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Does SIZE Matter?
Liquidity Provision by the Nasdaq Anonymous Trading Facility

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Abstract:

I examine the effects of Nasdaq's introduction of an anonymous trading facility called SIZE. I compare SIZE to competing ECNs in terms of liquidity and market impact. Despite rapid growth, SIZE has not yet attained a significant market share and rarely influences short-run price evolution. I conclude with discussion of the Nasdaq-ECN mergers and speculate about a role for SIZE in trading listed securities.

Keywords: ECN; SuperMontage; TotalView; market impact;

JEL: G14; G20;

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I. Introduction

The Nasdaq is a decentralized trading network of broker dealers and automated quote and execution systems. Because of fragmentation in the Nasdaq marketplace, traders on the Nasdaq receive a montage of quote activity currently known as the *TotalView*.¹ This enables traders to observe the demand and supply interest of nearly all market participants.

The microstructure of the Nasdaq has its' roots in the possibly collusive activity among Nasdaq dealers first documented by Christie and Schultz (1994). Their paper prompted Securities and Exchange Commission (SEC) and Justice department investigations, and lead to reforms of the Nasdaq. Primary among them was the so-called *display rule* which guaranteed market visibility of electronic limit orders in the Nasdaq montage. Subsequent studies by Barclay, Christie, Harris, Kandel and Schultz (1999) and Weston (2000), among others, have documented that the reforms enhanced market quality.

No one predicted how rapidly the ECNs would take market share from the dealers. Barclay, Hendershott and McCormick (2003), Huang (2002) and Weston (2002) are among the important papers describing the growing role of ECN trading in Nasdaq equities. These papers document the growing market share of ECNs, their role in reducing spreads, and the growing competition between electronic networks.

By 2001, ECNs were handling nearly 40% of volume. Nasdaq knew that it needed to respond or possibly face extinction. Nasdaq's first response was organizational. It made the decision to go public in 2001 and gradually become independent of the National Association of Security Dealers. It has used stock to make acquisitions as well. It acquired two major competing ECNs, Brass Utility in September 2004 and Instinet, originally brought public by Reuters, in December 2005.

Nasdaq's technological response was a new trade and quote platform called SuperMontage. It was introduced in October 2002 and was fully implemented on December 2, 2002. It offered market makers and ECNs the ability to display multiple levels of liquidity rather than just their top quote. The initiative was also a possible Trojan horse. Nasdaq introduced an anonymous quote and execution facility which appears in Total View under the identity SIZE. This was a direct, Nasdaq branded attempt to compete with the ECNs.

This paper looks at the impact of the SIZE facility in two windows, December 2002 right after

¹ Total View quotes are publicly disseminated on a subscription basis.

the full SuperMontage rollout, and the most recent trading month, November 2005. I find that SIZE does *not* matter. The Nasdaq ECN has not achieved substantial market penetration since its' introduction three years ago. SIZE is the dominant ECN in only 2 of 50 stocks examined. Nor does it have a disproportionate market impact; in about 50% of the stocks it has a significant short-run effect compared to nearly 100% for Instinet.

My measurement of market impact is most closely related to Hasbrouck's (1991) model of joint trade and quote formation. Engle and Russell (1998) extended this model to include the time duration between trades on the NYSE. Engle and Patton (2004) look at NYSE price impact in an error-correction framework. This paper differs not only in looking at the Nasdaq, but also by testing for ECN specific impact.

The organization of this paper is as follows. In Section II, I outline the rise of ECNs in the Nasdaq microstructure. The Nasdaq's new SuperMontage and Total View display and execution systems are described. Section III introduces Hasbrouck's vector autoregressive model of trade and quote formation. Details of the data set and samples selected are in Section IV. Section V estimates Hasbrouck's VAR on a large cap and small cap sample. Section VI compares Instinet and SIZE in terms of market impact. I conclude in Section VII with a summary of the empirical results and informed speculation about the future of the Nasdaq microstructure.

II. ECN Entry to the Nasdaq Montage

The Nasdaq marketplace is a patchwork system that debuted back in 1971.² Since 1987, it has offered potentially greater transparency than the NYSE. The Small Order Execution System (SOES) provided an automatic execution facility for retail orders up to 1,000 shares. This system led to the rise of the so-called *SOES bandits*³.

A second wave of reforms followed the wave of government investigations into Nasdaq collusion. The SEC instituted new *Order Handling Rules* (OHR)⁴ in 1997 that put customer orders on an even playing field with dealer quotes. Nasdaq quoted and effective spreads declined substantially following these reforms. Inside spreads were narrowed further with the introduction of \$0.01 decimal

² For a detailed history of Nasdaq, see Smith, Selway and McCormick (1998).

³ See Harris and Schultz (1998) for an assessment of the profitability of the SOES bandits.

⁴ Release No. 34-38156; File No. SR-NASD-96-43 January 10, 1997. <http://www.sec.gov/rules/other/34-38156.txt>

spreads on April 9, 2001.

