NBER WORKING PAPER SERIES

INFORMATION, TRADING AND STOCK RETURNS: LESSONS FROM DUALLY-LISTED SECURITIES

K.C. Chan
Wai-Ming Fong
René M. Stulz

Working Paper No. 4743

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
May 1994

We are grateful to Yakov Amihud for comments, to Tom George for useful discussions, and to Bong-Chan Kho for research assistance. This paper is part of NBER's research program in Asset Pricing. Any opinions expressed are those of the authors and not those of the National Bureau of Economic Research.

NBER Working Paper #4743
May 1994

INFORMATION, TRADING AND STOCK RETURNS: LESSONS FROM DUALLY-LISTED SECURITIES

ABSTRACT

This paper compares the intra-day patterns on the NYSE and AMEX of volatility, trading volume and bid-ask spreads for European dually-listed stocks, Japanese dually-listed stocks also listed in London, and Japanese dually-listed stocks not listed in London with American stocks of comparable average trading volume and volatility. It is shown that the intra-day patterns for these stocks are remarkably similar even though the public information flows differ markedly across these stocks during the trading day. In the morning, Japanese stocks have the greatest volatility and volume, followed by European stocks and American stocks. These rankings are reversed in the afternoon. We argue that these patterns are consistent with markets reacting to the overnight accumulation of public information which is greatest for Japanese stock and smallest for American stocks and inconsistent with the view that early morning volatility can be attributed to monopolistic specialist behavior.

K.C. Chan
Hong Kong University of Science & Technology
Clear Water Bay, Kowloon
HONG KONG

Wai-Ming Fong
Chinese University of Hong Kong
Shatin, New Territories
HONG KONG

René M. Stulz
College of Business
Ohio State University
1775 College Road
Columbus, OH 43210
and NBER

1. Introduction.

Considerable effort has been devoted recently to learning about the determinants of stock return volatility. This research has identified trading noise, public information, private information and trading mechanisms as potentially important determinants of the volatility of stock returns. To identify the relative importance of these determinants, contributions to the literature have focused mostly on experiments that exploit differences in trading mechanisms, in the arrival of public information, and in whether markets are open. For instance, French and Roll (1986) use the suspension of trading on some Wednesdays in 1968 to compare non-trading days to trading days with similar rates of arrival of public information. Barclay, Litzenberger and Warner (1990) use Saturdays on the Tokyo stock exchange and U.S. returns of Japanese dually-listed stocks to investigate the impact of trading on volatility when public information arrival is reduced. Stoll and Whaley (1990) make the case that the opening mechanism of the NYSE increases stock return volatility, whereas Amihud and Mendelson (1991) use the fact that the Tokyo stock exchange has two trading periods to argue that higher opening volatility is mostly the result of the incorporation of overnight information. Foster and George (1992) use trading and non-trading period returns of dually-listed stocks and control stocks that trade only in the U.S. to argue that the greater volatility at the open is due to the accumulation of orders at the open. Papers in this literature focus on trading and nontrading period returns because there are no differences among stocks in the arrival of public information during the trading period for the experiments they conduct.

In this paper, we investigate the determinants of stock return volatility in a setting where the rate of arrival of public information differs predictably across stocks during the trading day. We compare the intraday return behavior during the U.S. trading day of European, Japanese, and

American stocks listed on the NYSE or the AMEX.[1] For European stocks, the arrival of public information drops off at the end of the morning in the U.S. as the European business day comes to an end. In contrast, for Japanese stocks, the arrival of public information is uniformly low during the U.S. trading day because the business day in Japan does not overlap with the trading day in the U.S. Hence, using these three classes of stocks, we compare stocks with very different patterns of public information arrival. Since the rate of public information arrival changes during the day across our sample, the sample is also well-suited to study the relation between the arrival of public information, volatility, trading volume, and bid-ask spreads. In particular, the sample is useful to address the issue of whether the arrival of public information leads to more trading, either because the arrivals of public and private information are correlated or because, as in the models of Varian (1989) and Harris and Raviv (1993), investors trade on public information because it changes their priors differentially.

If public information is an important determinant of volatility, one would expect European stocks to experience a drop in volatility relative to American stocks when the European business day ends. We find that indeed more of the daily volatility of European stocks accrues during the morning than for American stocks with similar daily volume and volatility, but the difference is not statistically significant. The rate of accrual of volatility does not significantly differ between American stocks and European stocks in any of the four 65-minute trading periods from 10:35 to 14:55; furlher, the cumulative difference in the rate of accrual of volatility between European stocks and the American matching stocks never exceeds 2% of daily volatility. When we turn to

[1] In an interesting recent paper, Kleidon and Werner (1993) examine the intraday patterns of cross-listed U.K. stocks from the open in London to their close in the U.S. to understand better the implications of 24-hour trading of stocks. In their paper, they do not provide the comparisons across classes of stocks with different arrival rates of public information which are the focus of this paper. In this paper, we treat European stocks as a group and Japanese stocks as a group. Consequently, we do not investigate separately London-listed stocks. The results we report for the European sample are not inconsistent with those of Kleidon and Werner (1993), though.

Japanese stocks, these stocks also display higher volatility in the morning despite the fact that there is no reason to suspect that they would have more public information in the morning than their matching American stocks. After the first hour of trading, 40% of the daily volatility of Japanese stocks has accrued in contrast to 29% of the daily volatility of European stocks. American matching stocks, however, accrue significantly more volatility than Japanese stocks in every trading period from 10:35 to 14:55.

Our results raise two puzzles: (1) why do foreign stocks behave so much like comparable American stocks during the trading day and (2) why is the high volatility in the early morning trading in New York pervasive across stocks? Since the European and some Japanese stocks trade in Europe, there are observed foreign prices for most of the foreign stocks in our sample when New York opens and there is also a competing market for these stocks. The explanations for the higher volatility in the morning, such as price discovery or the role of the specialist imply that the abnormal early morning volatility should be smaller for foreign stocks, which we do not observe. Explanations which rely on private information trading also seem to be inappropriate here since one would expect private information to be more important in New York for domestic stocks.

We argue that trading on accumulated overnight public information helps explain the puzzle that volatility and volume are high on foreign stocks early in the morning. If overnight public information is incorporated in prices at the opening, one would expect less volatility and less volume on Japanese stocks than on their matching stocks early in the morning since the arrival rate of public information for these stocks is low relative to American stocks. In contrast, if there is uncertainty as to how American investors will react to the accumulated overnight public information, the opposite is possible if the accumulated public information for Japanese stocks is more important than the accumulated public information accrued on American stocks and the public information accruing on these stocks early in the morning. To understand this, suppose that stock trading is segmented, in the sense that investors trade a stock in their home country if they can.[2] This means that American investors trade foreign stocks in New York if they are listed there. When New York opens, American investors therefore adjust their portfolios based on how the information that accrued overnight affects their priors. Since markets have been open in the foreign countries after the previous close of New York trading, substantially more public information has accrued about foreign stocks than about domestic stocks. Hence, one would expect both more volatility and more trading for foreign stocks in the morning in reaction to the overnight accumulation of public information. Since public information about American firms accrues at a higher rate during the day, one would expect more volatility and trading for these stocks later in the day. However, if American news is informative about foreign stocks, the differences in volatility and volume patterns between foreign and domestic stocks during the rest of the day are likely to be smaller than one would expect if American news conveys no information about foreign stocks, which helps explain why intraday day patterns are similar for domestic and foreign stocks.

The paper proceeds as follows. In section 2, we present our data and returns evidence. In section 3, we show the volatility patterns. In sections 4 and 5, we discuss respectively the evidence on volume and bid-ask spreads. We conclude in section 6.

Section 2. Data and evidence on returns.

The dataset we use is constructed as follows. Using the 1986 and 1987 ISSM tapes, we

---

[2] Kleidon and Werner (1993) provide evidence that the London and New York markets are segmented, in the sense that they have separate, distinct intra-day patterns such that the New York intra-day pattern is not the continuation of the London intra-day pattern. Their concept of segmentation does not imply segmented trading, but segmented trading implies distinct intra-day patterns.

select all listings under the names ADR, New York Shares and Common Stocks from countries in the European time zone and from Japan. To be kept in the dataset, firms must have at least 6 trades a day on average, have 100 trading days in the year, and the lowest price in the year must be more than $3. For each foreign firm, we select three matching domestic stocks which have similar trading activity in terms of the average daily number of trades, have similar standard deviations of hourly returns, and trade on the same exchange as the dual listed share.[3] We drop all observations from October 14, 1987 to October 30, 1987. The Appendix lists our sample of foreign stocks and the matching stocks. We have 14 European stocks in 1986 and 21 in 1987. There are 5 Japanese stocks in the sample for 1986 and for 1987; of the Japanese stocks, 2 are listed in London in 1986 and in 1987.

To investigate intraday patterns, we treat the opening trade separately from the rest of the day that is divided in six equally spaced intervals of 65 minutes from 9:30 a.m. to 4.00 p.m. For the opening return, we use the return from the previous overnight close to the first trade or to the mid-point of the first bid-ask quote, whichever is first observed. The return for each interval is computed from the mid-point of the last bid-ask quote before the end of the previous interval to the mid-point of the last bid-ask quote of the interval. If the bid-ask quote does not change during the interval, the return for the interval is set equal to zero. If the absolute value of the return is greater than 50% during the interval, it is ignored.

For the variance estimates, we first compute the average return, r_{ij}, for each interval i and each firm j by taking the average of the returns r_{ijt} across T days, where T is the number of days for which the returns are available. We then compute a squared return adjusted for the average return, $(r_{ijt} - r_{ij})^2$, which we call V_{ijt}. We average V_{ijt} across firms of the same class in the sample

[3] We also compared intra-day patterns by matching ADRs with domestic stocks of similar volume only. Our conclusions are generally the same in that case.

to obtain V_{it} for that class of firms. In this study, we use six different firm classes: European firms, Japanese firms, Japanese firms also listed in London, Japanese firms not listed in London, matching firms of European firms, and matching firms of Japanese firms.

To test for differences in intraday patterns between two classes of firms, we pair them in the following system of equations:

$$\begin{aligned} V_{it} &= b_i b_D + e_{it} \\ V_{ct} &= \left(1 - \sum_{j=1}^{5} b_j\right) b_D + e_{ct} \\ V_{it}^{*} &= (b_i + b_i^{*}) b_D^{*} + e_{it}^{*} \\ V_{ct}^{*} &= \left(1 - \sum_{j=1}^{5} (b_j + b_j^{*})\right) b_D^{*} + e_{ct}^{*} \end{aligned} \qquad i = 0,1,\ldots,5 \qquad (1)$$

where $i = 0$ corresponds to the open, and the variables and coefficients with an asterisk are for the second firm class. In this setting, the parameter b_D is the total intraday variance excluding the opening variance. The b_i coefficients, for $i = 0,1,\ldots,5$, measure the opening and intraday variance as a fraction of the total intraday variance, and the b_i^{*} coefficients measure the variance differences between the first and the second firm class. This approach is inspired by the work of Foster and Viswanathan (1993). They estimate intraday patterns separately for each firm and then derive implications from the distribution of these patterns across firms. The small number of dually-listed firms prevents us from focusing on the distribution of intraday patterns across firms. Instead, we estimate the intraday patterns for each class of firms directly.

In estimating equations (1), we use Hansen's (1982) Generalized Method of Moments (GMM) procedure. We impose the following orthogonality conditions:

$$g_T(b) = \frac{1}{T}\sum_{t=1}^{T} \begin{bmatrix} e_{0t} \\ e_{1t} \\ \cdots \\ e_{8t} \\ e^*_{0t} \\ e^*_{1t} \\ \cdots \\ e^*_{8t} \end{bmatrix} = 0 \qquad (2)$$

To estimate **b**, the vector of 14 unknown b coefficients, we minimize the quadratic form g'Wg, where W, a symmetric weighting matrix, is a consistent estimator of the inverse of the asymptotic covariance matrix of $T^{1/2}g_T(\hat{b})$, where $\hat{b}$ is the estimate of **b**, after adjusting for serial correlation as suggested by Newey and West (1987). Note that in (2), each equation describes the variance in an intraday period. Consequently, if there is autocorrelation in the residuals, it arises from the daily autocorrelation of the volatility for that intraday period. The correlation in volatility between intraday periods, or cross-correlation, is captured as cross-sectional covariance in the weighting matrix W. Though the system is just identified and our GMM estimates coincide with those of ordinary least squares, our standard errors are robust to heteroskedasticity, autocorrelation and cross-correlation between intra-day periods.

