>                     | <b>222%</b>                    | <b>203%</b>  |

| Net Change in NYSE Arca Quotes sent to OPRA |                                 |                                |                  |
|---|---------------------------------|--------------------------------|------------------|
| <b>Symbol</b>                               | <b>Average Daily Nickel MPI</b> | <b>Average Daily Penny MPI</b> | <b>Total</b>     |
| A   | 7,174                           | 67,845                         | 75,019           |
| AMD   | (5,378)                         | 82,815                         | 77,437           |
| CAT   | 106,601                         | 133,978                        | 240,579          |
| FLEX  | (158)                           | 8,601                          | 8,443            |
| GE  | 21,542                          | 62,564                         | 84,106           |
| INTC  | 7,066                           | 36,343                         | 43,409           |
| IWM   | 226,436                         | 398,153                        | 624,589          |
| MSFT  | 31,511                          | 78,990                         | 110,501          |
| QQQQ  | -                               | 567,812                        | 567,812          |
| SMH   | 5,172                           | 29,494                         | 34,665           |
| SUNW  | (31)                            | 10,175                         | 10,145           |
| TXN   | 33,776                          | 117,847                        | 151,623          |
| WFMI  | 34,981                          | 52,198                         | 87,179           |
| <b>Total</b>                                | <b>468,690</b>                  | <b>1,646,816</b>               | <b>2,115,506</b> |

\*For WFMI Period data is split on 1/26/07  
\*\*For GE and MSFT period data is split on 2/2/07  
\*\*\*All other period data is split on 2/9/07  
\*\*\*\*Nickel MPI includes series with a premium >\$3.00  
and Penny MPI includes series with a premium <=\$3.00

### Appendix B

| <b>Volume Weighted Effective Spreads for Penny MPI trades</b> |              |          |          |          |          |          |          |
|---|--------------|----------|----------|----------|----------|----------|----------|
| <b>Period</b>   | <b>Issue</b> | <b>A</b> | <b>B</b> | <b>C</b> | <b>I</b> | <b>P</b> | <b>X</b> |
| Pre   | A            | \$ 0.091 | \$ 0.051 | \$ 0.069 | \$ 0.070 | \$ 0.078 | \$ 0.076 |
| Post  | A            | \$ 0.042 | \$ 0.034 | \$ 0.035 | \$ 0.033 | \$ 0.041 | \$ 0.040 |
| Pre   | AMD          | \$ 0.053 | \$ 0.044 | \$ 0.052 | \$ 0.052 | \$ 0.063 | \$ 0.056 |
| Post  | AMD          | \$ 0.026 | \$ 0.024 | \$ 0.025 | \$ 0.025 | \$ 0.024 | \$ 0.029 |
| Pre   | CAT          | \$ 0.069 | \$ 0.047 | \$ 0.059 | \$ 0.060 | \$ 0.063 | \$ 0.071 |
| Post  | CAT          | \$ 0.035 | \$ 0.029 | \$ 0.033 | \$ 0.033 | \$ 0.031 | \$ 0.042 |
| Pre   | FLEX         | \$ 0.061 | \$ 0.047 | \$ 0.058 | \$ 0.056 | \$ 0.055 | \$ 0.062 |
| Post  | FLEX         | \$ 0.045 | \$ 0.026 | \$ 0.027 | \$ 0.029 | \$ 0.025 | \$ 0.029 |
| Pre   | GE           | \$ 0.047 | \$ 0.046 | \$ 0.049 | \$ 0.048 | \$ 0.048 | \$ 0.053 |
| Post  | GE           | \$ 0.021 | \$ 0.017 | \$ 0.019 | \$ 0.021 | \$ 0.018 | \$ 0.020 |
| Pre   | INTC         | \$ 0.053 | \$ 0.040 | \$ 0.051 | \$ 0.047 | \$ 0.053 | \$ 0.047 |
| Post  | INTC         | \$ 0.021 | \$ 0.017 | \$ 0.019 | \$ 0.020 | \$ 0.018 | \$ 0.021 |
| Pre   | IWM          | \$ 0.051 | \$ 0.055 | \$ 0.063 | \$ 0.054 | \$ 0.054 | \$ 0.064 |
| Post  | IWM          | \$ 0.028 | \$ 0.024 | \$ 0.049 | \$ 0.027 | \$ 0.028 | \$ 0.026 |
| Pre   | MSFT         | \$ 0.050 | \$ 0.037 | \$ 0.047 | \$ 0.043 | \$ 0.045 | \$ 0.050 |
| Post  | MSFT         | \$ 0.022 | \$ 0.017 | \$ 0.019 | \$ 0.021 | \$ 0.018 | \$ 0.021 |
| Pre   | QQQQ         | \$ 0.067 | \$ 0.039 | \$ 0.054 | \$ 0.044 | \$ 0.050 | \$ 0.051 |
| Post  | QQQQ         | \$ 0.020 | \$ 0.018 | \$ 0.023 | \$ 0.017 | \$ 0.018 | \$ 0.019 |
| Pre   | SMH          | \$ 0.049 | \$ 0.040 | \$ 0.049 | \$ 0.048 | \$ 0.050 | \$ 0.049 |
| Post  | SMH          | \$ 0.025 | \$ 0.024 | \$ 0.027 | \$ 0.028 | \$ 0.024 | \$ 0.026 |
| Pre   | SUNW         | \$ 0.058 | \$ 0.041 | \$ 0.051 | \$ 0.049 | \$ 0.054 | \$ 0.048 |
| Post  | SUNW         | \$ 0.022 | \$ 0.020 | \$ 0.019 | \$ 0.020 | \$ 0.017 | \$ 0.019 |
| Pre   | TXN          | \$ 0.045 | \$ 0.039 | \$ 0.049 | \$ 0.053 | \$ 0.052 | \$ 0.054 |
| Post  | TXN          | \$ 0.025 | \$ 0.020 | \$ 0.023 | \$ 0.024 | \$ 0.021 | \$ 0.025 |
| Pre   | WFMI         | \$ 0.075 | \$ 0.049 | \$ 0.060 | \$ 0.066 | \$ 0.086 | \$ 0.061 |
| Post  | WFMI         | \$ 0.031 | \$ 0.028 | \$ 0.027 | \$ 0.030 | \$ 0.029 | \$ 0.031 |

