# Trading Patterns, Bid-Ask Spreads and Estimated Security Returns: The Case of Common Stocks at Calendar Turning Points

by

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## ABSTRACT

Returns computed with closing bid or ask prices that may not represent "true" prices imparts measurement error into portfolio returns if investor buying and selling behavior displays systematic patterns. This paper finds systematic tendencies for closing prices to be recorded at the bid in December and at the ask in early January. After controlling for changing bid and ask prices, this pattern results in large portfolio returns on the two trading days surrounding the end of the year, especially for low-price stocks. Other temporal return patterns (e.g., weekend and holiday effects) are also related to systematic trading patterns.


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## 1. Introduction

Stock returns used in most empirical finance research are computed with closing bid or ask prices that may not represent "true" prices at which market orders would cross in a trade not involving a market maker.[1] Computing stock returns with closing transaction prices may, therefore, impart measurement error into portfolio returns in the presence of systematic patterns in the relative frequencies of bid vs. ask transaction prices.[2] Keim and Stambaugh (1984) entertain such measurement error as a possible explanation of the "weekend effect."

This paper considers such measurement error as a partial explanation of systematic patterns in stock returns associated with calendar turning points such as the turn of the year and beginning of the week. The bulk of the analysis is couched in terms of the turn-of-the-year effect since this is the most dramatic temporal return pattern. The turn of the year is also a period that exhibits a distinct shift in investor buying and selling behavior--the abrupt end of tax-loss selling at the end of the year. We use a new data file that contains closing bid, ask and transaction prices and permits (1) examination of patterns in relative frequencies of bid vs. ask end-of-day transaction prices, and (2) computation of the "bias" defined as the

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[1]The adverse selection model of the bid-ask spread proposed by Bagehot (1971) and Glosten and Milgrom (1985) argues that a relatively uninformed market maker, when confronted with an information-motivated order, will revise his expectation of the future stock value and incorporate the revised expectations into the bid and ask quotes. That is, transactions prices observed at the bid or ask may reflect the "true" price. Although empirical tests of the components of the bid-ask spread (e.g., Glosten and Harris (1988), Hasbrouck (1988) and Stoll (1989)) offer some support for the adverse selection model, there is also considerable support for inventory models of the spread that suggest the "true" price lies inside the market maker's bid-ask quotes.

[2]Admati and Pfleiderer (1988) develop a model in which expected price changes are related to patterns in buy and sell volume. See also Brock and Kleidon (1989).

difference between returns computed with transaction prices and returns computed with bid prices.[3]

The outline of the paper is as follows. Section 2 contains an example that demonstrates the extent to which such a bias may pervade returns computed with transaction prices (e.g., those provided by the Center for Research in Security Prices). Section 3 directly measures the impact of systematic trading patterns on computed returns at the turn of the year via the closing bid, ask and transaction prices for OTC National Market System Stocks for the five turn-of-the-year periods from 1983 to 1988. Based on the evidence for the OTC market, the large returns for small stocks relative to large stocks on the last trading day and the first trading day of the year is partly attributable to the "trading pattern" bias. Section 4 shows with data for the 1988-89 TOY period that these observations for the OTC stocks generalize to NYSE and AMEX stocks. Section 5 demonstrates that the bias discussed here may also partially explain other temporal return patterns, and uses the weekend and holiday effects as examples. The paper concludes with a brief summary.

## 2. Systematic trading patterns, bid-ask spreads and returns

Most studies of the behavior of the stock market use stock returns provided by CRSP. These returns are computed using the last transaction price of the day on days when the stock trades. On days when the stock does not trade, the price used in a return calculation is the average of the last bid and ask prices. Thus, the two prices used to compute a daily return are some combination of a bid, ask or average of the bid and ask. In the absence of systematic patterns in seller (buyer) initiated trades or in the amount of

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[3]Phillips and Smith (1980) discuss a similar bias in measured profits from trading rules in the options markets that results from the use of transaction prices rather than bid or ask quotes.

nontrading, returns calculated in this manner present no particular problem. However, such conditions do not always exist. One example is the turn-of-the-year period. The next sections cite evidence of systematic trading patterns at the turn of the year, and then present an example of how these patterns might induce a turn-of-the-year effect into computed transaction returns, even when bid (or ask) prices do not change.

### 2.1 Trading frequency around the turn of the year

Lakonishok and Smidt (1984), using volume data for NYSE and AMEX firms from the Cornell University Price and Volume file, find systematic patterns in trading frequencies for smaller firms surrounding the end of the year. In particular, they find relatively higher trading frequency immediately before the end of the year and relatively lower trading frequency after year end. The same information can be gleaned from the CRSP Daily Master file which flags stocks that do not trade on a particular day with the negative value of the average of the end-of-day bid and ask prices. Table 1 contains a summary of the trading frequencies drawn from the CRSP file for size-sorted categories for the combined NYSE and AMEX (Panel A) and also separately (Panels B and C). The categories are created by sorting securities on market value of common equity based on prices and number of shares outstanding on the last trading day of November preceding the turn of the year, and allocating securities to ten categories containing equal numbers of securities.

The ten columns in each of the three panels in Table 1 report the percentage of the total sample of stocks that do not trade on each day surrounding the end of the year, both individually (columns 1 to 6) and cumulatively for the first four days of the new year (columns 7 to 10). I report percentages only for the post-1971 period because for the eight-year period from 1964 to 1971 the CRSP file contains no negative prices (a finding

that would imply all stocks traded every day).[4] Consistent with evidence in Lakonishok and Smidt (1984), the evidence for the combined sample of NYSE and AMEX firms indicates more nontrading among smaller capitalization firms in the first few days of January, relative to the end of December. On average, 27 percent of the firms in the smallest decile do not trade on the first trading day of the year. By the second day of the year, 12 percent of these firms have still not traded; and by the end of the fourth day, 3 percent of the smallest firms have yet to trade. For the larger firms, the level of non-trading is minimal and there are no apparent patterns in the data.

Panels B and C of Table 1 report the same information separately for NYSE and AMEX stocks respectively. These deciles are the outcome of size rankings conducted separately for each exchange. For the NYSE firms in Panel B there is more nontrading after the year end relative to the last couple days of the year, but the levels of nontrading are minimal: the highest frequency of nontrading is four percent for the smallest size decile on the first two days of the year. All stocks trade at least once by the second day of the year except for those in the smallest decile. On the other hand, there is substantial nontrading for the AMEX stocks over the first four days of the new year. On average, 36 percent of the AMEX stocks did not trade on the first trading day of the new year, and 6 percent have still not traded by the fourth day. For the larger AMEX stocks, this pattern in trading at the end of the year is greatly diminished.[5]

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[4]See Foerster and Keim (1988) for a more complete discussion of the frequency of trading implied by CRSP's recording of negative prices. They examine back issues of the Wall Street Journal and find numerous cases of nontrading during the 1964-1971 period.

[5]The percentage of stocks that did not trade on an average day, for the 1972 to 1987 period, is 1.6% for all NYSE stocks and 15.9% for all AMEX stocks (Foerster and Keim (1989), table 3).

## 2.2 Patterns in buyer- vs. seller-initiated trades

Dyl (1977) reports an abnormal selling volume in the shares of losers (for tax reasons) at the end of the calendar year. Lakonishok and Smidt (1984) examine the "closing ratio" [(close-low)/(high-low)] and conclude that "for small companies there is some selling pressure till the last day of December" and a change from selling pressure to buying pressure begins on December 31. Ritter (1988) finds corroborating evidence. These results are consistent with Roll's (1983a) conjecture that part of the turn-of-the-year effect is due to a shift from transactions at the bid to transactions at the ask. Direct evidence on this conjecture is provided below in sections 3 and 4.