With $\hat{b}$ as the vector of estimates of **b**, and δ_T as the consistent estimator of

$$\frac{\partial g_T(b)}{\partial b},$$

we have

$$\sqrt{T}(\hat{b} - b) \sim N(0,[\delta_T' W \delta_T]^{-1}).$$

We test for the significance of the estimates using this covariance matrix.

Volume for an intraday interval refers to the normalized number of shares traded during that interval. We first calculate the number of shares traded over each interval. We then compute the firm average as the average across all intervals and all days. To obtain the normalized volume during an interval, we divide the number of shares traded over that interval by the firm average, and take the average across firms. To test for significance, we estimate equations (1) using the volume instead of the squared returns.

The bid-ask spread is measured as a percent of the bid-ask mid-point. It is observed at the market open and at the end of each trading interval. We then estimate equations (1) using the bid-ask spreads, but the estimated coefficients are scaled so that they can be interpreted as the bid-ask spread in an interval as a fraction of the bid-ask spread during the third trading interval (11:40-12:45).

Although our focus is not the intraday returns, we present evidence on these returns in table 1 and figure 1 for the sake of completeness. Intra-day returns follow a U-shaped pattern for all stocks similar to the one documented previously by Harris (1986). This reinforces one of the two puzzles we document, namely the similarity in intra-day patterns between domestic and foreign stocks trading in New York: all stock groups have a significant last interval return. The overnight return is positive for all stock groups, but significant for foreign stocks only. The other intra-day returns are insignificant except for the return for European stocks in the first interval. Looking at the difference in returns between firm types, we find that European stocks have significantly lower returns in the first trading interval and significantly higher returns overnight and in the fifth trading interval. Japanese stocks have a significantly higher return than their matching stocks overnight and in the last interval and do not have a significantly different return from their matching stocks in any other interval. The Japanese stocks listed in London have a significantly higher return in the third trading period than those which are not and have insignificantly different returns in all the other periods.

Section 3. Intra-day volatility patterns.

Intra-day volatility patterns have been studied for U.S. stocks with the database we use. First, Wood, McInish and Ord (1985) using minute by minute transactions data show a U-shaped pattern for intra-day volatility. Harris (1986) also documents a strong U-shaped pattern for intra-day volatility using 15-minutes returns. Finally, Foster and Viswanathan (1993) present results that are comparable to our study. They investigate the intra-day volatility for three groups of stocks. They divide the sample of NYSE stocks on the ISSM database that meet some selection criteria into deciles of trading activity and select 20 stocks in the first, fifth and tenth deciles of trading activity. They show that, for all their deciles, there is significant intraday variation in volatility, with volatility being the highest during the first half-hour of trading. To make the first half-hour comparable to the other periods, they double its return. They compare all trading intervals to the first half-hour and find that all intervals have a significantly lower variance than the first interval. For the first and tenth deciles, the coefficient estimates of regressions similar to (1) show a distinct U-shaped pattern, but no such pattern is present for the fifth decile.

Table 2 presents our coefficient estimates of equations (1). Since the fractions of intraday intervals sum to one, the coefficient for the last trading interval is just one minus the sum of the 5 previous intraday intervals and no individual t-test is possible for that interval. The results for European stocks are given in panel A. The estimates give the normalized variance for an interval, defined as a fraction of the total intraday variance ignoring the close-to-open variance. It is immediately apparent that the variance fractions follow a U-shaped pattern during the day and this is confirmed in figure 2A. The close-to-open variance has the highest fraction and the fractions decline thereafter until the interval from 12:45 to 13:50. After this period, the fractions increase again. The same pattern holds for the domestic comparison stocks.

Table 2 makes it possible to compare per period the volatility patterns of the European in overnight normalized variances is of the same magnitude as the differences in overnight normalized variances for European stocks and their matching American stocks, which is significant. Hence, one can interpret this evidence as indicating that investors are more willing to trade at the open when a competing exchange is open. Two possible reasons for this are: (a) opening prices are less noisy or (b) trading is cheaper because of competition. Given that the rate of volatility accrual for Japanese stocks not listed in London is not higher following the open, it is hard to argue that the data is supportive of (a). To investigate (b), we have to look at bid-ask spreads which we do next.

Section 5. Bid-ask spread intra-day patterns.

We now turn to a comparison of the bid-ask intra-day patterns. Existing evidence for American stocks from McInish and Wood (1992), Hasbrouck (1991a,b) and Foster and Viswanathan (1993) indicates that there is a U-shaped pattern in bid-ask spreads. Foster and Viswanathan show that there are significant differences in adverse selection costs during the day, but that these differences are hard to reconcile with models of concentrated trading which suggest that the bid-ask spread should be lower when trading is highest. Their evidence is stronger for the most actively traded firms, however.

In table 7, we provide our evidence on intra-day patterns in bid-ask spreads. In panel A, we report the results for European stocks. The midday spread is lower for European stocks than it is for their matching American stocks. However, at the open, the normalized spread for European stocks, i.e., the spread divided by its midday value, is significantly higher than for American stocks: 17.2% versus 11.7%. Hence, the existence of a competing market for the European stocks does not imply a smaller spike in spread in the morning, which makes it hard intraday volatility during the first trading interval even though, in contrast to the European and American stocks, their home business and trading days are over. As a result of this greater accrual of volatility in the first trading interval, Japanese stocks have significantly higher normalized volatility than their comparison group during that interval. In contrast, the comparison group has significantly higher normalized volatility over each of the subsequent four intervals and identical normalized volatility during the last interval. Hence, there is more evidence of differences in volatility pattems between Japanese and U.S. stocks than between European and U.S. stocks, in the sense of more intervals with significant differences. This is evidenced by the fact that the ratio of moming to aftemoon normalized volatility of Japanese stocks is significantly higher than the ratio of moming to aftemoon normalized volatility of matching stocks. Finally, for the Japanese stocks, the differences in normalized volatility are more economically significant: the fraction of intraday volatility that accrues to Japanese stocks in the first period of trading is almost 50% higher than the fraction that accrues to the comparison group of American stocks.

Table 3 provides a measure of how volatility accrues during the day which confirms the results of table 2. The volatility accrual rate for European stocks is faster than for their matching American stocks throughout the day until the last trading period, so that before the start of that period significantly more volatility has accrued for European stocks than for their matching American stocks. The volatility accrual rate for Japanese stocks is faster also, but it is also faster relative to European stocks. In contrast to European stocks, Japanese stocks accrue significantly more volatility than their matching American stocks early in the moming. At the end of the first three trading periods, the Japanese stocks have accrued significantly more volatility than their matching stocks. However, the difference in volatility accrual falls steadily during the day so that by the end of the fourth trading period the fraction of daily volatility accrued for Japanese stocks is indistinguishable from the fraction of daily volatility accrued for American stocks.

There are several possible explanations for the evidence we uncover in tables 2 and 3. First, following Amihud and Mendelson (1991), one could argue that opening prices are noisy estimates of public information, so that the first hour of trading incorporates public information into prices that was already available at the opening. Since the Japanese business day closes after the end of the Japanese trading day, Japanese public information accrues after the close of the trading day in Japan. For stocks not listed in Europe, this information can only be incorporated into prices when the NYSE opens. In contrast, for stocks listed in Europe, there is trading when the NYSE opens, so stock prices provide more precise estimates of the existing public information. The price discovery hypothesis suggests that morning volatility accrual should be less for the stocks listed in London. Panel C in table 2 explores this hypothesis by dividing the Japanese stocks into stocks listed in London and stocks not listed in London. In the first trading period, there is no difference between the two groups, whereas in the second period, London-listed stocks have higher normalized volatility than non-London listed stocks. This evidence does not support the price discovery hypothesis. The second trading period corresponds to the London close; hence, the Japanese stocks listed in London have an increase in volatility around the London close, so that their intra-day volatility in the U.S. inherits both the U-shaped pattern of London stocks and the U-shaped pattern of U.S. stocks. In contrast, but similarly to Kleidon and Werner (1993), the European stocks do not exhibit an increase in volatility at the close of the European markets.

Since the New York specialist does not have a monopoly position at the opening for European stocks and for Japanese stocks listed in London, the higher first period normalized volatility can be attributed to specialist behavior only if one believes that American investors would not switch to the foreign market to avoid specialist rent-seeking. Whereas such a view is plausible given the higher transaction costs abroad, one would still expect to observe greater volatility for domestic stocks for the simple reason that there are fewer alternatives for investors wishing to trade domestic stocks than for investors wishing to trade foreign stocks. Hence, it is hard to view our evidence as supportive of the argument advanced by Stoll and Whaley (1990).

It could well be that the massive overnight arrival of public information for foreign stocks is accompanied by an equally massive arrival of short-lived private information. If this were the case, one would expect investors to trade on this private information early in the day. With this view, though, one would expect the volatility increase to be smaller for Japanese stocks traded in London than for Japanese stocks not traded in London simply because some of the private information will be traded upon in London. As explained above, this is not the case.

The final explanation we consider is inspired by the trading models of Varian (1989) and Harris and Raviv (1993). In these models, investors trade on public information because new information leads them to change their priors. Hence, American investors in Japanese or European stocks trade on the overnight public information as the New York market opens if there is segmented trading. Since we don't assume that these investors have valuable private information which would be lost if they did not trade before New York opens, one would not expect them to use the London market. Since London trading does not reflect how American investors react to overnight public information, the lack of a volatility difference in the first period of trading between Japanese stocks listed in London and those that are not can be understood with our explanation. If our explanation is correct, though, one would expect more trading early in the morning for foreign stocks. We turn to a comparison of intra-day patterns in volume next.

All the above analysis is done by computing returns using the mid-point between the bid and ask quotes. We interpret this mid-point as the efficient market price, so that changes in that mid-point correspond to the incorporation of new information into prices. It could be, though, that the mid-point moves around because of microstructural considerations, such as inventory concerns. This raises the question of whether these concerns could make our inferences from the data invalid. One approach would be to follow the time-series analysis of Hasbrouck (1991a,b) and allow explicitly for a transitory component in the mid-point of the bid-ask quote. Instead, we show that our results about the similarity of the volatility patterns do not seem to depend on the use of the mid-point of the bid-ask quote. Panel A of table 4 shows results obtained using transaction prices. The intraday variance of transaction prices is higher because of bid-ask bounce. However, there seems to be no systematic microstructural effect which explains our results. The intraday patterns using transaction prices are mostly the same. In terms of the comparison between foreign and American stocks, the most pronounced effect of using transaction returns is for the first trading period for European stocks where the volatility difference is now significant and for the second trading period for Japanese stocks where it is no longer significant. As a result of these changes, the European stocks accrue significantly more volatility in the morning than matching American stocks. The differences between transaction return volatilities and bid-ask midpoint volatilities are illustrated in panel B of table 4 and figure 3. There is a significant difference for the overnight period, but no significant differences for the intraday periods for the dually-listed stocks, except for the fourth trading period for the Japanese stocks listed on the LSE. Considering transaction returns has the effect of strengthening somewhat the result that European stocks have higher volatility than matching American stocks in the morning.

Section 4. Intra-day patterns in volume.

