

Execution costs on Nasdaq and the NYSE

NYSE Research

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This analysis compares execution costs for marketable orders on the New York Stock Exchange (NYSE) and the Nasdaq Stock Market (Nasdaq). The main result is that the execution of marketable orders is significantly more expensive on Nasdaq than on the NYSE in terms of effective spreads, whether measured in dollars or relative to share price.

To measure execution costs, we use monthly reports published in accordance with Securities and Exchange Commission Rule 11Ac1-5 (“Dash 5”), which include various measures of execution quality for individual securities. We focus on effective spreads, a widely used measure of execution costs. It is defined as twice the distance between the transaction price and the quote midpoint that was in effect when the market center received the order. Effective spreads are a better measure of execution costs than quoted spreads, because orders do not always execute exactly at the bid or offer price. Effective spreads take this into account by incorporating any price improvement or disimprovement that an order may receive.

For example, suppose a market buy order was received by a market center at 10:00:00 am, when the quote was \$9.50 to \$9.60. The order executes at 10:00:04 at a price of \$9.58. The effective spread uses the execution price at 10:00:04 and the quote midpoint at 10:00:00, and is $2 * (\$9.58 - \$9.55) = 6$ cents. In this example, the quoted spread (10 cents) overstates execution cost, because the order received a price improvement of 2 cents.

Two features of our analysis help us provide an objective picture of differences between Nasdaq and the NYSE. First, our methodology closely follows the one used in an official SEC study published in 2001.¹ It involves selecting a representative sample of Nasdaq stocks and then finding NYSE firms that are similar in terms of market capitalization, share price, trading volume, and volatility. Second, we also follow the SEC approach in using a Nasdaq sample that emphasizes the most liquid Nasdaq stocks. This is accomplished by first

¹ SEC, 2001, “Report on the comparison of order execution across equity market structures,” U.S. Securities and Exchange Commission, Washington, DC.

selecting a representative sample of Nasdaq securities and then adding the thirty most liquid stocks. Because we use no such selection for the matching NYSE stocks, which are determined solely based on how well they match the Nasdaq stocks, this procedure assures that our sample is not biased in favor of NYSE.

Our analysis focuses on marketable orders only (market orders and marketable limit orders), because Dash 5 reports do not provide measures of execution costs for non-marketable limit orders. Using all reports between November 2001 and December 2002, we find:

- For market orders, the median Nasdaq effective spread is 9.2 cents (67 bp), and the median for the matched NYSE firms is 6.9 cents (45 bp).
- For marketable limit orders, the median Nasdaq effective spread is 6.3 cents (47 bp), and the median for the matched NYSE firms is 3.8 cents (25 bp).
- When computing the pairwise differences of effective spreads between the matched Nasdaq and NYSE securities, we find that the differences are significantly greater than zero, indicating that Nasdaq spreads are systematically greater than NYSE spreads. The median pairwise difference is 9 bp for market orders and 12 bp for marketable limit orders.
- The results become more pronounced when we control for monthly changes in market capitalization, trading volume, share price, and volatility. Using these controls, Nasdaq market orders are 23 bp more expensive than those on the NYSE, and Nasdaq marketable limit orders are 25 bp more expensive.

1 Data and methodology

The first step in our analysis is to determine all eligible securities on both markets. We include only single-class common stocks of domestic issuers, and impose several criteria that are designed to exclude the least active stocks and securities with missing data on both markets. We also require a trading history of at least two years. These criteria closely follow the ones used in SEC (2001) and are described in detail in Table 1. The final sample contains 1093 Nasdaq firms and 1043 NYSE firms.

The second step is to select a representative sample of Nasdaq securities. To do this, we sort the 1093 eligible Nasdaq stocks by decreasing dollar trading volume during the third quarter of 2001. Then every fifth stock is selected, starting with the most active. This results in a sample of 219 securities.

The third step is to add the most liquid Nasdaq stocks. Again, we follow the SEC approach and produce three different rankings of the 1093 Nasdaq stocks: according to market capitalization (on 9-30-2001), dollar trading volume, and share volume (both during the third quarter of 2001). Thirty-five different securities appear in the top 20 of at least one of these three lists (“Top20 stocks”). Out of those, the volume-stratified sample already contains five; so we add the 30 remaining Top20 securities to the stratified sample, resulting in 249 Nasdaq securities.

The fourth step is to identify exactly one matching NYSE security for each Nasdaq stock. No NYSE stock is assigned to more than one Nasdaq stock. Following the SEC procedure, we require that the matched stocks be as close as possible to the Nasdaq stocks along four dimensions: market capitalization (*MCAP*) and share price (*PRC*) on 9-30-2001, and average adjusted daily dollar volume (*ADV*) and the average daily relative price range (*RR*) during the third quarter of 2001. Volume is adjusted to take different counting procedures across markets into account, and is computed by multiplying Nasdaq volume by 0.7 and leaving NYSE volume unchanged.² The volatility measure, the daily relative range, is defined as the daily range divided by the closing price.³

More formally, we compute matching errors, D_{ij} , for each possible combination of the 249 Nasdaq stocks i and the 1043 NYSE stocks j as follows:

$$D_{ij} = \left| \frac{MCAP_i}{MCAP_j} - 1 \right| + \left| \frac{PRC_i}{PRC_j} - 1 \right| + \left| \frac{ADV_i}{ADV_j} - 1 \right| + \left| \frac{RR_i}{RR_j} - 1 \right|. \quad (1)$$

² See footnote 16 in SEC (2001). The results remain qualitatively unchanged when matching without this adjustment.

³ SEC (2001) uses a different volatility measure, the weekly return volatility over 29 months preceding their analysis period. They also show that an alternative 12-month measure produces similar results. In this analysis, the volatility measure is based on daily ranges because it does not rely on stationarity assumptions over such an extended period. Alternatively, one could use some measure of intra-day volatility, but they would be highly sensitive to the way they are computed. It does not seem likely that any of the conclusions offered in this analysis is sensitive to the choice of volatility measure.