## 2.3 Systematic trading patterns and computed returns: an example

Given the trading patterns discussed above, consider the following expression for the closing price of stock i on day t:

$$\tilde{P}_{it} = \tilde{x}_{it}[\tilde{w}_{it}\,\tilde{P}^{B}_{it} + (1 - \tilde{w}_{it})\tilde{P}^{A}_{it}] + (1 - \tilde{x}_{it})(\tilde{P}^{B}_{it} + \tilde{P}^{A}_{it})/2$$

$$= \tilde{x}_{it}[\tilde{w}_{it}\,\tilde{P}^{B}_{it} + (1 - \tilde{w}_{it})(1 + \tilde{s}_{it})\tilde{P}^{B}_{it}] + (1 - \tilde{x}_{it})[\tilde{P}^{B}_{it} + (1 + \tilde{s}_{it})\tilde{P}^{B}_{it}]/2 \quad (1)$$

where $\tilde{P}^{B}_{it}$ = final bid price for stock i on day t,

$\tilde{P}^{A}_{it}$ = final ask price for stock i on day t,

$\tilde{s}_{it}$ = bid-ask spread relative to the bid price $[(\tilde{P}^{A}_{it} - \tilde{P}^{B}_{it})/\tilde{P}^{B}_{it}]$

$$\tilde{w}_{it} = \begin{cases} 1 \text{ with probability } q_t \text{ if the closing price is a bid at t} \\ 0 \text{ otherwise, with probability } (1 - q) \end{cases}$$

$$\tilde{x}_{it} = \begin{cases} 1 \text{ with probability } p_t \text{ if the stock trades on day t} \\ 0 \text{ otherwise, with probability } (1 - p) \end{cases}$$

The first term in brackets on the RHS of eq(1) represents the transaction price which is dependent on the probability of the closing price occurring at

the bid or the ask. The second term in brackets incorporates the possibility of nontrading into the price formulation, and reflects CRSP's policy of recording this price midway between the bid and the ask.[6]

Using eq(1), with some rearrangement, we can express the computed return for security i on day t as

$$\tilde{R}_{it} = \frac{\{\tilde{x}_{it}[\tilde{w}_{it}+(1-\tilde{w}_{it})(1+\tilde{s}_{it})] + \frac{1}{2}(1-\tilde{x}_{it}) + \frac{1}{2}(1-\tilde{x}_{it})(1+\tilde{s}_{it})\}\tilde{P}^{B}_{it}}{\{\tilde{x}_{it-1}[\tilde{w}_{it-1}+(1-\tilde{w}_{it-1})(1+\tilde{s}_{it-1})]+\frac{1}{2}(1-\tilde{x}_{it-1})+\frac{1}{2}(1-\tilde{x}_{it-1})(1+\tilde{s}_{it-1})\}\tilde{P}^{B}_{it-1}} - 1 \quad (2)$$

Consider the case of no change in bid price over the interval. Under this scenario, equation (2) measures the movement within the bid-ask spread. Assume also that the magnitude of the spread ($s_{it}$) does not change through time, but that the probability of a closing bid price, $q_t$, or the probability of a trade, $p_t$, is conditional on day t. In this case, the expected value of the movement within the spread is approximated (due to Jensen's inequality) as

$$E(\tilde{\delta}) = \frac{p_t q_t + p_t(1-q_t)(1+\bar{s}) + \frac{1}{2}(1-p_t) + \frac{1}{2}(1-p_t)(1+\bar{s})}{p_{t-1}q_{t-1} + p_{t-1}(1-q_{t-1})(1+\bar{s}) + \frac{1}{2}(1-p_{t-1}) + \frac{1}{2}(1-p_{t-1})(1+\bar{s})} - 1 . \quad (3)$$

Table 2 contains values for the expected movement within the spread, as expressed in eq(3), for a representative low-price security on the first trading day of the year. The probabilities of the occurrence of a transaction

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[6]As written, equation (1) assumes the same closing bid and ask prices whether a trade occurs or not. Also, equation (1) does not account for transactions at prices occurring inside the bid-ask spread. For the NASDAQ stocks analyzed in section 3 this is not critical since trades take place at the bid or the ask (although due to nonsynchronous closing bid-ask quotes and final transaction prices, quotes and transaction prices may not coincide). For AMEX and, especially, NYSE stocks that often trade inside the spread, equation (1) will tend to exaggerate the location of the price within the bid and ask bounds.

are based on the combined NYSE-AMEX data surrounding the turn of the year in Table 1. In particular, I assume the probability of a transaction, p, on day t-1 is 95% and the probability of a transaction on day t is 70%. The table reports return values for varying probabilities, $q_t$, of a bid price on day t and day t-1, and assumes no change in the bid price or in the bid-ask spread from day t-1 to t. The bid-ask spread is assumed to be 6% stated relative to the bid price. This is a representative bid-ask spread for NYSE, AMEX and OTC NMS stocks in the bottom decile of market capitalization as of December 23, 1988.[7] Bid-ask spreads and daily trading volume for all ten market capitalization categories on each market (based on NYSE market capitalization cutoffs) are reported in the Appendix.

The values in table 2 can be interpreted as measures of the potential trading pattern bias conditional on the probability of the occurrence of a bid (or ask) price at t and t-1. The magnitude of the intra-spread movement can be quite large. For example, the cell in the northeast corner of the table indicates that a movement from the bid price on day t-1 to an ask price at t results in a 4.9% one-day return, even with no change in the bid price. A tendency for stocks with these characteristics to move from a bid price at day t-1 (say, prob. = 70%) to an ask price at t (say, prob. = 40%) yields a bias of 1.5%. The implication is that portfolio returns based on CRSP data will reflect these intra-spread movements if systematic trading patterns lead to a clustering of bid or ask prices.

## 3. Evidence from the OTC market

In April 1982 NASDAQ created the National Market System (NMS), a computerized marketplace for trading in over-the-counter shares. This

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[7]The bid and ask prices are drawn from Bridge Trading Company. Access to the Bridge data was generously provided by Dimensional Fund Advisors.

computerized system provides in machine-readable form much additional market information including end-of-day bid and ask prices as well as end-of-day transaction prices. These data permit identification of systematic tendencies for the final transaction price of the day to occur at the bid or the ask price.

Trading on the NMS during the first year was limited to the most actively-traded stocks (about 80 stocks). By the end of 1983 there were 682 stocks trading on the NMS. The analysis here, therefore, uses NMS stocks during the five turn-of-the-year periods since 1983 (1983-84,,,1987-88). Data for the first two turn-of-the-year periods are drawn from the 1985 CRSP NASDAQ file. The remainder of the data are from tapes provided by the National Association of Securities Dealers.[8]

For each of the five turn-of-the-year periods, I sort all of the NMS stocks on the basis of per-share price as of the last trading day of November.[9] The stocks are equally divided into ten portfolios based on this ranking, the composition of each portfolio remaining the same for each of the forty trading days surrounding the end of the year. The number of stocks per portfolio ranges from about 50 in 1983-84 to about 255 in 1987-88.

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[8]I thank Gene Finn, Chief Economist for NASD, for generously supplying these tapes. After the work reported in this section was complete, CRSP released an updated NASDAQ file ending December 1987. However, the NASD-supplied data extend through January 1988, so the results for the last three TOY periods are based on these data.

[9]I sort on price per share for two reasons. First, sorting on market capitalization or, alternatively, share price produce similar rankings of securities (Stoll & Whaley (1983) and Blume and Stambaugh (1984)). For the sample of NYSE and AMEX stocks used in most studies of size and seasonal effects, the average Spearman rank correlation between year-end rankings based on size and price is greater than .8 over the 1963 to 1987 period. Second, since the bias discussed above is directly related to price per share, sorting by price will illustrate the maximum impact the bias has on measured cross-sectional differences in portfolio returns.

### 3.1 Systematic closing price movements within the spread

First, I investigate the extent to which systematic trading patterns impact the frequency with which a closing price occurs at the closing bid or ask quote.[10] For each of the forty days surrounding the end of the year, I compute the ratio of the number of closing prices at the bid to the number of closing prices at the ask over all NMS stocks in each price portfolio. The ratio reveals divergence from equal frequencies of bid and ask closing transactions for portfolio p on day t. Figure 1 plots the average value of this ratio for the forty days surrounding the end of the year for each portfolio. In December there is a marked tendency for end-of-day prices to occur closer to the bid (i.e., values greater than 1), and this tendency is much stronger for lower-price securities (the ratio is nearly 2 for the smallest price portfolio on the penultimate trading day of the year -- i.e., nearly twice as many bids than asks). On the last trading day in December the ratio drops for all the portfolios, but the most impressive drop occurs on the first trading day of the year when for the lowest price portfolio, for example, the ratio drops to .61 -- a tendency to close closer to the ask.[11]

To measure systematic movements within the spread, I compute the within-spread location of the closing price for each NMS stock i for each day t as

$$L_{it} = \frac{\text{Closing Price}_{it} - \text{Bid}_{it}}{\text{Ask}_{it} - \text{Bid}_{it}}$$

where $0 \leq L_{it} \leq 1$, and 0 represents a closing transaction at the bid and 1

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[10]The bid and ask quotes used here are the best (inside) quotes recorded at the 4:00 P.M. close of trading.

[11]A test of whether these patterns are related to tax-loss selling would be to conduct the experiment with portfolios sorted on their potential for tax-loss selling (e.g., price change over the last six months).

represents an ask.[12] I then compute the average value of L over all NMS stocks in portfolio p for each of the forty days

$$\bar{L}_{pt} = \frac{1}{n} \sum_{i=1}^{n} L_{it} .$$

Changes in L measure movements within the spread that are purged of any movement in the bid and ask quotes.

Table 3 reports percentage changes in the value of L for each of the ten portfolios for the sixteen trading days surrounding the end of the year. These values appear in the top row of numbers corresponding to each trading day. On the last and the first trading days of the year there is a tendency for the movements within the spread to be positive and significant, especially for lower-price shares. The mean percentage change in L ranges from 45.93% (t = 10.35) for the lowest price portfolio to 0.29% (t = 0.04) for portfolio 9 on the first trading day of the year. The range on the last trading day of the year is 22.70% (t = 4.41) to 5.42% (t = 0.43). For the remaining days, the values display no obvious pattern and are generally not significantly different than zero. This behavior is consistent with a large return (measured with transaction prices) on the last day and first day of the year, especially when viewed in light of an average bid-ask spread, stated as a percent of the bid price, of about six percent for the stocks in the lowest price decile.