Jain and Joh (1988) report the hourly trading volume of the NYSE and demonstrate a U-shaped pattern in trading volume during the day. Foster and Viswanathan (1993) examine the intra-day volume pattern for top, bottom and middle deciles sorted by trading activity. They find intra-day differences in volume for all categories, but the differences are most pronounced for the most actively traded stocks. For all categories, though, the intra-day pattern has a U-shape with volume highest in the first half hour, falling until the fourth hour and then increasing again. The highest volume coincides with the highest variance, which is supportive of the model of concentrated trading of Admati and Pfleiderer (1988). Foster and Viswanathan (1993) investigate formally the relation between the regression coefficients of the volume regressions and of the volatility regressions. For deciles one and ten they find a significant positive relation between the coefficients of the two regressions.

In table 5 and figure 4, we present our results for the intra-day variation in volume. In panel A, we show the results for the European stocks. It is immediately clear that these stocks exhibit a U-shaped intra-day pattern and this is shown in figure 4A. One way to evaluate this pattern is by comparing a period's fraction of daily volume with the fraction of daily volume of the period from 11:40 to 12:45. When we perform this comparison, we find significant differences for all periods. European stocks have significantly more of their daily volume in the morning, American stocks have significantly more in the afternoon, except in the last period. Relative to the period from 11:40 to 12:45, European stocks have significantly sharper peaks than matching American stocks. For instance, the first interval volume is 1.644 times the volume of the mid-day period for European stocks and 1.215 for matching stocks. The difference has a t-statistic of 8.116. For the last period, the ratios are respectively 1.297 and 1.379, with a t-statistic for the difference of 1.642. To investigate further the concentration of trading, we compute Herfindahl indices as the sum of the squared volume accrual rates. This ratio would take a value of one if all trading is concentrated in one period and a value of 1/6 if trading takes place equally in each period. The Herfindahl index is 0.180 for European stocks and 0.172 for American matching stocks. Hence, both European and American stocks seem to have equally concentrated trading when measured this way. We saw in table 2 that the normalized variance of European stocks exceeds the normalized variance of American comparison stocks by 1.9% of total intraday variance during the first trading interval; in contrast, the difference in volume is 4.6%. Whereas European stocks have significantly higher volume in the morning, they have significantly lower volume in the afternoon except during the last trading period where there is no difference between European and American stocks.

One might be tempted to attribute the differences in significance between tables 2 and 5 to differences in the power of the tests. It is true that differences between European and American firms of similar magnitudes are significant for normalized volume but not for normalized volatility. A closer look at the cumulative accrual of volume shows, however, that the volume and volatility patterns are quite different. The estimate of the cumulative difference in normalized volatility from 10:35 to 14:55 is zero whereas the estimate of the cumulative difference in normalized volume is 4.0% over that period. For the last trading period, table 2 documents a significant difference in normalized volatility, whereas it documents no significant differences in normalized volatility in the four previous periods. In contrast, the normalized volume difference is not significant for the last period and is significantly different for all the other periods.

Panel B of table 5 provides results for the Japanese stocks. For these stocks, we again observe a U-shaped pattern which is also apparent in figure 4B. This pattern is more pronounced than for American stocks: a higher fraction of Japanese stock trading accrues in the first and last trading intervals than for American stocks. For both the Japanese and matching American stocks, the fraction of daily volume which accrues during the last interval is roughly comparable to the fraction of daily volume which accrues during the first interval. The higher end-of-day volume of the Japanese stocks is not accompanied by higher volatility. Except for the last interval, though, Japanese stocks have greater volatility when they have greater volume. In contrast to the comparison between European stocks and American stocks, the differences in volume are smaller than the differences in volatility: the fraction of volume that accrues to Japanese stocks in excess of the fraction of volume that accrues to American stocks during the first interval is only 3.7% of the daily total in contrast to 9.9% for the variance. The small differences explain why the Herfindahl ratio for trade concentration of Japanese stocks, 0.186, is so close to the one for matching American stocks, 0.174. As for the comparison with European stocks, the Japanese stocks have lower normalized volume each period from 10:35 to 14:55 and higher normalized volume in the first and last interval.

Table 6 provides results on cumulative intraday volume. It shows that the normalized volume of American stocks catches up with the normalized volume of Japanese stocks more quickly during the day than it catches up with the normalized volume of European stocks. By 13:50, as much of the daily volume has accrued for American comparison stocks as for Japanese stocks; for European stocks, this occurs by 14:55. This evidence is consistent with the view that investors receive more information to trade upon late in the morning for European stocks than for Japanese stocks.

The private information story would suggest more accumulation of volume early in the day for Japanese stocks which do not trade on the London Stock Exchange. Panel C of tables 5 and 6 compares Japanese stocks listed in London with those that are not. There is some evidence that (1) stocks listed in London trade more at the open and (2) volume accumulates faster after the opening for stocks not listed in London. Interestingly, the greater normalized volume at the open for London-listed stocks is approximately offset by the lesser normalized volume of these stocks during the first two trading intervals. Hence, availability of the London market does lead to a shift in trading towards the open. This shift is not accompanied by a similar significant shift in variances: in table 2, the overnight normalized variance for stocks traded in London is insignificantly higher and the first interval variance is insignificantly lower. Further, the difference in overnight normalized variances is of the same magnitude as the differences in overnight normalized variances for European stocks and their matching American stocks, which is significant. Hence, one can interpret this evidence as indicating that investors are more willing to trade at the open when a competing exchange is open. Two possible reasons for this are: (a) opening prices are less noisy or (b) trading is cheaper because of competition. Given that the rate of volatility accrual for Japanese stocks not listed in London is not higher following the open, it is hard to argue that the data is supportive of (a). To investigate (b), we have to look at bid-ask spreads which we do next.

Section 5. Bid-ask spread intra-day patterns.

We now turn to a comparison of the bid-ask intra-day patterns. Existing evidence for American stocks from McInish and Wood (1992), Hasbrouck (1991a,b) and Foster and Viswanathan (1993) indicates that there is a U-shaped pattern in bid-ask spreads. Foster and Viswanathan show that there are significant differences in adverse selection costs during the day, but that these differences are hard to reconcile with models of concentrated trading which suggest that the bid-ask spread should be lower when trading is highest. Their evidence is stronger for the most actively traded firms, however.

In table 7, we provide our evidence on intra-day patterns in bid-ask spreads. In panel A, we report the results for European stocks. The midday spread is lower for European stocks than it is for their matching American stocks. However, at the open, the normalized spread for European stocks, i.e., the spread divided by its midday value, is significantly higher than for American stocks: 17.2% versus 11.7%. Hence, the existence of a competing market for the European stocks does not imply a smaller spike in spread in the morning, which makes it hard to explain this spike by the monopolist behavior of NYSE specialists. The normalized spread for European stocks falls continuously throughout the day, except for being higher in the interval from 13:50 to 14:55 than in the surrounding intervals. All afternoon spreads are lower than at midday for European stocks and two are significantly lower. The last trading period spread is the lowest of the day and is significantly lower than the spread of the American matching stocks. As shown on figure 5, European stocks do not exhibit a U-shaped pattern of bid-ask spreads even though their volume and volatility do. The normalized bid-ask spread of European stocks is significantly higher than that of the matching stocks at the beginning of the day and significantly lower at the end of the day. Nevertheless, the matching stocks do not exhibit much of a U-shaped pattern either: the bid-ask spread of matching stocks at the end of the day is not significantly higher than the bid-ask spread at midday.

Panel B of table 7 and figure 5 provide evidence for Japanese stocks. Again, for these stocks the bid-ask spread at midday is lower than for the matching American stocks. The results early in the morning are similar to those shown in panel A, with a higher normalized spread for the Japanese stocks than for their matching American stocks. Contrary to the European stocks, though, the bid-ask spread for Japanese stocks at the end of the day is not significantly lower than at midday. There is no evidence that competition by foreign markets eliminates the higher bid-ask spread in the morning. The absence of a higher bid-ask spread at the end of the day cannot be attributed to competition since foreign markets are closed at that time. Further, in our sample, the behavior of the Japanese stocks at the end of the day is not different from their matching stocks.

It is difficult to believe that the greater normalized spread of foreign stocks early in the morning reflects greater adverse selection resulting from a higher probability that the specialist would end up trading with investors who have private information. This is because, presumably, private information trading is more likely to take place on the deeper home market of a security and during the foreign business day. It may well be, though, that in the morning, as American investors react to overnight public information, there is a substantial risk for the specialist of large changes in his inventory resulting from changes in the American investors' demand for foreign securities. The specialist would protect himself from such changes by posting a greater bid-ask spread.

Section 6. Concluding remarks.

In this paper, we investigate the intraday volatility, volume, and bid-ask spread patterns for stocks that differ markedly in the arrival rate of public information during the trading day. We find that, in spite of the differences in the arrival rate of public information, all groups of stocks have U-shaped patterns of volume and volatility. The U-shaped patterns in volatility cannot be explained by the contemporaneous arrival of public information for the different stocks. Models with trading on private information do not seem to be consistent with our results. This is because, for Japanese stocks, one would expect volatility to be less for the stocks listed in London than for the other stocks if private information is a major determinant of volatility because investors with private information presumably take advantage of the opportunity to trade in London. We find no support for this.

A plausible story for our results is that investors in the U.S. trade on the basis of the accumulated stock of public information since the last closing of the U.S. markets. This stock of information is the largest for Japanese stocks since a whole business day takes place between the close and open of U.S. markets, the second largest for European stocks since more than half a business day takes place between the close and open of U.S. markets, and smallest for American stocks. With this view, investors trade on public information because it changes their priors. The process of demand revelation causes prices to exhibit greater volatility. Consequently, the opening price is not a noisy estimate of the fundamentals known at the open; rather, the demand by American investors is revealed only over time as they react to the accumulated public information. The volatility of matching American stocks is lower in the moming because not much has happened to change investors' priors. Bid-ask spreads are larger in the morning for foreign stocks because there is more uncertainty about demand. The foreign stocks also have a trading concentration at the end of the day, but it is more likely due to random forces than to investors reacting to public information, since little public information has accrued on these stocks during the day. Hence, this concentration of trading does not lead to higher bid-ask spreads. Whereas one can understand the greater concentration of trading of foreign stocks early in the day, the concentration of trading towards the end of the day is a puzzle left for future research.

The great similarity of the intra-day pattems across European, Japanese and American stocks suggests that, once one compares stocks with similar volume and volatility, differences in the rate of arrival of public information during the day, as opposed to ovemight, are not as important as expected. This result can be interpreted as evidence that news during the U.S. business day are sufficiently important for foreign stocks that they lead to intra-day pattems similar to those of U.S. stocks of similar volume and volatility.

References

Admati, A., and P. Pfleiderer, 1988, A theory of intraday patterns: Volume and price variability, The Review of Financial Studies 1, 3-40.

Amihud, Y., and H. Mendelson, 1991, Efficiency and trading: Evidence from the Japanese stock market, The Journal of Finance 46, 1765-1790.

Barclay, M.J., R.H. Litzenberger, and J.B. Warner, 1990, Private information, trading volume, and stock return variances, The Review of Financial Studies 3, 233-253.

Foster, M., and T. George, 1992, Volatility, trading mechanisms and international cross-listing, unpublished working paper, Ohio State University.

Foster, F., and S. Viswanathan, 1993, Variations in trading volume, return volatility and trading costs: Evidence on recent price formation models, The Journal of Finance 48, 187-211.

French, K. and R. Roll, 1986, Stock return variances: The arrival of information and the reaction of traders, The Journal of Financial Economics 17, 5-26.

Hansen, L., 1982, Large sample properties of generalized method of moment estimator, Econometrica 50, 1029-1054.

Harris, L., 1986, A transactions data study of weekly and intradaily patterns in stock returns, Journal of Financial Economics 16, 99-117.

Harris, M., and A. Raviv, 1993, Differences of opinion make a horse race, The Review of Financial Studies 6, 473-506.

Hasbrouck, J., 1991a, Measuring the information content of stock trades, The Journal of Finance 46, 179-207.

Hasbrouck, J., 1991b, The summary informativeness of stock trades: An econometric analysis, The Review of Financial Studies 4, 571-595.