Then we sort the Nasdaq sample according to its ticker symbol. Beginning with the first ticker, we select the NYSE stock with the lowest matching error as the matching firm. The NYSE security is then removed from the sample of potential matches for the remaining Nasdaq securities, and the next pair is formed. This process continues until we have a complete set of 249 matched pairs.⁴ The appendix lists the 249 Nasdaq stocks and their NYSE matches.

1.1 Execution-quality data

This study uses Dash 5 reports on market orders and marketable limit orders obtained from www.marketsystems.com (MSI). To compare execution quality between NYSE and Nasdaq, it seems appropriate to include all market centers that are directly associated with one of these markets (all market centers whose Dash-5 “Participant ID” starts with “N” for NYSE stocks and with “T” for Nasdaq stocks). To eliminate potential errors and non-representative Dash 5 variables, we apply two filters to the Dash 5 data: (1) we delete all order size/order type combinations where the reported effective spreads exceed 50% of the average share price during that month; (2) for each security and each month, we delete all monthly order size/order type categories that are based on fewer than twenty orders. Over the 14-month period on which the analysis is based, the final data set on the 249 matched firms covers executed market orders of 33 billion shares on Nasdaq (109 billion shares executed marketable limits) and 23 billion shares on the NYSE (18 billion in marketable limits).⁵

⁴ SEC (2001) uses a weighting scheme that deems a 0.05 error in the volatility component optimal. Because there is no sound theoretical argument for not considering zero errors optimal, this paper does not follow that approach. Empirically, using the 0.05 target error in the volatility component does not change any of the results presented in this paper.

⁵ Given that we use a matching procedure that considers (dollar) trading volume as one of four criteria, it may seem surprising that Nasdaq share volume is greater than NYSE share volume during the analysis period. There are three partial explanations for this. First, the matching procedure uses dollar trading volume and not share order volume. Second, the matching procedure also considers price, market capitalization, and volatility. Third, the matching is based on variables that precede the analysis period to avoid selection bias. We note that the higher Nasdaq volume in the matched pairs will tend to bias the results in favor of Nasdaq, because high-volume stocks are generally associated with lower execution costs.

It is also interesting to observe that marketable limit orders have substantially greater share volume on Nasdaq than on the NYSE. This likely reflects the fact that some ECNs operate pure limit-order markets.

1.2 Estimation methodology

Dash-5 effective spreads are reported separately for four different order sizes, so we first aggregate them by computing averages weighted by the number of shares executed. Thus, our estimates refer to all marketable orders between 100 and 9999 shares. Based on the matched sample, we then compute pairwise differences between Nasdaq and NYSE effective spreads. We present results for Nasdaq-NYSE differences measured in dollars and basis points (dollar effective spreads standardized by the monthly average of daily closing prices). A positive difference implies higher cost on Nasdaq, while a negative difference implies higher cost on the NYSE.

Our first set of results, based on effective spreads aggregated over the entire 14-month period, reports means and medians for the 249 paired differences. Statistical tests are Wilcoxon tests of the hypothesis that the median pairwise differences are zero, and t-tests of the hypothesis that the mean pairwise differences are zero.

The second set of results is also based on the matched sample, but uses monthly observations and adds four monthly control variables: the logarithm of market capitalization, the inverse of share price, the logarithm of daily dollar trading volume, and the daily price range divided by the closing price. The controls correspond to the variables used to find the matching pairs and serve two purposes. First, they help control for residual matching errors. Second, by incorporating monthly time variation, this approach adjusts for potentially different time paths of the matching variables between Nasdaq and the NYSE. We estimate the following panel regression model, which has one observation for each matched pair i and each month t between November 2001 and December 2002:

$$\Delta ES_{it} = \alpha + \beta \Delta \ln(MCAP_{it}) + \gamma \Delta(1/PRC_{it}) + \delta \Delta \ln(ADV_{it}) + \phi \Delta RR_{it} + \varepsilon_{it} \quad (2)$$

where Δ represents the difference Nasdaq–NYSE and ES is one of the two effective-spread measures. The monthly control variables are as defined above, based on equally weighted averages of daily values. In this regression, the intercept coefficient α measures the difference between Nasdaq and NYSE execution quality.

2 Results

We present results separately for market orders (Table 2) and marketable limit orders (Table 3). The tables report share-weighted averages for the two execution-quality measures (effective spreads in dollars and in basis points). Panel A presents means and medians for the univariate matched-sample comparison. It reports the effective-spread levels for the two markets and the difference between Nasdaq and the NYSE. A positive differential implies that the Nasdaq spread is greater, and a negative differential implies that the NYSE spread is greater. Panel B contains the matched-pairs monthly panel regression (see Equation 2).

The results across the two tables and the two methodologies lead to very similar conclusions: effective spreads are significantly lower on the NYSE. The magnitude of the differences, however, depends on the methodology used. For market orders, effective spreads are between 2.3 cents (median pairwise difference in Panel A) and 5.1 cents (regression estimates in Panel B) higher on Nasdaq. The mean pairwise difference is 3.9 cents (Panel A). Measuring effective spreads in basis points leads to very similar conclusions: estimates of the differential range from nine basis points (median pairwise difference in Panel A) to 27 basis points (mean pairwise differential in Panel A). Controlling for changes over time, Panel B implies a difference of 23 basis points.

Compared to market orders, marketable limit orders impose an additional risk on traders, because they may not execute if the market moves away when the order is submitted. This additional risk, however, is not captured by the spread measures available in the Dash 5 reports. However, this omission should not affect the cost differences between the two markets, unless the probability of non-execution or the order submission strategy is fundamentally different. Table 3 shows that effective spreads for marketable limit orders are somewhat lower than those for market orders. The differences between Nasdaq and NYSE, however, are almost identical for both order types. Using the regression estimates in Panel B of Tables 2 and 3, market orders are 5.1 cents (23 bp) more expensive on Nasdaq; marketable limits are 5.1 cents (25 bp) more expensive.