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[12]For synchronous closing prices and bid-ask quotes, this ratio will always equal one or zero for NMS stocks since trades are always with a dealer at his bid or ask. Due to transaction prices that might occur earlier in the day than at the close, there may be reported transaction prices that don't equal the closing bid or ask prices. I use all observations (including non-synchronous observations) to compute the average ratio $\bar{L}_{pt}$. For NYSE and AMEX stocks that might trade inside the bid and ask quotes, the inequalities in the text will hold.

Also note that this trading-pattern bias is apparently not reversed by the end of January. This is perhaps most apparent in Figure 1 where the ratio of bids to asks moves from its highest value at the end of December to its lowest value at the beginning of January. There is, however, no apparent reversal of this pattern during the month of January -- the ratio stays at a value less than 1 for the entire month. The implication is that this trading-pattern bias is embedded in monthly returns computed with end-of-December and end-of-January prices.

### 3.2 The trading pattern bias in returns computed with transaction prices

To measure the potential bias in returns (computed with transaction prices) that arises as a result of systematic trading patterns, I compute returns for each day t only for those securities that traded on both days t and t-1. Returns are computed in two ways: (1) using bid prices only; and (2) using closing transaction prices only. The bias is measured as the difference between the transaction-price returns and the bid-price returns.[13]

The average value of the bias is reported in the bottom row of numbers for each trading day in Table 3 for the ten price portfolios for the last six days of the year and the first ten days of the new year. For most days reported in Table 3 the bias is not significantly different from zero. The bias tends to be significant only on the last day and the first day of the year, and is larger for smaller-price securities. The magnitude of the bias is large enough to produce a turn-of-the-year effect (difference in extreme portfolio biases) of 1.1% and 2.0% on the two days surrounding the turn of the

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[13]The mean, over all days, of the difference between the two index returns represents an estimate of the bid-ask bias discussed by Blume and Stambaugh (1983). See Section 5 for such an estimate over all OTC NMS stocks. Systematic differences in the magnitude of the bias through time reflect the "trading pattern" bias discussed here.

year.[14] This represents a substantial portion of the difference in return between extreme price deciles of NYSE and AMEX stocks for those days. For example, the small-price premium for the two days bracketing the end of the year, for the (almost) comparable 1983 to 1987 period, is 1.1% and 2.6% for NYSE stocks and 3.8% and 4.2% for AMEX stocks.[15]

It is important to point out that the trading-pattern bias does not explain the entire turn-of-the-year effect for OTC stocks. Table 4 reports average returns computed with closing bid prices for the ten price-sorted portfolios for sixteen days surrounding the end of the year for the period from December 1983 to January 1988. It is apparent from Table 4 that the bid-to-bid returns--returns that are not subject to the bias discussed above--do display a unique pattern. The pattern is different, however, from previously reported evidence on the turn-of-the-year effect; the pattern of NMS stock returns around the turn of the year is altered such that the returns occurring on the two days surrounding the end of the year are not substantially larger than the returns for the other days in the beginning of January.[16]

## 4. Evidence from the NYSE and AMEX

The results in section 3 are drawn from data for OTC stocks, but most of the evidence on the turn-of-the-year effect and other temporal return patterns

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[14]The magnitude of this bias will of course vary with the general level of bid-ask spreads. An interesting question concerns the extent to which variation in the levels of bid-ask spreads is related to variation in the magnitude of empirical regularities that have been extensively documented for the past sixty-year period.

[15]These numbers represent the difference in returns between the smallest and largest price deciles computed with data from the 1987 CRSP daily master and return files.

[16]See Williams (1986) and Rock (1988) for models to explain remaining turn-of-the-year price behavior.

is based on data for NYSE and AMEX stocks.[17] An important question concerns the generality of the results across different kinds of market structures. In an attempt to confirm the results from the OTC market for NYSE and AMEX firms, I collected closing bid, ask and transaction prices for the 1988-89 turn-of-the-year period from the Bridge Trading Company for all NYSE, AMEX and OTC NMS stocks. I separated securities by exchange, ranked the AMEX stocks by their end-of-November price and identified ten decile cutoff values. Using these AMEX price decile cutoffs, I allocated stocks from each exchange into ten price portfolios, resulting in separate portfolios across exchanges that contained stocks with approximately the same average price. For example, the lowest price portfolios of NYSE, AMEX and OTC firms contained securities with an average end-of-November bid price of, respectively, $.82, $.77 and $.92. Because of differences in the average price (and size) of stocks trading in the three different markets, however, the portfolios do not contain an equal number of securities.

To determine whether the pattern in buying and selling behavior observed in the OTC stocks is also evident in the NYSE and AMEX markets, I compute frequency distributions of closing prices, relative to closing bid and ask prices, for each of the ten trading days surrounding the end of the year for the ten price deciles on each exchange. The results for the lowest price decile on each exchange are reported in the three panels of figure 2. The figure displays, for all three markets, a very similar pattern in the relative frequencies of closing bid and ask transaction prices surrounding the turn of the year in 1988-89. The pattern is most pronounced for the lower-price

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[17]Exceptions are Lamoureux and Sanger (1987) and Reinganum (1988) who examine OTC stock returns.

stocks shown in figure 2, and becomes less pronounced for the higher-price securities on each market (not shown here).[18]

The systematic bid-ask patterns in figure 2 suggest that a portion of the turn-of-the-year effect in 1988-89 (if one occurred) may be related to the bias discussed in section 3. Thus, I compute transaction-to-transaction and bid-to-bid returns (as described in section 3, but without dividends) for each security, and compute average returns for the ten price deciles described above for each exchange. I measure the turn-of-the-year effect on each day as the difference in returns between the two extreme price deciles. Since the results are similar across the markets I report only the NYSE results for both the transaction and bid returns in figure 3. Consistent with past evidence, low-price stocks substantially outperform high-price stocks on the last trading day in December (3.5%) and the first trading day in January (6.9%) as measured with transaction-price returns. Using returns measured with bid prices, the magnitude of the effect on these two days is approximately cut in half. In figure 4 I report the difference between the transaction- and bid-price returns for each exchange on each day surrounding the end of the year (i.e., the NYSE bar for day +1 in figure 4 equals the difference between the two day +1 bars in figure 3). Except for the OTC NMS stocks on the last trading day in December, the bias is positive and economically significant (1.5 to 2.5 percent) on the two days bracketing the end of the year for each market. Although we are working with a sample of only one turn-of-the-year period, the results suggest the trading-pattern bias in returns (observed for the OTC stocks in section 3) also affects NYSE and AMEX stock returns used in past turn-of-the-year studies.

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[18]Within-spread observations for the OTC securities result from nonsynchronous recording of transaction prices and quotes.

## 5. Are other calendar-related patterns related to systematic trading patterns?

It is natural to ask whether other temporal patterns in security returns are related to the systematic trading patterns discussed here. To examine the day-of-the-week and other patterns that have been documented, I compute the within-spread location of the closing price, L, averaged over all OTC NMS stocks for each day during the entire five years (1983-1987) for which the CRSP NASDAQ file contains bid, ask and closing transaction prices for the OTC NMS stocks. Figure 5 plots this daily series for the period from January 1983 to December 1987. The jump from a tendency for transactions at the bid at the end of December to transactions at the ask in the beginning of January documented in section 3 is readily apparent at each year end in figure 5. What is perhaps even more interesting is the within-year pattern in L: it tends to gradually drop throughout the entire year, reaching its lowest level in December.[19] This is further confirmation that the trading-pattern bias at the turn of the year is embedded in longer-interval returns when the interval begins in December. The pattern is apparent in each of the five years except 1986, and is suggestive of a predictable component. The existence of such a predictable component, provided it is not swamped by "true" price changes, has implications for the time series properties of measured returns.

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[19]The L ratio reported here reflects only the tendency for final transaction prices to be bid or ask prices and, therefore, says nothing about such tendencies for all transactions throughout the day. Nevertheless, the tendency for final transaction prices to be closer to the bid price as the year progresses is consistent with Constantinides (1984) model of optimal tax-induced trading that predicts that tax-loss selling of stocks gradually increases from January to December.

### 5.1 The weekend effect

The percentage change in L measures movements within the spread that are purged of any movement in the bid and ask quotes. Thus, by computing average changes in the value of L by day of the week, day of the month, etc. we can determine whether particular days are associated with systematic movements within the spread.

Porter (1988) finds systematic differences in the probabilities of bid and ask prices across days of the week -- especially for low-price shares -- and conjectures that the tendency for prices to close at the ask on Friday and at the bid on Monday may partially explain the observed negative Monday returns. Results using the data portrayed in figure 5 are consistent with Porter's findings: The mean percentage change in L (t-statistic) is 1.0% (4.11) on Friday and -2.03% (-7.84) on Monday. The percentage changes are not significantly different than zero on the other three days.

