The Random Walk Hypothesis and Technical Analysis

by GEORGE E. PINCHES

DURING the last decade no subject in the area of investment analysis and selection has received more attention than the "random-walk hypothesis." Advocates of this hypothesis argue that in an efficient market, such as the major security exchanges, at any point in time the actual price of a security will be a good estimate of its intrinsic value. A growing amount of empirical evidence has been devoted to assessing the validity of this hypothesis. The testing has been of two different types. The first and predominant type has involved statistical testing of price series over time. The tests have provided support for the hypothesis that stock price changes are independently distributed random variables.[1] Essentially, these findings argue that the intrinsic value of a stock-price series fluctuates in a random manner as new information enters the market.

A second, and more recent, method of empirical testing involves the use of various mechanical trading rules or other factors that are considered "technical" in nature. If changes in stock prices fluctuate in a random manner than no mechanical trading rule should produce a profit. In addition, if a stock-price series fluctuates in a random manner, then changes in stock prices should be independent of all past history about a company which is generally available to the public, hence already discounted.

The purpose of this article is threefold. First, the general theoretical beliefs behind security analysis, technical analysis, and the random-walk hypothesis are examined. Particular attention is devoted to variations in the random-walk hypothesis. Secondly, the available studies on five different technical factors are examined. These factors are: mechanical plans, volume, short interest, odd-lot trading, and advance-decline statistics. Finally, comments will be made about the adequacy of these tests of technical factors and some suggestions for further research considered. It should be emphasized that most of the studies cited in this paper were *not* undertaken by practitioners. There is, at the present, a distinct lack of unbiased research on the validity of technical analysis as perceived and used by practitioners.

THEORETICAL CONSIDERATIONS

Security Analysis

Security analysts argue that the price of a share of stock is based almost exclusively on the value of the company whose securities are in question. The present price of a share of stock is equal to the discounted value of the stream of future income from the stock.[2] Hence, at any time, the price is a function of a set of anticipated payoffs and anticipated capitalization rates corresponding to future time periods. When anticipations change —as new information enters the market—then the price of the security changes.

In an uncertain world with less than complete dissemination of information, the actual price of a security will not, except by accident, be equal to its intrinsic or theoretical value. However, security analysts hope to profit by determining if the present market estimate (as evidenced by the stock price) is an accurate estimate of the instrinsic value of the security. If the market is placing either too high or too low a value on the security

1. Footnotes appear at end of article.

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(when compared with its intrinsic value) then a buy or sell order should be placed.

Technical Analysis

Technical analysts, on the other hand, believe that the value of a stock depends primarily on supply and demand and may have very little relationship to any intrinsic value.[3] Carried to its extreme, it could be argued that technical analysts do not want any information concerning prospective earnings. However, a more general statement of technical analysis can be summarized as follows:

1. The market value of a security is determined solely by the interaction of supply and demand.
2. Supply and demand are governed at any moment by many hundreds of factors, some rational and some irrational. Information, opinions, moods, guesses (shrewd or otherwise) as to the future, combine with blind necessities in this equation. No ordinary man can hope to grasp and weigh them all, but the market does this automatically.
3. Disregarding minor fluctuations, prices move in trends which persist for an appreciable length of time.
4. Changes in trend, which represent an important shift in the balance between supply and demand, however caused, are detectable *sooner or later* in the action of the market itself.[4]

In order to assess the strength of supply and demand factors, technical analysts employ a wide variety of tools. These tools include bar and point-and-figure charts, confidence indices, odd-lot data, short interest ratios, advance-decline figures, volume, statistics on new highs and lows, moving average trend lines, relative strength measures, and statistics on debits and credits of brokerage balances. There are no reliable indications, to my knowledge, that indicate which of these are employed most frequently and what weight is placed on various technical tools. However, a technician who is expecting to gain insights into supply and demand will, in all likelihood, employ more than one of the above technical factors. In fact, there is every reason to believe that all, or at least a number of these factors, might have to be viewed before any meaningful picture of potential supply and demand factors could be obtained.