3 Conclusion

We present an analysis of Nasdaq and NYSE execution costs, using the same basic methodology as the 2001 SEC report on market quality. We document significantly greater effective spreads for marketable orders in Nasdaq securities than for their matched NYSE counterparts. These results are based on a broad sample, covering 249 matched pairs of stocks, 14 recent months, and all order sizes between 100 and 9999 shares.

Table 1: Sample selection

The table describes the selection of the final sample from the universe of all securities.

| Criteria | NYSE | Nasdaq |
|--|-------------|-------------|
| <u>General filters</u> | | |
| All U.S. domestic securities on 9/30/2001 | 2579 | 3949 |
| Dual-class stock | -215 | -147 |
| Non-common-stock securities | -967 | -215 |
| No price on 9/30/2001 | -6 | -38 |
| No SIC code on 9/30/2001 | -1 | -1 |
| No financial statement data 9/30 - 12/31/2001 | -79 | -259 |
| No daily price data 10/1/1999 - 12/31/2001 | -65 | -495 |
| | <i>1246</i> | <i>2794</i> |
| <u>Trading filters 7/1 - 9/30/2001</u> | | |
| Switched trading venue | -6 | -5 |
| Mean daily trading volume < \$20,000 | -25 | -598 |
| Missing price, any day | -4 | -7 |
| Missing volume, any day | 0 | 0 |
| Change in share class or type | 0 | -2 |
| Lowest price < \$3.00 | -78 | -601 |
| Average daily number of trades < 20 | -64 | -405 |
| | <i>1069</i> | <i>1176</i> |
| <u>Rule 11Ac1-5 filters Nov 2001 to Dec 2002</u> | | |
| No continuous data for at least one category | -26 | -83 |
| Final sample | 1043 | 1093 |

Table 2: Effective spreads on Nasdaq and NYSE market orders

The table is based on monthly SEC rule 11Ac1-5 execution-quality reports between November 2001 and December 2002. Panels A and B use 249 Nasdaq-NYSE matched pairs. The Nasdaq sample consist of a dollar-volume stratified sample of 219 securities, plus all 30 securities that were in the top 20 of either market capitalization, dollar volume, or share volume during 2001Q3. The NYSE firms are matched by minimizing the absolute matching error across four dimensions: market capitalization (MCAP), share price (PRC), adjusted daily dollar volume (ADV), and the daily relative price range (RR) during 2001Q3.

Panel A uses execution-quality data on market orders that are based on averages across order sizes and months, weighted by shares executed. It presents statistics on pairwise differences of Nasdaq execution quality - NYSE execution quality. Panels B is based on equation (2) in the text and does not aggregate over time. Instead, the control variables vary over time with observations corresponding to the month of the 11Ac-5 report. The results are based on a regression of pairwise matched differences in execution quality on pairwise differences (Δ) in four control variables ($\ln(\text{MCAP})$, $\ln(1/\text{PRC})$, $\ln(\text{ADV})$, and RR). The intercept measures the Nasdaq-NYSE difference in execution quality.

Panel A: Matched-sample pairwise comparison (249 Nasdaq stocks matched to 249 NYSE stocks)

| | Nasdaq mean | NYSE mean | Mean pairwise difference | p-value of t-statistic | Nasdaq median | NYSE median | Median pairwise difference | Wilcoxon p-value |
|--------------------------|----------------|-----------|--------------------------------|------------------------|------------------|----------------|----------------------------------|------------------|
| Effective spread (in \$) | \$0.114 | \$0.074 | \$0.039 | (0.00) *** | \$0.092 | \$0.069 | \$0.023 | (0.00) *** |
| Effective spread / price | 0.0085 | 0.0059 | 0.0027 | (0.00) *** | 0.0067 | 0.0045 | 0.0009 | (0.00) *** |

Panel B: Monthly panel regression using pairwise differences (249 Nasdaq stocks matched to 249 NYSE stocks, 3423 monthly observations)

| Dependent variable | Intercept | $\Delta\ln(\text{MCAP})$ | $\Delta(1/\text{PRC})$ | $\Delta\ln(\text{ADV})$ | ΔRR | adj. R sq. |
|-----------------------------------|-----------|--------------------------|------------------------|-------------------------|-------------------|------------|
| Δ Effective spread (in \$) | 0.051 | 0.039 | -0.096 | -0.038 | 0.405 | 0.15 |
| (p-value) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | |
| Δ Effective spread / price | 0.0023 | 0.0004 | 0.0083 | -0.0030 | 0.0808 | 0.49 |
| (p-value) | (0.00) | (0.19) | (0.01) | (0.00) | (0.00) | |

Table 3: Effective spreads on Nasdaq and NYSE marketable limit orders

The table is based on monthly SEC rule 11Ac1-5 execution-quality reports between November 2001 and December 2002. Panels A and B use 249 Nasdaq-NYSE matched pairs. The Nasdaq sample consist of a dollar-volume stratified sample of 219 securities, plus all 30 securities that were in the top 20 of either market capitalization, dollar volume, or share volume during 2001Q3. The NYSE firms are matched by minimizing the absolute matching error across four dimensions: market capitalization (MCAP), share price (PRC), adjusted daily dollar volume (ADV), and the daily relative price range (RR) during 2001Q3.

Panel A uses execution-quality data on marketable limit orders that are based on averages across order sizes and months, weighted by shares executed. It presents statistics on pairwise differences of Nasdaq execution quality - NYSE execution quality. Panels B is based on equation (2) in the text and does not aggregate over time. Instead, the control variables vary over time with observations corresponding to the month of the 11Ac-5 report. The results are based on a regression of pairwise matched differences in execution quality on pairwise differences (Δ) in four control variables ($\ln(\text{MCAP})$, $\ln(1/\text{PRC})$, $\ln(\text{ADV})$, and RR). The intercept measures the Nasdaq-NYSE difference in execution quality.