Jain, P., and G. Joh, 1988, The dependence between hourly prices and trading volume, Journal of Financial and Quantitative Analysis 23, 269-283.

Kleidon, A., and I. Werner, 1993, Round-the-clock trading: Evidence from U.K. cross-listed securities, working paper, Stanford University, Stanford, CA.

McInish, T., and R. Wood, 1992, An analysis of intraday patterns in bid/ask spread for NYSE stocks, The Journal of Finance 47, 753-764.

Newey, W., and K. West, 1987, A simple positive semi-definite heteroskedasticity and autocorrelation consistent covariance matrix, Econometrica 55, 703-708.

Stoll, H., and R. Whaley, 1990, Stock market structure and volatility, The Review of Financial Studies 3, 37-71.

Varian, H., 1989, Differences of opinion in financial markets, in Financial Risk: Theory, Evidence and Implications, Proceedings of the Eleventh Annual Economic Policy Conference of the Federal Reserve Bank of St. Louis, C. Stone, ed. (Boston: Kluwer Academic Publishers), 3-37.

Wood, R., T. McInish and J. Ord, 1985, An investigation of transactions data for NYSE stocks, The Journal of Finance 40, 723-739.

Table 1. Returns (86-87)

Intraday returns of domestic and foreign stocks trading in New York. The percentage return for each interval is computed with the bid-ask midpoints. The ratio, "Morning/Afternoon", is computed excluding the opening return. The t-statistics are obtained using the Newey and West (1987) method with 15 lags.

A. European vs. U.S.

	Mean Returns (%) per Interval							Intraday	Morning / Afternoon
	Open	10:35	11:40	12:45	13:50	14:55	16:00	Total	t-stat (=1)
(1) Domestic:	0.033	-0.006	0.000	0.010	0.002	-0.009	0.052	0.0813	0.098
t-stat (=0)	1.409	-0.373	0.007	1.149	0.288	-1.048	4.368		-1.519
(2) European:	0.108	-0.068	0.015	0.004	0.005	0.010	0.063	0.1366	-0.627
t-stat (=0)	3.609	-4.250	1.262	0.427	0.544	1.357	5.969		-4.189
(1) - (2):	-0.075	0.062	-0.015	0.005	-0.003	-0.019	-0.011	-0.0553	0.725
t-stat (=0)	-2.377	4.413	-1.543	0.602	-0.356	-1.983	-1.246		1.765 (=0)

B. Japanese vs. U.S.

	Mean Returns (%) per Interval							Intraday	Morning / Afternoon
	Open	10:35	11:40	12:45	13:50	14:55	16:00	Total	t-stat (=1)
(1) Domestic:	0.011	0.018	0.009	0.004	0.010	0.002	0.045	0.0990	0.547
t-stat (=0)	0.530	1.270	0.957	0.542	1.528	0.279	4.181		-1.151
(2) Japan (All):	0.156	0.022	-0.007	-0.009	0.006	0.005	0.079	0.2529	0.068
t-stat (=0)	2.114	1.076	-0.637	-1.437	0.876	0.616	5.787		-3.312
(1) - (2):	-0.146	-0.004	0.016	0.013	0.004	-0.003	-0.035	-0.1539	0.478
t-stat (=0)	-1.951	-0.202	1.117	1.590	0.491	-0.261	-3.213		1.020 (=0)

C. J-LSE vs. J-non LSE

	Mean Returns (%) per Interval							Intraday	Morning / Afternoon
	Open	10:35	11:40	12:45	13:50	14:55	16:00	Total	t-stat (=1)
(1) Japan (Non-LSE):	0.183	0.019	-0.007	-0.016	0.002	-0.002	0.071	0.2503	-0.044
t-stat (=0)	2.327	0.770	-0.501	-2.046	0.239	-0.172	4.382		-2.395
(2) Japan (LSE):	0.104	0.026	-0.008	0.002	0.012	0.015	0.091	0.2419	0.190
t-stat (=0)	1.283	1.071	-0.562	0.198	1.350	1.898	6.641		-3.343
(1) - (2):	0.079	-0.007	0.001	-0.018	-0.010	-0.017	-0.020	0.0084	-0.233
t-stat (=0)	1.352	-0.260	0.050	-1.718	-0.947	-1.638	-1.445		-0.567 (=0)

Table 2. Variance (86-87)

Intraday variances of domestic and foreign stocks trading in New York. Using the bid-ask midpoints, the normalized variance for each interval is computed as a fraction of the total intraday variance. The ratio, "Morning/Afternoon", is computed excluding the opening variance. The t-statistics are obtained using the Newey and West (1987) method with 15 lags.

A. European vs U.S.

	Fraction of Intraday Total							Intraday	Morning / Afternoon
	Open	10:35	11:40	12:45	13:50	14:55	16:00	Total	t-stat (=1)
(1) Domestic:	0.380	0.270	0.192	0.137	0.106	0.121	0.173	0.00035	1.495
t-stat (=0)	5.556	19.662	11.036	22.735	20.909	17.427		12.458	5.431
(2) European:	0.793	0.289	0.181	0.149	0.104	0.122	0.154	0.00026	1.629
t-stat (=0)	7.605	21.929	24.545	17.798	14.031	10.993		14.377	6.325
(1) - (2):	-0.412	-0.019	0.011	-0.013	0.002	-0.002	0.019	0.00009	-0.134
t-stat (=0)	-6.758	-1.149	0.603	-1.315	0.292	-0.124			-1.139 (=0)

B. Japanese vs. U.S.

	Fraction of Intraday Total							Intraday	Morning / Afternoon
	Open	10:35	11:40	12:45	13:50	14:55	16:00	Total	t-stat (=1)
(1) Domestic:	0.443	0.274	0.174	0.150	0.112	0.117	0.173	0.00015	1.486
t-stat (=0)	3.626	20.479	20.152	23.883	22.976	23.460		13.199	5.374
(2) Japan (All):	5.638	0.403	0.143	0.106	0.084	0.098	0.165	0.00008	1.878
t-stat (=0)	7.501	10.328	11.091	8.915	10.783	10.699		11.590	4.497
(1) - (2):	-5.195	-0.129	0.030	0.044	0.028	0.019	0.008	0.00006	-0.392
t-stat (=0)	-6.977	-3.251	1.877	3.423	3.111	1.864			-2.029 (=0)

C. J-LSE vs. J-non LSE

	Fraction of Intraday Total							Intraday	Morning / Afternoon
	Open	10:35	11:40	12:45	13:50	14:55	16:00	Total	t-stat (=1)
(1) Japan (Non-LSE):	5.466	0.408	0.130	0.105	0.078	0.104	0.175	0.00009	1.798
t-stat (=0)	6.100	7.011	8.392	6.593	9.196	7.096		8.660	2.895
(2) Japan (LSE):	5.914	0.396	0.166	0.107	0.093	0.088	0.151	0.00008	2.017
t-stat (=0)	7.558	13.341	11.308	7.827	7.955	11.493		12.454	5.600
(1) - (2):	-0.448	0.012	-0.036	-0.002	-0.014	0.017	0.024	0.00001	-0.219
t-stat (=0)	-0.523	0.187	-1.929	-0.108	-1.114	0.992			-0.703 (=0)

Table 3. Cumulative Variance (86-87): Excluding Open

Cumulative intraday variances of domestic and foreign stocks trading in New York. Using the bid-ask midpoints, the cumulative variance for each interval is computed as a cumulative fraction of the total intraday variance excluding the opening variance. The t-statistics are computed using the Newey and West (1987) method with 15 lags.

A. European vs. U.S.

Cumulative Fraction of Intraday Total

	10:35	11:40	12:45	13:50	14:55	16:00	Intraday Total
(1) Domestic:	0.270	0.462	0.599	0.706	0.827	1.000	0.00035
t-stat (=0)	19.662	30.160	40.918	53.529	73.430		12.458
(2) European:	0.289	0.470	0.620	0.724	0.846	1.000	0.00026
t-stat (=0)	21.929	29.936	43.068	56.443	94.433		14.377
(1) - (2):	-0.019	-0.008	-0.020	-0.018	-0.019		0.00009
t-stat (=0)	-1.149	-0.409	-1.141	-1.107	-1.929		

B. Japanese vs. U.S.

Cumulative Fraction of Intraday Total

	10:35	11:40	12:45	13:50	14:55	16:00	Intraday Total
(1) Domestic:	0.274	0.448	0.598	0.710	0.827	1.000	0.00015
t-stat (=0)	20.479	30.889	40.843	51.723	70.605		13.199
(2) Japan (All):	0.403	0.547	0.653	0.736	0.835	1.000	0.00008
t-stat (=0)	10.328	18.334	27.684	38.940	54.230		11.590
(1) - (2):	-0.129	-0.099	-0.055	-0.026	-0.008		0.00006
t-stat (=0)	-3.251	-3.055	-2.247	-1.297	-0.533		

C. J-LSE vs. J-non LSE

Cumulative Fraction of Intraday Total

	10:35	11:40	12:45	13:50	14:55	16:00	Intraday Total
(1) Japan (Non-LSE):	0.408	0.538	0.643	0.721	0.825	1.000	0.00009
t-stat (=0)	7.011	11.747	18.250	25.201	39.762		8.660
(2) Japan (LSE):	0.396	0.562	0.669	0.761	0.849	1.000	0.00008
t-stat (=0)	13.341	24.832	33.508	42.075	54.570		12.454
(1) - (2):	0.012	-0.024	-0.026	-0.040	-0.024		0.00001
t-stat (=0)	0.187	-0.479	-0.676	-1.235	-1.088		

Table 4. Variance (86-87): Using Transaction Prices

Intraday variances of domestic and foreign stocks trading in New York. Using the transaction prices, panel A shows the norm--alized variance for each interval computed as a fraction of the total intraday variance. Panel B shows the difference from the results obtained using the bid-ask midpoints in Table 2. The ratio, 'Morning/Afternoon', is computed excluding the opening variance. The t-statistics are obtained using the Newey and West (1987) method with 15 lags.

A-1. European vs U.S.

	Fraction of Intraday Total							Intraday	Morning / Afternoon
	Open	10:35	11:20	12:35	13:50	14:55	16:30	Total	t-stat (=1)
(1) Domestic:	0.302	0.252	0.175	0.155	0.112	0.121	0.185	0.00045	1.396
t-stat (=0)	5.170	17.361	34.512	9.142	25.942	20.997		11.901	4.444
(2) European:	0.601	0.299	0.185	0.138	0.107	0.116	0.155	0.00036	1.649
t-stat (=0)	8.435	9.571	11.558	13.400	14.107	11.459		10.644	3.647
(1) - (2):	-0.300	-0.047	-0.010	0.017	0.005	0.005	0.030	0.00009	-0.253
t-stat (=0)	-4.641	-1.968	-0.607	0.865	0.658	0.469			-1.727 (=0)

A-2. Japanese vs. U.S.

	Fraction of Intraday Total							Intraday	Morning / Afternoon
	Open	10:35	11:40	12:45	13:50	14:55	16:00	Total	t-stat (=1)
(1) Domestic:	0.377	0.247	0.151	0.149	0.108	0.115	0.230	0.00023	1.206
t-stat (=0)	4.256	9.133	12.649	13.871	11.593	12.324		11.400	1.031
(2) Japan (All):	4.172	0.401	0.144	0.105	0.083	0.097	0.170	0.00011	1.857
t-stat (=0)	8.303	7.654	8.647	8.337	9.357	11.057		9.460	3.230
(1) - (2):	-3.794	-0.154	0.007	0.044	0.025	0.018	0.060	0.00012	-0.650
t-stat (=0)	-7.225	-3.824	0.364	2.480	2.292	1.813			-2.710 (=0)

A-3. J-LSE vs. J-non LSE

	Fraction of Intraday Total							Intraday	Morning / Afternoon
	Open	10:35	11:40	12:45	13:50	14:55	16:00	Total	t-stat (=1)
(1) Japan (Non-LSE):	4.076	0.381	0.127	0.112	0.088	0.107	0.186	0.00012	1.628
t-stat (=0)	6.896	6.042	7.974	7.562	7.688	9.448		8.358	2.245
(2) Japan (LSE):	4.315	0.433	0.172	0.093	0.075	0.081	0.146	0.00011	2.313
t-stat (=0)	7.992	10.846	7.907	7.130	7.118	7.970		9.296	4.013
(1) - (2):	-0.239	-0.053	-0.046	0.020	0.013	0.026	0.040	0.00001	-0.684
t-stat (=0)	-0.419	-1.607	-2.465	1.495	0.934	2.020			-2.437 (=0)

Table 4. (Continued)

B-1. European vs U.S.

