An Investigation of Transactions Data for NYSE Stocks: Discussion
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trading is found to induce autocorrelation, particularly in 1971–1972. A number of patterns are found in trading frequency, number of shares per trade, size of price changes, length of time between trades, and the absolute value of price change.

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DISCUSSION

GEORGE TAUCHEN*: This is a very good paper. Professors Wood, Ord, and McInish have expended a great deal of effort to collect, edit, and analyze two very large data sets, and they are to be commended for undertaking such a task. Their work uncovers a number of interesting empirical regularities about short-term movements in stock prices that I believe will stimulate interesting follow-up work by financial market theorists.

The results of the analysis of the minute-by-minute market returns index can be summarized in three stylized facts. First, the process generating average market returns differs significantly over the trading day. Average returns tend to be high in the earliest part of the day, in particular in the first thirty minutes of trading, and then jump sharply upwards again at the very end of the trading day. The high early-day average returns are less apparent in 1982 data than in the 1971–1972 data, and they are less pronounced when overnight returns are excluded. Nevertheless, the evidence still points towards a concentration of high returns in the early part of the day and then again at the end of the day.

Second, the variability of returns also differs significantly over the day, and in a manner comparable with the interday differences in average returns. The standard deviation of returns when plotted against trading minute has a U-shape which is not quite symmetric, being thicker on the left side than on the right. Thus, the market becomes very active right at and just after the opening of

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trading, presumably as traders interpret and react to the accumulated overnight news. It then enters a quieter phase through the midday and ends with another burst of activity.

Third, there is very little evidence for autocorrelation in overall market returns on a minute-by-minute basis, once the problems associated with asynchronous trading are taken into account. The authors utilize two controls for the effects of asynchrony: (i) they exclude the first thirty minutes of trading where the effects are most apparent due to random "start-up" times for trading in each stock; and (ii) they use subsets of the data comprised only of the most actively traded stocks. Once these controls are implemented, any evidence for autocorrelation just about vanishes.

To compile their profile of the typical trading day, Wood, Ord, and McInish apply classical statistical methods to two very large data sets, each comprised of data for over three million transactions. Such large data sets have to contain errors and Wood, Ord, and McInish mention their extensive efforts to detect and correct the errors, some of which are extremely subtle and thereby hard to find. It would have been well worthwhile if, in addition to using standard error detection methods such as filters, they had obtained further protection against errors by using robust statistical procedures [4]. Any robust measure of location, like the median or a trimmed mean, and a robust measure of dispersion like the interquartile range would be preferred to using simple means and standard deviations. There are also well-established robust methods for performing the autocorrelation analysis. Robust procedures have bounded influence functions whereas the classical procedures do not, and robust methods are therefore "resistant" to the effects of large data errors. The use of robust procedures also provides protection against making misleading inferences due to the presence of extreme observations which may be accurately recorded, but are not representative of the entire body of data.

Wood, Ord, and McInish conclude from the findings of extensive within-day heterogeneity in the returns-generating process that models of stock prices that postulate continuous, or perhaps only piecewise continuous sample paths, with iid increments are incorrect. Strictly speaking they are right in this conclusion but such models will still provide useful approximations for a variety of applications, in particular option pricing. Indeed, any model that postulates diffusion-like behavior for stock prices has to break down when applied to data on a fine enough time scale. A diffusion-like model implies that the standard deviation per unit time of the price change becomes infinite as the time scale shrinks to zero, which contradicts the facts. Nonetheless, the model can still provide excellent approximations for applications on a larger time scale. There is an analogy in physics, where classical celestial mechanics are adequate for calculating planetary orbits but break down when applied on an atomic scale where the granular structure of matter is important.

It is interesting to investigate the potential economic importance of the systematic movements in average returns that Wood, Ord, and McInish find. Table I shows that in 1972 the average return including the overnight return for the first thirty minutes is 0.2840×10^{-4}, which is equivalent to 28.4 cents per $10,000 invested. But to earn this return an investor would have to purchase the index at the close of trading of the previous day and hold it through the first thirty minutes, and thus the funds would be tied up for 18 hours. The foregone interest earnings, assuming a 5% interest rate, on $10,000 for this length of time is $1.03, which is an opportunity cost well in excess of the 28.4 cents earned on the market index. The presence of arbitrage profits, however, becomes more likely if we consider buying at the first minute of the day, and selling at the thirtieth. In this case, the mean return for the market index from Table I is 12.4 cents per $10,000, while the foregone interest earings are only 2.9 cents. I do not know whether this excess return is sufficient to cover commissions and other transactions costs. These calculations are only intended to help put the empirical results in perspective. Analogous and more comprehensive calculations are clearly warranted in future research.

Finally, in their analysis of the trading statistics for transaction-level data, Wood, Ord, and McInish uncover two more interesting empirical facts. First, it is seen in Table II that large price changes (in magnitude) tend to be morely likely the longer it has been since the most recent price change. This finding casts doubts on the assumption that the price-change distribution is independent of the mixing process, which is a basic assumption in the mixture of distributions model [1, 2, 3, 5]. Second, large price changes are associated with large trading volume at the transactions level. This casts doubt on a model which views the market as comprised of many heterogeneous traders [5, 6] in continuous Walrasian equilibrium, as such a model would predict independence of price-change magnitude and volume at the transactions level. Both of these findings deserve further scrutiny.

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