The coexistence of dealers and ECNs led to fragmentation in the Nasdaq marketplace. Traders needed to use special routing systems like Selectnet⁵ to reach different pools of liquidity. Nasdaq attempted to address this problem through the introduction of the SuperMontage system, which was fully implemented on December 2, 2002. SuperMontage combined the functionality of the prior SuperSOES and Selectnet systems, allowing market makers and ECNs to be reached through one trading mechanism. Internal Nasdaq studies⁶ showed dramatic decreases in execution time and higher fill rates.

Significant pools of liquidity remain outside of SuperMontage though. In particular, the Instinet ECN chose not to participate in SuperMontage and provided liquidity through the Nasdaq Alternate Display Facility (ADFN). Instinet handled 18.6% of Nasdaq share volume⁷ in 2002.

Even though trading remains fragmented on Nasdaq, the limit order book still provides a centralized view of nearly all the available liquidity.⁸ Nasdaq provides this in its' Level II display to which I now turn.

III. Details on the Nasdaq Limit Order Book

The best way to discuss the Nasdaq limit order book is to consider an example. I include one partial display for American Power Conversion (APCC: NNM), one of the mid-size cap stocks in the Nasdaq 100 Index, at 10:54:28 on December 2, 2002.

[Insert Table I About Here]

Table I shows the first five price levels (tiers) of the bid and the first three tiers of the ask. In the complete display, there are 51 distinct non-zero bid and ask prices in the stock. Note, of course,

⁵ Selectnet was an internal preferencing mechanism that enabled traders to reach specific markets and ECNs.

⁶ See "Results on the Introduction of NASDAQ's SuperMontage," by NASDAQ Economic Research, February 4, 2003.

⁷ See the Instinet Annual Report of 2002, http://media.corporate-ir.net/media_files/irol/12/125562/reports/2002ar.pdf

⁸ While the real-time Total View data feed includes multiple levels of liquidity, the historical nastraq database does not record anything but the top quote.

that market makers are obliged to offer two-sided quotations; the market maker Dain Rauscher (DAIN) is at 15.98 on the bid and at 16.00 on the offer.⁹ Depths are in 100s of shares.

The *inside market* or *Level I quote* consists of the best bid and ask prices and the largest depth. In this case, the Level I quote would be 15.99 \times 16.00 with a depth of 1 \times 1. This would be the quote you would see displayed on most free Internet quote services like Yahoo. It would not offer you the identity of the liquidity provider, nor would it show you additional depth at the inside quote. The Level II, in this instance, reveals three ECNs on the bid, Brass Utility (BRUT) which is the top bidder, Archipelago (ARCA), and Island (CINN).¹⁰ On the inside ask, there are two ECNs, the Nasdaq's SIZE facility and Instinet¹¹ (ADFN). Having ECNs at the inside market is not unusual on Nasdaq; for every Nasdaq stock analyzed, an ECN was the most frequent inside market participant. In the aggregate, Nasdaq found that dealers were providing less than 12% of all quotes in December 2002.

There are two market makers in the display: DAIN, and Salomon Smith Barney (SBSH). The American Stock Exchange (AMEX), which was owned by Nasdaq at the time, appears on both the bid and ask.

One cannot assume that the market makers or ECNs show their complete depth. Nasdaq allows them to display a given size and hold a reserve size. For example, Dain Rauscher may actually have 1,000 shares to sell. An order of that size would be filled in its entirety, even though they are only showing a depth of 100 shares. Many market makers show the same depth during the entire trading day, perhaps for strategic reasons. Market makers may also be buyers or seller through the ECNs.

I next turn to modeling the dynamics of the level II display using an econometric model.

⁹ A complete list of Nasdaq market makers and ECNs and their symbols may be found on the Nasdaq website, www.nasdaqtrader.com.

¹⁰ During this time period Island (which had been acquired by Instinet in February 2002), reported its trading volume to the Cincinnati stock exchange and used the symbol CINN.

¹¹ At the time, Instinet was technically classified as a UTP, an unlisted trading privileges member, similar to regional stock exchanges like the Midwest Exchange (MWSE) and the American Stock Exchange (AMEX).

IV. The Hasbrouck VAR

I follow the standard bivariate VAR model of intra-day quote and trade evolution first introduced by Hasbrouck (1991). Time t here is measured in terms of quote revisions: any change in the quote montage represents a tick. The quote database only updates every second though, so changes within the second are not recorded.

Let r_t be the percentage change in the midpoint of the bid-ask spread, $\log((p_t^b + p_t^a)/2) - \log((p_{t-1}^b + p_{t-1}^a)/2)$. Let x_t^0 denote the net sum of the sequence of signed trades since the last tick. A transaction is considered to be a buy (sell) and is signed +1 (-1) if it is above (below) the midquote.¹² The quote revision model is specified as follows

$$r_t = a_{r,0} + \sum_{i=1}^5 a_{r,i} r_{t-i} + \sum_{i=0}^{15} b_{r,i} x_{t-i}^0 + \varepsilon_{r,t}. \quad (1)$$