Panel A: Matched-sample pairwise comparison (249 Nasdaq stocks matched to 249 NYSE stocks)

| | Nasdaq mean | NYSE mean | Mean pairwise difference | p-value of t-statistic | Nasdaq median | NYSE median | Median pairwise difference | Wilcoxon p-value |
|--------------------------|----------------|-----------|--------------------------------|------------------------|------------------|----------------|----------------------------------|------------------|
| Effective spread (in \$) | \$0.080 | \$0.040 | \$0.039 | (0.00) *** | \$0.063 | \$0.038 | \$0.023 | (0.00) *** |
| Effective spread / price | 0.0062 | 0.0036 | 0.0027 | (0.00) *** | 0.0047 | 0.0025 | 0.0012 | (0.00) *** |

Panel B: Monthly panel regression using pairwise differences (249 Nasdaq stocks matched to 249 NYSE stocks, 3466 monthly observations)

| Dependent variable | Intercept | $\Delta \ln(\text{MCAP})$ | $\Delta(1/\text{PRC})$ | $\Delta \ln(\text{ADV})$ | ΔRR | adj. R sq. |
|-----------------------------------|-----------|---------------------------|------------------------|--------------------------|--------------------|------------|
| Δ Effective spread (in \$) | 0.051 | 0.027 | -0.058 | -0.028 | 0.184 | 0.13 |
| (p-value) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | |
| Δ Effective spread / price | 0.0025 | -0.0001 | 0.0087 | -0.0021 | 0.0387 | 0.50 |
| (p-value) | (0.00) | (0.37) | (0.00) | (0.00) | (0.00) | |

Appendix: List of matching Nasdaq-NYSE pairs

The Nasdaq sample initially consists of a dollar-volume stratified sample of 219 securities. Then I identify all 35 securities that were in the top 20 of either market capitalization (MCAP), dollar volume, or share volume during 2001Q3. Five of these were already in the initial sample, the remaining 30 are added. Thus, the final sample includes 249 firms. The Top20 indicator identifies the Nasdaq Top20 firms. For each Nasdaq firm in the sample, I then identify one best-matching NYSE firm that is matched by minimizing the absolute matching error across four dimensions: MCAP, share price, adjusted dollar volume, and the daily relative price range during 2001Q3 (see equation (1) in the text).

| Nasdaq | | | NYSE | |
|--------|----------------------------------|-------|--------|---------------------------------|
| Ticker | Name | Top20 | Ticker | Name |
| AMGN | AMGEN INC | 1 | MWD | MORGAN STANLEY DEAN WITTER & CO |
| AMAT | APPLIED MATERIALS INC | 1 | TXN | TEXAS INSTRUMENTS INC |
| AMCC | APPLIED MICRO CIRCUITS CORP | 1 | AMD | ADVANCED MICRO DEVICES INC |
| BEAS | B E A SYSTEMS INC | 1 | EMC | E M C CORP MA |
| BRCO | BROCADE COMMUNICATIONS SYS INC | 1 | MU | MICRON TECHNOLOGY INC |
| CHIR | CHIRON CORP | 1 | KG | KING PHARMACEUTICALS INC |
| CSCO | CISCO SYSTEMS INC | 1 | AOL | A O L TIME WARNER INC |
| COST | COSTCO WHOLESALE CORP | 1 | KSS | KOHL'S CORP |
| EBAY | EBAY INC | 1 | BBY | BEST BUY COMPANY INC |
| FITB | FIFTH THIRD BANCORP | 1 | KMB | KIMBERLY CLARK CORP |
| GENZ | GENZYME CORP | 1 | APC | ANADARKO PETROLEUM CORP |
| INTC | INTEL CORP | 1 | GE | GENERAL ELECTRIC CO |
| JDSU | J D S UNIPHASE CORP | 1 | LU | LUCENT TECHNOLOGIES INC |
| KLAC | K L A TENCOR CORP | 1 | ADI | ANALOG DEVICES INC |
| LLTC | LINEAR TECHNOLOGY CORP | 1 | LOW | LOWES COMPANIES INC |
| MXIM | MAXIM INTEGRATED PRODUCTS INC | 1 | GDT | GUIDANT CORP |
| NTRS | NORTHERN TRUST CORP | 1 | WY | WEYERHAEUSER CO |
| NVLS | NOVELLUS SYSTEMS INC | 1 | PVN | PROVIDIAN FINANCIAL CORP |
| NVDA | NVIDIA CORP | 1 | PCS | SPRINT CORP |
| ORCL | ORACLE CORP | 1 | HD | HOME DEPOT INC |
| PAYX | PAYCHEX INC | 1 | HDI | HARLEY DAVIDSON INC |
| PSFT | PEOPLESOFT INC | 1 | AES | A E S CORP |
| QLGC | QLOGIC CORP | 1 | SFA | SCIENTIFIC ATLANTA INC |
| QCOM | QUALCOMM INC | 1 | PFE | PFIZER INC |
| RFMD | R F MICRO DEVICES INC | 1 | WFT | WEATHERFORD INTL INC NEW |
| SANM | SANMINA HOLDINGS INC | 1 | LSI | L S I LOGIC CORP |
| SOTR | SOUTHTRUST CORP | 1 | MAY | MAY DEPARTMENT STORES CO |
| SUNW | SUN MICROSYSTEMS INC | 1 | BA | BOEING CO |
| VRSN | VERISIGN INC | 1 | JPM | J P MORGAN CHASE & CO |
| VRTS | VERITAS SOFTWARE CORP | 1 | T | A T & T CORP |
| BRCM | BROADCOM CORP | 1 | Q | QWEST COMMUNICATIONS INTL INC |
| DELL | DELL COMPUTER CORP | 1 | MER | MERRILL LYNCH & CO INC |
| MSFT | MICROSOFT CORP | 1 | C | CITIGROUP INC |
| PMCS | P M C SIERRA INC | 1 | MOT | MOTOROLA INC |
| SEBL | SIEBEL SYSTEMS INC | 1 | CD | CENDANT CORP |
| COMS | 3COM CORP | 0 | VRC | VARCO INTERNATIONAL INC DEL |
| ALTR | ALTERA CORP | 0 | CPN | CALPINE CORP |
| AEOS | AMERICAN EAGLE OUTFITTERS INC NE | 0 | TER | TERADYNE INC |
| ANAT | AMERICAN NATIONAL INS CO | 0 | CBH | COMMERCE BANCORP INC NJ |
| ANDW | ANDREW CORP | 0 | CRA | APPLERA CORP |