Random Walk Theory

The random-walk theory, in its general form, is suggested directly from the nature of the markets under consideration. If the security markets are perfect, or not too imperfect, the participants in such a market will eliminate any profits above the base minimum required to induce them to continue in the market, except for any profits which might accrue to someone who has private information. The price of a security should reflect all of the information available to participants in the market. In such a market all changes in price should be independent of any past history about a company which is generally available to the public. Except for a possible trend related to the desired rate of return, future stock prices could just as well be determined by the flip of a coin (unless private information is available) as by any elaborate analysis of past data.

As Smidt has recently pointed out, probability distributions of price changes which could occur under three distinct sets of circumstances are consistent with the random-walk hypothesis.[5] These circumstances are:

1. The information that becomes available to market participants is itself random in its effect on prices.
2. All participants are thoroughly informed about new information as soon as it is publicly available.
3. That well informed participants anticipate how lags in information available to less well informed participants will affect the latter's trading.

These different circumstances under which distributions of price changes could be consistent with the random-walk hypothesis may explain, in part, why so many variations of the random-walk hypothesis appear to exist. In a very narrow context the random-walk hypothesis has been formulated to mean that future price movements are independent of past *price movements* and that future price movements cannot be predicted based on *past price data alone*. However, a far broader (and, in my opinion, the correct) interpretation of the random-walk hypothesis is the belief that present prices reflect *all past public information*. This has been eloquently stated by Cootner:

> When statisticians hypothesize that the course of stock prices describes a random-walk or Brownian motion, they do not imply that a skilled student of the subject cannot forecast price changes. They merely imply that one cannot forecast the future based on *past history alone*.[6]

In this form the random-walk hypothesis implies that *all* past data of a technical nature should be irrelevant in attempting to forecast future price movement. Before the random-walk hypothesis can be accepted, statistically reliable evidence must be provided indicating that future price movements are independent of *all available*

past technical information concerning the security in question. In the next section the available studies on the relationship of certain technical factors to stock prices are examined.

STUDIES OF TECHNICAL FACTORS

Mechanical Trading Rules

While some technical analysts might question whether mechanical trading rules adequately simulate their performance, these studies at least attempt to employ similar procedures. Alexander devised a mechanical trading rule employing a filter technique.[7] The X per cent filter was defined as follows: if the daily closing price of a particular security moves up at least X per cent, buy and hold the security until its price moves down at least X per cent from a subsequent high, at which time simultaneously sell and go short. The short position should be maintained until the daily closing price rises at least X per cent above a subsequent low at which time one covers and buys. Moves less than X per cent in either direction are ignored.

The findings of this study, which indicated profits substantially in excess of a buy-and-hold policy, are questionable because: there was a procedural error which introduced an upward bias to the results; no allowance was made for commissions; and stock indices were employed instead of actual stocks. In a later paper Alexander reworked his earlier results to take account of the upward bias.[8] In this case the profitability of the filter was drastically reduced, but (without commissions) still produced returns slightly in excess of a naive buy-and-hold policy.[9]

In another study Cootner employed a mechanical rule which compared the price today with an average of the price in the last forty weeks.[10] This rule is: if the current price was higher than the moving average, buy the stock; if it was less than the moving average, sell short. If the current price rises above the moving average, all short positions should be covered. If the price falls below the moving average, eliminate long positions. He employed this procedure with a five per cent (above or below the moving average) threshold before buy or short sale decisions were executed, and also ran the test using only long positions. After allowing for commissions, the tests (on individual stocks) indicated that with a five per cent threshold greater profits were made than with a buy-and-hold strategy.