Following Handa, Schwartz and Tiwari (2000) and Madhavan and Cheng (1997), I include 15 lags of the signed trades. A representative estimation for American Power Conversion (APCC) is discussed below,

$$10^4 \times r_t = \begin{array}{r} 0.946 + \\ (1.227) \end{array} + \begin{array}{r} -77.896r_{t-1} \\ (3.032) \\ +0.046x_t^0 \\ (1.053) \\ +0.094x_{t-5}^0 \\ (1.654) \\ -0.086x_{t-10}^0 \\ (1.514) \\ +0.007x_{t-15}^0 \\ (0.155) \end{array} + \begin{array}{r} +0.011r_{t-2} \\ (4.270) \\ -0.036x_{t-1}^0 \\ (0.636) \\ -0.027x_{t-6}^0 \\ (0.468) \\ +0.103x_{t-11}^0 \\ (1.810) \end{array} + \begin{array}{r} +80.330r_{t-3} \\ (3.126) \\ +0.031x_{t-2}^0 \\ (0.553) \\ -0.043x_{t-7}^0 \\ (0.750) \\ -0.060x_{t-12}^0 \\ (1.059) \end{array} + \begin{array}{r} +8.554r_{t-4} \\ (0.333) \\ -0.014x_{t-3}^0 \\ (0.254) \\ +0.017x_{t-8}^0 \\ (0.305) \\ -0.011x_{t-13}^0 \\ (0.193) \end{array} + \begin{array}{r} +58.211r_{t-5} \\ (2.266) \\ -0.055x_{t-4}^0 \\ (0.974) \\ -0.006x_{t-9}^0 \\ (0.097) \\ +0.019x_{t-14}^0 \\ (0.335) \end{array} + \varepsilon_{r,t}.$$

As in Hasbrouck, my quote revision process is part of a bivariate VAR with a symmetric model for the trade process,

$$x_t^0 = a_{x,0} + \sum_{i=1}^5 a_{x,i} r_{t-i} + \sum_{i=1}^{15} b_{x,i} x_{t-i}^0 + \varepsilon_{x,t}. \quad (2)$$

¹² I also tallied the sum of the trading volumes x_t using the same assignment scheme, but I found that the binary variable x_t^0 worked better.

Estimating (2) for APCC, I obtain

$$\begin{aligned}
 x_t^0 = & 4.880 + \begin{matrix} -0.610r_{t-1} & -0.332r_{t-2} & -1.901r_{t-3} & +0.832r_{t-4} & +0.023r_{t-5} \\ (0.403) & (0.219) & (1.254) & (0.549) & (0.015) \\ +0.838x_{t-1}^0 & +0.001x_{t-2}^0 & +0.002x_{t-3}^0 & -0.003x_{t-4}^0 & +0.003x_{t-5}^0 \\ (326.297) & (0.226) & (0.526) & (0.897) & (0.817) \\ +0.000x_{t-6}^0 & +0.002x_{t-7}^0 & +0.003x_{t-8}^0 & +0.006x_{t-9}^0 & +0.002x_{t-10}^0 \\ (0.139) & (0.707) & (0.842) & (1.785) & (0.714) \\ +0.003x_{t-11}^0 & +0.007x_{t-12}^0 & +0.004x_{t-13}^0 & +0.013x_{t-14}^0 & +0.039x_{t-15}^0 \\ (0.843) & (2.152) & (1.159) & (3.848) & (15.192) \end{matrix} + \varepsilon_{x,t}.
 \end{aligned}$$

Transactions are positively autocorrelated and highly predictable. (2) has an R^2 of 0.76. Both of these results are qualitatively similar to Hasbrouck's, though the dynamics are more persistent than in his sample of NYSE stocks.

I will now proceed to estimate the bivariate VAR on a larger cross section of stocks that are detailed in the next section.

V. Data and Sample Selection

Since January 1999, Nasdaq has collected a complete record of quotes and trades in a monthly compilation called the Nasdaq Trade and Quote Database (NASTRAQ) database. The market participant is also identified in the quote montage. Since the introduction of multiple levels of liquidity in SuperMontage in October 2002, Nasdaq has unfortunately only provided the top quote from each market participant in the historical database.

I selected two samples of stocks from this database for the month of December 2002. The first group is a random selection of 25 stocks from the Nasdaq 100 index. This is the primary index of large capitalization Nasdaq stocks. In December of 2002, they had an average market capitalization of \$11.904 billion, and an average share price of \$28.34. The complete list along with some data characteristics is in Table II.

[Insert Table II About Here]

I chose a random sample of 25 smaller capitalization stocks using three criteria: (1) a price of greater than \$5.00 per share; (2) an average daily trading volume of 7,500 to 40,000 shares; and (3) 90 day moving average of volume in the 28 to 52nd percentile. The selections are described in Table III. This small to midcap group is a very different world from the Nasdaq 100. The average market capitalization is \$549.70 million with an average share price of \$16.09.

[Insert Table III About Here]

Quote generation on the Nasdaq 100 is extremely active. There are an average of 69.24 market makers and ECNs per stock, generating 263,786 quote revisions.

Again, the small cap group averages are qualitatively very different. There are 21.04 market makers and ECNs per stock, with only 12,168 quote revisions. This diversity should provide a robust look at the impact from SIZE.