| | | | | |
|------|---------------------------------|---|-----|-----------------------------------|
| APPB | APPLEBEES INTERNATIONAL INC | 0 | YRK | YORK INTL CORP NEW |
| ADSK | AUTODESK INC | 0 | NBL | NOBLE AFFILIATES INC |
| CELG | CELGENE CORP | 0 | IRF | INTERNATIONAL RECTIFIER CORP |
| CEPH | CEPHALON INC | 0 | LEN | LENNAR CORP |
| CMVT | COMVERSE TECHNOLOGY INC | 0 | HAL | HALLIBURTON COMPANY |
| CYTC | CYTYC CORP | 0 | DO | DIAMOND OFFSHORE DRILLING INC |
| DLTR | DOLLAR TREE STORES INC | 0 | CY | CYPRESS SEMICONDUCTOR CORP |
| ERTS | ELECTRONIC ARTS INC | 0 | COF | CAPITAL ONE FINANCIAL CORP |
| JKHY | HENRY JACK & ASSOC INC | 0 | OCR | OMNICARE INC |
| HGSI | HUMAN GENOME SCIENCES INC | 0 | NSM | NATIONAL SEMICONDUCTOR CORP |
| IFIN | INVESTORS FINANCIAL SERVS CORP | 0 | JEC | JACOBS ENGINEERING GROUP INC |
| LNCR | LINCARE HOLDINGS INC | 0 | HCR | MANOR CARE INC NEW |
| MVSN | MACROVISION CORPORATION | 0 | CAM | COOPER CAMERON CORP |
| MEDI | MEDIMMUNE INC | 0 | BHI | BAKER HUGHES INC |
| NATI | NATIONAL INSTRUMENTS CORP | 0 | CNX | CONSOL ENERGY INC |
| NTAP | NETWORK APPLIANCE INC | 0 | BJS | B J SERVICES CO |
| ORLY | O REILLY AUTOMOTIVE INC | 0 | HP | HELMERICH & PAYNE INC |
| PDCO | PATTERSON DENTAL CO | 0 | TRI | TRIAD HOSPITALS INC |
| PIXR | PIXAR | 0 | NDE | INDYMAC BANCORP INC |
| BPOP | POPULAR INC | 0 | TSS | TOTAL SYSTEM SERVICES INC |
| QSFT | QUEST SOFTWARE INC | 0 | CCI | CROWN CASTLE INTERNATIONAL CORP |
| QTRN | QUINTILES TRANSNATIONAL CORP | 0 | ESV | E N S C O INTERNATIONAL INC |
| RLRN | RENAISSANCE LEARNING INC | 0 | NFX | NEWFIELD EXPLORATION CO |
| RESP | RESPIRONICS INC | 0 | HAR | HARMAN INTERNATIONAL INDS INC NEW |
| SYMC | SYMANTEC CORP | 0 | SII | SMITH INTERNATIONAL INC |
| TLAB | TELLABS INC | 0 | JBL | JABIL CIRCUIT INC |
| USAI | U S A NETWORKS INC | 0 | JCP | PENNEY J C INC |
| TTEN | 3 T E C ENERGY CORP | 0 | NCS | N C I BUILDING SYSTEMS INC |
| ACDO | ACCREDITO HEALTH INC | 0 | SKE | SPINNAKER EXPLORATION CO |
| AFFX | AFFYMETRIX INC | 0 | NOI | NATIONAL OILWELL INC |
| PCSA | AIRGATE P C S INC | 0 | RYL | RYLAND GROUP INC A |
| ALSC | ALLIANCE SEMICONDUCTOR CORP | 0 | CHB | CHAMPION ENTERPRISES INC |
| ALOY | ALLOY INC | 0 | LSS | LONE STAR TECHNOLOGIES INC |
| AMSY | AMERICAN MANAGEMENT SYSTEMS INC | 0 | DY | DYCOM INDUSTRIES IN |
| AMWD | AMERICAN WOODMARK CORP | 0 | TRR | T R C COMPANIES INC |
| ABCW | ANCHOR BANCORP WISCONSIN INC | 0 | JLL | JONES LANG LASALLE INC |
| APOG | APOGEE ENTERPRISES INC | 0 | TFS | THREE FIVE SYSTEMS INC |
| AGII | ARGONAUT GROUP INC | 0 | CDI | C D I CORP |
| ASTE | ASTEC INDUSTRIES INC | 0 | DRQ | DRIL QUIP INC |
| APWR | ASTROPOWER INC | 0 | PRX | PHARMACEUTICAL RESOURCES INC |
| BEBE | BEBE STORES INC | 0 | SAH | SONIC AUTOMOTIVE INC |
| BBOX | BLACK BOX CORP DEL | 0 | SGR | SHAW GROUP INC |
| CSAR | CARAUSTAR INDUSTRIES INC | 0 | GRB | GERBER SCIENTIFIC INC |
| CEGE | CELL GENESYS INC | 0 | ENZ | ENZO BIOCHEM INC |
| CHDN | CHURCHILL DOWNS INC | 0 | TRC | TEJON RANCH CO |
| CTBK | CITYBANK LYNNWOOD WASHINGTON | 0 | BDG | BANDAG INC |
| COLM | COLUMBIA SPORTSWEAR COMPANY | 0 | BBI | BLOCKBUSTER INC |
| CRXA | CORIXA CORP | 0 | CKP | CHECKPOINT SYSTEMS INC |
| CSGP | COSTAR GROUP INC | 0 | MKT | ADVANCED MARKETING SERVICES INC |
| CRGN | CURAGEN CORP | 0 | CVD | COVANCE INC |
| CYBX | CYBERONICS INC | 0 | SOL | SOLA INTERNATIONAL INC |
| DLIA | DELIAS CORP | 0 | RRC | RANGE RESOURCES CORP |
| DIGL | DIGITAL LIGHTWAVE INC | 0 | PDE | PRIDE INTERNATIONAL INC DEL |