Fama and Blume conducted an extensive study on the 30 stocks in the Dow-Jones industrial average employing daily closing prices.[11] The filter they employed was expressed as a percentage change from the previous peak or trough. This rule required that a long position be taken when a stock's closing price exceeded a reference trough by the size of the filter. The long position was held until the closing price was less than the reference peak by the amount of the filter. At this point the position was switched from long to short. Short or long positions were continued until a signal to change them was reached. The reference peak (trough) was the highest (lowest) preceding closing price from the day the position was opened. Fama and Blume conclude that the results of this study confirm that (after commissions) a mechanical trading rule such as this cannot outperform the market. However, Smidt feels their logic and conclusions are not totally convincing. Specifically, he suggests that: "a member of the NYSE might well find it attractive to take advantage of the statistical dependencies that Fama and Blume have so well documented."[12]

Levy constructed a number of "reversed variable ratio models" whereby the portfolio would be composed of both stocks and bonds and the stock portion would be increased (decreased) as the market became stronger (weaker).[13] While this study is more in the nature of a portfolio model, it provides additional insights into the usefulness of mechanical trading rules. The results obtained by Levy, even after allowance for commissions, were superior to a random buy-and-hold policy. Jensen, however, criticizes a number of the factors which Levy employed and suggests that there is still good reason to believe that mechanical trading rules based solely on past price movements will not be able to produce profits greater than those available from random investment selection at equal or less risk.[14]

Van Horne and Parker (in collaboration with Seelenfreund in one article) have produced a series of tests of mechanical trading rules. In their first study moving averages of 30 stocks were calculated for 100, 150 and 200 days prior to each day's closing price.[15] The trading rule formulated stated that: if the daily closing price exceeded the moving average of past prices by X per cent for two consecutive days, a buy order was placed. If the closing price was below the moving average two consecutive days by X per cent, a sell order was issued. The decision rules were tested for the investor who took only a long position and both a long and short position. In the latter case, a short position was undertaken every time a long position was liquidated. Using five different thresholds and three moving averages with long, and with long and short positions, a total of thirty variations were tested. None proved profitable when compared with a buy-and-hold strategy.

In a modification of this study Parker and Van Horne

employed a weighted moving average where more emphasis was placed on recent prices.[16] This modification, which was run on 32 variations, provided (in every case) less profits than the unweighted moving average employed in the first study.

In their most recent article Parker, Van Horne and Seelenfreund developed a quadratic predictive model employing adaptive exponential smoothing.[17] Using very similar procedures to their previous articles, they found that in most cases (after brokerage commissions) the buy-and-hold policy resulted in an annual rate of return greater than that for trading rules. However, it is noteworthy that a number of stocks (which were usually poor performers) did better with the trading rules than on a buy-and-hold policy.

One final study which is similar in nature to those previously discussed has been published. Using monthly data employing both unweighted and exponential smoothing, James devised a number of mechanical trading rules.[18] He concluded that the use of monthly moving averages did not appear to have any substantial benefits for investors.

In evaluating the findings of these studies, it is difficult to reconcile all of the differences in results. However, it does appear that, at least for certain stocks and certain time periods, there are some mechanical trading rules that perform as well or slightly better than a buy-and-hold policy.[19] A different investment climate, especially one in which average returns from a buy-and-hold policy were lower, might produce different results. However, these tentative findings, with certain exceptions, provide some support for the random-walk hypothesis. In addition, they suggest that profitable mechanical trading rules (after commissions) are extremely hard to devise.

Volume and Price

Possible relationships between price and volume have been observed in a number of studies. Granger and Morgenstern employed spectral analysis on both weekly and monthly data for stock indices and individual stocks in their study. They conclude that, ". . . at least in the short run, and for the normal day-to-day or week-to-week workings of the stock exchange the movements in the amount of stock sold are unconnected with movements in price."[20]

In a subsequent study Godfrey, Granger and Morgenstern proceeded further by employing spectral analysis on daily data for several stocks.[21] The only strong correlation they observed was between volume and the differences between the high and low price for the day. While they expected to find a high correlation between absolute values of first difference in prices and volume, such findings were not forthcoming.