To examine whether these systematic movements between the bid and ask prices translate into the intra-week pattern of returns found by others, I construct two indexes of OTC stocks from the CRSP NASDAQ file--one computed with closing transaction prices and the other computed with the midpoint of the bid-ask spread. To be included in the index for day t, I require a stock to have traded on both day t and day t-1. Returns computed with each method are combined with equal weights on each day t, resulting in two separate daily return indexes for the period January 1983 to December 1987. The mean of the difference between the two index returns can be interpreted as an estimate of the bid-ask bias discussed by Blume and Stambaugh (1983). Systematic differences in the magnitude of the bias through time reflect the "trading pattern" bias discussed above.

Average values of the bias are reported in Table 5 in the rightmost column, along with average values of returns computed with closing transaction prices (column 1) and with midpoints of the bid-ask spread (column 2). Over all days, the average value of the bias is .04% per day. This is quite close to the estimate of .051% of Blume and Stambaugh for a sample of low-price NYSE stocks.

The middle panel of Table 5 reports summary statistics separately for each day of the week. The bias is negative only on Monday (-.031%; t = -4.50) and tends to rise during the week to a maximum value on Friday of .078% (t = 9.10). This pattern in the bias is consistent with the observed intra-week pattern in returns and may serve to partially explain the day-of-the-week effect. Consistent with the results in Keim and Stambaugh (1984), however, returns computed with prices in the center of the bid-ask spread still exhibit the familiar intra-week pattern (column 2).

### 5.2 The holiday effect

Ariel (1988) finds that over one third of the return accruing to the market over the 1963-82 period was earned on the trading days preceding the eight holidays that result in a market closing each year. To determine whether the holiday effect is related to a trading pattern bias, I compute the average value of the percentage change in L for the trading days preceding seven of the holidays examined by Ariel (I exclude New Years) and for the remaining trading days of the year (again, excluding New Years). The mean value of the percentage change in L (t-statistic) is 4.19% (4.12) for the pre-holiday trading days and 0.25 (0.97) for the rest of the days. These results suggest that the holiday effect is in part a movement from the bid to the ask.

I therefore estimate the bias in returns computed with closing prices--as reported in section 5.1 for the weekend effect--for the trading days immediately preceding holidays (excluding New Years day). The rightmost column in the bottom panel of Table 5 contains the estimate of the bias for OTC stocks--computed in exactly the same manner as in section 5.1--averaged over the seven pre-holiday trading days (excluding New Years) for the 1983-87 period. The average bias is .113% (t = 5.17), which represents 32% of the average pre-holiday return of .356% as computed with closing transaction prices. (Ariel reports an average pre-holiday return--including New Years--of .33% for the equal-weighted NYSE and AMEX index for the 1983-1986 period.) The data suggest that the pre-holiday return may be, in part, due to simultaneous movements from the bid to the ask price.[20]

## 6. Concluding remarks

This paper demonstrates that the occurrence of systematic trading patterns can impart biases into returns computed from closing transaction prices. This trading pattern bias is larger for lower-price stocks since the bid-ask spread, as a percentage of price, is larger for such stocks. As an example, the paper shows that systematic tendencies for December closing prices to be recorded at the bid and early January closing prices to be recorded at the ask can result in large portfolio returns on the last trading day in December and the first trading day in January--even if bid (and ask) prices do not change. The paper also shows that the weekend and holiday effects may be related to systematic movements within the bid-ask spread.

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[20]Lakonishok and Smidt (1988) find, however, that this holiday effect has persisted for over 90 years for the Dow Jones index of industrial stocks of predominantly large firms.

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## TABLE 1

**Frequency of non-trading around the turn of the year for ten size categories of NYSE and AMEX stocks for the fifteen turn-of-the-year periods from December 1972 to January 1987.**

Non-trading frequency is measured as the percentage of all stocks that did not trade on a particular day. Trading inactivity is inferred from the CRSP Daily Master File which flags stocks that do not trade with the negative value of the average of the end-of-day bid and ask prices.

| Size Category[a] | Non-Traded Stocks as a % of Total on Day: | | | | | | % Of Total That Didn't Trade by Day: | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | -2 | -1 | +1 | +2 | +3 | +4 | +1 | +2 | +3 | +4 |
| A. NYSE and AMEX Stocks | | | | | | | | | | |
| Smallest | 7 | 5 | 27 | 24 | 24 | 22 | 27 | 12 | 6 | 3 |
| 2 | 5 | 4 | 14 | 12 | 11 | 12 | 14 | 4 | 2 | 1 |
| 3 | 3 | 3 | 9 | 7 | 6 | 7 | 9 | 3 | 1 | 0 |
| 4 | 2 | 2 | 5 | 4 | 4 | 4 | 5 | 1 | 1 | 0 |
| 5 | 2 | 1 | 3 | 2 | 2 | 2 | 3 | 1 | 0 | 0 |
| 6 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 0 | 0 | 0 |
| 7 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 0 | 0 | 0 |
| 8 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| 9 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| Largest | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| B. NYSE Stocks only | | | | | | | | | | |
| Smallest | 1 | 1 | 4 | 4 | 3 | 3 | 4 | 1 | 0 | 0 |
| 2 | 0 | 1 | 3 | 1 | 2 | 1 | 3 | 0 | 0 | 0 |
| 3 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 0 | 0 | 0 |
| 4 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 |
| 5 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 6 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 7 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Largest | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C. AMEX Stocks only | | | | | | | | | | |
| Smallest | 7 | 5 | 36 | 32 | 33 | 29 | 36 | 18 | 10 | 6 |
| 2 | 7 | 5 | 24 | 22 | 22 | 21 | 24 | 10 | 4 | 3 |
| 3 | 6 | 5 | 21 | 18 | 18 | 19 | 21 | 7 | 3 | 2 |
| 4 | 6 | 5 | 15 | 14 | 13 | 13 | 15 | 4 | 2 | 1 |
| 5 | 6 | 4 | 14 | 12 | 11 | 12 | 14 | 4 | 2 | 1 |
| 6 | 5 | 5 | 12 | 10 | 9 | 9 | 12 | 4 | 1 | 0 |
| 7 | 5 | 4 | 11 | 9 | 8 | 9 | 11 | 3 | 1 | 1 |
| 8 | 4 | 4 | 8 | 6 | 6 | 6 | 8 | 2 | 1 | 0 |
| 9 | 4 | 2 | 6 | 4 | 6 | 5 | 6 | 1 | 1 | 0 |
| Largest | 5 | 6 | 9 | 6 | 5 | 6 | 9 | 3 | 1 | 1 |

[a]The size categories are created by sorting securities on market value of common equity based on prices and number of shares outstanding on the last trading day of November preceding the turn of the year, and allocating securities to ten categories containing equal numbers of securities.

## TABLE 2

**Computed values for the expected movement within the spread, as expressed in equation (3), for a representative low-price security on a typical first trading day of the year. Expected value of the intra-spread movement (%) is computed for day *t* for a stock with a 6% bid-ask spread (as a percentage of bid) for varying probabilities of occurance of a bid price on day *t* and day *t*-1, and holding constant the probability of a transaction occuring on day *t* (.7) and on day *t*-1 (.95)[a]**

| Probability of a Bid Price on Day *t* | Probability of a Bid-Price on Day *t*-1 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | 1.0 |
| 0.0 | -0.7 | -0.2 | 0.4 | 0.9 | 1.5 | 2.0 | 2.6 | 3.2 | 3.8 | 4.3 | 4.9 |
| 0.1 | -1.1 | -0.6 | -0.0 | 0.5 | 1.1 | 1.6 | 2.2 | 2.8 | 3.3 | 3.9 | 4.5 |
| 0.2 | -1.5 | -1.0 | -0.4 | 0.1 | 0.7 | 1.2 | 1.8 | 2.4 | 2.9 | 3.5 | 4.1 |
| 0.3 | -1.9 | -1.4 | -0.8 | -0.3 | 0.3 | 0.8 | 1.4 | 1.9 | 2.5 | 3.1 | 3.7 |
| 0.4 | -2.3 | -1.8 | -1.2 | -0.7 | -0.1 | 0.4 | 1.0 | 1.5 | 2.1 | 2.7 | 3.3 |
| 0.5 | -2.7 | -2.2 | -1.6 | -1.1 | -0.6 | 0.0 | 0.6 | 1.1 | 1.7 | 2.3 | 2.8 |
| 0.6 | -3.1 | -2.6 | -2.0 | -1.5 | -1.0 | -0.4 | 0.1 | 0.7 | 1.3 | 1.8 | 2.4 |
| 0.7 | -3.5 | -3.0 | -2.4 | -1.9 | -1.4 | -0.8 | -0.3 | 0.3 | 0.9 | 1.4 | 2.0 |
| 0.8 | -3.9 | -3.4 | -2.8 | -2.3 | -1.8 | -1.2 | -0.7 | -0.1 | 0.4 | 1.0 | 1.6 |
| 0.9 | -4.3 | -3.8 | -3.2 | -2.7 | -2.2 | -1.6 | -1.1 | -0.5 | 0.0 | 0.6 | 1.2 |
| 1.0 | -4.7 | -4.2 | -3.6 | -3.1 | -2.6 | -2.0 | -1.5 | -0.9 | -0.4 | 0.2 | 0.7 |

[a]The values in the table assume no change in the bid price and the bid-ask spread. The assumed values for the transaction probabilities are based (approximately) on the numbers reported in Panel A of Table 1 for the smallest size category of stock. The six percent bid-ask spread is based on the numbers reported in the Appendix for the smallest size category.