| | | | | |
|------|----------------------------------|---|-----|--------------------------------|
| DCTM | DOCUMENTUM INC | 0 | TWR | TOWER AUTOMOTIVE INC |
| DCLK | DOUBLECLICK INC | 0 | ETS | ENTERASYS NETWORK INC |
| DYII | DYNACQ INTERNATIONAL INC | 0 | STW | STANDARD COMMERCIAL CORP |
| EXAR | EXAR CORP | 0 | PWR | QUANTA SERVICES INC |
| FFIV | F 5 NETWORKS INC | 0 | KMX | CIRCUIT CITY STORES INC |
| FBAN | F N B CORP PA | 0 | MTW | MANITOWOC INC |
| FINL | FINISH LINE INC | 0 | PVH | PHILLIPS VAN HEUSEN CORP |
| FTFC | FIRST FEDERAL CAPITAL CORP | 0 | PRA | PROASSURANCE CORP |
| FFBC | FIRST FINANCIAL BANCORP OHIO | 0 | RDK | RUDDICK CORP |
| FPFC | FIRST PLACE FINANCIAL CORP NM | 0 | PNN | PENN ENGINEERING & MFG CORP |
| GLDB | GOLD BANC CORP INC | 0 | GES | GUESS INC |
| GTRC | GUITAR CENTER INC | 0 | HDL | HANDLEMAN CO |
| HBHC | HANCOCK HOLDING CO | 0 | CW | CURTISS WRIGHT CORP |
| HDWR | HEADWATERS INC | 0 | SEI | SEITEL INC |
| HOTT | HOT TOPIC INC | 0 | CHS | CHICOS FAS INC |
| IDXX | I D E X X LABORATORIES INC | 0 | WGR | WESTERN GAS RESOURCES INC |
| IMGN | IMMUNOGEN INC | 0 | UNT | UNIT CORP |
| IMDC | INAMED CORP | 0 | LNY | LANDRYS RESTAURANTS INC |
| ISSX | INTERNET SECURITY SYSTEMS INC | 0 | RDC | ROWAN COMPANIES INC |
| ISLE | ISLE OF CAPRI CASINOS INC | 0 | PWN | CASH AMERICA INTERNATIONAL INC |
| JDAS | J D A SOFTWARE GROUP INC | 0 | BHE | BENCHMARK ELECTRONICS INC |
| KNSY | KENSEY NASH CORP | 0 | TTI | TETRA TECHNOLOGIES INC |
| KEYS | KEYSTONE AUTOMOTIVE INDS INC | 0 | TWP | TREX INC |
| NITE | KNIGHT TRADING GROUP INC | 0 | OO | OAKLEY INC |
| LGTO | LEGATO SYSTEMS INC | 0 | KEG | KEY ENERGY SERVICES INC |
| LTBG | LIGHTBRIDGE INC | 0 | BGC | GENERAL CABLE CORP DEL NEW |
| LFIN | LOCAL FINANCIAL CORP | 0 | IDT | I D T CORP |
| MSBK | MAIN STREET BANKS INC | 0 | ESL | ESTERLINE TECHNOLOGIES CORP |
| MANH | MANHATTAN ASSOCIATES INC | 0 | CHP | C & D TECHNOLOGIES INC |
| MANU | MANUGISTICS GROUP INC | 0 | GTW | GATEWAY INC |
| MCSI | MCSI INC | 0 | MNS | M S C SOFTWARE CORP |
| MMSI | MERIT MEDICAL SYSTEMS INC | 0 | SFY | SWIFT ENERGY CO |
| MOVI | MOVIE GALLERY INC | 0 | ASF | ADMINISTAFF INC |
| NBTB | N B T BANCORP INC | 0 | TCC | TRAMMELL CROW CO |
| NAUT | NAUTICA ENTERPRISES INC | 0 | MWY | MIDWAY GAMES INC |
| OLOG | OFFSHORE LOGISTICS INC | 0 | KWD | KELLWOOD COMPANY |
| OCAS | OHIO CASUALTY CORP | 0 | EYE | V I S X INC |
| OSUR | ORASURE TECHNOLOGIES INC | 0 | VTA | VESTA INSURANCE GROUP INC |
| PRXL | PAREXEL INTERNATIONAL CORP | 0 | WLM | WELLMAN INC |
| PRKR | PARKERVISION INC | 0 | NEV | NUEVO ENERGY CO |
| PEGS | PEGASUS SOLUTIONS INC | 0 | ITN | INTERTAN INC |
| PIOS | PIONEER STANDARD ELECTRONICS INC | 0 | TGX | THERAGENICS CORP |
| PLXS | PLEXUS CORP | 0 | PCP | PRECISION CASTPARTS CORP |
| POWI | POWER INTEGRATIONS INC | 0 | WMS | W M S INDUSTRIES INC |
| RADS | RADIANT SYSTEMS INC | 0 | ALN | ALLEN TELECOM INC |
| RARE | RARE HOSPITALITY INTL INC | 0 | PPD | PRE PAID LEGAL SERVICES INC |
| RBNC | REPUBLIC BANCORP | 0 | UCI | UICI |
| SBAC | S B A COMMUNICATIONS CORP | 0 | AXL | AMERICAN AXLE & MFG HLGDS INC |
| POOL | S C P POOL CORP | 0 | SPF | STANDARD PACIFIC CORP NEW |
| SNDK | SANDISK CORP | 0 | ANN | ANNTAYLOR STORES CORP |
| SASR | SANDY SPRING BANCORP INC | 0 | AWR | AMERICAN STATES WATER CO |
| SCIO | SCIOS INC | 0 | ACI | ARCH COAL INC |
| SECD | SECOND BANCORP INCORPORATED | 0 | CGX | CONSOLIDATED GRAPHICS INC |