VI. Estimates of the Bivariate VAR

I estimated the bivariate VAR (1) and (2) for the two samples discussed in the previous section. I then solve for the moving average representation and compute the impulse responses. From the long run impulse response, I obtain an estimate of the market impact.

VI.A Market impact

Hasbrouck argues that the trades represent public information since they are disseminated over the tape, while quotes are private information. Both, however, contribute to possibly persistent changes in transactions prices.

The market impact of the trade can be measured by the dynamic effect on subsequent quote revisions. This is a complicated process involving the interaction of the lags in (1) and (2). A tick occurs, on average, every 1.3 seconds for one of the Nasdaq 100 stocks, so 36 ticks represent on average one minute of clock time. The market impact of a one unit buy order for APCC after 36 periods sums to 27.240×10^{-4} . It implies a \$0.0681 midquote revision for a \$25 stock.

[Insert Figure I About Here]

To examine the longer run dynamics, I graph the market impact through 144 periods, or about four minutes of clock time, in Figure 1. The impact of a buy order stabilizes after 2 minutes of clock time and is essentially constant from there.

The American Power Conversion (APCC) results on market impact from the earlier section are indeed quite typical of the Nasdaq 100 as a whole. The market impact is measured positive for all but two stocks in the large cap sample, with an average midpoint quote revision of 13.14×10^{-4} . This implies a \$0.0328 quote revision for a \$25 stock. Estimates for the random Nasdaq 100 sample

are in Table IV.

[Insert Table IV About Here]

The smaller cap Nasdaq sample has a substantially higher market impact although the point estimates here are not as sharp. 20 of the 25 of the market impacts are estimated as positive, and several are quite large, with a median market impact of 177.09×10^{-4} . For a \$25 stock, this would represent a midpoint change of \$0.443. The small cap market impact estimates can be found in Table V.

[Insert Table V About Here]

These estimates are slightly higher than Hasbrouck's NYSE sample, but lower than two more recent studies. Handa, Schwartz and Tiwari (2000) find an average 15 period price effect of \$0.059 per share for non-floor trades on the American Stock Exchange. Engle and Patton (2004) report their lowest NYSE market impact of \$0.054 in their larger capitalization 8th decile for small trades. Their largest impact, \$0.442 for medium trades in decile 2, is exactly in line with our small cap estimate. The measured impact in the small cap VAR is large for two reasons: the effect on quote revisions dies off slowly, and the trade impact itself is positively correlated.

Below, I explore the question of the presence of SIZE or other ECNs in the Level II may effect these estimates.

VII. Competition Among ECNs

Market Share in 2002

A common way to assess the importance of a liquidity provider is to determine how often they are providing the best quote in a particular security. In Table VI for the Nasdaq 100 and Table VII for the small cap stocks, I show the percentage of inside bid and ask appearances for SIZE and the most active ECN in the security.

[Insert Table VI and VII About Here]

As in Huang (2002), I find that ECNs are important providers of liquidity, but primarily for the large caps. In 2002, this was more often than not, Instinet (ADFN). For 23 of 25 stocks, Instinet

has the largest market share, averaging 24.43%. SIZE averages less than 0.5% across the 25 issues. The largest share is for Verisign (VRSN), Altair (ALTR), and Intel (INTC), suggesting a positive relationship between market cap and share.

In the small cap sample, the Island ECN (CINN) is the most active inside quote participant in 9 stocks. Archipelago (ARCA) is second with 8 stocks and Instinet (ADFN) in third with 6. Bloomberg is the most active in 1 stock. Size has an insignificant share of 0.17%.

The presence of a particular participant does not by itself indicate that they are significant contributors to subsequent quote revisions though. I turn now to the model to address that question.

Conditional market impact

I first test for the effect that individual ECNs have on quote revisions. Let $I(q_{1,t}^{b,i})$ be a dummy variable indicating the presence of ECN i on the inside bid and $I(q_{1,t}^{a,i})$ an indicator of inside ask appearances. In our bivariate VAR, I add¹³ both $I(q_{1,t}^{b,i})$ and $I(q_{1,t}^{a,i})$,

$$r_t = \sum_{i=1}^5 a_{r,i} r_{t-i} + \sum_{i=1}^{15} b_{r,i} x_{t-i}^0 + \sum_{i=1}^2 \theta_{r,i}^b I(q_{1,t}^{b,i}) + \sum_{i=1}^2 \theta_{r,i}^a I(q_{1,t}^{a,i}) + \varepsilon_{r,t}. \quad (3)$$

$\theta_{r,i}^b$ and $\theta_{r,i}^a$ measure the effect of individual ECNs impacting the next tick from the bid or ask side through their quote behavior. I confine the analysis here to a comparison between SIZE, $i = 1$, and the dominant ECN, Instinet, $i = 2$.

ECNs have a more significant role in the large caps than in the small caps. SIZE is statistically significant for 13 stocks: ESRX, INTC, LNCR, MLNM, PCAR and USAI on the bid, and CHRW, CMCSA, ERICY, IVGN, LNCR, PETM and SYMC on the ask. Instinet is a truly dominant presence in the large cap stocks. It is statistically significant in every large cap on the bid, except for WFMI, and for all 25 stocks on the ask.