	Fraction of Intraday Total							Intraday Total	Morning / Afternoon t-stat (=0)
	Open	10:35	11:40	12:45	13:50	14:55	16:00		
(1) Domestic:	0.081	0.022	0.015	-0.020	-0.005	0.000	-0.011	-0.00009	0.098
t-stat (=0)	2.129	1.321	0.807	-1.058	-1.292	0.055			1.443
(2) European:	0.187	-0.012	-0.004	0.013	-0.003	0.007	-0.001	-0.00010	-0.019
t-stat (=0)	3.533	-0.356	-0.259	1.182	-0.328	0.731			-0.111

B-2. Japanese vs. U.S.

	Fraction of Intraday Total							Intraday Total	Morning / Afternoon t-stat (=0)
	Open	10:35	11:40	12:45	13:50	14:55	16:00		
(1) Domestic:	0.064	0.028	0.022	0.001	0.004	0.003	-0.058	-0.00008	0.372
t-stat (=0)	0.784	0.982	1.901	0.123	0.466	0.299			3.362
(2) Japan (All):	1.462	0.003	-0.001	0.001	0.001	0.002	-0.005	-0.00003	0.013
t-stat (=0)	3.219	0.039	-0.066	0.086	0.084	0.159			0.040

B-3. J-LSE vs. J-non LSE

	Fraction of Intraday Total							Intraday Total	Morning / Afternoon t-stat (=0)
	Open	10:35	11:40	12:45	13:50	14:55	16:00		
(1) Japan (Non-LSE):	1.390	0.027	0.003	-0.007	-0.009	-0.002	-0.011	-0.00003	0.170
t-stat (=0)	2.451	0.301	0.169	-0.418	-0.677	-0.158			0.426
(2) Japan (LSE):	1.598	-0.037	-0.007	0.014	0.018	0.007	0.005	-0.00003	-0.296
t-stat (=0)	3.315	-0.925	-0.367	1.122	2.422	0.684			-0.961

Table 5. Normalized Volume (86-87)

Intraday variation in volume of domestic and foreign stocks trading in New York. The normalized volume for each interval is co puted as the number of shares traded over the interval divided by the average of all intervals. The ratio, "Morning/Afternoon", is computed excluding the opening volume. The t-statistics are obtained using the Newey and West (1987) method with 15 lags.

A. European vs. U.S.

	Fraction of Intraday Total							Intraday Total	Morning / Afternoon t-stat (=1)
	Open	10:35	11:40	12:45	13:50	14:55	16:00		
(1) Domestic:	0.054	0.193	0.182	0.159	0.123	0.137	0.206	607.205	1.144
t-stat (=0)	38.815	64.790	58.219	67.055	54.802	62.234		38.357	7.962
(2) European:	0.063	0.238	0.193	0.145	0.101	0.123	0.200	610.670	1.357
t-stat (=0)	20.928	49.166	46.831	41.828	37.490	31.740		27.695	8.580
(1) - (2):	-0.008	-0.046	-0.010	0.014	0.022	0.014	0.006	-3.465	-0.213
t-stat (=0)	-3.141	-8.745	-2.286	3.680	6.815	3.354			-5.406 (=0)

B. Japanese vs. U.S.

	Fraction of Intraday Total							Intraday Total	Morning / Afternoon t-stat (=1)
	Open	10:35	11:40	12:45	13:50	14:55	16:00		
(1) Domestic:	0.054	0.211	0.180	0.155	0.119	0.132	0.204	608.658	1.201
t-stat (=0)	26.896	24.059	44.186	37.654	30.898	29.318		33.766	4.759
(2) Japan (All):	0.073	0.248	0.172	0.136	0.096	0.118	0.230	608.125	1.251
t-stat (=0)	22.219	45.681	25.291	22.846	23.533	24.416		20.443	6.546
(1) - (2):	-0.019	-0.037	0.007	0.020	0.023	0.014	-0.027	0.533	-0.049
t-stat (=0)	-4.866	-4.015	1.065	2.933	3.989	2.282			-0.886 (=0)

C. J-LSE vs. J-non LSE

	Fraction of Intraday Total							Intraday Total	Morning / Afternoon t-stat (=1)
	Open	10:35	11:40	12:45	13:50	14:55	16:00		
(1) Japan (Non-LSE):	0.065	0.254	0.178	0.133	0.101	0.115	0.219	605.492	1.295
t-stat (=0)	20.971	41.389	20.573	21.527	22.015	24.440		17.245	5.941
(2) Japan (LSE):	0.085	0.240	0.165	0.140	0.088	0.121	0.246	604.857	1.196
t-stat (=0)	10.970	22.795	20.016	13.921	14.321	12.290		17.714	3.696
(1) - (2):	-0.020	0.014	0.013	-0.007	0.013	-0.005	-0.027	0.635	0.100
t-stat (=0)	-2.237	1.121	1.244	-0.639	1.904	-0.499			1.465 (=0)

Table 6. Cumulative Normalized Volume (86-87): Excluding Open

Intraday variation in cumulative volume of domestic and foreign stocks trading in New York. The cumulative volume for each interval is computed as a cumulative fraction of the intraday total volume excluding the opening volume. The t-statistics are obtained using the Newey and West (1987) method with 15 lags.

A. European vs. U.S.

	Cumulative Fraction of Intraday Total						Intraday Total
	10:35	11:40	12:45	13:50	14:55	16:00	
(1) Domestic:	0.193	0.375	0.534	0.657	0.794	1.000	607.205
t-stat (=0)	64.790	85.969	135.419	142.072	192.555		38.357
(2) European:	0.238	0.431	0.576	0.677	0.800	1.000	610.670
t-stat (=0)	49.166	69.325	76.842	106.364	173.495		27.695
(1) - (2):	-0.046	-0.056	-0.042	-0.020	-0.006		-3.465
t-stat (=0)	-8.745	-8.116	-5.859	-3.086	-1.394		

B. Japanese vs. U.S.

	Cumulative Fraction of Intraday Total						Intraday Total
	10:35	11:40	12:45	13:50	14:55	16:00	
(1) Domestic:	0.211	0.390	0.546	0.665	0.796	1.000	608.658
t-stat (=0)	24.059	43.585	62.494	77.401	107.067		33.766
(2) Japan (All):	0.248	0.420	0.556	0.652	0.770	1.000	608.125
t-stat (=0)	45.681	60.153	73.487	85.891	101.193		20.443
(1) - (2):	-0.037	-0.030	-0.010	0.013	0.027		0.533
t-stat (=0)	-4.015	-2.649	-0.884	1.229	2.919		

C. J-LSE vs. J-non LSE

	Cumulative Fraction of Intraday Total						Intraday Total
	10:35	11:40	12:45	13:50	14:55	16:00	
(1) Japan (Non-LSE):	0.254	0.431	0.564	0.666	0.781	1.000	605.492
t-stat (=0)	41.389	49.692	59.807	78.102	91.549		17.245
(2) Japan (LSE):	0.240	0.405	0.545	0.633	0.754	1.000	604.857
t-stat (=0)	22.795	32.783	49.593	55.336	63.007		17.714
(1) - (2):	0.014	0.027	0.020	0.033	0.027		0.635
t-stat (=0)	1.121	1.746	1.457	2.662	2.067		

Table 7. Bid Ask Spread Relative to Midday (86-87)

Intraday patterns in bid-ask spreads of domestic and foreign stocks trading in New York. The bid-ask spread for each interval is measured as a percent of the bid-ask midpoint at the end of each interval, and reported below as a fraction of the bid-ask spread for the third trading interval (11:40 - 12:45). The t-statistics are obtained using the Newey and West (1987) method with 15 lags.

A. European vs. U.S.

percent of price	Open	10:35	11:40	12:45	13:50	14:55	16:00	Midday Spread t-stat (=0)
(1) Domestic:	1.117	1.035	1.008	1	0.998	0.997	1.008	1.022
t-stat (=1)	23.705	10.082	2.300		-0.726	-1.046	1.286	37.370
(2) European:	1.172	1.040	1.015	1	0.989	0.999	0.974	0.890
t-stat (=1)	23.734	6.557	2.526		-2.026	-0.151	-4.803	37.398
(1) - (2):	-0.055	-0.004	-0.008	0	0.009	-0.002	0.035	0.131
t-stat (=0)	-5.942	-0.594	-1.134		1.548	-0.308	5.110	

B. Japanese vs. U.S.

percent of price	Open	10:35	11:40	12:45	13:50	14:55	16:00	Midday Spread t-stat (=0)
(1) Domestic:	1.097	1.026	0.997	1	0.991	0.991	0.997	0.914
t-stat (=1)	17.760	5.204	-0.837		-2.344	-1.902	-0.509	36.691
(2) Japan (All):	1.241	1.056	1.003	1	0.991	0.974	0.992	0.490
t-stat (=1)	9.420	4.666	0.274		-1.047	-3.119	-0.839	45.003
(1) - (2):	-0.144	-0.031	-0.006	0	0.001	0.017	0.005	0.424
t-stat (=0)	-5.601	-2.539	-0.551		0.078	1.682	0.398	

C. J-LSE vs. J-non LSE

percent of price	Open	10:35	11:40	12:45	13:50	14:55	16:00	Midday Spread t-stat (=0)
(1) Japan (Non-LSE):	1.235	1.045	0.993	1	0.987	0.976	0.989	0.483
t-stat (=1)	7.324	2.658	-0.422		-1.068	-2.206	-0.791	43.903
(2) Japan (LSE):	1.247	1.072	1.019	1	0.997	0.972	0.997	0.501
t-stat (=1)	7.694	4.207	1.076		-0.204	-1.740	-0.145	34.907
(1) - (2):	-0.012	-0.027	-0.026	0	-0.010	0.005	-0.009	-0.018
t-stat (=0)	-0.311	-1.060	-0.992		-0.509	0.222	-0.314	

Figure 1. Returns (86 - 87)