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|------|----------------------------------|---|-----|---------------------------------|
| SHFL | SHUFFLE MASTER INC | 0 | ZQK | QUIKSILVER INC |
| TSFG | SOUTH FINL GROUP INC | 0 | OLN | OLIN CORP |
| SLNK | SPECTRALINK CORP | 0 | PBY | PEP BOYS MANNY MOE & JACK |
| SRCL | STERICYCLE INC | 0 | CRY | CRYOLIFE INC |
| STEI | STEWART ENTERPRISES INC | 0 | OI | OWENS ILL INC |
| SYKE | SYKES ENTERPRISES INC | 0 | OMM | O M I CORP NEW |
| SCTC | SYSTEMS & COMPUTER TECHNOLOGY | 0 | NR | NEWPARK RESOURCES INC |
| TGIC | TRIAD GUARANTY INC | 0 | CKH | SEACOR HOLDINGS INC |
| TRMB | TRIMBLE NAVIGATION LTD | 0 | CTS | C T S CORP |
| TRMS | TRIMERIS INC | 0 | EVG | EVERGREEN RESOURCES INC |
| TRYF | TROY FINANCIAL CORP | 0 | CV | CENTRAL VERMONT PUB SVC CORP |
| TUES | TUESDAY MORNING CORP | 0 | DNR | DENBURY RESOURCES INC |
| UNBJ | UNITED NATIONAL BANCORP NJ | 0 | THO | THOR INDUSTRIES INC |
| UNFI | UNITED NATURAL FOODS INC | 0 | GPI | GROUP 1 AUTOMOTIVE INC |
| UEIC | UNIVERSAL ELECTRONICS INC | 0 | MPH | CHAMPIONSHIP AUTO RACING TM INC |
| USFC | USFREIGHTWAYS CORP | 0 | SUP | SUPERIOR INDUSTRIES INTL INC |
| VARI | VARIAN INC | 0 | FDS | FACTSET RESEARCH SYSTEMS INC |
| WFSI | W F S FINANCIAL INC | 0 | TG | TREDEGAR CORP |
| WDFC | WD-40 CO | 0 | STC | STEWART INFORMATION SVCS CORP |
| WCBO | WEST COAST BANCORP ORE NEW | 0 | RNT | AARON RENTS INC |
| ZOLL | ZOLL MEDICAL CORP | 0 | ATW | ATWOOD OCEANICS INC |
| ANSI | ADVANCED NEUROMODULATION SYS INC | 0 | CGC | CASCADE NATURAL GAS CORP |
| ALCO | ALICO INC | 0 | SKY | SKYLINE CORP |
| ALLE | ALLEGIANT BANCORP INC | 0 | RSC | REX STORES CORP |
| ASGR | AMERICA SERVICE GROUP INC | 0 | CSV | CARRIAGE SERVICES INC |
| AINN | APPLIED INNOVATION INC | 0 | KTO | K 2 INC |
| ARTI | ARTISAN COMPONENTS INC | 0 | HKF | HANCOCK FABRICS INC |
| AVTR | AVATAR HOLDINGS INC | 0 | NTK | NORTEK INC |
| AVID | AVID TECHNOLOGY INC | 0 | SIE | SIERRA HEALTH SERVICES INC |
| OZRK | BANK OF THE OZARKS INC | 0 | CRN | CORNELL COMPANIES INC |
| BSET | BASSETT FURNITURE INDUSTRIES INC | 0 | OSM | OSMONICS INC |
| BELM | BELL MICROPRODUCTS INC | 0 | NSS | N S GROUP INC |
| BJCT | BIOJECT MEDICAL TECHNOLOGIES INC | 0 | CPE | CALLON PETROLEUM CO DEL |
| BCGI | BOSTON COMMUNICATION GROUP INC | 0 | KEI | KEITHLEY INSTRUMENTS INC |
| BUCA | BUCA INC | 0 | MVK | MAVERICK TUBE CORP |
| CCCG | C C C INFORMATION SVCS GROUP INC | 0 | CAO | C S K AUTO CORP |
| CLZR | CANDELA CORP | 0 | ENC | ENESCO GROUP INC |
| CLRS | CLARUS CORP DEL | 0 | USG | U S G CORP |
| CMTL | COMTECH TELECOMMUNICATIONS CORP | 0 | TT | TRANSTECHNOLOGY CORP |
| CVAS | CORVAS INTERNATIONAL INC | 0 | FWC | FOSTER WHEELER LTD |
| CCEL | CRYO CELL INTERNATIONAL INC | 0 | CKR | C K E RESTAURANTS INC |
| CYGN | CYGNUS INC | 0 | MTZ | MASTEC INC |
| DSSI | DATA SYSTEMS & SOFTWARE INC | 0 | WZR | WISER OIL CO |
| DIOD | DIODES INC | 0 | LMS | LAMSON & SESSIONS CO |
| EMBX | EMBEX INC | 0 | HEI | HEICO CORP NEW |
| ENMD | ENTREMED INC | 0 | RTI | R T I INTERNATIONAL METALS INC |
| FESX | FIRST ESSEX BANCORP INC | 0 | MHO | M I SCHOTTENSTEIN HOMES INC NEW |
| FMAR | FIRST MARINER BANCORP | 0 | GI | GIANT INDUSTRIES INC |
| FFBK | FLORIDAFIRST BANCORP INC NEW | 0 | LAD | LITHIA MOTORS INC |
| FLOW | FLOW INTERNATIONAL CORP | 0 | SRI | STONERIDGE INC |
| GMCR | GREEN MOUNTAIN COFFEE INC | 0 | KDE | 4 KIDS ENTERTAINMENT INC |
| GRKA | GREKA ENERGY CORP | 0 | FOB | BOYDS COLLECTION LTD |
| GSOE | GROUP 1 SOFTWARE INC NEW | 0 | IMR | I M C O RECYCLING INC |