## TABLE 3

**Intra-spread price movements and the transaction return bias resulting from systematic trading patterns.**

**The first row for each trading day contains the mean percentage change in the within-spread location of the closing price, defined as $L_{it}$ = (Closing Price$_{it}$ - Bid$_{it}$ )/(Ask$_{it}$ - Bid$_{it}$), on each day $t$ surrounding the end of the year for the OTC NMS stocks, that traded on both day $t$ and $t$ - 1, within each of ten price categories. The second row contains the mean estimate of the transaction-return bias (computed as the difference between returns computed with transaction prices and returns computed with bid prices) for OTC NMS stocks that traded on both days $t$ and $t$-1.**

| Day Relative to the end of the Year | Price Portfolio[a] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Lowest | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Highest |
| -6 | 5.52 | -4.36 | -1.44 | 7.48 | -2.67 | 4.54 | -10.83 | -5.71 | 0.65 | 4.75 |
| | 0.43 | 0.01 | -0.04 | 0.11 | 0.13 | 0.05 | -0.11 | -0.05 | 0.01 | 0.02 |
| -5 | 9.52 | 11.69**[b] | 15.97 | 8.43 | 4.20 | 7.40 | 10.45** | 13.18* | 1.94 | 9.26** |
| | 0.45 | 0.25 | 0.33** | 0.23** | 0.10 | 0.19* | 0.17** | 0.10 | 0.02 | 0.05** |
| -4 | -11.35 | -11.40* | -6.90 | -13.31 | 0.26 | -7.60 | -4.77 | -0.58 | -6.65 | -13.03** |
| | -0.24 | -0.28 | -0.13 | -0.13 | -0.06 | -0.10 | -0.10 | -0.02 | 0.03 | -0.10 |
| -3 | 5.55 | -1.25 | 3.55 | 3.17 | -1.73 | 10.26 | -2.19 | -12.02** | 10.09 | -2.62 |
| | 0.00 | -0.05 | -0.02 | -0.07 | -0.06 | 0.05 | -0.04 | -0.14** | 0.00 | -0.02 |
| -2 | -5.42 | 1.34 | -11.58** | 7.33 | -4.76 | -4.22 | -3.69 | 1.14 | 2.62 | 8.78** |
| | -0.40 | -0.01 | -0.13* | 0.12 | -0.06 | -0.02 | 0.05 | -0.01 | -0.05 | 0.05* |
| EOY | 20.13* | 22.70** | 5.42 | 7.72* | 13.24* | 16.80* | 20.77** | 8.44 | 10.01 | 10.33 |
| | 1.21* | 0.71** | 0.08 | 0.18* | 0.15 | 0.34** | 0.17 | 0.15 | 0.21 | 0.15 |
| +1 | 45.93** | 32.38** | 40.67** | 26.62** | 16.89** | 11.50* | 0.29 | 13.13 | 0.83 | 5.80 |
| | 2.04** | 1.05** | 0.81** | 0.58** | 0.36** | 0.23 | 0.14 | 0.21* | 0.07 | 0.02 |
| +2 | 3.20 | -2.15 | 0.79 | 2.64 | 9.97 | -1.10 | 9.66 | 5.82 | 9.14** | 6.58 |
| | 0.39 | -0.26 | -0.04 | 0.05 | 0.11 | 0.00 | 0.06 | 0.10 | 0.00 | 0.03 |
| +3 | -6.16 | -0.42 | 3.38 | -9.25 | -9.21* | 8.19 | -1.47 | -0.40 | -3.08 | -1.96 |
| | -0.43 | 0.05 | 0.13 | -0.19 | -0.09 | -0.02 | -0.05 | -0.10 | 0.06 | -0.02 |
| +4 | 4.40 | -6.03 | 2.80 | 5.93 | 15.04** | -2.84 | 2.12 | -4.86 | -2.30 | 4.93 |
| | 0.51** | -0.30* | 0.09 | 0.21 | 0.18* | -0.05 | 0.12* | -0.04 | -0.03 | 0.01 |
| +5 | -6.85 | -10.72** | -8.06 | -6.93 | -22.64** | -13.62 | -10.69 | -3.48 | -3.34 | -4.89 |
| | 0.06 | -0.05 | -0.16 | -0.05 | -0.20* | -0.21* | -0.03 | -0.09 | -0.01 | -0.03 |
| +6 | -0.28 | 11.43* | 3.79 | -0.39 | 11.62* | 10.68 | 5.45 | 7.82 | 4.29 | -0.69 |
| | 0.15 | 0.19* | 0.19 | -0.10 | 0.10 | 0.15 | 0.07 | 0.03 | 0.01 | 0.00 |
| +7 | 8.34 | 5.29 | 3.54 | 9.26* | 5.12 | 2.48 | 6.64* | 13.05* | 0.36 | 0.91 |
| | -0.06 | 0.25 | -0.02 | 0.18** | 0.04 | 0.12 | 0.02 | 0.12* | -0.03 | -0.01 |
| +8 | 0.04 | -6.44 | -5.50 | -0.99 | -2.19 | 4.71 | -3.08 | -6.53 | 8.71 | -7.60 |
| | 0.31 | -0.18 | -0.17 | -0.02 | -0.08 | 0.02 | -0.05 | 0.00 | 0.01 | -0.02 |
| +9 | 0.18 | 3.84 | 2.85 | -0.05 | -0.72 | 3.05 | -6.76 | 1.11 | 4.29 | 18.69** |
| | 0.02 | 0.11 | 0.22 | 0.07 | 0.14 | 0.12 | -0.05 | -0.04 | 0.08 | 0.06 |
| +10 | 2.95 | -5.26 | -0.99 | 2.57 | 2.52 | -2.14 | 0.77 | -9.10 | -1.98 | -10.17* |
| | 0.04 | 0.16 | -0.10 | 0.09 | 0.03 | -0.13** | 0.01 | -0.09 | -0.05 | -0.07 |

[a]The price portfolios are created by sorting all NMS stocks on price per share on the last trading day of November in each year, and allocating stocks into ten categories containing equal numbers of stocks.

[b]Standard errors are based on five daily portfolio observations, one from each turn-of-the-year period.

* Indicates significance at the 5% level based on a t-test of the null hypothesis that the mean is zero.

** Indicates significance at the 1% level based on a t-test of the null hypothesis that the mean is zero.

## TABLE 4

**Mean (standard error) of daily bid-to-bid returns for OTC NMS stocks, that traded on both day *t* and day *t*-1, within each of ten price categories for trading days surrounding the end of the year for the period December 1983 to January 1988.**