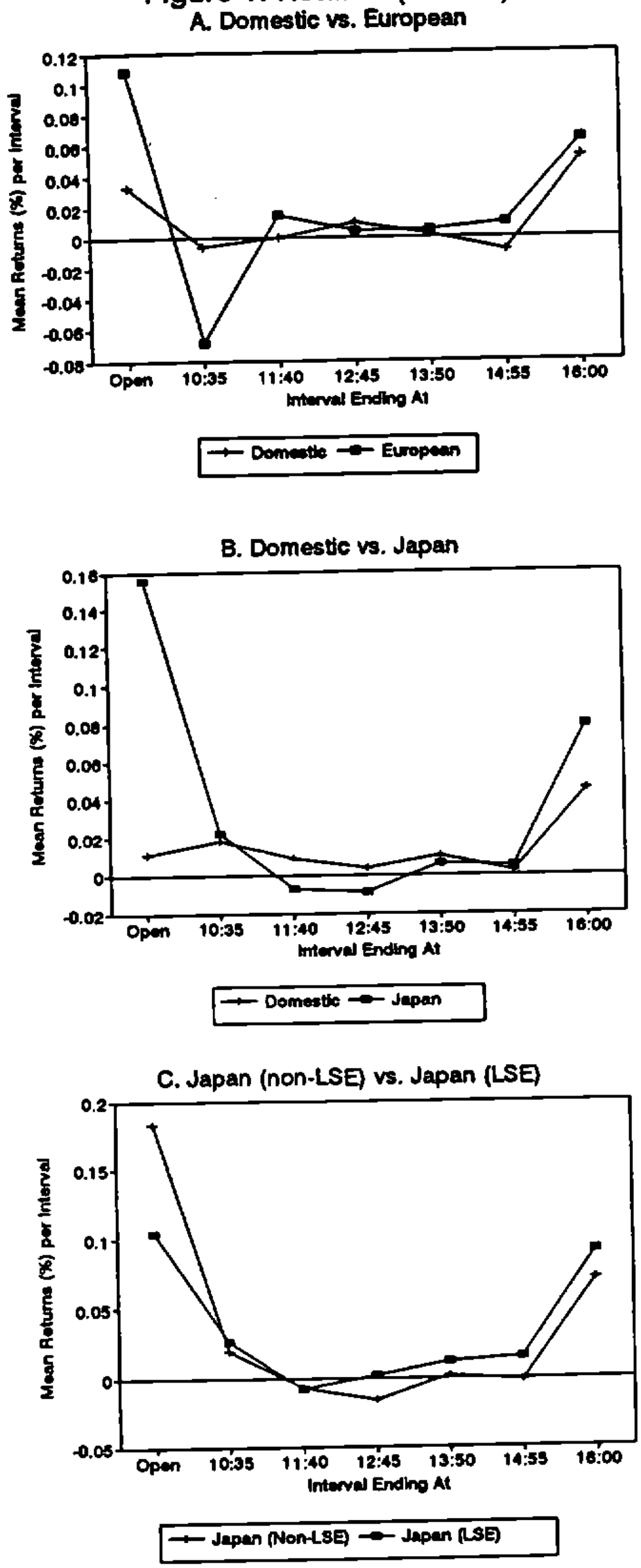
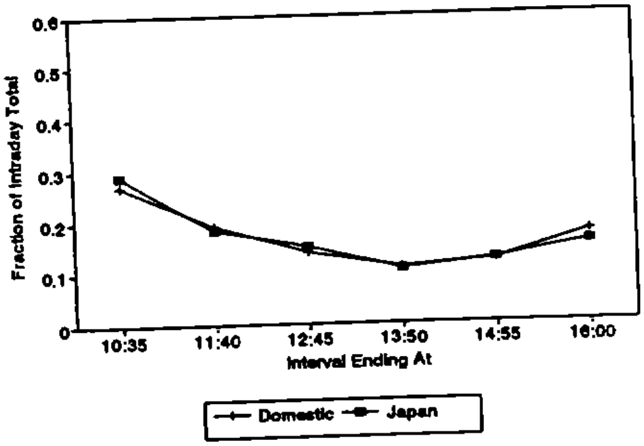
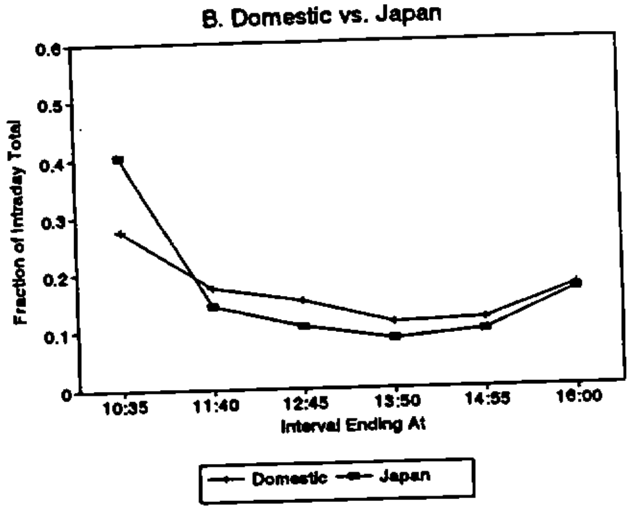


Figure 2. Variance (86 -87)

A.Domestic vs. European



B. Domestic vs. Japan



C. Japan (non-LSE) vs. Japan (LSE)

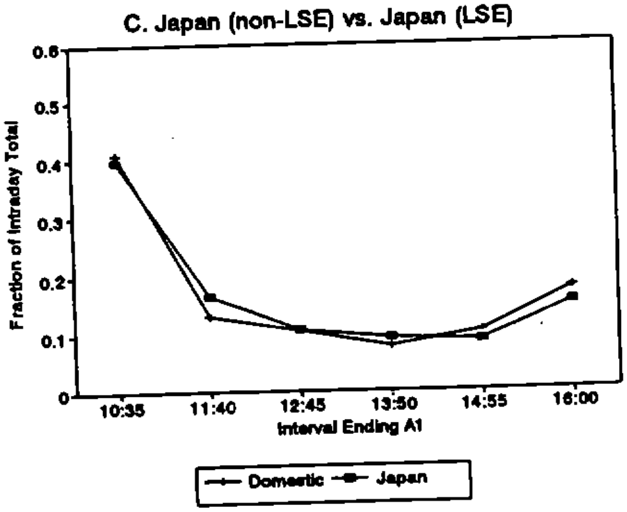


Fig 3. Midpoint Var - Transactions Var

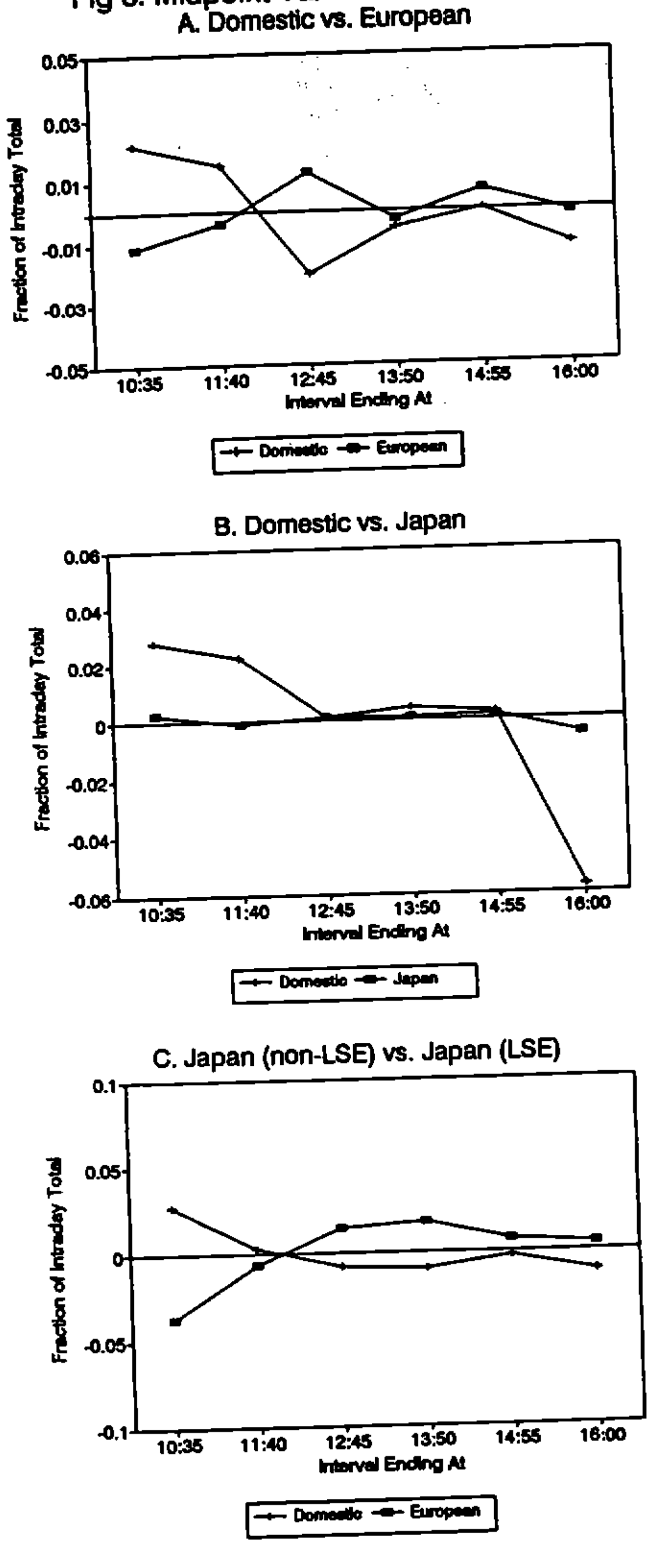


Figure 4. Normalized Volume (86 - 87)

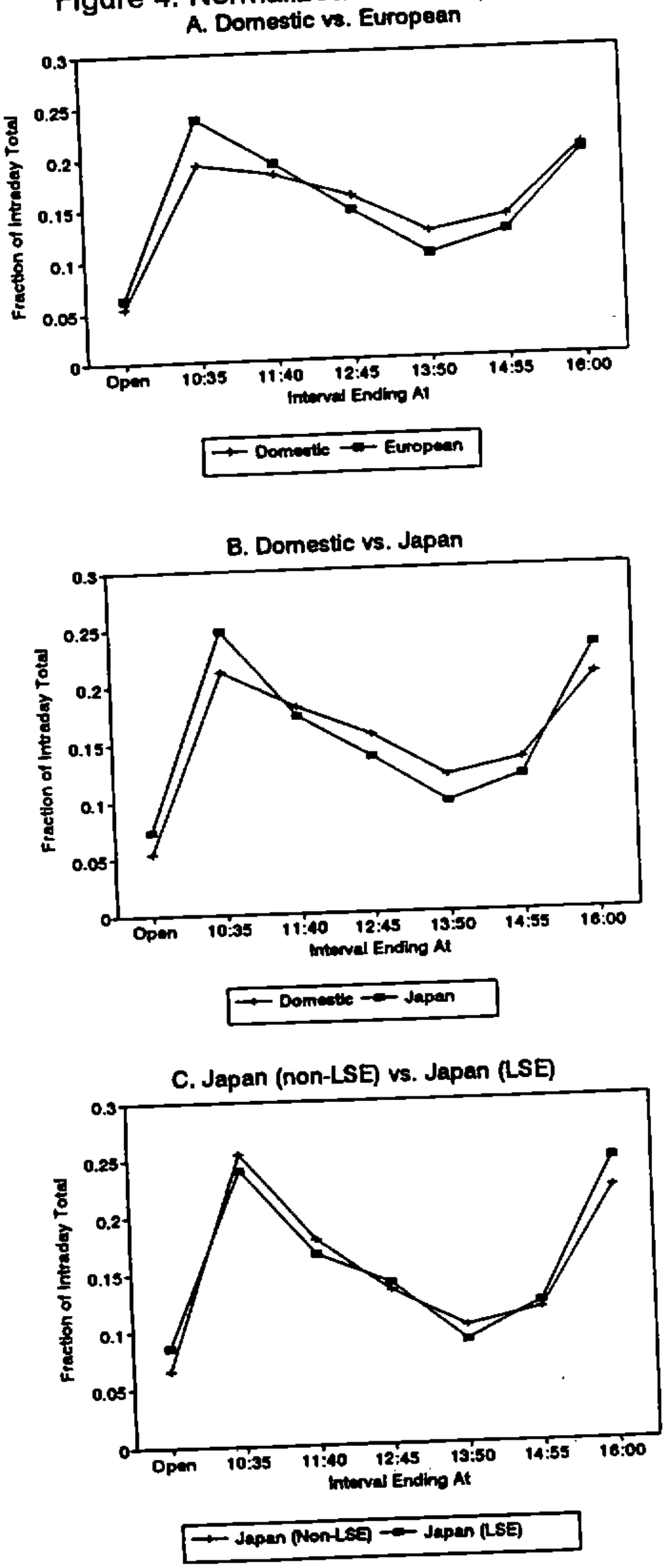
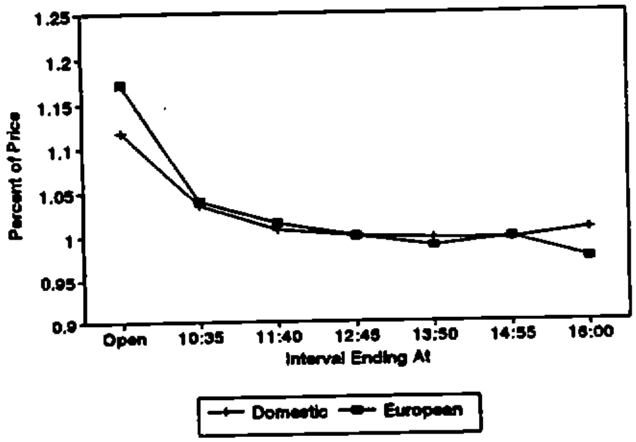
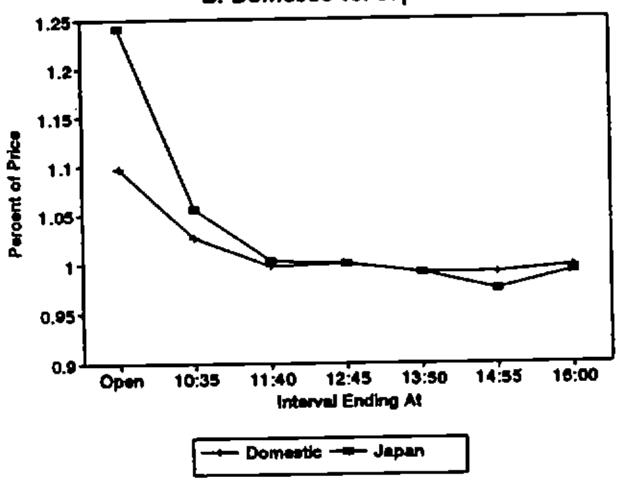