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|------|---------------------------------|---|-----|---------------------------------|
| HEPH | HOLLIS EDEN PHARMACEUTICALS INC | 0 | DFS | DEPARTMENT 56 INC |
| ICTG | I C T GROUP INC | 0 | LDL | LYDALL INC |
| IIVI | II VI INC | 0 | OFG | ORIENTAL FINANCIAL GROUP INC |
| IMCO | IMPCO TECHNOLOGIES INC | 0 | VTS | VERITAS D G C INC |
| JJSF | J & J SNACK FOODS CORP | 0 | SRT | STARTEK INC |
| JACO | JACO ELECTRONICS INC | 0 | FJC | FEDDERS CORP |
| JOSB | JOS A BANK CLOTHIERS INC | 0 | CBZ | COBALT CORP |
| KVHI | K V H INDUSTRIES INC | 0 | RWY | RENT WAY INC |
| LJPC | LA JOLLA PHARMACEUTICAL CO | 0 | HXL | HEXCEL CORP NEW |
| LOJN | LO JACK CORP | 0 | DAB | DAVE & BUSTERS INC |
| LNET | LODGENET ENTERTAINMENT CORP | 0 | MEH | MIDWEST EXPRESS HOLDINGS INC |
| MIPS | M I P S TECHNOLOGIES INC | 0 | SFP | SALTON INC |
| SHOO | MADDEN STEVEN LTD | 0 | FLE | FLEETWOOD ENTERPRISES INC |
| MTSN | MATTSON TECHNOLOGY INC | 0 | SKS | SAKS INC |
| MESA | MESA AIR GROUP INC NEV | 0 | PME | PENTON MEDIA INC |
| MSSN | MISSION RESOURCES CORP | 0 | MMR | MCMORAN EXPLORATION CO |
| NUCO | N U C O 2 INC | 0 | RES | R P C INC |
| NARA | NARA BANCORP INC | 0 | CPY | C P I CORP |
| NEOG | NEOGEN CORP | 0 | UAG | UNITED AUTO GROUP INC |
| OGLE | OGLEBAY NORTON CO | 0 | AZZ | A Z Z INC |
| OSBC | OLD SECOND BANCORP INC | 0 | OXM | OXFORD INDUSTRIES INC |
| ONXX | ONYX PHARMACEUTICALS INC | 0 | UNA | UNOVA INC |
| PBIX | PATRIOT BANK CORP NEW | 0 | HUF | HUFFY CORP |
| PTIX | PERFORMANCE TECHNOLOGIES INC | 0 | INT | WORLD FUEL SERVICES CORP |
| PHAR | PHARMANETICS INC | 0 | OS | OREGON STEEL MILLS INC |
| QRSI | Q R S CORP | 0 | APN | APPLICA INC |
| RNBO | RAINBOW TECHNOLOGIES INC | 0 | MWL | MAIL WELL INC |
| RCOT | RECOTON CORP | 0 | CDT | CABLE DESIGN TECHNOLOGIES CORP |
| REFR | RESEARCH FRONTIERS INC | 0 | CHH | CHOICE HOTELS INTERNATIONAL INC |
| RELL | RICHARDSON ELECTRONICS LTD | 0 | CAE | CASCADE CORP |
| RGLD | ROYAL GOLD INC | 0 | AVL | AVIALL INC NEW |
| SCAI | SANCHEZ COMPUTER ASSOC INC | 0 | CRK | COMSTOCK RESOURCES INC |
| SAFM | SANDERSON FARMS INC | 0 | POP | POPE & TALBOT INC |
| STCO | SIGNAL TECHNOLOGY CORP | 0 | CKC | COLLINS & AIKMAN CORP NEW |
| SPEX | SPHERIX INC | 0 | LUB | LUBYS INC |
| SSNC | SS & C TECHNOLOGIES INC | 0 | ACO | AMCOL INTERNATIONAL CORP |
| STLY | STANLEY FURNITURE CO NEW | 0 | SWM | SCHWEITZER MAUDUIT INTL INC |
| STTX | STEEL TECHNOLOGIES INC | 0 | SHS | SAUER DANFOSS INC |
| STSA | STERLING FINANCIAL CORP WASH | 0 | MFI | MICROFINANCIAL INC |
| SNBC | SUN BANCORP INC | 0 | PCU | SOUTHERN PERU COPPER CORP |
| SUPC | SUPERIOR CONSULTANT HLDNG CORP | 0 | AOR | AURORA FOODS INC |
| SYNM | SYNTROLEUM CORP | 0 | HYC | HYPERCOM CORP |
| WRLS | TELULAR CORP | 0 | FMT | FREMONT GENERAL CORP |
| TRFX | TRAFFIX INC | 0 | BYD | BOYD GAMING CORP |
| PANL | UNIVERSAL DISPLAY CORP | 0 | WNC | WABASH NATIONAL CORP |
| URBN | URBAN OUTFITTERS INC | 0 | BWS | BROWN SHOE INC NEW |
| VLNC | VALENCE TECHNOLOGY INC | 0 | MPS | MODIS PROFESSIONAL SERVICES INC |
| VXGN | VAXGEN INC | 0 | GFF | GRIFFON CORP |
| XICO | XICOR INC | 0 | IKN | IKON OFFICE SOLUTIONS INC |
| ZIGO | ZYGO CORP | 0 | ABF | AIRBORNE INC |