| Day Relative to the end of the Year | Price Portfolio[a] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Lowest | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Highest |
| -6 | 0.02 | 0.08 | -0.11 | 0.04 | 0.02 | 0.24 | 0.11 | 0.05 | 0.09 | 0.11 |
| | (0.29)[b] | (0.37) | (0.30) | (0.34) | (0.27) | (0.29) | (0.35) | (0.27) | (0.22) | (0.24) |
| -5 | 0.91 | 0.41 | 0.50 | 0.45 | 0.19 | 0.14 | 0.25 | 0.15 | 0.19 | 0.09 |
| | (0.23) | (0.34) | (0.26) | (0.35) | (0.19) | (0.16) | (0.16) | (0.22) | (0.21) | (0.13) |
| -4 | -0.55 | -0.42 | -0.36 | -0.29 | -0.24 | -0.18 | -0.26 | -0.10 | -0.05 | -0.23 |
| | (0.68) | (0.40) | (0.43) | (0.43) | (0.40) | (0.40) | (0.32) | (0.25) | (0.26) | (0.27) |
| -3 | -0.43 | -0.40 | 0.01 | -0.15 | 0.03 | -0.16 | 0.15 | -0.08 | 0.06 | -0.03 |
| | (0.45) | (0.30) | (0.26) | (0.13) | (0.25) | (0.18) | (0.13) | (0.13) | (0.12) | (0.12) |
| -2 | 0.53 | 0.22 | 0.12 | 0.32 | 0.29 | 0.27 | 0.32 | 0.15 | 0.21 | 0.20 |
| | (0.36) | (0.24) | (0.24) | (0.17) | (0.18) | (0.15) | (0.19) | (0.16) | (0.14) | (0.20) |
| EOY | 2.04 | 0.99 | 0.60 | 0.85 | 0.56 | 0.56 | 0.47 | 0.38 | 0.44 | 0.24 |
| | (0.15) | (0.17) | (0.12) | (0.21) | (0.06) | (0.15) | (0.12) | (0.10) | (0.09) | (0.05) |
| +1 | 1.13 | 0.74 | 0.97 | 0.79 | 0.56 | 0.64 | 0.42 | 0.30 | 0.18 | 0.40 |
| | (0.90) | (0.77) | (0.60) | (0.49) | (0.50) | (0.50) | (0.47) | (0.51) | (0.45) | (0.42) |
| +2 | 2.11 | 2.16 | 1.94 | 1.66 | 1.30 | 1.34 | 1.19 | 1.05 | 0.92 | 0.75 |
| | (0.33) | (0.56) | (0.47) | (0.48) | (0.40) | (0.54) | (0.39) | (0.41) | (0.44) | (0.34) |
| +3 | 2.01 | 1.31 | 1.30 | 1.37 | 1.13 | 1.09 | 0.98 | 1.00 | 0.79 | 0.62 |
| | (0.39) | (0.33) | (0.50) | (0.52) | (0.42) | (0.33) | (0.42) | (0.46) | (0.50) | (0.29) |
| +4 | 1.77 | 1.00 | 1.41 | 1.30 | 1.15 | 1.15 | 1.08 | 0.95 | 0.72 | 0.62 |
| | (0.13) | (0.39) | (0.19) | (0.29) | (0.34) | (0.31) | (0.31) | (0.36) | (0.24) | (0.24) |
| +5 | 0.57 | -0.14 | 0.15 | -0.12 | -0.13 | 0.23 | -0.13 | -0.29 | -0.29 | -0.04 |
| | (0.45) | (0.53) | (0.42) | (0.63) | (0.49) | (0.45) | (0.53) | (0.42) | (0.43) | (0.46) |
| +6 | 0.10 | -0.27 | -0.54 | -0.27 | -0.25 | -0.36 | -0.40 | -0.29 | -0.24 | -0.12 |
| | (0.77) | (0.75) | (0.62) | (0.61) | (0.64) | (0.55) | (0.58) | (0.50) | (0.38) | (0.40) |
| +7 | 1.12 | 0.74 | 0.69 | 0.60 | 0.46 | 0.42 | 0.35 | 0.28 | 0.40 | 0.30 |
| | (0.82) | (0.55) | (0.57) | (0.43) | (0.47) | (0.49) | (0.45) | (0.45) | (0.37) | (0.38) |
| +8 | 0.60 | 0.78 | 0.47 | 0.30 | 0.51 | 0.29 | 0.41 | 0.25 | 0.21 | 0.16 |
| | (0.39) | (0.17) | (0.28) | (0.21) | (0.26) | (0.10) | (0.18) | (0.21) | (0.13) | (0.10) |
| +9 | 0.86 | 0.59 | 0.90 | 0.71 | 0.72 | 0.58 | 0.51 | 0.53 | 0.49 | 0.33 |
| | (0.31) | (0.46) | (0.39) | (0.32) | (0.47) | (0.34) | (0.45) | (0.32) | (0.26) | (0.24) |
| +10 | 1.05 | 0.71 | 1.05 | 0.76 | 0.95 | 1.12 | 0.90 | 0.83 | 0.72 | 0.63 |
| | (0.55) | (0.21) | (0.42) | (0.26) | (0.27) | (0.40) | (0.31) | (0.28) | (0.27) | (0.31) |

[a]The price portfolios are created by sorting all NMS stocks on price per share on the last trading day of November in each year, and allocating stocks into ten categories containing equal numbers of stocks.

[b]Standard errors are based on five daily portfolio returns, one from each turn-of-the-year period.

## TABLE 5

**Are other temporal return patterns related to the trading pattern bias?**

**Daily returns for OTC stocks computed with (1) closing transaction prices and (2) midpoints of the bid-ask spread for stocks that traded on both day *t* and day *t* -1.[a] Statistics are computed over the period January 1983 to December 1987.**

| | (1) Closing-Price Return (std. dev.) | | (2) Mid-Spread Return (std. dev.) | | (3) Bias: (1)-(2) (t-statistic) | |
|---|---|---|---|---|---|---|
| All Days | 0.015 | (0.921) | -0.024 | (0.893) | 0.040 | (11.73) |
| Monday | -0.365 | (1.128) | -0.335 | (1.116) | -0.031 | (-4.50) |
| Tuesday | -0.145 | (0.919) | -0.188 | (0.925) | 0.043 | (6.40) |
| Wednesday | 0.140 | (0.784) | 0.086 | (0.741) | 0.053 | (7.39) |
| Thursday | 0.186 | (0.763) | 0.133 | (0.750) | 0.052 | (7.85) |
| Friday | 0.251 | (0.825) | 0.172 | (0.772) | 0.078 | (9.10) |
| Pre-Holidays[b] | 0.356 | (0.374) | 0.243 | (0.360) | 0.113 | (5.17) |
| All Other Days[c] | 0.003 | (0.930) | -0.034 | (0.903) | 0.037 | (10.89) |

[a]A stock is included in the index return computed for day *t* only if it traded (and had a closing price) on days *t* and *t* -1.

[b]Average daily returns for the trading days prior to seven of the eight holidays considered by Ariel (1988): President's Day, Good Friday, Memorial Day, Independence Day, Labor Day, Thanksgiving and Christmas.

[c]Average daily returns for all days except those listed in footnote b and the last trading day of the year.

## APPENDIX

**Summary statistics for bid-ask spreads, bid price per share and market capitalization for NYSE, AMEX and OTC NMS stocks grouped according to market capitalization on December 23, 1988. Securities are allocated within each exchange based on decile cutoffs from the separate ranking of only the NYSE stocks.[1]**

| Market Capitalization Category | Average Market Capitalization ($ Mil) | Average Bid Price | (Ask-Bid) / Bid | |
|---|---|---|---|---|
| | | | Mean | Median |
| **A. NYSE STOCKS** | | | | |
| Smallest | $27.83 | $5.64 | 6.60% | 4.35% |
| 2 | 67.90 | 10.42 | 2.51 | 2.08 |
| 3 | 111.10 | 12.80 | 2.06 | 1.79 |
| 4 | 174.89 | 15.88 | 1.75 | 1.54 |
| 5 | 288.69 | 20.03 | 1.58 | 1.27 |
| 6 | 477.56 | 24.60 | 1.20 | 1.04 |
| 7 | 799.86 | 26.45 | 1.00 | 0.88 |
| 8 | 1376.56 | 30.39 | 0.85 | 0.79 |
| 9 | 2598.94 | 36.85 | 0.81 | 0.63 |
| Largest | 9942.26 | 55.11 | 0.58 | 0.46 |
| **B. AMEX STOCKS** | | | | |
| Smallest | $19.73 | $6.59 | 6.16% | 4.00% |
| 2 | 65.88 | 13.66 | 2.65 | 1.79 |
| 3 | 110.76 | 19.39 | 2.39 | 1.71 |
| 4 | 170.70 | 29.41 | 1.44 | 1.19 |
| 5 | 283.08 | 30.36 | 1.55 | 1.20 |
| 6 | 446.33 | 33.93 | 1.51 | 1.19 |
| 7 | 804.35 | 31.16 | 1.20 | 0.79 |
| 8 | 1311.20* | 48.46* | 1.25* | 0.81 |
| 9 | 2320.51* | 18.56* | 2.32* | 0.70 |
| Largest | 11594.62* | 8.00* | 1.56* | 1.56 |
| **C. OTC NMS STOCKS** | | | | |
| Smallest | $20.03 | $6.64 | 7.97% | 6.00% |
| 2 | 64.94 | 13.14 | 3.42 | 2.82 |
| 3 | 111.42 | 15.96 | 2.79 | 2.30 |
| 4 | 173.03 | 19.16 | 2.06 | 1.79 |
| 5 | 286.38 | 21.54 | 1.92 | 1.67 |
| 6 | 464.49 | 26.18 | 1.39 | 1.14 |
| 7 | 776.76 | 34.28 | 1.42 | 0.88 |
| 8 | 1355.61 | 29.01 | 1.07 | 0.94 |
| 9 | 2330.28* | 39.21* | 4.90* | 0.48 |
| Largest | 4775.27* | 40.34* | 0.61* | 0.17 |

[1]The NYSE groups contain an approximately equal number of securities (about 160). Because of differences in the average market capitalization of stocks trading in the three different markets, however, the AMEX and OTC groups do not contain an equal number of securities. The AMEX groups range from 1 to 511 stocks , and the OTC groups range from 4 to 1380. All data are from the Bridge Trading Company.

*Computed with less than 10 observations.