In an attempt to explain the negative serial dependence of price relatives of individual stocks Moore employed volume as one of his independent variables.[22] He found that volume had very little relationship to the observed serial dependence. However, there is some question as to the validity of his measure of volume since he employed the number of business Fridays during which a stock was *not* traded on the New York Stock Exchange.

In a study which skirts the direct question of the relationship of volume and price, Osborne observes that:

> These results have the quite plausible and obvious interpretation that volume represents interest or attention to stocks, and that prices tend to move under the impact of this interest.[23]

In a later article Osborne defines certain I (Inferior) and S (Superior) events.[24] A ten per cent S event was a maximum value in a sequence of high prices for which there were preceding and following trades in the market at ten per cent less than the price at S and none greater than S of closer proximity. An I event was similarly defined from a minimum in the sequence of lows. The effects were small, but Osborne found that volume events tended to precede I and S events (primarily S events):

> The slight evidence that volume events tend to precede and avoid following I and S events is an imperfect expression of the complicated and esoteric rules for volume trading signals ("head and shoulders" pattern).[25]

Another highly interesting study has been completed by Ying employing daily data for Standard and Poor's 500 stock average and the volume of sales on the New York Stock Exchange.[26] Employing both analyses of variance and spectral analysis, Ying finds significant relationships between volume and price. Briefly, a fall in volume normally is associated with falling prices while a large volume or an increasing volume signifies an increase in price.

The overall findings concerning the possible relationship between volume and price may be disheartening to some proponents of the random-walk hypothesis. While much more investigation is required, tentative findings indicate that movements in volume tend to lead movements in stock prices. If these findings are substantiated by further research, this means that price movements and some *past history* are not independent.

Short Interest, Odd-Lot Trading, And Advance-Decline Statistics

It is generally held that a rise in short interest in a stock creates demand for this stock. Thus, instead of falling in price like the short-sellers expect, a rise in short interest actually signals a potential rise in the price of the stock under consideration. In his study, Biggs concentrated on the long-run relationships between short-interest and monthly stock prices.[27] His findings indicated no consistent long-run relationships between short-interest and price.

Seneca, in his study, employs a regression analysis using monthly data for the period January, 1946 to July, 1965.[28] The dependent variable is Standard and Poor's 500 stock average while the independent variables are corporate dividends and short interest. Viewed in this macro context, Seneca finds no long-run indication that a large short interest is indicative of higher stock prices.[29]

Mayor, in a study employing both regression and simulation techniques, fails to find any significant relationships between short interest and stock prices.[30] Equally important is his finding that short traders, taken as a whole, suffer substantial losses. This finding may be explained somewhat by the observations made by Smith.[31] His findings also indicated no significant relationship between short interest and stock price. In addition, he concluded that stocks with a high short interest had greater volatility than stocks with low short interest positions. This increased volatility might explain the finding by Mayor that most short traders suffer substantial losses.

The general findings of all these studies suggest that a high short interest is not related to rising stock prices. However, other tests are probably needed employing additional techniques to assess if this tentative conclusion is correct.

Odd-lot sales and purchases are often examined to ascertain what the "small" investor is doing. While very few studies have been undertaken in this area, two by Kewley and Stevenson stand out. In their first article they concluded that no significant advantage was achieved by using buy or sell signals developed from the ratio of odd-lot sales to odd-lot purchases.[32] Responding to a criticism by Drew concerning the use of an absolute instead of relative measure, they designed a further test of the validity of odd-lot statistics.[33] These findings indicate that it is possible to make a valid buy recommendation based on a moving average odd-lot sale to purchase ratio. However, it was not possible to obtain a valid sell ratio by this procedure. Kaish, in a study employing individual firm instead of aggregate data, offers some additional insight into the nature of odd-lot trading.[34] These findings, while admittedly tentative, offer some support to the usefulness of odd-lot statistics as a technical indicator of potential demand.