| <b>Volume Weighted Effective Spreads for Nickel MPI trades</b> |              |          |          |          |          |          |          |
|--|--------------|----------|----------|----------|----------|----------|----------|
| <b>Period</b>  | <b>Issue</b> | <b>A</b> | <b>B</b> | <b>C</b> | <b>I</b> | <b>P</b> | <b>X</b> |
| Pre  | A            | \$ 0.121 | \$ 0.082 | \$ 0.171 | \$ 0.167 | \$ 0.151 | \$ 0.184 |
| Post   | A            | \$ 0.080 | \$ 0.087 | \$ 0.111 | \$ 0.107 | \$ 0.076 | \$ 0.120 |
| Pre  | AMD          | \$ 0.107 | \$ 0.082 | \$ 0.105 | \$ 0.098 | \$ 0.080 | \$ 0.098 |
| Post   | AMD          | \$ 0.101 | \$ 0.074 | \$ 0.071 | \$ 0.084 | \$ 0.057 | \$ 0.072 |
| Pre  | CAT          | \$ 0.117 | \$ 0.083 | \$ 0.104 | \$ 0.102 | \$ 0.091 | \$ 0.115 |
| Post   | CAT          | \$ 0.086 | \$ 0.081 | \$ 0.086 | \$ 0.090 | \$ 0.090 | \$ 0.109 |
| Pre  | FLEX         | \$ 0.133 | \$ 0.085 | \$ 0.134 | \$ 0.124 | \$ 0.117 | \$ 0.121 |
| Post   | FLEX         | \$ 0.050 | \$ 0.070 | \$ 0.061 | \$ 0.095 | \$ 0.079 | \$ 0.099 |
| Pre  | GE           | \$ 0.092 | \$ 0.089 | \$ 0.101 | \$ 0.104 | \$ 0.119 | \$ 0.103 |
| Post   | GE           | \$ 0.068 | \$ 0.071 | \$ 0.065 | \$ 0.067 | \$ 0.046 | \$ 0.071 |
| Pre  | INTC         | \$ 0.113 | \$ 0.074 | \$ 0.097 | \$ 0.100 | \$ 0.087 | \$ 0.094 |
| Post   | INTC         | \$ 0.079 | \$ 0.057 | \$ 0.060 | \$ 0.064 | \$ 0.049 | \$ 0.064 |
| Pre  | IWM          | \$ 0.183 | \$ 0.122 | \$ 0.117 | \$ 0.154 | \$ 0.136 | \$ 0.152 |
| Post   | IWM          | \$ 0.093 | \$ 0.080 | \$ 0.090 | \$ 0.081 | \$ 0.088 | \$ 0.093 |
| Pre  | MSFT         | \$ 0.090 | \$ 0.065 | \$ 0.100 | \$ 0.089 | \$ 0.087 | \$ 0.098 |
| Post   | MSFT         | \$ 0.068 | \$ 0.047 | \$ 0.063 | \$ 0.064 | \$ 0.048 | \$ 0.060 |
| Pre  | SMH          | \$ 0.106 | \$ 0.076 | \$ 0.073 | \$ 0.088 | \$ 0.072 | \$ 0.108 |
| Post   | SMH          | \$ 0.067 | \$ 0.059 | \$ 0.072 | \$ 0.070 | \$ 0.046 | \$ 0.078 |
| Pre  | SUNW         | \$ 0.100 | \$ 0.060 | \$ 0.110 | \$ 0.091 | \$ 0.116 | \$ 0.110 |
| Post   | SUNW         | \$ 0.066 | \$ 0.053 | \$ 0.071 | \$ 0.078 | \$ 0.061 | \$ 0.073 |
| Pre  | TXN          | \$ 0.120 | \$ 0.082 | \$ 0.094 | \$ 0.106 | \$ 0.082 | \$ 0.114 |
| Post   | TXN          | \$ 0.074 | \$ 0.049 | \$ 0.074 | \$ 0.065 | \$ 0.060 | \$ 0.080 |
| Pre  | WFMI         | \$ 0.119 | \$ 0.101 | \$ 0.104 | \$ 0.119 | \$ 0.108 | \$ 0.123 |
| Post   | WFMI         | \$ 0.072 | \$ 0.059 | \$ 0.061 | \$ 0.063 | \$ 0.059 | \$ 0.074 |