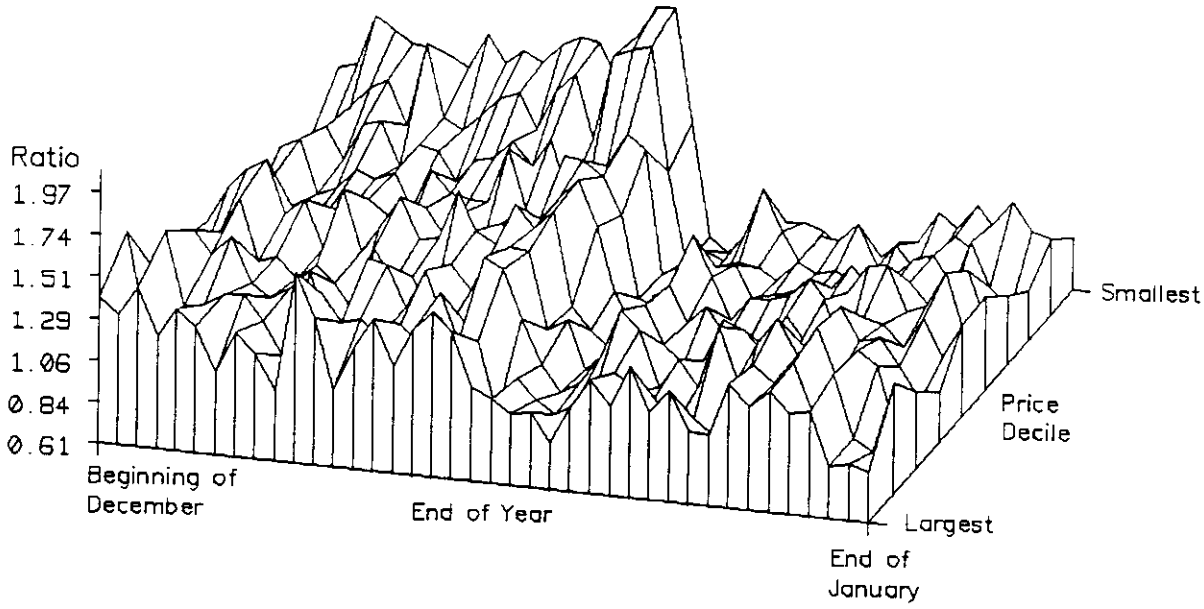


**Fig. 1 Systematic closing price movements within the bid-ask spread on the trading days surrounding the end of the year for the period 12/83 to 1/88.**

Average values of the ratio of the number of closing prices at the bid to the number of closing prices at the ask, averaged within each price decile of OTC NMS stocks and over the five turn-of-the-year periods from 12/83 to 1/88, for each of the forty trading days surrounding the end of the year.

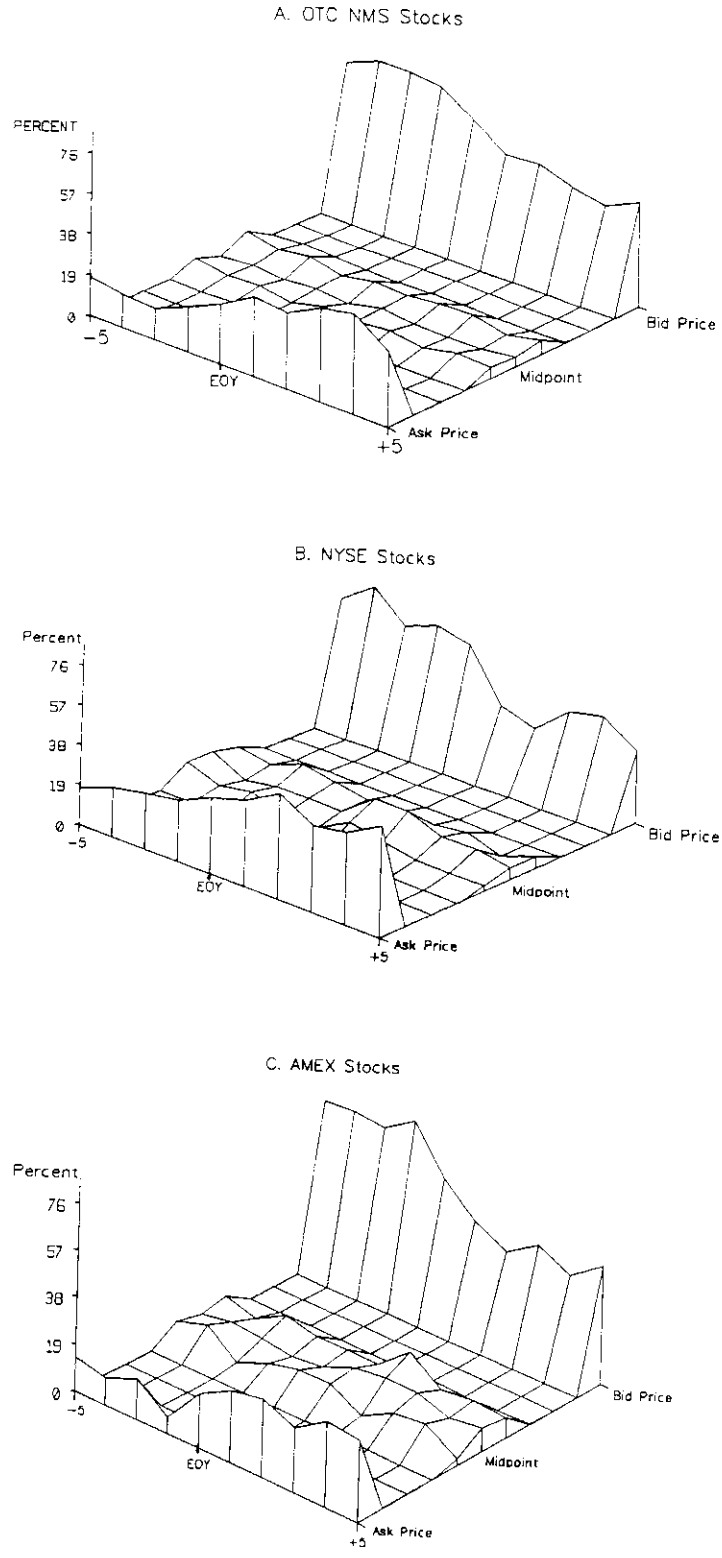


**Fig. 2 Frequency distribution of final transaction prices relative to the closing bid and ask prices for the stocks in the smallest decile of price for each of the ten trading days surrounding the end of 1988.**

The sample of stocks for each exchange is determined by the lowest price decile cutoff from a November 31, 1988 sort of only AMEX stocks.