Among the small cap sample of 25 stocks, SIZE has a statistically significant market impact on the bid in only two, HGIC and HIBB. Instinet has a significant impact in 5 stocks: CORS, EMBX, FFIC, HIBB, and WDFC. On the ask, SIZE is significant only in HIBB. Instinet has a significant impact in 7 stocks: CRZO; FFIUC; HGIC; HIBB; TGIC; VITL; and WDFC.

¹³ I also tried adding the depth of the market maker when they took the inside, but I found no additional explanatory power.

Market share in 2005

By November 2005, SIZE had more than doubled its' market share in the Nasdaq 100 sample¹⁴ to 2.11%. Nonetheless, the overall market share is still small, and SIZE does not have a dominant market share in any individual security. Bloomberg (BTRD) has emerged as an important player, with leading ECN shares in 15 securities. BRUT is second with 6 lead positions. Instinet has also declined in importance though this may be attributable to data classification.

In the small cap securities, SIZE is the dominant ECN in only 2 cases: FFIC and HGIC, but it has grown its' market share even more significantly than the large caps to 2.41%. In FFIC, PEAK, and TGIC, the SIZE share is above 4%. Instinet remains the dominant player here, with a leading market share in 9 securities compared to 7 for Bloomberg.

VIII. The Future

As a result of the mergers with BRUT and Instinet, Nasdaq's share of trading volume in its' own listings will exceed 50%. Adding the broker-dealer volume reported through Nasdaq, the publicly traded Nasdaq Stock Market Incorporated (NNM: NDAQ) may reach an 80% share in Nasdaq stocks¹⁵. This is a remarkable turnaround for an exchange that was close to extinction. Investors clearly like the merger. Their stock, trading under the symbol NDAQ, has risen from a low of \$8.10 per share in January 2005 to almost \$45 in November 2005. Only Archipelago, which will merge with the New York Stock Exchange (NYSE) in 2006, and Bloomberg remain important independent competitors.

SIZE has grown substantially in the three years since its' introduction, but it is not yet a significant factor in Nasdaq liquidity. Perhaps as the Nasdaq expands into NYSE securities, the role of SIZE will continue to grow in importance.

¹⁴ In the 2005 estimates, Nasdaq attributes quotes posted by market makers through non-Nasdaq ECNs (e.g. Instinet and Bloomberg) back to the market maker. This has the effect of overstating the importance of dealers and understating the market share of the ECN. SIZE does not suffer from this distortion.

¹⁵ Chris Rice, "Market Mergers Good News for Investors," State Street Global Advisors, April 29, 2005.

References

- Barclay, M. J., W. G. Christie, J. H. Harris, E. Kandel, and P. H. Schultz, 1999, "The effects of market reform on the trading costs and depths of Nasdaq stocks," *Journal of Finance* 54, 1-34.
- M. J. Barclay, T. Hendershott, D. T. McCormick, 2003, "Competition among trading venues: information and trading on electronic communications networks," *Journal of Finance* 58, 2637-65.
- W.G. Christie and P.H. Schultz, 1994, "Why do NASDAQ market makers avoid odd-eighth quotes?" *Journal of Finance* 49, 1813-40.
- Engle, R. F., and J. Russell, 1998, "Autoregressive conditional duration: a new model for irregularly spaced transaction data," *Econometrica* 66, 1127-63.
- Engle, R.F. and A.J. Patton, 2004, "Impacts of trades in an error-correction model of quote prices," *Journal of Financial Markets* 7, 1-25.
- Handa, P., R. Schwartz and A. Tiwari, 2000, "Not held orders: evidence on the value of order timing in an equity market," U. of Iowa Working Paper.
- L. Harris and P. Schultz, 1998, "The trading profits of SOES bandits, " *Journal of Financial Economics* 50, 39-62.
- Huang, R.D., 2002, "The quality of ECN and Nasdaq market maker quotes," *Journal of Finance* 57: 1285-1319.
- Hasbrouck, J., 1991, "Measuring the information content of stock trades," *Journal of Finance* 46, 179-207.
- Klock, M. and D. T. McCormick, 1999, "The impact of market maker competition on Nasdaq spreads," *The Financial Review* 34, 55-74.
- Madhavan, A. and M. Cheng, 1997, "In search of liquidity: block trades in the upstairs and downstairs markets," *Review of Financial Studies* 10, 175-204.
- Smith, J.W., J. P. Selway, and D.T. McCormick, 1998, "The Nasdaq stock market. historical background and current operation," NASD Working Paper 98-01.
- Weston, J., 2000, "Competition on the Nasdaq and the impact of recent market reforms," *Journal of Finance* 55, 2565-98.
- Weston, J., 2002, "Electronic communication networks and liquidity on the Nasdaq," *Journal of Financial Services Research* 22, 125-39.