### Appendix C

#### Quoted Spread Width Changes

| <b>Period</b> | <b>Issue</b> | <b>Spread Width<br/>Penny MPI</b> | <b>Spread Width<br/>Nickel MPI</b> | <b>% Change<br/>Penny MPI</b> | <b>% Change<br/>Nickel MPI</b> |
|---------------|--------------|-----------------------------------|------------------------------------|-------------------------------|--------------------------------|
| Pre-Pilot     | A            | \$ 0.094                          | \$ 0.192                           | -56.9%                        | -28.5%                         |
| Post-Pilot    | A            | \$ 0.041                          | \$ 0.137                           |                               |                                |
| Pre-Pilot     | AMD          | \$ 0.072                          | \$ 0.159                           | -56.7%                        | -23.7%                         |
| Post-Pilot    | AMD          | \$ 0.031                          | \$ 0.122                           |                               |                                |
| Pre-Pilot     | CAT          | \$ 0.081                          | \$ 0.170                           | -52.8%                        | -28.2%                         |
| Post-Pilot    | CAT          | \$ 0.038                          | \$ 0.122                           |                               |                                |
| Pre-Pilot     | FLEX         | \$ 0.076                          | \$ 0.127                           | -52.2%                        | -30.9%                         |
| Post-Pilot    | FLEX         | \$ 0.036                          | \$ 0.088                           |                               |                                |
| Pre-Pilot     | GE           | \$ 0.070                          | \$ 0.159                           | -60.8%                        | -34.3%                         |
| Post-Pilot    | GE           | \$ 0.027                          | \$ 0.105                           |                               |                                |
| Pre-Pilot     | INTC         | \$ 0.062                          | \$ 0.144                           | -60.0%                        | -33.8%                         |
| Post-Pilot    | INTC         | \$ 0.025                          | \$ 0.095                           |                               |                                |
| Pre-Pilot     | IWM          | \$ 0.078                          | \$ 0.190                           | -53.7%                        | -37.0%                         |
| Post-Pilot    | IWM          | \$ 0.036                          | \$ 0.120                           |                               |                                |
| Pre-Pilot     | MSFT         | \$ 0.063                          | \$ 0.135                           | -58.5%                        | -29.4%                         |
| Post-Pilot    | MSFT         | \$ 0.026                          | \$ 0.095                           |                               |                                |
| Pre-Pilot     | QQQQ         | \$ 0.063                          | N/A                                | -62.4%                        | N/A                            |
| Post-Pilot    | QQQQ         | \$ 0.024                          | N/A                                |                               |                                |
| Pre-Pilot     | SMH          | \$ 0.072                          | \$ 0.139                           | -56.1%                        | -24.0%                         |
| Post-Pilot    | SMH          | \$ 0.032                          | \$ 0.106                           |                               |                                |
| Pre-Pilot     | SUNW         | \$ 0.069                          | \$ 0.090                           | -64.1%                        | -17.1%                         |
| Post-Pilot    | SUNW         | \$ 0.025                          | \$ 0.075                           |                               |                                |
| Pre-Pilot     | TXN          | \$ 0.069                          | \$ 0.156                           | -57.2%                        | -35.4%                         |
| Post-Pilot    | TXN          | \$ 0.030                          | \$ 0.100                           |                               |                                |
| Pre-Pilot     | WFMI         | \$ 0.079                          | \$ 0.197                           | -56.5%                        | -37.6%                         |
| Post-Pilot    | WFMI         | \$ 0.034                          | \$ 0.123                           |                               |                                |