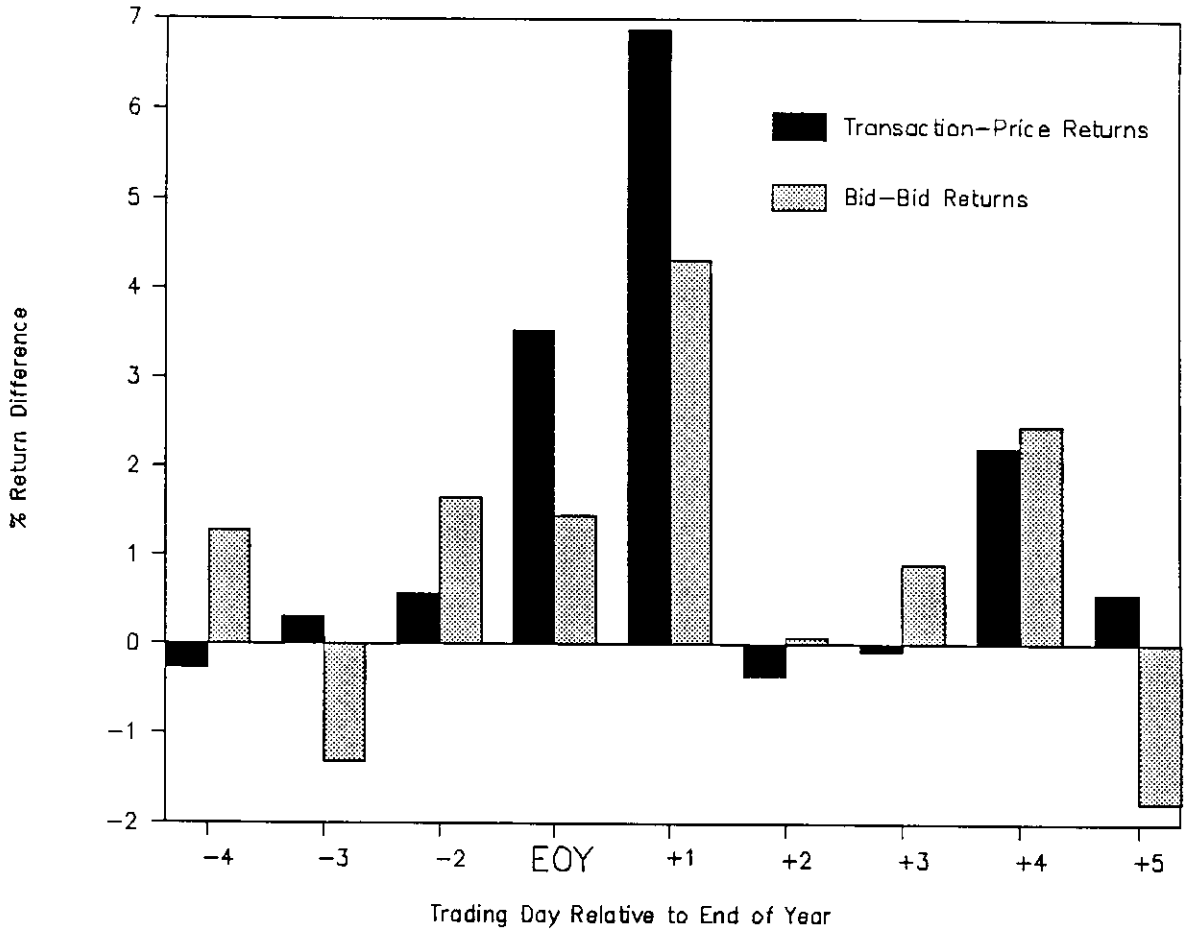


**Fig. 3 Turn-of-the-year effect for NYSE stocks 1988-1989**

Difference in average returns between the lowest and highest price deciles of NYSE stocks (based on AMEX price decile cutoffs) for nine days surrounding the end of 1988. Returns are separately with (1) final transaction prices only and (2) bid prices only.

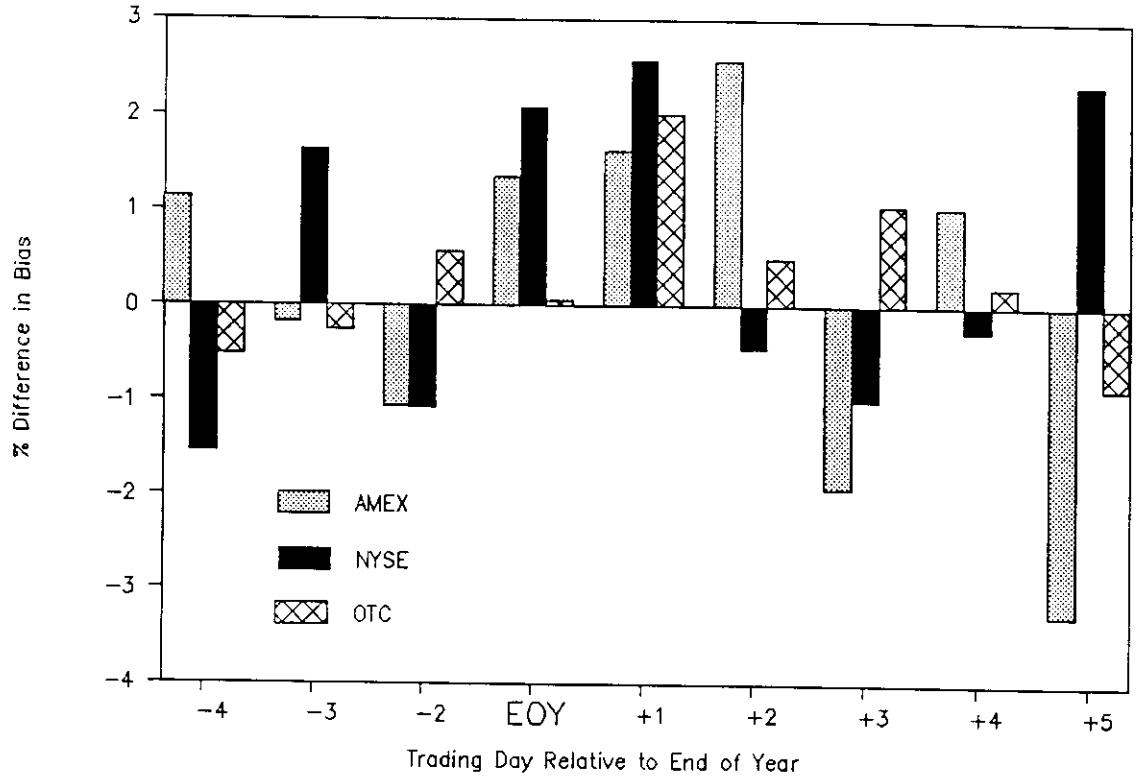


**Fig. 4 Trading pattern bias at the turn of the year, 1988-89**

Difference in the magnitude of the price effect measured with returns computed with transaction prices relative to the price effect measured with returns computed with bid prices. The price effect is computed as the difference in returns between the lowest and highest price stocks. The difference in the magnitude of the price effect -- the trading pattern bias -- is reported separately for each exchange for each of nine days surrounding the end of 1988.

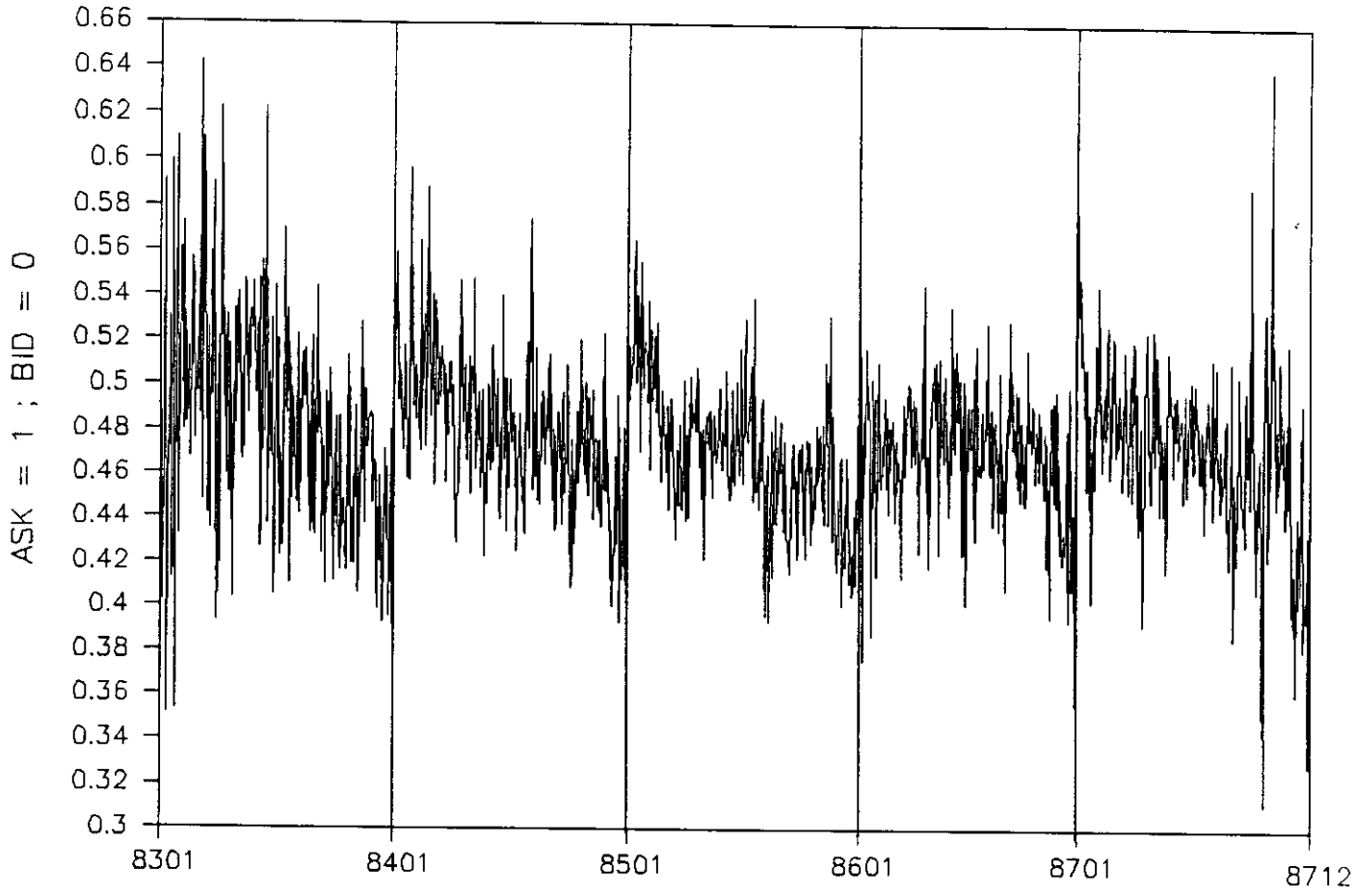


**Fig. 5 Time series of the location, L, of the final transaction price within the bid-ask spread, 1983 - 1987.**

Average values of the within-spread location of the final transaction price

$$L_{it} = \frac{\text{Closing Price}_{it} - \text{Bid}_{it}}{\text{Ask}_{it} - \text{Bid}_{it}}$$

computed over all OTC NMS stocks for each trading day over the period January 1983 to December 1987.