Table I
Level II Display for American Power Company (APCC)¹⁶

MMID	Bid	Depth	MMID	Ask	Depth
BRUT	15.99	1	SIZE	16.00	1
DAIN	15.98	1	DAIN	16.00	1
AMEX	15.97	25	ADFN	16.00	4
ARCA	15.97	3	SBSH	16.01	3
CINN	15.97	4	AMEX	16.03	25

¹⁶ This is the first five tiers of the limit order book for APCC at 10:58:24 on December 2, 2002. Depth is in 100s of shares. Market maker identities are explained in the text.

Table II
Market Characteristics for Nasdaq 100¹⁷

Company	Symbol	Mkt Cap	Avg. Price	Ticks	MMs
ADC TELECOMMUNICATIONS INC	ADCT	1,660.72	2.07	285,865	86
ALTERA CORP	ALTR	4,787.35	12.52	341,731	82
AMERICAN PWR CNVRSION	APCC	3,020.71	15.31	151,516	59
CDW CORPORATION	CDWC	3,786.66	45.77	333,458	63
C.H. ROBINSON WORLDWIDE	CHRW	2,673.00	31.60	100,937	46
COMCAST CORP	CMCSA	53,357.15	23.71	313,724	69
EBAY INC	EBAY	22,030.38	34.31	403,741	84
ERICSSON (L M) TEL	ERICY	12,916.13	8.17	173,545	78
EXPRESS SCRIPTS INC	ESRX	3,844.92	48.92	315,877	59
IDEC PHARMACEUTICAL	IDPH	5,254.06	33.80	362,925	81
INTEL CORP	INTC	115,992.70	17.82	458,673	110
INVITROGEN CORP	IVGN	1,530.94	30.46	196,218	56
LINCARE HOLDINGS INC	LNCR	3,189.31	32.39	214,494	50
MILLENIUM PHARMACEUTICALS	MLNM	2,806.36	9.40	283,255	92
MOLEX INC	MOLX	2,444.24	24.42	266,070	57
PACCAR INC	PCAR	5,451.42	46.77	320,970	50
PETSMART INC	PETM	2,598.66	18.36	136,054	62
PIXAR	PIXR	3,162.71	57.97	119,386	47
PEOPLESOFT INC	PSFT	6,735.46	18.50	340,449	93
SIGMA-ALDRICH	SIAL	3,478.90	49.15	222,853	52
STAPLES INC	SPLS	9,085.64	18.66	265,158	72
SYMANTEC CORP	SYMC	6,400.92	42.17	338,770	83
INTERACTIVE CORP	USAI/IACI	16,107.06	24.36	273,760	68
VERISIGN INC	VRSN	2,114.37	8.79	209,987	79
WHOLE FOODS MARKET INC	WFMI	3,182.23	53.13	165,241	53
Average		11,904.48	28.34	263,785	69

¹⁷ Market capitalization is in millions of dollars. The average price is the monthly average of the daily closes. The number of market makers is the total for the entire month. All data are for December 2002.

Table III
Market Characteristics for Small Caps¹⁸

Company	Symbol	Mkt. Cap	Avg. Price	Ticks	MMs
AMERISERV FINANCIAL INC	ASRV	39.66	2.84	2,623	19
AUTONOMY CORP PLC	AUTN	317.52	14.19	3,029	20
BIOSOURCE INTL INC	BIOI	52.00	5.67	928	18
BSB BANCORP	BSBN	200.50	21.87	6,961	27
CORUS BANKSHARES INC	CORS	621.05	44.23	25,611	21
CARRIZO OIL GAS INC	CRZO	73.83	5.18	2,698	15
DEB SHOPS INC	DEBS	300.35	21.94	18,884	22
EMBEX INC	EMBX	99.18	12.15	12,233	20
EXPONENT INC	EXPO	103.16	14.37	6,031	17
FLUSHING FINANCIAL CORP	FFIC	214.03	16.68	12,216	24
HARLEYSVILLE GROUP INC	HGIC	778.58	25.90	33,136	28
HIBBETT SPORTING GOODS INC	HIBB	255.87	16.71	18,729	29
INVESTORS REAL ESTATE TRUST	IRETS	381.03	10.52	6,621	15
JOHN HANCOCK FIN TRENDS FUND INC	JHFT	49.28	12.89	6,307	10
NEW HORIZONS WORLDWIDE INC	NEWH	49.12	4.65	3,150	18
NATIONAL HOME HEALTH CARE	NHHC	54.05	9.83	2,543	19
PEAK INTERNATIONAL LTD	PEAK	45.90	3.83	1,641	16
PETROLEUM DVLPMNT CORP	PETD	82.21	5.26	1,917	18
PACIFIC MERCANTILE BANCORP	PMBC	45.72	7.14	906	17
SMARTSERV ONLINE INC	SSOL	0.00	0.00	2,359	23
TRIAD GUARANTY INC	TGIC	549.19	38.32	33,267	23
VITAL SIGNS INC	VITL	377.21	29.22	17,604	21
VOLVO AB SWE	VOLVY	7,245.13	17.27	15,895	35
WD-40 CO	WDFC	477.43	28.69	28,961	20
WHITNEY HOLDING CORP	WTNY	1,330.55	32.98	39,957	31
Average		549.70	16.09	12,168.28	21.04

¹⁸ Market capitalization is in millions of dollars. The average price is the monthly average of the daily closes. The number of market makers is the total for the entire month. All data are for December 2002.