\*For WFMI Period data is split on 1/26/07  
\*\*For GE and MSFT period data is split on 2/2/07  
\*\*\*All other period data is split on 2/9/07

### Appendix D

| Percent Change in ADV by Exchange After Penny Pilot Implementation |       |       |       |       |       |       |       |
|--|-------|-------|-------|-------|-------|-------|-------|
| Issue  | A     | B     | C     | I     | P     | X     | Total |
| A  | (77%) | 24%   | 15%   | 12%   | 177%  | 159%  | 20%   |
| AMD  | 40%   | (5%)  | 18%   | (28%) | 263%  | 124%  | 49%   |
| CAT  | (44%) | 17%   | (13%) | (26%) | (18%) | (17%) | (20%) |
| FLEX   | (7%)  | (14%) | (5%)  | (49%) | (5%)  | (37%) | (28%) |
| GE   | (7%)  | 32%   | 11%   | 14%   | (22%) | (19%) | (1%)  |
| INTC   | (16%) | (40%) | 3%    | (18%) | (19%) | 20%   | (11%) |
| IWM  | 32%   | 80%   | 55%   | 53%   | 208%  | 57%   | 59%   |
| MSFT   | (40%) | (33%) | (9%)  | (0%)  | 125%  | (42%) | (10%) |
| QQQQ   | (9%)  | 12%   | 20%   | 62%   | 40%   | 10%   | 28%   |
| SMH  | 28%   | (17%) | 7%    | 30%   | 139%  | (25%) | 20%   |
| SUNW   | 16%   | 67%   | (15%) | (45%) | 75%   | (7%)  | (8%)  |
| TXN  | 12%   | (2%)  | (4%)  | (8%)  | (28%) | (37%) | (14%) |
| WFMI   | (13%) | (3%)  | 39%   | (2%)  | (65%) | (57%) | (24%) |
| Exch. Total  | (3%)  | 6%    | 29%   | 32%   | 50%   | 5%    |       |
| <i>Change in ADV across all 13 issues</i>                          |       |       |       |       |       |       | 24%   |
| Change in national equity options ADV                              |       |       |       |       |       |       | 8%    |

| Net Change in ADV by Exchange After Penny Pilot Implementation |         |         |         |         |         |         |          |
|--|---------|---------|---------|---------|---------|---------|----------|
| Issue  | A       | B       | C       | I       | P       | X       | Total    |
| A  | (464)   | 85      | 97      | 153     | 406     | 390     | 668      |
| AMD  | 1,172   | (144)   | 2,452   | (5,237) | 16,985  | 11,044  | 26,273   |
| CAT  | (1,180) | 278     | (1,081) | (2,834) | (626)   | (630)   | (6,072)  |
| FLEX   | (22)    | (29)    | (25)    | (560)   | (14)    | (171)   | (822)    |
| GE   | (445)   | 1,457   | 1,785   | 2,179   | (2,861) | (2,897) | (783)    |
| INTC   | (1,530) | (3,573) | 585     | (5,823) | (2,910) | 2,174   | (11,077) |
| IWM  | 6,479   | 7,069   | 87,985  | 41,614  | 19,732  | 6,361   | 169,241  |
| MSFT   | (4,028) | (3,712) | (2,231) | (64)    | 7,942   | (8,396) | (10,488) |
| QQQQ   | (6,866) | 3,321   | 25,588  | 82,371  | 12,510  | 3,401   | 120,324  |
| SMH  | 2,476   | (400)   | 527     | 2,964   | 2,712   | (1,231) | 7,049    |
| SUNW   | 340     | 339     | (432)   | (2,162) | 939     | (258)   | (1,234)  |
| TXN  | 210     | (38)    | (241)   | (953)   | (1,283) | (2,197) | (4,502)  |
| WFMI   | (80)    | (38)    | 1,159   | (117)   | (3,951) | (1,986) | (5,013)  |
| Exch. Total  | (3,936) | 4,615   | 116,168 | 111,531 | 49,580  | 5,604   |          |
| <i>Change in ADV across all 13 issues</i>                      |         |         |         |         |         |         | 283,562  |
| Change in national equity options ADV                          |         |         |         |         |         |         | 662,952  |