The final articles to be reviewed deal with the number of securities advancing or declining in the market. Zakon and Pennypacker employ correlation analysis to determine if the Advance-Decline line is a leading indicator of general stock market peaks.[35] They conclude that while the Advance-Decline line coincides with peaks in Standard and Poor's 425 stock average, there is no statistical evidence to indicate that it is a good leading indicator. These results probably should be tempered by the observation that a weekly, rather than a daily index was employed.

In two unique studies Theil and Leenders, and Fama employ information theory to examine the percent of stocks increasing, decreasing, or remaining unchanged.[36] Theil and Leenders conclude that there is considerable positive dependence in successive values of the proportions of securities advancing, declining, and remaining unchanged on the Amsterdam Stock Exchange. Thus, past data does provide some information about future proportions of stocks that will advance, decline, or remain unchanged. Fama replicates this study using data from the New York Stock Exchange. He concludes that the influence of today's events on tomorrow's events seems much weaker for the New York Exchange than for the Amsterdam Exchange. Dryden, in a study employing Markov processes, concludes that there is some evidence that dependence exists among successive daily price changes for securities of the United Kingdom.[37] These findings, in general, appear to indicate that advance-decline statistics may provide some information that is not already available.

SUMMARY and CONCLUSIONS

Interpreted in a very narrow sense, the random-walk hypothesis implies that future price movements are virtually independent of past price movements. Accordingly, we should not be able to effectively (profitably) forecast future stock prices from *past price* information alone. While the results of mechanical trading rules that simulate technical trading rules are not entirely consistent, it appears that these findings could support a very narrow interpretation of the random-walk hypothesis. If mechanical trading rules could be devised that consistently outperformed a random buy-and-hold policy, then substantial proof would exist that the random-walk hypothesis is incorrect. However, with some exceptions, the studies of mechanical trading rules do not indicate that profits can be generated by these rules.

In its complete form the random-walk hypothesis

argues that current stock prices should reflect all readily available past and present information. Accordingly, investors should not be able to gain from any past information and future prices should be independent of such factors as volume of sales, short interest, odd-lot sales, and stock advances and declines. The findings of the studies in this area, while somewhat contradictory, indicate that: (1) there is a relationship between present or past movements in volume and present or future movements in price; (2) short interest has no discernible relationship to price; (3) odd-lot sales may provide some clues to expected price movements; and (4) advances and declines in securities may have enough relationship to price to be of some usefulness. These findings, in total, provide slim evidence that the random-walk hypothesis may be incorrect or, at least, incomplete.

The avenues open for investigation in this area appear endless, but it is imperative that two points be recognized. While questions may be raised about some of the methods employed and/or the data utilized, further assessment of the validity of technical analysis requires studies that accurately measure what technicians, or practitioners, feel are the relevant relationships. Any statistical analysis in this area will be useless, unless it rests on firm pragmatic foundations as to the nature and usefulness of the indicator under examination.

Secondly, and possibly more important, is the fact that all of technical analysis has not been subjected to rigorous tests. One small aspect of technical analysis cannot be tested and found wanting, and accordingly declare the random-walk hypothesis substantiated and all of technical analysis invalid. Only a naive technician or academician would argue that technicians employ only *one technical indicator at a time.* Instead, sophisticated users of technical indices use many technical factors in varying weights depending on the situation. Accordingly, it is imperative to ascertain what technical indicators are employed and what weights are given to the various technical indicators. Only when numerous tests are available in which all technical factors (given varying weights) are examined and the performance based on these rules compared with a buy-and-hold policy, will we be in a position to assess accurately the validity of technical analysis and the random-walk hypothesis. ♦