Fig 5.Bid-Ask Spread Relative to Midday

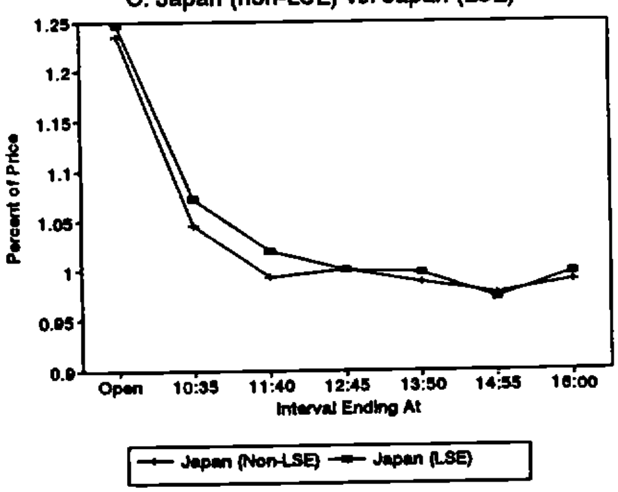
A. Domestic vs. European



B. Domestic vs. Japan



C. Japan (non-LSE) vs. Japan (LSE)



Appendix. Sample of Foreign Stocks and American Matching Stocks

For each foreign stock in the sample and its three American matching stocks, this table provides the ticker symbol, the firm name, the CUSIP number, the number of trading days for the year, the average number of trades per day, the standard deviation of hourly returns, the firm size in unit of $1,000 (the average price for the year times the number of shares outstanding at the beginning of the year), the exchange where the stock is listed at the end of the year (N denotes NYSE and A denotes AMEX), and the lowest price for the year.

A1. European Stocks Listed in NYSE/AMEX in 1986

OBS	SYM.	NAME	CUSIP	DAYS	NTPD	Std Dev.	SIZE	PEX	LOWPRI
1	ASA	ASA LTD	00205010	236	92.14	0.005563	347851	N	28.8
2	AUS	AUSIMONT COMPO N V	05211510	236	21.86	0.008601	561388	N	12.3
3	BP	BRITISH PETE LTD	11088940	236	30.15	0.003672	67021344	N	30.1
4	BTI	B A T INDS P L C	05527020	236	53.55	0.006001	8701392	A	4.2
5	BTY	BRITISH TELECOMMS P L C	11102130	233	13.13	0.004164	179571440	N	24.6
6	ETZ	ETZ LAVUD LTD	29788210	236	6.67	0.011485	20641	A	8.4
7	ICI	IMPERIAL CHEM INDS PLC	45270450	236	58.67	0.003337	8841772	N	42.1
8	KLM	KLM ROYAL DUTCH AIRLS	48251610	236	46.32	0.005569	799275	N	17.5
9	LAS	LASER INDS LTD	51806110	236	30.85	0.012002	49078	A	9.8
10	NHY	NORSK HYDRO A S	65653160	118	15.68	0.004812	1733943	N	16.9
11	NVO	NOVO INDUSTRI A S	67010020	236	49.69	0.006409	787331	N	25.9
12	RD	ROYAL DUTCH PETE CO	78025760	236	139.78	0.003106	21352752	N	59.8
13	SC	SHELL TRANS & TRADING LTD	82270350	236	39.33	0.003527	13319805	N	36.0
14	UN	UNILEVER N V	90478450	236	35.39	0.003406	6078483	N	137.7

American Matching Stocks in 1986

OBS	SYM.	NAME	CUSIP	DAYS	NTPD	Std Dev.	SIZE	PEX	LOWPRI
1	CLX	CLOROX CO	18905410	236	83.28	0.005585	1357360	N	44.0
1	HPC	HERCULES INC	42705610	236	92.02	0.005570	2684133	N	37.0
1	NES	NEW ENGLAND ELEC SYS	64400110	236	77.18	0.005540	797475	N	24.4
2	ALN	ALLEN GROUP INC	01763410	236	23.87	0.008507	152105	N	14.8
2	ELE	ELECTROSPACE SYS INC	28616210	236	17.70	0.008630	215784	N	13.6
2	NBI	NBI INC	62873510	236	25.89	0.008503	107740	N	7.5
3	IOR	IOWA RES INC	46253710	236	32.04	0.004157	345430	N	22.0
3	IWG	IOWA ILL GAS & ELEC CO	46247010	236	25.97	0.004176	528383	N	34.5
3	WPL	WISCONSIN PWR & LT CO	97682610	236	32.21	0.003831	660131	N	39.0
4	HFI	HUDSON FOODS INC	44378210	211	43.74	0.009961	188198	A	10.8
4	MAX	MATRIX CORP N J	57682910	236	53.61	0.009588	214216	A	14.3
4	OZA	OZARK HLDGS INC	69263210	182	49.64	0.006308	192495	A	11.6
5	BDG	BANDAG INC	05981510	236	15.31	0.004221	641599	N	57.0
5	CYL	CYCLOPS CORP	23252510	236	11.30	0.004185	252007	N	51.4
5	WIC	WICOR INC	92925310	236	14.17	0.004283	219106	N	29.4
6	HMN	HANDYMAN CORP	41033510	233	6.31	0.011701	87494	A	26.5
6	JEC	JACOBS ENGR GROUP INC	46981410	236	6.01	0.011409	37597	A	6.3
6	TDX	TRIDEX CORP	89590610	236	6.91	0.011295	14240	A	6.5
7	SPS	SOUTHWESTERN PUB SVC CO	84574310	236	65.27	0.003918	1266701	N	25.3
7	TE	TECO ENERGY INC	87237510	236	67.51	0.003681	1210587	N	34.0
7	WPC	WISCONSIN ELEC PWR CO	97665610	236	60.44	0.003569	1724923	N	38.4
8	EFU	EASTERN GAS & FUEL ASSOC	27646110	236	46.79	0.005555	611956	N	22.3
8	IR	INGERSOLL RAND CO	45686610	236	39.14	0.005471	1182693	N	50.9
8	SLN	SEA LD CORP	81140810	181	37.81	0.005460	571807	N	19.8
9	GMN	GREENMAN BROS INC	39537010	236	34.69	0.011844	89292	A	8.4
9	HHH	HERITAGE ENTMT INC	42722710	179	29.80	0.012112	27569	A	6.6
9	NLI	NEWMARK & LEWIS INC	65157610	236	31.49	0.012223	54844	A	10.8
10	CCP	CECO IND	15003610	225	14.44	0.004825	171764	N	28.5
10	CSN	CINCINNATI BELL INC	17187010	236	16.78	0.004857	415561	N	36.3
10	LG	LACLEDE GAS CO	50558810	236	13.28	0.004835	302117	N	28.0
11	HRB	BLOCK H & R INC	09367110	236	52.41	0.006388	514800	N	35.8
11	KSF	QUAKER ST OIL REFNG CORP	74741910	236	41.74	0.006368	684398	N	23.0
11	RAD	RITE AID CORP	76775410	236	58.80	0.006481	1245727	N	24.3
12	AIT	AMERICAN INFO TECHS CORP	02680410	236	136.91	0.004159	12365377	N	98.0
12	EO	CONSOLIDATED EDISON CO N Y I	20911110	236	124.83	0.003929	5827416	N	37.6
12	SBC	SOUTHWESTERN BELL CORP	84533310	236	154.61	0.003525	9948680	N	79.0
13	CNT	CENTEL CORP	15133410	236	41.61	0.004067	1524205	N	45.0
13	LOU	LOUISVILLE GAS & ELEC CO	54667610	236	43.51	0.003772	710030	N	29.0
13	MDA	MAPCO INC	56509710	236	38.09	0.004131	1432451	N	36.0
14	AD	AMSTED INDS INC	03217710	102	40.60	0.002767	502821	N	41.3
14	ORU	ORANGE & ROCKLAND UTILS INC	68406510	236	31.62	0.004445	416818	N	26.3
14	SWX	SOUTHWEST GAS CORP	84489510	236	34.98	0.004571	203265	N	16.6

A2. European Stocks Listed in NYSE/AMEX in 1987

OBS	SYM	NAME	CUSIP	DAYS	NTPD	Std Dev.	SIZE	PEX	LOWPRI
1	ASA	ASA LTD	00205010	219	154.62	0.010600	535918	N	20.0
2	AUS	AUSIMONT COMPO N V	05211510	219	20.36	0.011999	556687	N	10.0
3	BAB	BRITISH AWYS PLC	11041920	192	40.39	0.009332	1631031	N	16.1
4	BCM	BANCO CENTRAL S A	05947020	219	8.56	0.008319	1816074	N	16.5
5	BP	BRITISH PETE LTD	11088940	219	74.66	0.004757	28168704	N	43.3
6	BTI	B A T INDS P L C	05527020	219	31.50	0.009717	12737035	A	6.7
7	BTY	BRITISH TELECOMM P L C	11102140	219	18.74	0.004617	25450848	N	31.5
8	GLX	GLAXO HLDGS PLC	37732730	115	298.97	0.010945	12517367	N	7.9
9	HAN	HANSON TR PLC	41135230	219	118.06	0.009615	6860159	N	5.3
10	HRK	HARD ROCK CAFE PLC	41163240	146	23.87	0.013195	118923	A	5.1
11	ICI	IMPERIAL CHEM INDS PLC	45270450	219	66.11	0.005343	13866652	N	62.6
12	KLM	KLM ROYAL DUTCH AIRLS	48251610	219	46.31	0.009301	1043989	N	13.3
13	LAS	LASER INDS LTD	51806110	219	22.66	0.017963	49357	A	4.8
14	NHY	NORSK HYDRO A S	65653160	219	22.70	0.007587	2400634	N	19.5
15	NVO	NOVO INDUSTRI A S	67010020	219	37.94	0.009127	4215200	N	17.3
16	NW	NATL WESTMINSTER BK PLC	63853940	219	16.47	0.005247	7526411	N	24.0
17	PHG	PHILIPS N V	71833750	151	42.66	0.007944	5453637	N	14.3
18	RD	ROYAL DUTCH PETE CO	78025760	219	153.58	0.007034	31114320	N	94.4
19	SC	SHELL TRANS & TRADING LTD	82270350	219	36.99	0.005408	21249600	N	58.1
20	TEF	COMPANIA TELEFONICA NACIONAL	20390120	113	79.82	0.014821	6601878	N	16.0
21	UN	UNILEVER N V	90478450	219	68.70	0.008492	5053540	N	38.0