Table IV
Market Impact Estimates for Nasdaq 100¹⁹

Symbol	Market Impact
ADCT	56.156
ALTR	-2.422
APCC	27.240
CDWC	9.531
CHRW	3.158
CMCSA	5.235
EBAY	29.794
ERICY	7.751
ESRX	-0.795
IDPH	7.470
INTC	3.338
IVGN	0.122
LNCR	2.497
MLNM	32.025
MOLX	4.088
PCAR	2.471
PETM	2.660
PIXR	34.628
PSFT	15.060
SIAL	41.606
SPLS	19.891
SYMC	8.782
USAI	6.919
VRSN	6.292
WFMI	4.980
Average	13.14

¹⁹ All coefficient estimates are $\times 10^4$. Boldface indicates significance at the 1% level. The sample period is December 2002 with the number of observations found in Table 1.

Table V
Market Impact Estimates for Small Caps²⁰

Symbol	Market Impact
ASRV	-1,817.160
AUTN	4,041.595
BIOI	-5,010.849
BSBN	22.575
CORS	-60.705
CRZO	1,995.768
DEBS	-183.641
EMBX	217.710
EXPO	9.576
FFIC	177.087
HGIC	132.192
HIBB	108.897
IRETS	798.455
JHFT	NA
NEWH	-1,723.901
NHHC	7,126.999
PEAK	3,052.230
PETD	1,416.998
PMBC	5,103.388
SSOL	4,975.316
TGIC	454.442
VITL	92.918
VOLVY	44.135
WDFC	16.658
WTNY	5.192
Median	177.09

²⁰ All coefficient estimates are $\times 10^4$. Boldface indicates significance at the 1% level. The sample period is December 2002 with the number of observations found in Table 2.

Table VI
Market Share of Inside Quotes in Nasdaq 100 Issues²¹

Symbol	December 2002			November 2005		
	SIZE	MMID	Share	SIZE	MMID	Share
ADCT	0.16%	ADFN	15.31%	1.71%	BTRD	3.41%
ALTR	1.45%	ADFN	24.58%	2.21%	BRUT	4.34%
APCC	0.65%	ADFN	26.96%	2.49%	BTRD	3.29%
CDWC	0.39%	ADFN	26.96%	1.18%	BTRD	3.39%
CHRW	0.04%	ADFN	18.54%	1.48%	BTRD	4.21%
CMCSA	0.47%	ARCA	23.44%	2.33%	BRUT	5.04%
EBAY	0.92%	ADFN	23.79%	2.12%	BRUT	3.37%
ERICY	0.32%	ARCA	16.05%	2.54%	BTRD	4.76%
ESRX	0.40%	ADFN	27.11%	2.34%	BTRD	4.56%
IDPH	0.58%	ADFN	24.59%			
INTC	1.02%	ADFN	17.93%	2.66%	BRUT	4.17%
IVGN	0.32%	ADFN	21.60%	1.24%	BTRD	3.31%
LNCR	0.05%	ADFN	26.01%	1.87%	BTRD	3.41%
MLNM	0.69%	ADFN	19.91%	2.13%	BRUT	4.34%
MOLX	0.20%	ADFN	27.61%	2.65%	INET	3.50%
PCAR	0.04%	ADFN	29.05%	1.58%	BTRD	4.29%
PETM	0.59%	ADFN	22.54%	1.33%	BTRD	3.95%
PIXR	0.15%	ADFN	26.33%	1.55%	BTRD	3.23%
PSFT	0.51%	ADFN	26.48%			
SIAL	0.02%	ADFN	32.02%	1.70%	BTRD	2.97%
SPLS	0.36%	ADFN	21.37%	1.96%	BTRD	4.05%
SYMC	0.23%	ADFN	22.72%	1.63%	BRUT	3.94%
USAI	0.24%	ADFN	24.59%			
VRSN	1.93%	ADFN	22.96%	2.75%	BTRD	4.45%
WFMI	0.04%	ADFN	32.91%	1.47%	BTRD	3.84%

²¹ The first column for both dates is the market share of inside quotes for SIZE, the anonymous trading identity. The next column is the ECN that appears most frequently on the inside quote. In the November 2005 figures, Nasdaq attributes liquidity from non-Nasdaq ECNs back to the dealer who placed the quote.