FOOTNOTES

1. See Cootner, Paul H., ed., *The Random Character of Stock Market Prices* (Cambridge, Mass.: MIT Press, 1964); and Fama, Eugene F., "The Behavior of Stock-Market Prices," *Journal of Business*, XXXVIII (January, 1965), 34-105. However, if a price series follows a "martingale," the expected value of future prices is the most recently observed price. In this sense it is possible that the distribution of future prices may depend on past prices. See Mandelbrot, Benoit, "Forecasts of Future Prices, Unbiased Markets, and 'Martingale' Models," *Journal of Business: A Supplement*, XXXIX (January, 1966), 226-241. An excellent, non-technical, survey of current research is provided in Brealey, Richard A., *An Introduction to Risk and Return from Common Stocks* (Cambridge, Mass.: MIT Press, 1969).
2. The specific relationship of dividends, earnings, capital appreciation, and capital investment does not need to be specified since only the general process is under consideration.
3. See Cohen, Jerome B. and Edward D. Zinbarg, *Investment Analysis and Portfolio Management* (Homewood, Illinois: Richard D. Irwin, Inc., 1967), Chapter 14; and Levy, Robert A., "Conceptual Foundations of Technical Analysis," *Financial Analysts Journal*, XXII (July-August, 1966), 83-89.
4. Edwards, Robert D., and John Magee, *Technical Analysis of Stock Trends* (Springfield, Mass.: 5th ed., John Magee, 1966), 86. Emphasis in original.
5. Smidt, Seymour, "A New Look at the Random Walk Hypothesis," *Journal of Financial and Quantitative Analysis*, III (September, 1968), 235-237.
6. Cootner, *op. cit.*, 80. Emphasis in original.
7. Alexander, Sidney S., "Price Movements in Speculative Markets: Trends or Random Walks," *Industrial Management Review*, II (May, 1961), 7-26.
8. Alexander, Sidney S., "Price Movements in Speculative Markets: Trends or Random Walks, No. 2," *Industrial Management Review*, V (Spring, 1964). 25-46.
9. Evans has pointed out that for portfolios of securities there is a mechanical trading rule which consistently leads to significantly greater returns than a buy-and-hold policy. Alexander's findings, as well as the other studies using trading rules, possibly should be modified to take account of this research. See Evans, John L., "The Random Walk Hypothesis, Portfolio Analysis and the Buy-and-Hold Criterion," *Journal of Financial*

and Quantitative Analysis, III (September, 1968), 327-342.

Smidt argues that the returns from mechanical trading rules should be calculated on total capital employed, not average capital (Smidt, *op. cit.*, 250). The findings of all the studies probably should be modified to allow the trader to be compensated for the periods in which his funds were not fully invested.