American Matching Stocks in 1987

OBS	SYM	NAME	CUSIP	DAYS	NTPD	Std Dev.	SIZE	PEX	LOWPRI
1	BEV	BEVERLY ENTERPRISES	08785110	219	132.16	0.010520	878562	N	6.6
1	NSC	NORFOLK SOUTHN CORP	65584410	219	162.72	0.010603	2842808	N	21.0
1	PZL	PENNZOIL CO	70990310	219	168.14	0.010643	3104107	N	38.5
2	GOT	GOTTSCHALKS INC	38348510	219	21.69	0.011927	66086	N	7.4
2	RGC	REPUBLIC GYPSUM CO	76047310	219	16.71	0.011975	86392	N	4.6
2	UTR	UNITRODE CORP	91328310	219	19.34	0.011929	163223	N	5.8
3	EMH	EMHART CORP VA	29121010	219	37.10	0.009455	1072660	N	16.0
3	HMX	HARTMARX CORP	41711910	219	38.11	0.009327	565145	N	18.3
3	KSU	KANSAS CITY SOUTHN INDS INC	48517010	219	35.86	0.009275	551515	N	35.0
4	FLA	FLORIDA EAST COAST INDS	34063210	219	8.76	0.008149	488469	N	39.5
4	HNM	HANNA M A CO	41052210	219	9.58	0.008524	242836	N	17.0
4	HSI	HI SHEAR INDS INC	42839910	219	7.81	0.008438	111761	N	12.3
5	FPC	FLORIDA PROGRESS CORP	34110910	219	81.84	0.005024	1730070	N	29.4
5	PGY	GLOBAL YIELD FUND INC	37936L10	219	71.62	0.004993	550953	N	8.8
5	SDO	SAN DIEGO GAS & ELEC CO	79744010	219	79.84	0.004347	1879778	N	28.3
6	DPC	DATAPRODUCTS CORP	23810710	219	31.65	0.010856	238543	A	6.9
6	FFA	FIRSTFED AMERICA INC	33790510	219	27.28	0.010891	48942	A	8.8
6	PGI	PLY GEM INDS INC	72941610	219	29.26	0.010525	114196	A	9.0
7	IPW	INTERSTATE PWR CO	46107410	219	18.06	0.004662	225179	N	19.4
7	IWG	IOWA ILL GAS & ELEC CO	46247010	219	20.07	0.004135	519974	N	34.5
7	WKR	WHITTAKER CORP	96668010	219	16.08	0.004385	269918	N	22.1
8	CHA	CHAMPION INTL CORP	15852510	219	257.84	0.011147	3428698	N	23.3
8	CRR	CONSOLIDATED RAIL CORP	20986410	163	258.46	0.011211	2160351	N	19.9
8	KM	K MART CORP	48258410	219	321.97	0.011188	5777130	N	21.6
9	CCC	COMMERCIAL CR CO	20161510	219	100.43	0.009460	1223291	N	17.0
9	FDS	FEDERATED DEPT STORES INC	31409910	219	129.51	0.009456	2872442	N	28.4
9	LIL	LONG ISLAND LTG CO	54267110	219	94.82	0.009484	1085744	N	6.1
10	RBG	RANSBURG CORP	75322810	219	22.32	0.012838	93529	A	6.4
10	SCF	SCANDANAVIA FD INC	80600310	219	19.56	0.014016	58444	A	5.8
10	WJR	CYPRESS FD INC	23278710	219	27.28	0.013151	70340	A	5.6
11	CNT	CENTEL CORP	15133410	219	53.99	0.005091	1616308	N	32.8
11	TEP	TUCSON ELEC PWR CO	89881310	219	60.47	0.005271	1381461	N	49.3
11	WWP	WASHINGTON WTR PWR CO	94068810	219	56.42	0.005298	589680	N	22.3
12	AVT	AVNET INC	05380710	219	48.84	0.009388	1109094	N	18.5
12	CSA	CARESSA GROUP INC	19039410	219	54.86	0.009213	75927	N	12.8
12	JCI	JOHNSON CTLS INC	47836610	219	54.58	0.009431	607842	N	20.5
13	CRW	CROWN CRAFTS INC	22830910	219	22.23	0.017845	23572	A	10.9
13	NLI	NEWMARK & LEWIS INC	65157610	219	22.58	0.018443	64452	A	3.5
13	SFY	SWIFT ENERGY CO	87073810	219	24.98	0.018494	43912	A	4.1
14	RTE	R T E CORP	74973810	219	23.19	0.007671	233023	N	17.4
14	RYK	RYKOFF SEXTON CO	78375910	219	22.31	0.007680	177726	N	17.4
14	UGI	UGI CORP	90268610	219	26.15	0.007552	256967	N	21.8
15	SKY	SKYLINE CORP	83083010	219	43.68	0.008924	177360	N	11.1
15	TIN	TEMPLE INLAND INC	87986810	219	44.46	0.009477	1442009	N	35.0
15	TNB	THOMAS & BETTS CORP	88431510	219	33.50	0.009582	823645	N	41.5
16	FMO	FEDERAL MOGUL CORP	31354910	219	13.81	0.005302	509553	N	29.1

16	RTC	ROCHESTER TEL CORP	77175810	219	19.17	0.005162	447986	N	37.0
16	SW	STONE & WEBSTER INC	86157210	219	14.07	0.005093	485467	N	48.8
17	HP	HELMERICH & PAYNE INC	42345210	219	41.22	0.008154	650234	N	17.5
17	KLT	KANSAS CITY PWR & LT CO	48513410	219	40.51	0.008135	841510	N	21.0
17	NOB	NORWEST CORP	66938010	219	49.05	0.008118	1247907	N	31.8
18	RAL	RALSTON PURINA CO	75127710	219	150.40	0.006680	5867946	N	57.6
18	UTP	UTAH PWR & LT CO	91750810	219	170.09	0.006749	1491052	N	20.8
18	Z	WOOLWORTH F W CO	98088110	219	155.81	0.007213	2963948	N	29.5
19	MN	MANPOWER INC NEW	56418210	143	36.43	0.005610	799838	N	42.1
19	NPH	NORTH AMERN PHILIPS CORP	65704510	175	32.34	0.005071	1280759	N	37.3
19	WGL	WASHINGTON GAS LT CO	93883710	219	29.61	0.005460	408904	N	19.5
20	KB	KAUFMAN & BROAD INC	48617010	219	79.46	0.014393	347861	N	9.0
20	SGL	SUPERMARKETS GEN CORP	86844310	162	76.01	0.014455	1490665	N	25.1
20	TW	TRANS WORLD CORP	87311810	218	65.09	0.015628	802520	N	9.3
21	BOL	BAUSCH & LOMB INC	07170710	219	74.37	0.008325	1276297	N	30.8
21	ROR	RORER GROUP INC	77675510	219	70.68	0.008308	995740	N	29.8
21	TMC	TIMES MIRROR CO	88736010	219	78.42	0.008437	5286628	N	60.4

B1. Japanses Stocks Listed in NYSE/AMEX in 1986

OBS	SYM	NAME	CUSIP	DAYS	NTPD	Std Dev.	SIZE	PEX	LOWPRI
1	HIT	**HITACHI LTD	43357850	236	28.54	0.003292	156296944	N	35.5
2	HMC	HONDA MTR LTD	43812830	236	44.36	0.003629	62379856	N	55.0
3	KYO	**KYOCERA LTD	50155620	236	9.53	0.003809	7372510	N	39.6
4	MC	MATSUSHITA ELEC INDL LTD	57687920	236	33.51	0.003424	159667536	N	60.0
5	SNE	SONY CORP	83569930	236	52.37	0.004886	4769083	N	18.1

** These stocks are also listed in London in 1986.

American Matching Stocks in 1986

1	IOR	IOWA RES INC	46253710	236	32.04	0.004157	345430	N	22.0
1	IPW	INTERSTATE PWR CO	46107410	236	23.75	0.003968	233903	N	21.1
1	WPL	WISCONSIN PWR & LT CO	97682610	236	32.21	0.003831	660131	N	39.0
2	CNT	CENTEL CORP	15133410	236	41.61	0.004067	1524205	N	45.0
2	LOU	LOUISVILLE GAS & ELEC CO	54667610	236	43.51	0.003772	710030	N	29.0
2	SNG	SOUTHERN NEW ENGLAND TEL CO	84348510	236	49.64	0.004073	1588952	N	43.0
3	GFD	GUILFORD MLS INC	40179410	236	8.32	0.004040	224672	N	22.5
3	NJR	NEW JERSEY RES CORP	64602510	236	9.58	0.003961	102292	N	25.8
3	WST	WEST INC	95334810	236	7.90	0.003622	231840	N	24.9
4	MDA	MAPCO INC	56509710	236	38.09	0.004131	1432451	N	36.0
4	ORU	ORANGE & ROCKLAND UTILS INC	68406510	236	31.62	0.004445	416818	N	26.3
4	SWX	SOUTHWEST GAS CORP	84489510	236	34.98	0.004571	203265	N	16.6
5	CCB	CAPITAL CITIES COMMUNICATION	13985910	236	58.73	0.004953	3199108	N	208.2
5	IDA	IDAHO PWR CO	45138010	236	58.57	0.004773	891796	N	22.8
5	TEK	TEKTRONIX INC	87913110	236	48.50	0.005020	1180817	N	54.5

B2. Japanses Stocks Listed in NYSE/AMEX in 1987

OBS	SYM	NAME	CUSIP	DAYS	NTPD	Std Dev.	SIZE	PEX	LOWPRI
1	HIT	**HITACHI LTD	43357850	219	32.00	0.005170	22290416	N	59.3
2	HMC	HONDA MTR LTD	43812830	219	33.44	0.005058	8759186	N	78.0
3	KYO	**KYOCERA LTD	50155620	219	10.98	0.006708	5248604	N	48.0
4	MC	MATSUSHITA ELEC INDL LTD	57687920	219	19.89	0.007213	24546272	N	93.3
5	SNE	SONY CORP	83569930	219	42.01	0.006136	6236788	N	18.3

** These stocks are also listed in London in 1987.

American Matching Stocks in 1987

1	NPH	NORTH AMERN PHILIPS CORP	65704510	175	32.34	0.005071	1280759	N	37.3
1	ORU	ORANGE & ROCKLAND UTILS INC	68406510	219	27.48	0.005185	389971	N	25.0
1	WGL	WASHINGTON GAS LT CO	93883710	219	29.61	0.005460	408904	N	19.5
2	MDA	MAPCO INC	56509710	219	32.28	0.004814	1197977	N	39.9
2	SNG	SOUTHERN NEW ENGLAND TEL CO	84348510	219	34.87	0.004862	1590076	N	43.0
2	SRP	SIERRA PAC RES	82642510	219	39.10	0.004994	467008	N	18.0
3	PLA	PLAYBOY ENTERPRISES INC	72811710	219	11.92	0.006801	115986	N	8.4
3	PRE	PREMIER INDL CORP	74051210	219	11.17	0.006625	1114636	N	28.9
3	SGO	SEAGULL ENERGY CORP	81200710	219	9.76	0.006634	120291	N	12.1
4	HTN	HOUGHTON MIFFLIN CO	44156010	219	22.70	0.007212	457038	N	20.8
4	NJR	NEW JERSEY RES CORP	64602510	219	21.94	0.007241	79346	N	16.1

4	PHH	PHH GROUP INC	69332010	219	21.16	0.007256	588549	N	25.8
5	PIN	PUBLIC SVC CO IND INC	74446510	219	49.55	0.006166	828360	N	11.3
5	RCI	REICHHOLD CHEMS INC	75920010	145	35.40	0.006136	357119	N	32.8
5	SCG	SCANA CORP	80589810	219	44.37	0.006260	1343997	N	26.5