Table VII
Market Share of Inside Quotes in Small Cap Issues²²

Symbol	December 2002			November 2005		
	SIZE	MMID	Share	SIZE	MMID	Share
ASRV	0.00%	ARCA	12.80%	0.28%	INET	7.81%
AUTN	0.37%	ARCA	22.63%			
BIOI	0.10%	BTRD	14.66%			
BSBN	0.00%	ARCA	16.69%			
CORS	0.14%	ADFN	16.51%	1.65%	BTRD	4.04%
CRZO	1.89%	ARCA	12.37%	2.50%	BTRD	7.75%
DEBS	0.08%	ADFN	25.26%	1.12%	INET	3.61%
EMBX	0.07%	CINN	14.43%	1.46%	INET	1.92%
EXCO	0.05%	ADFN	18.57%			
FFIC	0.00%	CINN	20.46%	5.67%	INET	2.60%
HGIC	0.03%	ADFN	20.81%	3.43%	BTRD	2.32%
HIBB	0.10%	ADFN	16.94%	2.14%	BTRD	4.10%
IRETS	0.62%	CINN	22.01%	2.58%	INET	2.09%
JHFT	0.00%	CINN	19.11%	3.08%	INET	3.98%
NEWH	0.05%	ARCA	22.15%			
NHHC	0.00%	ARCA	16.14%	1.71%	INET	3.68%
PEAK	0.00%	CINN	14.65%	5.13%	INET	11.56%
PETD	0.38%	ARCA	13.58%			
PMBC	0.00%	CINN	23.45%	0.21%	INET	1.82%
SSOL	0.00%	CINN	19.76%			
TGIC	0.00%	CINN	22.33%	4.54%	BTRD	7.48%
VITL	0.06%	CINN	18.81%	1.44%	BTRD	1.69%
VOLVY	0.00%	NA	0.00%	2.60%	INET	3.99%
WDFC	0.19%	ADFN	25.45%	2.39%	BTRD	4.56%
WTNY	0.06%	ARCA	25.43%	1.07%	INET	2.21%

²² The first column for both dates is the market share of inside quotes for SIZE, the anonymous trading identity. The next column is the ECN that appears most frequently on the inside bid or ask. In the November 2005 figures, Nasdaq attributes liquidity from non-Nasdaq ECNs back to the dealer who placed the quote.

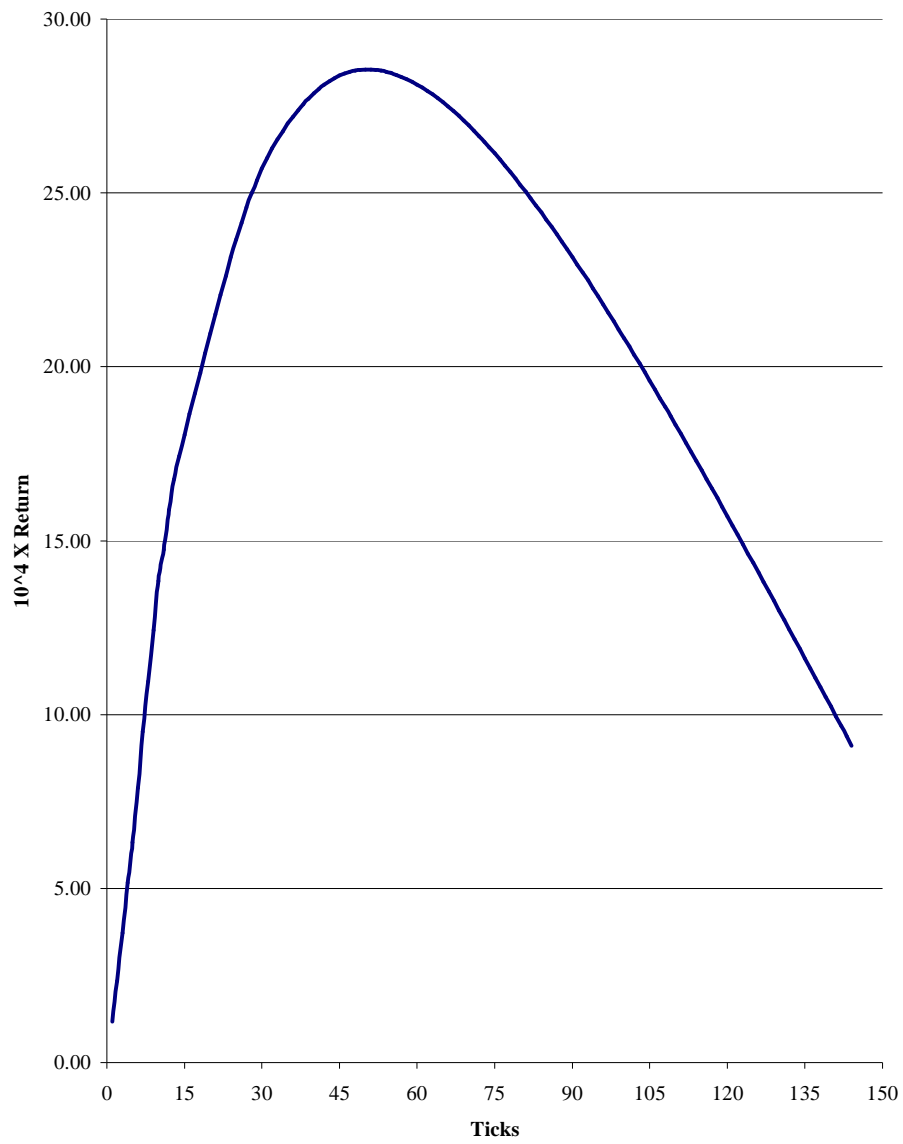


Figure 1: Market Impact for APCC