10. Cootner, Paul H., "Stock Prices: Random vs. Systematic Changes," *Industrial Management Review*, III (Spring, 1962), 24-45.
11. Fama, Eugene F., and Marshall E. Blume, "Filter Rules and Stock Market Trading," *Journal of Business: A Supplement*, XXXIX (January, 1966), 226-241.
12. Smidt, *op. cit.*, 251.
13. Levy, Robert A., "Random Walks: Reality or Myth," *Financial Analysts Journal*, XXIII (November-December, 1967), 69-77.
14. Jensen, Michael, "Random Walks: Reality or Myth: Comment," *Financial Analysts Journal*, XXIII (November-December, 1967), 77-85. For Levy's reply see, Levy, Robert A., "Random Walks: Reality or Myth—Reply," *Financial Analysts Journal*, XXIV (January-February, 1968), 129-132.
15. Van Horne, James C., and George G. C. Parker, "The Random Walk Theory: An Empirical Test," *Financial Analysts Journal*, XXIII (November-December, 1967), 87-92.
16. Van Horne, James C., and George G. C. Parker, "Technical Trading Rules: A Comment," *Financial Analysts Journal*, XXIV (July-August, 1968), 128-132.
17. Seelenfreund, Alan, George G. C. Parker, and James C. Van Horne, "Stock Price Behavior and Trading," *Journal of Financial and Quantitative Analysis*, III (September, 1968), 263-281.
18. James, F. E., Jr., "Monthly Moving Averages — An Effective Investment Tool?", *Journal of Financial and Quantitative Analysis*, III (September, 1968), 315-326.
19. See Footnote 9 for possible limitations on all of these studies.
20. Granger, Clive W. J., and Oskar Morgenstern, "Spectral Analysis of New York Stock Market Prices," *Kyklos*, XVI (1963), 16.
21. Godfrey, Michael D., Clive W. J. Granger, and Oskar Morgenstern, "The Random-Walk Hypothesis of Stock Market Behavior," *Kyklos*, XVII (1964), 1-30.
22. Moore, Arnold B., "Some Characteristics of Changes in Common Stock Prices," reprinted in Cootner, *The Random Character of Stock Market Prices*, 162-188.
23. Osborne, M. F. M., "Periodic Structure in the Brownian Motion of Stock Prices," *Operations Research*, X (May-June, 1962), 360.
24. Osborne, M. F. M., "Some Quantitative Tests for Stock Price Generating Models and Trading Folklore," *Journal of the American Statistical Association*, LXII (June, 1967), 321-340.
25. *Ibid.*, 338.
26. Ying, Charles C., "Stock Market Prices and Volume of Sales," *Econometrica*, XXXIV (July, 1966), 676-685.
27. Biggs, Barton M., "The Short Interest — A False Proverb," *Financial Analysts Journal*, XXII (July-August, 1966), 111-116.
28. Seneca, Joseph J., "Short Interest: Bearish or Bullish?", *Journal of Finance*, XXII (March, 1967), 67-70.
29. For certain objections to the analysis employed by Seneca see Hanna, Mark, "Short Interest: Bullish or Bearish? — Comment," *Journal of Finance*, XXIII (June, 1968), 520-523. See also Seneca, Joseph J., "Short Interest: Bullish or Bearish? Reply," *Journal of Finance*, XXIII (June, 1968), 524-527.
30. Mayor, Thomas H., "Short Trading Activities and the Price of Equities: Some Simulation and Regression Results," *Journal of Financial and Quantitative Analysis*, III (September, 1968), 283-298.
31. Smith, Randall D., "Short Interest and Stock Market Prices," *Financial Analysts Journal*, XXIV (November-December, 1968), 151-154.
32. Kewley, Thomas J., and Richard A. Stevenson, "The Odd-Lot Theory as Revealed by Purchase and Sales Statistics for Individual Stocks," *Financial Analysts Journal*, XXIII (September-October, 1967), 103-106.
33. Drew, Garfield A., "A Clarification of the Odd-Lot Theory," *Financial Analysts Journal*, XXIII (September-October, 1967), 107-108; and Kewley, Thomas J., and Richard A. Stevenson, "The Odd-Lot Theory for Individual Stocks: A Reply," *Financial Analysts Journal*, XXV (January-February, 1969), 99-104.
34. Kaish, Stanley, "Odd Lotter Trading of High and Low Quality Stocks," *Financial Analysts Journal*, XXV (March-April, 1969), 88-91.
35. Zakon, Alan J., and James C. Pennypacker, "An Analysis of the Advance-Decline Line as a Stock Market Indicator," *Journal of Financial and Quantitative Analysis*, III (September, 1968), 299-314.
36. Theil, H., and C. T. Leenders, "Tomorrow on the Amsterdam Stock Exchange," *Journal of Business*, XXXVIII (July, 1965), 277-284; and **Fama**, Eugene F., "Tomorrow on the New York Stock Exchange," *Journal of Business*, XXXVIII (July, 1965), 285-299.
37. Dryden, Myles M., "Share Price Movements: A Markovian Approach," *Journal of Finance*, XXIV (March, 1969), 49-60.